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*"To the solid ground
Of Nature trusts the mind which builds for aye"*—WORDSWORTH

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"To the solid ground
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THURSDAY, MAY 5, 1892

TEXT-BOOKS OF PSYCHOLOGY

The Human Mind a Text-book of Psychology By James Sully, M A, LL D Two Vols (London Longmans, 1892)

Hand-book of Psychology Feeling and Will. By James Mark Baldwin, M A, Ph D (London Macmillan, 1891)

Text-book of Psychology By William James (London Macmillan, 1892)

IN his treatise on the "Human Mind," Mr Sully has not attempted to supplant, but rather to supplement, his own admirable "Outlines of Psychology" The method in the two works is the same, and the arrangement of the subject matter, though it differs slightly in some details, is, on the whole, essentially and in principle similar A chapter has been added on the physical basis of mental life, dealing briefly with the nervous system and with neuro psychical correlations But the author wisely refers his readers to text-books of physiology or to manuals of physiological psychology for a full treatment of these matters He also gives an adequate account of the recent experimental researches on the nature and conditions of some of the simpler responsive activities, but is not blind to the difficulties and uncertainties of this so-called experimental psychology

It is well known that Mr Sully lays great stress on the genetic method in psychology

"It is evident," he says, "that we require a knowledge of these psychical elements [reached by analysis] and of the laws of their combination, in order to account for the complex products of the mature human consciousness Now, the perfect account of a thing means the history of that thing from its first crude to its completed form When the psychologist has succeeded by analysis, aided by objective observation and hypothesis, in obtaining the requisite data, he proceeds to reconstruct the course of psychical development"

From the standpoint of biology and evolution, this genetic aspect of psychology is of especial importance, and we cannot be too grateful to Mr Sully for his able, clear-headed, and, on the whole, cautious presentation of this view of the matter But it is one which, as Mr Sully himself well knows, is of peculiar difficulty Few of us remember anything of the genesis of our modes of psychological procedure in the early days of our life, and when we do remember scraps here and there, we are only too apt to interpret them in terms of our adult procedure, with which we are so much more familiar It is, moreover, well nigh impossible for the psychologist to realize the nature of the psychical processes of the child, so that infant psychology is a field wherein we may suppose much and can prove little Mr Sully again and again appeals to the supposititious child

"The child, for example," he says, "begins to note that some varieties of living things, *e g* flies or birds, die He then compares these results, and, extracting the common relation, finds his way to the more comprehensive generalization, 'All animals die' Later on he compares this result with what he has observed of flowering and other plants, and so reaches the yet higher and more abstract generalization, 'All living things die'"

Of course there may be a child here and there who proceeds, or, in the absence of all instruction in the matter, might proceed, thus But children and uneducated persons very rarely reach a general and universal concept, properly so called The child notes that its pets and other animals die or are killed this begets a stronger and stronger expectation that other animals will likewise die or be killed some day, and the expectation may rise to practical certainty without anything like a universal concept taking even vague and indefinite shape in the mind We therefore question the statement that "by induction the child reaches a large number of general or universal judgments," though it is unquestionable that he may have a large number of expectations which the logician may cast in universal form He may even state them in universal form himself, and say, "Animals die," "Apples have pips," the language he uses being here, as in so many cases, in advance of his conceptions.

In the discussion of the development of the moral sentiment, the distinctively moral feeling is perhaps

hardly differentiated with sufficient care from the merely prudential The prudential does not pass up into the moral on the same line of development, but the prudential and the moral are separate and sometimes widely divergent lines of development. It is sometimes said that the prudential is self-centred while the moral is social But is not what is socially right different from what is socially prudent? Or, in other words, is not morality something other than social prudence? Remorse for wrong has a different psychological quality from regret for error, no matter what the social implications of the error may be Mr Sully does not seem to have sufficiently brought out this distinction in his account of the genesis of the moral sense

But though there may be room for some difference of opinion as to the exact course of genetic development by which our more complex and more highly evolved psychological states have been reached, there can be no question that Mr Sully's painstaking and thoughtful discussion of their possible or probable mode of evolution is and will long remain of real and sterling value No living writer has paid more attention to this important aspect of psychology

There is one more point on which we may comment before we pass on to Prof Baldwin's work It is the doctrine of residual fusion

"The simplest form of assimilation," we read, "is to be found in that process by which a present sensation (or sensation complex) is re-apprehended or 'recognized' as something familiar What takes place here is the calling up by a present sensation of the trace or residuum of a past sensation (or sensations), which trace merges in or coalesces with the new sensation, being discernible only through the aspect of familiarity which it imparts to the sensation . We have to conceive of the nervous process somewhat after this manner A given central element or cluster of elements is re-excited to a functional activity similar to that of a previous excitation The residuum of this previous activity or surviving 'physiological disposition' somehow combines with and modifies the new activity; which blending of nervous processes has for its psychical correlative the peculiar mode of consciousness known as recognition, sense of familiarity, or identification Here, however, our physiological psychology seems to be more than usually conjectural"

And again—

"In recognition the percept and the image are fused, the presence of the latter being indicated merely in the peculiar appearance of familiarity which the percept assumes"

This so-called "fusion" of the percept and the image seems to us an awkward figure by which to describe the facts The sequence of states of consciousness in the case of (*a*) practical or perceptual, and (*b*) reflective or conceptual recognition, seems to be briefly as follows Suppose I recognize a man, A, as one whom I have met before, say at a dinner party Then I have first a percept $\overset{\text{A}}{q\ n\ s\ y}$, where A is the individual in question in the focus of consciousness, and $q\ n\ s\ y$ the "fringe" generated by his present surroundings, more or less out of focus This percept is immediately followed by the image $\overset{A}{s\ r\ t\ b}$, where A appears amid different surroundings This constitutes practical or perceptual recognition In reflective or conceptual recognition there follows an act of introspection (or retrospection), whereby the common central element in the two states of consciousness is explicitly identified There is no fusion in either case, except in so far as sequent states of consciousness have a central or focal element which is identifiable If we simply recognize A as someone we have met somewhere, we do not remember where, there is associated with the focal image, A, an indefinite fringe of pastness serving to differentiate it from the percept with its fringe of present surroundings, and if, on the other hand, we recognize A as a quite familiar person whom we have seen again and again amid all sorts of surroundings, there is a fringe which we can only describe as involving both pastness and frequency In the case of the animal or the child, recognition presumably does not pass beyond the practical stage—that is to say, a percept A with this fringe is followed by an image *A* with that fringe Reflective recognition, involving retrospection and a comparison of the two images (*A* with this fringe and *A* with that fringe) and the identification of the element common to both, is a product of conceptual processes of later genesis

In conclusion, it is sufficient to say that by his treatise on the human mind Mr Sully fully sustains his reputation as a psychologist

In his volume on "Feeling and Will," Prof Baldwin has completed the survey of the mind begun in his "Senses and Intellect"

The first three chapters contain an adequate physiological introduction There is, however, one statement which seems to us awkward if not misleading After briefly noting the views that have been suggested as to the relation of consciousness to the so-called nervous conditions, Prof Baldwin says —

"It has become apparent that nervous activity, considered by itself alone, does not bring us into the range of psychological science However we may decide the inquiry as to whether such activity is ever entirely free from consciousness, it is yet true that it may be quite outside of what is called the individual's consciousness In other words, the greater part of our ordinary nervous reactions are not above the threshold of our conscious lives So we reach a distinction between sentience as a nervous property and sentience as a conscious phenomenon, between *sentience and sensibility* Sensibility is synonymous with the usual consciousness of the individual's experience, and sentience is the nervous function which may or may not be accompanied by consciousness or inner aspect in general . The transition from simple sentience to the full consciousness is through a stage of subconscious modification"

With no desire to be hypercritical, this does not seem to us altogether satisfactory Sentience is spoken of as "the *nervous function* which may or may not be *accompanied by* consciousness" The words we have italicised seem to imply that sentience belongs to the physical, not the psychical order of existence If so, the "transition from simple sentience to full consciousness" is a transition from the physical to the psychical order, and consciousness becomes a mode of energy We do not think that this is the author's meaning, but in that case it would be well so to define sentience as to clearly show that though it may not rise to the level of consciousness, it is none the less of the conscious or psychical order.

When we leave the physiological and enter the psychical field, appeal is constantly made to the "principle of apperception" or "selective synthesis" But does not the author go somewhat beyond what is justified by our very imperfect knowledge of the facts of cerebral physiology when he asserts that "after we enter consciousness, we find a principle of apperception to which there is no analogy in physiological integration"? Elsewhere he says "Now, as a fact, the great principle of mental organization, selective synthesis, finds no apparent counterpart in physics" In direct opposition to this view, we venture to contend that nothing is more remarkable than the parallelism (if it be no more) of selective synthesis in the physical and the psychical spheres In the physical world this is best seen in the formation of chemical compounds and their segregation in crystalline form In the psychical world it is seen in the so-called principle of apperception This is, however, only the expression in the conceptual sphere of a principle which, stripped of all metaphysical implications, must be extended to the whole range of psychical life, as a general law of psychogenesis In the organic world (at any rate the animal world) the two principles (if two they be) meet And if, notwithstanding the splendid work done in bionomics, through the application of "natural selection" to the elucidation of the problem, we have not yet reached a scientific expression of selective synthesis in organic life and growth, this is no proof that there is no such selective synthesis

In accordance with the general principles he adopts, Prof Baldwin divides feeling into the two great classes of (1) sensuous feeling, and (2) ideal feeling Sensuous feeling relates to the bodily functions "Sensuous pleasure," says the author, "may be defined as the conscious effect of that which makes for the continuance of the bodily life or its advancement, and sensuous pain, the conscious effect of that which makes for the decline of the bodily life or its limitation" Ideal feelings, on the other hand, are the modifications of sensibility which accompany the exercise of the apperceptive function Ideal pleasure may be defined as "the conscious effect of that which makes for the continuance of the apperceptive life or its advancement, and ideal pain, the conscious effect of that which makes for the decline of the apperceptive life or its limitation" But though sensuous feeling can have no reference to the conceptual or apperceptive life, ideal feeling has reference (however much we affect to despise or ignore the mere body) to physical as well as intellectual well-being Hence Prof Baldwin concludes "that ideal tone (pleasure or pain) refers to personal well-being as a whole"

We must pass over without comment an important and interesting discussion of "reality and belief," which is worthy of careful consideration, and may proceed to note the somewhat unusual sense in which the author uses the word "ideals"

"Ideals," he says, "are not mental constructions at all if once constructed they would no longer be ideals which only means that what we call ideals are emotional in their nature, expressing the drift or felt outcome of the constructive process, not any actual attainment of it. If my ideal man, for example, were an intellectual construction, I would be able to describe him. . Ideals, therefore, are the forms which we feel our conceptions would take if we were able to realize in them a satisfying degree of unity, harmony, significance, and universality"

This seems to us somewhat strained It is a description of theoretically ideal ideals which have been emptied of all practical value There are assuredly practical ideals which, though unattainable, can be definitely realized as intellectual constructions permeated with emotional tone And it is these practical ideals which are influential on conduct

The distinction between subjective and objective ends in ethics is carefully drawn Subjective ends are the felt and more or less definitely realized motives of the voluntary process They alone have psychological value as the immediate determinants of conduct Objective ends are a matter of cognition

"Even though it were granted that all voluntary action arose and survived by exclusive reference to pleasure or to self-realization, yet it would be a patent fallacy to say that the only voluntary end is either of them that consciousness has all along been versed in our biology or our speculative ethics, and has aimed to fulfil the one or the other Consciousness has no inkling of the δύναμις of Aristotle, or the *connatus* of Spinoza, or the *Trieb* of Wundt and Schneider, of the 'strife [*sic*] for existence' of Spencer, the theoretic 'reverence for law' of Kant, the 'self-realization' of Green, or the dialectical 'becoming' of Hegel Let us discover these things if we may, but do not let us say that a man is not moral unless he has a realizing sense of them"

We have left ourselves no space to deal with Prof Baldwin's discussion of the phenomena of the will We do not by any means agree with all that he says thereon, but it is worthy of careful consideration

Prof James's "Text-book of Psychology" is a re-arranged abridgment of his larger "Principles," with the addition of some description of the senses and sense-organs We have so recently (NATURE, vol xliii p 506) expressed our opinion of the value of the larger work, that we can, without injustice to Prof James, afford to be brief in our notice of this abridgment, merely selecting the chapter on "Instinct" on which to offer a few comments

Every organism comes into the world with an innate capacity to perform, more or less definitely, certain activities under the appropriate environing circumstances Of these activities, a certain number which are (1) complex in character, and (2) performed (*a*) in a definite way, (*b*) without foresight of the end to be attained, (*c*) with no previous education in the performance, and (*d*) uniformly by all normal individuals of the species concerned, are now by pretty common consent described as instinctive Clearly such instinctive actions are the outcome of the innate capacity of the animal which performs them, but they are a peculiar and special manifestation of this innate capacity they have definite and clearly assignable characteristics Now no one can question that man comes into the world with a relatively enormous store of innate capacity, and that he has innate tendencies to perform half a hundred particular activities And yet he has but few instincts He leads a life of hesitation and choice, an intelligent life To say with Prof James that this is "not because he has no instincts—rather because

he has so many that they block each other's path" is practically to abandon the position which has been painfully and slowly gained by those who have thought and written on instinct Instinct is a definite and special manifestation of innate tendency here the innate tendency is not manifested in this definite and special way, but is thwarted To call both manifestation and non-manifestation alike instinct is, in our view, a retrograde step, which we regret that a psychologist of Prof James's insight and influence should have taken

We cannot, however, leave the book with a note of dissent, for we find far more in this text-book to agree with than to dissent from Whether we agree or dissent, we always find Prof James full of stimulating thought, and we advise all who are interested in psychology to read at least the chapters on "Habit," "The Stream of Consciousness," and "The Self," if they read no more.

C LL M

DYNAMICS OF ROTATION

Dynamics of Rotation an Elementary Introduction to Rigid Dynamics By A M Worthington Pp 155 (London Longmans, Green, and Co, 1892)

Spinning Tops By John Perry Pp 136 (London Society for Promoting Christian Knowledge, 1890)

THE persistence of spinning tops and of running bicycles in rearing themselves erect are common examples of a wide class of dynamical phenomena which are influenced or governed by the presence of rapidly rotating parts, and which have a prominent place in all departments of physical science, from the relations of the systems of the stars down to molecular actions

In formal treatises on abstract dynamics we are accustomed to find the properties of freely rotating systems relegated to an advanced part of the development of the subject, and expounded with all the powerful help which mathematical analysis can afford If we are to have a complete theory of the circumstances which determine the stability and transformations of rotational motions, this analytical aid is none too extensive But there is another mode of approaching a physical subject, which consists in learning from observation and properly varied experiment what are the phenomena that are persistent and stable, and then applying known dynamical principles to the elucidation of the properties of the motions thus known in fact to exist—a problem which need not in those simpler cases which are fundamental require any great amount of analytical knowledge.

As an additional reason for the customary abstract development of dynamics, there may perhaps be counted the historical fact that the questions that were of paramount importance when dynamical principles concerning extended systems of bodies were being evolved, related to the orbital and axial motions of the heavenly bodies, and their reconciliation with the law of universal gravitation The absence of frictional resistances, and the long duration and delicacy of astronomical observations, had led to a minute knowledge of the motions of the solar system, which taxed all the resources of Clairaut, D'Alembert, Laplace, and Lagrange, to verify and explain

Many of the dynamical principles which are now treated as elementary and fundamental were thus come upon in special analytical investigations relating to physical astronomy It was, for example, in this way that the principle of the conservation of angular momentum for the solar system was discovered by Laplace, and then generalized to a system with any kind of internal connections which is not subject to forces from outside it How far a general principle of this kind, when divested of its analytical dress, enables us to see into the general causes of things is well known A striking illustration is the *aperçu* of Prof James Thomson, that when once the trade winds have been explained as a consequence of the earth's rotation, they involve of necessity the existence also of anti-trades or south-west winds in the temperate zone, for if the trades blew by themselves their friction against the earth would always be acting round in the same direction, and therefore would tend to stop the earth's rotation, not by wholly destroying its motion, but by transferring its angular momentum undiminished to the atmosphere, where it would continually accumulate This simple remark thus shows that the trades blowing to the equator must be compensated by anti-trades blowing from it, and therefore also explains the existence of a region of high barometer between them It will also occur to memory how much J Purser, W Thomson, and specially G H Darwin, have established in the tidal evolution of the earth-moon system, by studying the possibilities of development that are allowed subject to the conservation of its angular momentum and the degradation of its energy

It has been reserved for our own half century to bring out the wealth of general dynamical ideas that is contained in the magnificent analytical presentation by Lagrange of the results of the application of the laws of motion to systems of bodies, the number of variables or co-ordinates being of necessity (for analytical purposes) restricted to the number of degrees of freedom, and everything turning out to be expressible in terms of one fundamental function—the energy of the system It will be apparent, on looking through Prof Cayley's Reports on Dynamics to the British Association, how much the progress of this department of abstract dynamics was indebted to the necessities of astronomy. That science presented a problem which was in one sense quite definite and precise, on account of the smallness of the planetary masses, but which nevertheless required a minute explanation of the perturbations to which the planetary bodies are subjected owing to their mutual actions The methods which proved comprehensive and efficient for this purpose also showed themselves, when they were examined from a more general standpoint, to reveal principles of a far-reaching character, that applied to dynamical systems however complicated The final stage of analytical development was reached when the keen perception of Sir W. R Hamilton saw that the whole subject could be removed from special considerations of space and time, and attached to the purely analytical treatment of a single varying action function, and the commentary of Jacobi showed precisely how to pass from this general differential analysis to the solutions of special dynamical questions

At the present time there seems to be no danger of the interruption of progress by too close an adherence to the

calculus. The fact is, that nearly all the problems of the numerical calculation of perturbations which were urgent at the beginning of the century, in order to bind the solar system to the scheme of universal gravitation, have now been satisfactorily disposed of There is no longer the same need for the greatest intellectual power to set itself to put right some periodic or secular inequality, which requires all the battery of analysis that is available, and often more New ground has been broken since then, and there is the great array of the physical sciences, all struggling to become purely dynamical, but all hampered in this by the fact that the dynamical machinery, the phenomena of matter and motion, on which they depend, are to a great extent concealed from direct observation or exploration Under such circumstances the method of progress is to carefully cherish, and reduce into a scheme such as will appeal directly to the understanding, all the general principles which have become evolved in the course of dynamical investigations relating to problems of which the data are thoroughly known, and to use them as a key for the dynamical interpretation of more recondite phenomena by the aid of analogies and the numerical verification of their results The mode of progress has thus veered from the analytical to the synthetical, from the powerful inverse analysis of Laplace and Lagrange to methods more akin to those which were worked by Newton.

It may be stated as a general rule that the relations most directly intelligible and most flexible in this kind of application are properties of constancy, or of maximum and minimum, such as belong in fact to the more obvious features of the continuous growth of pure quantity The conservation of energy, of linear momentum, of angular momentum, the minimum energy criterion of equilibrium, of steady motion, the maximum and minimum energy criteria which determine the motion following the application of impulses specified either by their actual amounts or by the velocities they produce at their points of application—these may all be cited in illustration The crown of the edifice will be Maupertuis's principle of Least Action, whose range of exact application, initiated for dynamics by Lagrange and Hamilton, is now being extended into all departments of physics, thus working out an answer to the question—To what extent can the succession of phenomena in inanimate Nature from instant to instant be treated as governed by a principle analogous to that of minimum expenditure of effort in the sentient world?

The phrase from instant to instant is essential, for a path may—as, for example, a great circle on a sphere—be the shortest between two points within a given range of each other, but may cease to have that property when the starting point and the final point are taken too far apart on it In a similar way, in statics, a certain region of stability is determined around each position of equilibrium, such that, if the system is not disturbed beyond that region, it will not leave the neighbourhood, while, in dynamics of a particle, such a region is more vaguely determined around each orbit by the nature of the enveloping curves or surfaces of the neighbouring orbits.

From the point of view of the direct appreciation of dynamical ideas, the small books at the head of this article form a very welcome addition to the ordinary text-books The work of Prof Perry, popular lecture though it be—and one feels constrained, from the confident style, to believe that his audience of operatives understood every word of it—leads on the reader by vivid illustration into contact with the boldest flights of dynamical speculation After the ordinary effects of spin have been copiously illustrated, we are taken into a world in which matter has two kinds of inertia, and, by aid of a chain of balanced gyrostats, we learn that a cord cannot ever transmit motion straight on without also twiddling about It is fortunate for those of us who have to follow or teach mechanical pursuits that this new species of matter is not often heard of, and is only called up in relation to such unnoticeable, and practically insignificant, phenomena as rotation of the plane of vibration of light waves The relations of ordinary mass to gravitation, and such like are sometimes intricate enough things to discuss, the introduction of a second kind of mass, and that of a vector character, might lead to despair

The great pioneer in this field of work, of eliciting the concealed dynamical mechanism of tangible phenomena, is, of course, Lord Kelvin, by whom nearly all our knowledge on the subject has been originated, at any rate in its present exact form Prof Perry's book is all the more welcome and suggestive, in that it claims to be chiefly a connected account of what he has learned at first hand from the teaching of Lord Kelvin, an account which has possibly not been published before by anyone, at least in a consecutive form

Prof Worthington, after an elementary quantitative introduction to dynamical principles, has gone over the part of dynamics of rotation which relates to a single spinning solid, in the manner of a text-book with numerical illustrations, and there is no doubt that a mastery of his explanations would be a very valuable part of the outfit of a student of physics J L

THE MAMMALIA OF BRITISH INDIA

The Fauna of British India, including Ceylon and Burma Published under the authority of the Secretary of State for India in Council Mammalia Part II By W T Blanford, F R S (London Taylor and Francis, 1891)

IN our issue of September 27, 1888, we had the pleasure of bringing before the notice of our readers the first part of Mr. Blanford's valuable monograph on the Mammals of British India The second part, completing this important work, has lately been published. The delay, as is explained in the preface, has been caused by the necessity Mr Blanford has been under of spending much time in editing the five volumes of the same series that have appeared since the first part of the present work was issued. His labours in this respect have been increased by two unfortunate and unforeseen circumstances—the lamented death of Mr Francis Day, and the expiration of the leave of Mr. E W Oates, in both cases before the termination of the portions of the work, on fishes and birds respectively, upon which they were engaged, and the completion of which has thus fallen upon Mr. Blanford himself.

In the preface of the present part, the origin of the series to which it belongs is thus related —

"The need for new and revised descriptive works had, for some years before 1881, been felt and discussed amongst naturalists in India, but the attention of the Government was, I believe, first called to the matter by a memorial dated September 15 of that year, prepared by Mr P L Sclater, the well-known Secretary of the Zoological Society, signed by Mr Charles Darwin, Sir J Hooker, Prof Huxley, Sir J Lubbock, Prof W. H Flower, and by Mr Sclater himself, and presented to the Secretary of State for India This memorial recommended the preparation of a series of hand books of Indian zoology, and my appointment as editor It is scarcely necessary to add that to the recommendation of men so highly respected and well known in the world of science, the publication of the present 'Fauna of British India' is greatly due, and that Mr Sclater is entitled to the thanks of all interested in the zoology of India for the important part he took in the transaction"

We are also glad to learn from the same source that the series of works on the fauna of British India will not be confined to the Vertebrata, the preparation of three volumes on Moths by Mr G F. Hampson having been commenced We trust that these will be followed by others dealing with those groups of which sufficient material is available, and for which authors may be forthcoming capable of treating them in a manner worthy to be placed by the side of those already issued

The second part of the Mammalia contains the orders Chiroptera, Rodentia, Ungulata, Cetacea, Sirenia, and Edentata It is fully equal to its predecessor in careful selection of the material which is most likely to be useful and attractive to those readers for whom the work is chiefly intended The descriptions, geographical distribution, and accounts of the habits of the various species can be thoroughly relied upon Nomenclature is always a thorny subject in zoology, and though Mr Blanford is usually most careful and judicious in his work in this department, we cannot agree with him in substituting the specific name of *maximus* for the time-honoured and universally used *Elephas indicus* The inconvenience of changing the name by which such a familiar animal is designated in thousands of books and museums, is so great that it can only be justified by some more imperious necessity than appears to exist in the present case That *maximus* was applied by Linnæus to both the then known species, and that it is incorrect and misleading (the other existing, and many of the extinct, species being as large as, or larger than, the Indian elephant) are sufficient reasons, in our judgment, for leaving the name in the oblivion in which it has slept for nearly a century Moreover, if *indicus* be rejected, the claims of Blumenbach's *asiaticus* cannot be overlooked.

The illustrations of the present part are far superior to those of the former one, and show a marked advance in the art of process-printing directly from the artists' drawings, without the intervention of the wood-cutter Many of those by Mr P Smit, though printed from blocks in the text, have all the softness and delicacy of the finest specimens of lithography, and add greatly to the attractiveness of this valuable work.

W H. F

OUR BOOK SHELF

Tanganyika Eleven Years in Central Africa. By Edward Coode Hore, Master Mariner (London Edward Stanford, 1892)

MR HORE was for eleven years a member of the Central African Mission established at Lake Tanganyika by the London Missionary Society, his special task being to undertake all the work that could be most effectually accomplished by one who had the knowledge and experience of a master mariner In the present book he gives an account of his labours The narrative contains many elements of interest, and will be read with pleasure by all who like to think of devoted courage in the service of great moral ideas Mr Hore became very familiar with Lake Tanganyika, which he surveyed in the first instance on board a native boat Afterwards the British supporters of the mission enabled him to build two vessels in which he had opportunities of doing his work in a style worthy of its magnitude and importance Of the physical characteristics of the lake and the surrounding regions he gives an unpretending but sound and sometimes picturesque account He has also much to say about the natives, whose confidence and good will he seems to have had a rare power of winning He has a very favourable opinion of their capacities, and knows of no good reason why they should ever be treated by Europeans otherwise than with kindness and patience

Beginner's Guide to Photography By a Fellow of the Chemical Society (London Perken, Son, and Rayment, 1892)

THIS very cheap and useful little guide has now reached its fourth edition The reader is led through all the phases of manipulation that at first sight seem so bewildering, but which with clear explanations are soon rendered more simple and eventually mastered All questions relating to "How to buy a Camera, and how to use it," may be said to be here fully answered, and by following the instructions an amateur may be saved from much disappointment and expense The explanations throughout the book are both clear and explicit, and the omission of such technicalities as might confuse rather than enlighten a reader will be found distinctly advantageous

Quain's Elements of Anatomy Edited by E A Schäfer, F R S, and G D Thane In Three Vols Vol II, Part 2. By Prof Thane Tenth Edition (London Longmans, Green, and Co., 1892)

IT is necessary here only to record the fact that the publishers have issued the second part of the second volume of this magnificent edition of Quain's standard work The editor is Prof. Thane, and the subjects dealt with are arthrology, myology, and angeiology There are no fewer than 255 illustrations, many of which are coloured

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

The Zebra's Stripes

ALMOST every writer who treats of the colours of animals refers to Galton's observations that in the bright starlight of an African night zebras are practically invisible even at a short distance, but there can be no doubt that their peculiar striped appearance is also of great protective value in broad daylight. On a recent zebra hunt near Cradock, in which I took part, several members of our party commented on the difficulties of seeing

zebras even at moderate distances, although there was nothing to hide them, the black and white stripes blending so completely that the animals assume a dull brown appearance quite in harmony with the general colour of the locality in which they are found, and in which, for instance, Rooi Rehbok (*Pelea capreolata*) is also well protected on account of its peculiar brownish coat A member of our party, who on another occasion gave proof that he is possessed of excellent eyesight, and who has frequently hunted in similar localities, saw a zebra which was wounded in one of the front legs at a distance of about 400 yards, and strange to say he mistook it for a big baboon In a letter which I received from him a few days ago, he said, "It galloped like a baboon from me, and I could only see that the colour was greyish-brown At about 500 yards from me it ran on to a little krantz, and mounting the highest rock, drew its body together just as a baboon does when its four feet are all together on the summit of a little rock" His remark as to the greyish-brown colour of the animal is the more valuable, as I believe this gentleman, Mr Wrench, A R M of Cradock, is quite unprejudiced In my own letter to him, which drew forth these remarks, I had only asked him for the distance at which he saw the zebra, and I did not ask him how it was that he mistook a black and white zebra for a brown baboon on a perfectly clear South African day My own observations also confirm that the stripes of the zebra are of protective value Riding along a slope I suddenly saw four zebras within 100 yards above me They were galloping down the hill, but stopped when they caught sight of me As soon as they stopped I saw their stripes pretty distinctly After I had fired and wounded one of them, they started again galloping down the hill round me in a semicircle at a distance of about 70 yards All this time they presented a dull brown appearance, no stripes being visible, although I had my attention fixed on this point They disappeared beyond a ridge, went down a little valley, and I heard afterwards that they ascended the next slope, which was not more than 1500 yards away from where I stood with a native servant Yet even this lynx eyed native could not see them going up this slope They had vanished from us

Perhaps it may interest some of your readers that zebras are still fairly plentiful on the rugged hills west of Cradock A troop of forty-one individuals was seen, on the very ground over which we hunted, a short time before we arrived Our party saw eleven in two days, but I believe three were seen on two if not on three different occasions This would reduce their number to eight, if not to five They are protected by Government, and also by the farmers themselves, but I am afraid that in spite of that their days are numbered They are said to be very destructive to wire fences, and as the inclosing of farms with wire fences is steadily on the increase in this colony, many a farmer will have, though perhaps reluctantly and in defiance of the law, to take up his gun and clear them off his property There will then probably be an outcry by people who know the difficulties of South African farming only from books written by travellers who hurry through South Africa in a first class railway carriage, but those who really know South Africa well will say it is a great, great pity, but it cannot be helped, unless Government provides speedily an abode for these and other animals threatened with extinction The first step in the right direction would perhaps be the establishment of a Government Zoological Garden, but I hope others who are more competent than I am will stir the people of Cape Colony up before it is too late, so that something more than mere game laws may be done to preserve them S SCHONLAND.

Albany Museum, Grahamstown.

The Protective Device of an Annelid.

IN September last I forwarded to NATURE the description of an effectual protective device adopted by a small tubicolous Annelid which had been sent to me from Jersey, the device consisting in the coiling-up of the end of the tube I have recently been able to submit specimens to Prof W C. McIntosh, of St. Andrews, who has kindly identified the builder as *Sabella saxicava*, a form which he tells me is common in the Channel Islands, and occurs also on our southern coast So far as I can learn, this peculiar and interesting habit of an Annelid had not previously been observed. ARNOLD T WATSON

Sheffield, May 1892.

The General Circulation of the Atmosphere.

IN that excellent lecture by Dr Pernter, delivered before the Scientific Club at Vienna, published by you in NATURE (vol xlv p 593), the theory of the trade winds being occasioned by the rising of the rarefied air at the equator causing an upward current, while cold air from north and south flows in to supply its place, coupled with the earth's rotation to the east, is attributed to Dr Dove "Dove was the first person "

But that theory will be found distinctly enunciated by Sir John Herschel in his "Treatise on Astronomy" (1833), where he attributes it to Captain Basil Hall, "where this is distinctly, and, as far as I am aware, for the first time reasoned out" Herschel was not aware that it had been distinctly reasoned out by George Hadley, F R S, in the thirty-ninth volume of the Philosophical Transactions, a century before Basil Hall.

J CARRICK MOORE

THE SURFACE-FILM OF WATER, AND ITS RELATION TO THE LIFE OF PLANTS AND ANIMALS.[1]

IT is necessary to the exposition of my subject that I should begin by reminding you of some well-known properties of the surface of water These are familiar to every student of physics, and are set forth in many elementary books They are well explained and illustrated, for instance, in Prof Boys's deservedly popular book on "Soap-bubbles" But there may be some persons here who have not quite recently given their thoughts to this subject, and it will only cost us a few minutes to repeat a few simple experiments, which will establish some fundamental facts relating to the surface-film of water

The following experiments were then shown —

(1) Mensbrugghe's float Proves that the surface-film of water offers resistance to the passage of a solid body from beneath

(2) Aluminium wire made to float on water Proves that the surface-film of water offers resistance to the passage of a solid body from above The resistance is proportional to the length of the line of contact of the solid with the water

(3) Copper gauze made to float on water Here, a number of intersecting wires are employed instead of a single wire, and the consequent increase in the length of the line of contact greatly increases the weight which can be supported

(4) Frame with vertical threads, carrying a light plate of brass The threads hang vertically at first, but when the whole is dipped into soapy water, the adhering film exerts a pull upon the sides of the frame, draws the threads into regular curves, and raises the brass plate When the film is broken, the threads resume their previous vertical position, and the plate falls

(5) Aluminium wire supported by vertical copper wires Each end of the aluminium wire forms a loop, which fits loosely to one of the copper wires When the apparatus is dipped into soapy water, the contraction of the film draws the aluminium wire upwards After pulling it down with a thread, the wire can be again drawn up This is another illustration of the tendency of the film to contract We use soapy water, because the film lasts for a considerable time, but the surface-film of pure water, though less viscous than that of soapy water, is even more contractile We have already seen that the surface-film clings with considerable tenacity to any solid body introduced into it, and that its hold increases with the length of the line of contact It is for this reason that fine meshes offer so great a resistance to the passage of the surface-film Air can pass through the meshes with perfect ease, water also, if not at the surface, can pass through readily enough, but the surface film in contact with air will only pass through with

[1] Lecture given at the Royal Institution, March 4, 1892, by L C Miall, Professor of Biology at the Yorkshire College, Leeds. Some passages were omitted in delivery, for want of time

difficulty, and if there is water behind it, the water may thus be restrained from passing through the meshes

(6) Muslin bag hung in front of the lantern Water poured into the bag (a large spoonful) does not flow out, but when the muslin beneath the water is rubbed with a rod, it becomes wetted, the surface-film passes to the outside of the bag, and the water trickles through

There are many plants which take advantage of this property of the surface-film of water, viz that it will not penetrate small spaces, in order to keep themselves dry You must have observed how the hairy grasses repel water. The surface-film is unable to pass into the fine space between the hairs, and accordingly the water above the surface-film is kept from contact with the leaf This simple artifice is often employed by plants which float at the surface of water Here it is important that they should keep dry, not only for the purpose of respiration, but for another reason too They commonly have great power of righting themselves when accidentally submerged, and this self-righting property depends upon the fact that the under surface of each leaf is always wet, while the upper surface is incapable of being wetted

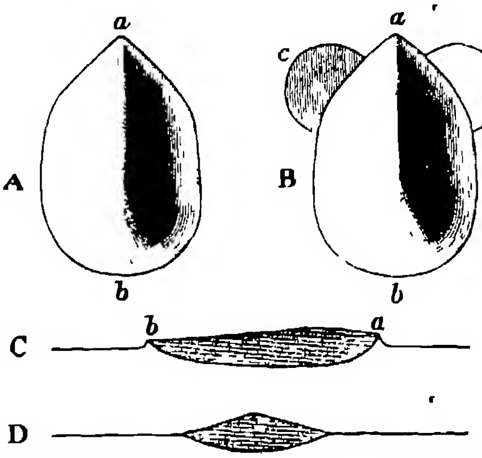


Fig 1 —Duckweed (*Lemna minor*), magnified A single frond, *a*, scar of attachment to parent A ridge extends from *a* to *b* across the upper surface of the frond, gently subsiding towards *b* B frond, budding-out two new fronds C, longitudinal section from *a* to *b* (A), showing ascending capillary curves at *a* and *b* D, transverse section, at right angles to the last The margins of the frond in this plane are level with the surface of the water N B The form of the fronds is somewhat variable Minor inequalities occur along the margin, but the principal ascending curves, which are also centres of attraction, are at *a*, *b*, and *c*

The microscopic hairs which thickly cover the upper surface are sufficient to exclude the water A leaf of Pistia is now submerged, and shown as an opaque object in the lantern You see by the gleaming of its surface that it is overspread by a continuous flat bubble of air, which looks like quicksilver beneath the water I will next invert a leaf of Pistia by means of a rotating lever It is now brought up beneath the surface of the water in an inverted position, and you see that, notwithstanding its buoyancy, it is unable to free itself and rise to the surface, because of the air-bubble, which adheres both to the leaf and to the disk at the end of the lever, and ties both together. Complete separation of the leaf from the disk would involve the division of the air-bubble into two smaller bubbles, one adhering to the leaf and the other to the disk. In this operation the surface-film would necessarily be extended directly in opposition to its natural tendency to contract. Several other water-plants exhibit the same properties as Pistia. I will mention two of the water-ferns—Salvinia and Azolla. Salvinia is found, floating on still water in the warmer parts of Europe, as well as in other quarters of the globe. The leaves are attached on opposite sides of a horizontal stem. Long hairy roots (or what look like roots, and really answer the same purpose) hang down into the water Salvinia has in a remarkable degree the power of rising when submerged, of always rising with its leaves up and its roots down, and of rising with the upper surface of its leaves perfectly dry. It is obvious that these qualities are most useful to a plant which may be pressed under

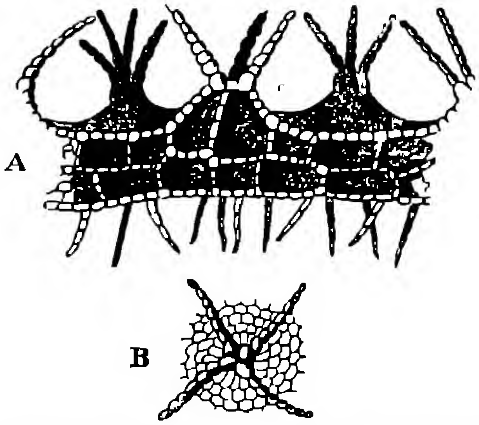


Fig. 2 —*Salvinia natans* A, combined surface view and section of floating leaf, modified from a figure in Sachs's "Botany" showing the air cavities, the submerged hairs of the lower surface, and the groups of stiff hairs on the upper surface These latter inclose spaces into which water cannot enter even when the leaf is completely submerged B, one group of hairs from the upper surface, seen from above.

water or drenched with rain Its nutrition, like that of all green plants, depends largely upon substances extracted from the air, and to be overspread with water, which disappeared only by a slow process of evaporation, would be disadvantageous, especially if the water were not absolutely clean Every leaf of Salvinia is, to begin with, excavated by a double layer of air-spaces, which lodge so much air as to give it great buoyancy On the

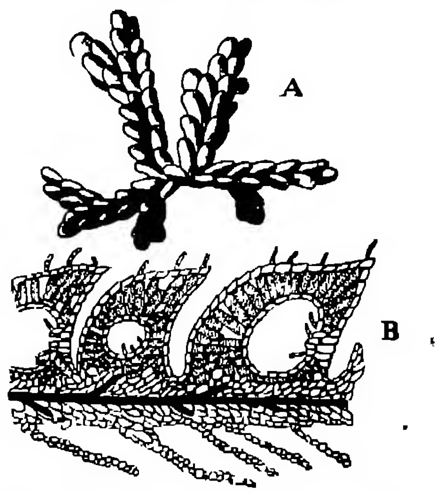


Fig. 3 —*Azolla caroliniana* A, stem with leaves, magnified B longitudinal section through part of ditto, highly magnified The air-cavities of the leaves are shown, the narrow spaces between the leaves, into which water cannot enter, the fine hairs of the upper surface, the submerged leaf-lobes, and the vascular bundles.

upper surface are placed at regular distances a number of prominences, each surmounted by a group of about four stiff, spreading hairs, which keep the water from reaching the surface of the leaf When forcibly depressed, the Salvinia takes down with it a layer of air, which forms a flat bubble over the leaf, and of course gives great power of self-righting, for the specific gravity of the upper

side is greatly reduced, while the lower side is weighted, as before, by the long, water logged roots. Once restored to the surface, the bubble bursts, and the little drops into which it is instantly resolved roll off like drops of quicksilver. Azolla, which is found in most hot countries, and is often grown in hothouses, behaves in a very similar way. Here the leaves are far smaller, and crowded together upon a branching stem of minute size. There are a few hairs upon the upper surface, and between the leaves are narrow clefts, connected with globular cavities, which occupy the centre of every leaf. These cavities, which are often closed, and never possess more than an outlet of extreme minuteness, are always filled with air; so are the clefts between the leaves. No water can lodge on the upper surface, apparently because the surface-film is stretched from the raised edge of one leaf to that of the next, and thus buoyancy, self-righting, and repulsion of water are efficiently secured.

Many plants which ordinarily float on the surface of the water (Salvinia, Azolla, Duckweed, *Potamogeton natans*, &c.) sink on the approach of winter. At this time it is very curious to see how completely they lose both their buoyancy and their power of repelling water. I do not know how this change is brought about, but the result is one of obvious advantage. The leaves, or in some cases the entire plants, sink to the bottom, and hibernate there, out of the reach of frost. Many perish; some are broken up by decay into isolated buds. When spring returns, the few survivors float up, and soon cover the surface with leaves. It would be interesting to know something of the mechanism by which these seasonal changes are effected.

One of the commonest objects in Nature, which is apt to escape our notice on account of its minute size, for it is less than one quarter of an inch in length, is the egg-raft of the gnat. This was beautifully described 150 years ago by Réaumur. The eggs of the gnat are cigar-shaped, and 250 or 300 of them are glued together, so as to make a little concave float, shaped like a shallow boat. The upper end of each egg is pointed, the lower end is provided with a lid, through which the larva will ultimately issue into the water. The gnat in all stages, even while still in the egg, requires an ample supply of air. It is therefore necessary that the egg-raft should float at the surface; it is also necessary that it should always float in the same position, so as to facilitate the escape of the larva. This is effectually secured by a provision of almost amusing simplicity. Let us first notice how efficient it is. If we take two or three of these tiny egg rafts, and place them in a jug of water, we may pour the water into a basin again and again; every time the egg-rafts float instantly to the surface, and the moment they come to the top, they are seen to be as dry as at first. The fact is that the surface-film cannot penetrate the fine spaces between the pointed ends of the eggs. The cavity of the egg-raft is thus overspread by an air-bubble, which breaks the instant it comes to the top. The larva of the gnat, when it escapes from the egg, floats at the surface, and it is enabled to do so in consequence of the properties of the surface-film. When the larva changes to a pupa it becomes buoyant, and floats at the surface, except when alarmed. To enable it to free itself without unnecessary effort from the surface of the water, the respiratory tubes of the pupa are furnished with a valvular apparatus, which can cut the connection with the air in a moment, and restore it at pleasure, when the pupa again floats to the surface.[1]

Another Dipterous insect, whose larva inhabits rapid streams, makes an ingenious use of the properties of the surface-film. This is the larva of Simulium, of which I have given some account in the lecture just quoted. At the time of the delivery of that lecture, I was wholly unable to explain how one difficulty in the life of the insect is surmounted. The larva clings to the water-weeds found in brisk and lively streams. The pupal stage is passed in the same situation. But a time comes when the fly has to emerge. Now the fly is a delicate and minute insect, with gauzy wings. How does it escape from the rushing water into the air above, where the remainder of its life has to be passed? This was a question upon which I had spent much thought, but in vain. It appeared to me for many months completely insoluble. However, I was informed last year by Baron Osten Sacken of a paper written by Verdat, seventy years ago, in which the emergence of the fly of Simulium is described. Guided by Verdat's description, I had little difficulty in seeing for myself how the difficulty is actually overcome. During the latter part of the pupal stage, the pupa-case becomes inflated with air, which is extracted from the water, and passed through the spiracles of the fly into the space immediately within the pupal skin. The pupal skin thus becomes distended with air, and assumes a more rounded shape in consequence. At length it splits along the back, in the way usual among insects, and there emerges a small bubble of air, which rises quickly to the surface of the water and there bursts. When the bubble bursts, out comes the fly. It spreads its hairy legs, and runs upon the surface of the water to find some solid support up which it can climb. As soon as its wings are dry, it flies to the trees or bushes overhanging the stream.

A very interesting inhabitant of the waters, which makes use of the properties of the surface-film to construct for itself a home beneath the surface, is the water-spider (*Argyroneta aquatica*). This interesting little animal has been described by many naturalists, some of whom, judging from their accounts, had no personal acquaintance with its habits. But among the number is the eminent naturalist Félix Plateau, son of the physicist to whom we are so much indebted for our knowledge of the phenomena of surface tension. I need hardly say that in his account of the water spider, Prof. Plateau gives a full and adequate account of the scientific principles concerned in the formation of its crystalline home.[1] Plateau remarks that the water-spider, like most other spiders, is an air-breathing animal. It dives below the surface, and spends nearly its whole life submerged. In order to do this without interruption to its breathing, the spider carries down a bubble of air, which overspreads the whole abdomen as well as the under side of the thorax. These parts of the body are covered with branched hairs, so fine and close that the surface-film of water cannot pass between them. The spider swims on its back, and the air lodges in the neighbourhood of the respiratory openings, which are placed on that surface which floats uppermost. When the spider comes to the top, as it does from time to time to renew its supply of air, it pushes the abdomen out of the water, and we can then see that this part of the body is completely dry. When it sinks, the water closes in again at a little distance from the body, and the bubble forms once more.

It would be inconvenient to the water-spider to be obliged to come frequently to the surface for the purpose of breathing. A predatory animal on the watch for its victims must lie in ambush close to the spot where they are expected to appear, and the water-spider accordingly requires a lurking-place filled with air, beneath the surface of the water. It has its own way of supplying this want. Relying on the fact, already illustrated by our muslin bag, that the surface-film of water will not readily pass through small openings, the spider proceeds as follows. It begins by drawing together some water-weeds with a few threads, in such a way that they meet at one or more points. It then fetches from the surface a fresh supply of air, and

[1] The larva and pupa of the gnat are more fully described in my British Association lecture on "Some Difficulties in the Life of Aquatic Insects," reported in NATURE, vol. xliv. p. 457.

[1] "Observations sur l'Argyronète aquatique," *Bull. Acad. Roy. de Belgique*, 2me. sér., tom. xxiii., 1867.

squeezes part of it out by pressing together the bases of its last pair of legs. The bubble rises, but is detained by some of the threads previously spun across its path. Then the spider returns to the surface to fetch another bubble, and repeats the operation as often as is necessary. Now and then she secures the growing bubble by additional threads, and before long has a bubble nearly as big as a walnut, inclosed within an invisible silken net, which imprisons the air as effectually as a dome of glass would do. The spider takes care to conceal her home from observation, and before long the minute Algæ, growing all the more vigorously because of the air brought to them, effectually conceal the habitation. The mouth of the dome, which is of course beneath, is narrowed to a small circle, and Plateau has observed a cylindrical horizontal tube, seven to eight millimetres in diameter, by which the spider is enabled to enter or leave her home without being observed. The air within is renewed as required, by the visits of the spider to the surface.

Besides this home, which is the ordinary lurking-place of the spider, another is required at the time when the young are hatched. The new-born spiders are devoid of the velvety covering of hairs, and would drown in a moment if placed in a nursery with a watery floor. The female spider therefore makes a special nest for this particular occasion, which floats on the surface of the water, rising well above it. It is bell-shaped and strongly constructed. The upper part is partitioned off, and contains the eggs. Beneath the floor of the nursery the mother takes her station, and watches over the safety of her brood, defending them against the predatory insects which abound in fresh waters. It is interesting to see how the faculty of spinning silk, used by the house-spider for her snares, and at other times for the fluffy cocoon in which the eggs are enveloped, furnishes to the water-spider the materials of her architecture. It is not less interesting to observe the economy of material which results from the use of the tenacious and contractile surface-film, in place of a solid wall.

We will next consider another property of the surface-film, which is turned to account in the daily life of the very commonest of our floating plants, I mean the duckweed, which overspreads every pond and ditch. A number of the green floating leaves of duckweed are now placed in a shallow dish in the field of the lantern, and I will ask you to observe how they are grouped. They have spontaneously arranged themselves in a very irregular fashion, forming strings and chains which spread hither and thither over the surface of the water. This is not the way in which most floating bodies behave. Let us remove the duckweed, and replace it by another dish of water in which I will put a number of small disks of cork.[1] You will see that the bits of cork are attracted one to another and crowd together in one place. Let us inquire why the floating bits of cork are thus attracted towards one another. If any solid capable of being wetted by water is partly immersed in water, the liquid rises round it in an ascending capillary curve. If the solid is not wetted by water, the curve will turn downwards. We may get ascending or descending capillary curves in other ways. If, for instance, I were to lay a sheet of paper upon water, and turn its edges up at certain places, we should get marked ascending curves at these points. The raising of some parts of the surface causes other parts to sink, and may bring about descending curves, or make previously formed descending curves more marked. We shall find it helpful in our experiments to notice one very simple plan of producing a descending capillary curve round the edge of a vessel. If we take a glass of water, and fill it until the water is level with the brim, we naturally speak of the glass as *full*; but if we are careful to avoid rude shaking, we may still add a considerable quantity of water without spilling any. The glass will then become what we may call *over-full*, and its surface will be bounded by a descending capillary curve. Now, it is of immediate importance to us to observe that *like* capillary curves, whether ascending or descending, attract one another, and that *unlike* curves repel one another. The theoretical explanation of this point is not difficult, but it must not detain us here. To place the fact itself beyond dispute, we will try a little experiment. A circular dish of water is now placed in the field of the lantern, and we will introduce into it a small disk of wood. Both the disk and the side of the vessel are wetted by water, and an ascending capillary curve rises round each. The result is that the two bodies attract one another. Every time the disk is moved away it is powerfully drawn towards the side of the vessel. With a little syringe we will add water to the dish in sufficient quantity to raise the level above the edge of the vessel. You will observe that the wooden disk is now repelled by the edge of the vessel, and floats free in the centre. By sucking up a little water, it becomes attracted once more, and so we may go on, causing it to be attracted or repelled, according as we add or subtract a small quantity of water. But what has all this to do with the duckweed? In order to explain the behaviour of duckweed, I must ask you to examine a careful representation of its form. This common plant has not, to my knowledge, been faithfully represented in any botanical book. You will see that the leaf is of an irregular oval shape, broader at one end than at the other, and that the narrow end is pointed. A raised ridge extends along the length of the leaf, from the point to the middle of the opposite or rounded border. Duckweed almost invariably propagates itself by budding. New leaves are pushed out symmetrically on each side of the point. They grow bigger and bigger, and gradually free themselves. The point upon each leaf marks the place where it was last attached to the parent leaf. Sometimes the budding is so rapid, that, before a fresh pair of leaves have become free, they have already budded out a second pair, which we may call the grand-daughters of the parent leaf. The pointed end of the leaf, and also the opposite end of the ridge, are raised above the general level, and very marked capillary curves ascend from the general water-level to these points. The free edge of every bud is also raised above the general water-level, and a capillary curve ascends to meet it. Hence, when a number of leaves of duckweed are floating freely on water, they are powerfully attracted one to another at certain points, while at intervening points they are relatively inert. If you take a floating leaf of duckweed, and bring near it a clean needle or a pencil-point, or any similar object, provided that it is not greasy, you will see that the leaf is at once attracted towards the point, but it always turns itself so as to bring one of its ascending curves round to the needle or pencil. We all see in the lantern how readily a leaf of duckweed is made to rotate rapidly by causing a needle-point to revolve round it, without ever touching it. Let us now try to imitate the behaviour of the leaves by some rude models. I have here some elliptical paper floats, cut out with a pair of scissors, and having each of the pointed ends a little turned up. We place these one by one on the surface of the water, and you see in the lantern how they are attracted to one another, point to point, and how they form long chains, which have a tendency to break up into stars. It is the existence of such points of attraction on the margin of the leaves which causes the duckweed to form chains and strings, so long as there is any unoccupied surface in the pond. A moment's consideration shows how profitable this tendency is to the plant. Were the duckweed to crowd together like the floating bits of cork, the pressure towards the centre of any considerable

[1] In order to avoid the inconvenience caused by the attraction of the sides of the vessel, the dish should be over-full of water.

mass of plants would be so great that the new leaves budded out would find no room in which to expand, but, by virtue of one very simple provision, viz the existence of inequalities of level along the edges of the leaves, clear spaces and lanes are left between the floating leaves, so long as any unoccupied space remains

Long exposure to the air, especially in still weather, affects the life of duckweed in a material way Dust and decaying organic substances give rise to a pellicle, which is most mischievous to floating plants, and I think I could show, if time allowed, how much the habits of duckweed have been altered thereby But, apart from visible impurities, mere exposure to air gives, as Lord Rayleigh has taught us, a considerable degree of superficial viscosity to water Hence, the leaves of duckweed, when the surface is contaminated, will tend to lie in whatever positions they may be thrown by accidental causes, such as wind, and the attractions due to capillarity will be more or less impeded But the effect of the superficial viscosity will in time be overcome by the attractive forces, so that it probably does not in the long run greatly affect the distribution of the leaves over the surface of water

Many other floating plants, but not all, behave more or less like duckweed, and for the same reason As yet I know of none which space themselves quite so effectually, and the extreme abundance of the common duckweed, as well as its world-wide distribution, may be partly due to the completeness of its adaptation to capillary forces Some dead objects may accidentally take a shape which causes them to spread out over water, but I have met with none which have particularly struck me Floating natural objects, such as sticks or seeds, behave, in many cases at least, very differently, and become densely massed My attention was first called to this subject by seeing how different was the grouping of duckweed from that of some seeds of *Potamogeton natans*, which were floating in the same pond

The capillary forces which spread the leaves of duckweed or Azolla upon the surface of water are indirectly concerned in the transport of these and like plants to fresh sites If we put a stick into water overspread with duckweed, we cannot fail to notice how the leaves cling to the stick They cling in a particular way, which enables them to bear transport more safely The wetted surface, for obvious physical reasons, is attracted to the wetted stick; and the water-repellent surface, which is that which best resists drying, is outwards The tenacity with which duckweed clings to the legs of water-birds, and the position which it almost inevitably takes under such circumstances, may have a good deal to do with the safe transport of the plant to distant pools It is not, I think, too much to say that the prosperity of duckweed depends very largely upon the capillary forces which come into play at the surface of water

We have now exhausted our time, though I have been obliged to leave unnoticed many special adaptations of living things to the peculiar conditions which obtain on the surface of water Had time allowed, I should have been glad to say something about the aquatic animals which creep on the surface-film as on a ceiling, and about the insects which run and even leap upon the surface-film without wetting their minute and hairy bodies.[1] All small animals and plants which float on water necessarily come into contact with the surface-film, and have to deal with the difficulties which result from it We have seen that they generally manage in the long run to convert these natural difficulties into positive advantages.

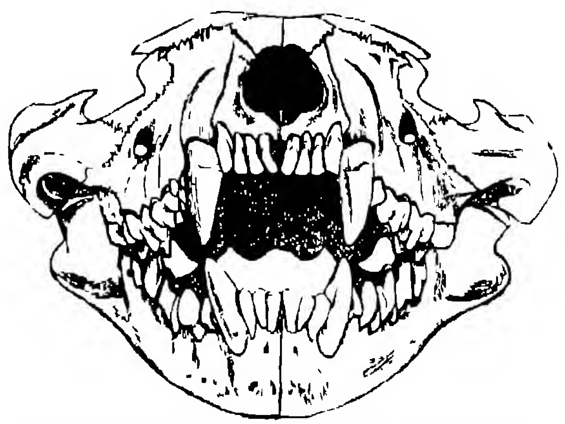
I have to thank my colleague, Dr Stroud, for his frequent explanations of the physical principles upon which these adaptations depend, and also for much practical and valuable help in the preparation of suitable experiments

[1] See NATURE, vol xliv p 137

THE DISCOVERY OF AUSTRALIAN-LIKE MAMMALS IN SOUTH AMERICA.

THE year 1891 proved a notable one in regard to marsupials The existing mole-like marsupial (*Notoryctes*) from the deserts of Central Australia having been made known to us, news came of the discovery in the Tertiaries of Patagonia of remains of carnivorous marsupials closely allied to the existing pouched wolf, or Thylacine, of Tasmania This discovery was immediately recognized as one likely to considerably modify some of our views regarding the distribution of mammals A preliminary account of these new marsupials was given by Dr Florentino Ameghino in a paper written for the new serial, *Revist Argent Hist Nat* This description seems to leave no doubt as to the correctness of the diagnosis of the fossil remains

Before going further, it may be well to remind our readers that, with the single exception of the opossums (*Didelphyidæ*) of America, all marsupials are now exclusively Australasian The carnivorous types, such as the Thylacine (*Thylacinus*) and the Tasmanian Devil (*Sarcophilus*), are distinguished from all living mammals in that their upper cutting-teeth (incisors) are either four or five in number on either side, while in the lower jaw there are invariably three This relation is shown in the figure of the skull of the Tasmanian Devil—a near ally of the Thylacine—where, between the large tusks of the upper jaw, we see the four pairs of incisors opposed to only three pairs in the lower jaw In ordinary mammals, on the other hand, the number of pairs of incisors in each jaw does not exceed three, the number of those in the two jaws being usually equal A further peculiarity of marsupials is that the cheek or grinding teeth comprise four true molars and not more than three premolars; whereas in ordinary mammals the typical number is three molars and four premolars, there being no known instance of the presence of four true molars except in some individuals of the fox like *Otocyon* Another peculiarity of most marsupials is the distinct inflection of the lower posterior extremity, or "angle," of the lower jaw, while very frequently the bony palate of the skull has unossified spaces



Front view of the skull of the Tasmanian Devil (After Flower)

The new forms described by Dr Ameghino were obtained from the lower part of that great series of freshwater formations with which so large an area of South America is covered It has been inferred that the Patagonian deposits in question are as old as the Lower Eocene of Europe, but, although they are undoubtedly of considerable age, this inference can scarcely be regarded as an established

fact, since the occurrence of mammals allied to those of the European Lower Eocene is quite capable of explanation by their survival to a later period in South America

One of the new Patagonian forms, to which Dr Ameghino applies the name *Prothylacinus*, is stated to be an animal of the general conformation of the Thylacine, having apparently the same number of teeth, although the upper incisors are unknown The main distinction of the fossil genus is, indeed, said to consist merely in the circumstance that the lower premolars are more widely separated from one another, the molars of the two forms being described as absolutely identical in character The fossil likewise exhibits the marsupial inflection of the angle of the lower jaw The absence of the upper incisors in the specimens of *Prothylacinus* is fortunately compensated in another genus described under the uncouth name of *Protoproviverra* Here we find that the number of teeth is exactly the same as in the Thylacine, there being four upper and three lower incisors, a canine, three premolars, and four molars on each side of the skull This dentition agrees numerically with that of the Tasmanian Devil, with the exception that there is an additional premolar in each jaw These fossils also exhibit the inflection of the angle of the mandible, and the presence of unossified vacuities in the palate, which we have seen to be marsupial features

As might have been expected to be the case, Dr Ameghino also states that there appears to be a complete passage from these marsupial forms to others belonging to that group of primitive carnivores known as Creodonts, of which the European Upper Eocene *Hyænodon* and *Pterodon* are well-known examples Now, if we are to trust these descriptions (and there appears every reason why we should), we must admit that *Prothylacinus* and *Protoproviverra* are veritable marsupials of an Australian type Then comes the question, How are we to explain the occurrence of such closely allied forms in areas so remote from one another as Patagonia and Australia?

It had long ago been urged that the occurrence of carnivorous marsupials in South America and Australia and nowhere else (at the present time) indicated a former connection between those two areas To this, however, Mr Wallace ("Distribution of Animals," vol i p 399) objected that the American opossums (*Didelphyidæ*) were not an Australian type, and that they occurred in the Tertiaries of Europe, and hence he argued that both the American and Australian marsupials probably took their origin from the presumed marsupials of the European Jurassic rocks This explanation, on Mr Wallace's own showing, will not, however, hold good for the close resemblance stated to exist between the American *Prothylacinus* and the Tasmanian Thylacine, since it is quite impossible to believe that two such similar forms could have maintained their likeness in such remote regions after having diverged from a common European ancestor as far back as the Jurassic period

It has, however, been long known that there are certain very remarkable relationships between the fauna and flora of all the great southern continents For instance, among mammals, the rodent family *Octodontidæ* is peculiar to South (including Central) America and Ethiopian Africa Then, again, among fishes, the family of the *Chromidæ* is confined to the rivers of South America and Africa, with one outlying genus in India, while the true mud-fishes (*Lepidosiren* and *Protopterus*) are solely South American and Ethiopian, the third representative of the same family being the Baramunda (*Neoceratodus*) of Queensland Again, the connection between the flora of Africa and that of Western Australia is so intimate as to have induced Mr Wallace (*op cit*, p 287) to express his belief that there must have been some kind of land connection, although not necessarily a continuous one, between these two widely distant areas The connection between the fauna of India and that of Ethiopian Africa is now too well known to stand in need of comment The matter does not, however, end here, for if we go back to the Mesozoic epoch there are equally striking evidences of the connection between the faunas and floras of the southern continents For instance, the extinct saurian genus *Mesosternum*, which appears to have been allied to the Plesiosaurs of the Lias, is known from early Secondary strata in Brazil and South Africa, and nowhere else Then, again, the remarkable Anomodont reptiles (*Dicynodon*, &c) of South Africa are closely connected with those of India, while the respective alliances between the Labyrinthodont amphibians and the Mesozoic floras of South Africa, India, and Australia are too well known to need more than mention

It appears, then, that, altogether apart from the new discovery, the common factors connecting the faunas and floras of the four great southern prolongations of the continental land of the globe undoubtedly point, not only to a more or less intimate connection between these several areas, but also to their more or less partial isolation from the more northern lands

Reverting to the new discovery, it may be observed that our comparatively intimate acquaintance with the Tertiary faunas of Europe and North America renders it in the highest degree improbable that marsupials of an Australian type lived during that time in either of those areas It is, however, quite possible that they may turn up at any time in Tertiary formations in Africa, while there is nothing to show that they may not also have existed in peninsular India Indeed, if we put aside as improbable any connection by way of the Pacific between South America and Australia, it seems impossible to give any explanation of the occurrence of allied marsupials in Patagonia and Australia without the assumption that their ancestors existed in some part of the great area lying between eastern South America and Western Australia R Lydekker

PHOTOGRAPHY IN COLOURS

The *Comptes rendus* for February 2, 1891, contained a brief note on colour photography, describing the method employed by M G Lippmann, who had been able to produce photographically the image of the spectrum with all its colours A summary of this note was given in Nature at the time (see vol xliii, p 360)

M G Lippmann, who has been continuing his researches, has communicated further results, which appear in the *Comptes rendus* for April 25 (No 17, vol cxiv) These results show that we are not far off the solution of a question which has been the aim of all the latest photographic researches The following is a translation of the note in question —

In the first communication which I had the honour to make to the Academy on this subject, I stated that the sensitive films that I then employed failed in sensitiveness and isochromatism, and that these defects were the chief obstacle to the general application of the method that I had suggested Since then I have succeeded in improving the sensitive film, and, although much still remains to be done, the new results are sufficiently encouraging to permit me to place them before the Academy.

On the albumen-bromide of silver films rendered orthochromatic by azalin and cyanin, I have obtained very brilliant photographs of spectra All the colours appear at once, even the red, without the interposition of coloured screens, and after an exposure varying from five to thirty seconds

On two of these *clichés* it has been remarked that the colours seen by transmission are very plainly complementary to those that are seen by reflection

The theory shows that the complex colours that adorn natural objects ought to be photographed just the same as the simple colours of a spectrum There was no necessity to verify the fact experimentally The four *clichés* that I have the honour of submitting to the Academy represent faithfully some objects sufficiently diverse, a stained glass window of four colours, red, green, blue, yellow, a group of draperies, a plate of oranges, surmounted by a red poppy, a many-coloured parrot These showed that the shape is represented simultaneously with the colours

The draperies and the bird required from five to ten minutes' exposure to the electric light or the sun The other objects were obtained after many hours of exposure to a diffuse light The green of the foliage, the grey of the stone of a building, are perfectly produced on another *cliché*, the blue of the sky, on the contrary, was represented as indigo It remains, then, to perfect the orthochromatism of the plate, and to increase considerably its sensibility

NOTES

THE Royal Society's *soirée* is being held as we go to press We hope to give next week some account of the principal objects exhibited

THE Bureau des Longitudes is sending an expedition to Senegambia to observe the total solar eclipse of April 1893

THE first session of the Institution of Mining and Metallurgy is to be held in the theatre of the Geological Museum, Jermyn Street, on Wednesday, May 18, when the President, Mr George Seymour, will deliver the inaugural address There will be an inaugural supper at the Criterion

AT the Royal Academy dinner Sir John Lubbock responded for science He said that no class derived more benefit and enjoyment from works of art than men of science Sir John referred also to the growing importance of art in relation to the material prosperity of the country Our merchants and manufacturers, he said, could no longer rely entirely on excellence of material and solidity of workmanship, but had to look to artistic charm and beauty of design

AT the annual meeting of the Royal Institution on May 2, the following gentlemen were elected officers for the ensuing year the Duke of Northumberland, President, Sir James Crichton Browne, Treasurer, Sir Frederick Bramwell, Secretary

IT is reported from Melbourne that Sir Thomas Elder has decided not to send out another exploring expedition into Central Australia at present He attributes the failure of his recent expedition, under Mr Lindsay, to the severity of the season, the drought having been unusually trying

ON May 7 the members of the Geologists' Association will make an excursion to Walthamstow, Mr J Walter Gregory acting as director The object of the excursionists will be to examine sections on the Tottenham and Forest Gate Railway The best section is about half a mile from St James's Street, and shows the lower terraces of the Lea Valley gravels resting on a very eroded surface of London Clay Masses of the London Clay stand up, which were probably once islets. The alterations in the position of the bed of the Lea are well shown by this cutting.

ON Tuesday next (May 10) Mr Frederick E Ives will begin a course of two lectures at the Royal Institution on photography in the colours of nature

AT the meeting of the Franklin Institute, Philadelphia, on March 16, Mr John Carbutt made some remarks on the results achieved by Mr Frederick E Ives in the field of colour photography, which, in his judgment, so far as practical results were concerned, were far in advance of anything that had as yet been accomplished elsewhere Mr Carbutt urged that it was eminently fitting for the Institute to recognize the value of the work of one of its own members, and moved that the subject of Mr Ives's investigations and results in the field of colour photography should be referred to the committee on science and the arts for investigation and appropriate recognition The motion was carried

SIR JAMES CRICHTON-BROWNE delivered the annual oration at the 118th anniversary meeting of the Medical Society of London, held on Monday evening He chose as his subject "Sex in Education" He showed that the female brain is lighter than that of the male, not only absolutely, but relatively to the respective statures and weights of the two sexes, that the specific gravity of parts of the female brain is less than that of corresponding parts of the male brain, and that the blood supply, which in the male is directed more towards the portions which are concerned in volition, cognition, and the ideo-motor processes, is in the female more directed towards portions which are mainly concerned in the discharge of sensory functions Sir James urged the necessity of such structural differences being taken into account in the conduct of education, and, while disclaiming any intention of bringing a wholesale indictment against high schools for girls, he nevertheless held that some of their methods were capable of leading to great evils, especially when not controlled by a judicious and sympathetic mistress He pointed out the difficulty of obtaining trustworthy information as to either the methods of many schools or their effects, more especially as the pupils themselves were often hostile to the inquiry, but he referred to one school at which he had been permitted to ascertain the facts, and in which he found that, out of 187 girls belonging to the upper and middle classes, well-fed and clad and cared for, and ranging from ten to seventeen years of age, as many as 137 complained of headaches, which in 65 instances occurred occasionally, in 48 frequently, and in 24 habitually He cited the authority of Sir Richard Owen for the position that children have no business with headaches, and that something must be wrong in the school in which they frequently suffer from them An account was given of the *modus operandi* of excessive brain work as a factor in the production of ill-health, and statistics were quoted to show the special liability of the female organism to disease at the period of life which the educator has seized on for his own He attached great importance to loss of appetite, especially morning appetite, as a result of overstrain, and as one which was calculated to be itself the fruitful parent of other evils, and he strongly condemned the recent decision of the University of St Andrews to open its classes in arts, science, and theology to women as well as to men, thus, as he declared, taking not a retrograde step, but a downhill step towards confusion and disaster. "What was decided amongst the prehistoric protozoa cannot be annulled by Act of Parliament, and the essential difference between male and female cannot be obliterated at a sweep of the pen by any Senatus Academicus"

THE weather during the past week has been unsettled generally, and showers of cold rain, hail, or sleet have occurred

in many districts The day temperatures have been low, with sharp frosts at night, on April 29 the thermometer on the grass fell as low as 20° in London, and heavy snow fell at Wick From official reports for the week ended April 30 the temperature was several degrees below the mean for the week in all districts, although the bright sunshine had exceeded the normal amount Gales were experienced on our exposed north and west coasts, but for the most part the wind has been light Bright aurora has again been seen at several places On May 1 the thermometer rose to 60° or more at several inland stations, but this improvement was not maintained The winds, which during a few days were northerly and north westerly, again became easterly over the whole of the British Isles, with unsettled and unseasonable weather

A SPECIAL meeting of the New England Meteorological Society was held in Boston on April 6, when the recommendation of the Council to transfer the weather service of the Society to the National Weather Bureau at Washington, with the object of forming a New England Weather Service under the direction of that Bureau, was formally ratified The New England Weather Service will continue to gather and publish observations of temperature and rainfall, and the monthly *Bulletin* will be continued as heretofore While that part of the Society's work, in which the greater number of persons is involved, is thus transferred to the New England Weather Service, the meetings and investigations of the Society will be continued as during the past eight years Three meetings will be held annually, and the proceedings will be published in the *American Meteorological Journal*, while the investigations will be published in the Annals of the Harvard College Observatory In the *Bulletin* for March, it is stated that it is the intention of the Weather Bureau to make a special study of thunderstorms during the coming summer The observations are to be made in several States, from May to August inclusive

THE Deutsche Seewarte (Hamburg) has recently issued an atlas of thirty-five charts, with introductory text, showing the physical conditions of the Indian Ocean, on a similar plan to that published for the Atlantic Ocean some years ago The rich materials at the disposal of the Seewarte have been discussed by Dr Köppen and others in every form that can be of use both to seamen and physicists Several charts are devoted to the currents, temperature and specific gravity, winds and monsoons, while the magnetic elements have been specially investigated by Dr Neumayer

THE Indian journals received by this week's mails report that Mr John Eliot, the Meteorological Reporter to the Government of India, has returned to Simla from Chaman and Murree, where he has been establishing new meteorological observatories

ON Friday last Colonel J. F Maurice, Professor of Military Art and History to the Staff College, read at the meeting of the Royal United Service Institution a most interesting paper on military geography This he described as a science dealing with all those conditions of the surface of the world which affected armies, campaigns, and battles He sought to show how in the case of each of the great European countries strategic methods are affected by geographical conditions.

OPINIONS are being expressed by scientific workers in India in favour of the making of systematic experiments with snake poison The Committee for the Management of the Calcutta Zoological Gardens are constructing, from private subscriptions, a snake house with the most modern improvements, which will contain specimens of all the principal poisonous snakes in the country If the necessary funds were available, arrangements could be made to fit up a small laboratory in connection with the snake-house, for the purpose of conducting inquiries of all descriptions bearing upon the pathology of snake-bite and cognate subjects, and in future there would be no difficulty in arranging for the carrying out of any special experiments that might be required. It is understood that Dr D D Cunningham, F R S, President of the Committee, would in that case be willing to take an active part in organizing and promoting such inquiries and carrying out such experiments, including the testing of the various alleged remedies for snake bite which are from time to time brought to notice A Calcutta paper, quoted by the *Pioneer Mail*, understands that if the Government of India will make a grant of Rs 5000 towards this object, the Lieutenant-Governor will endeavour to meet the balance from Provincial funds

THE well known mycologist, Dr. Stephan Schulzer von Muggenburg, has just died at the age of ninety

AT the coming "World's Columbian Exposition" at Chicago, it is proposed to have an exhibition of the "worst weeds" from all the States and Territories of the Union

UNDER the editorship of Mr E M Holmes a Catalogue has just been issued of the "Hanbury Herbarium" in the Museum of the Pharmaceutical Society The collection consists of above 600 dried specimens of plants yielding products used in pharmacy, or believed to have medicinal properties, each specimen being labelled with its locality or the source whence it was obtained, and often accompanied by notes or extracts from letters of foreign correspondents The collection was formed by the late Daniel Hanbury, F R S, and, by the desire of his executors, who presented it to the Pharmaceutical Society, it is preserved in a separate room, known as the "Hanbury Room," on the premises of the Society in Bloomsbury Square

THE second part of "Botanicon Sinicum," by Dr Bretschneider, the learned physician to the Russian Legation in Pekin, has just been issued in Shanghai in the Journal of the North China Branch of the Royal Asiatic Society The work deals with the botany of the Chinese classics, the object being to identify as far as possible the plants mentioned in the writings of Confucius, Mencius, and the other great sages of ancient China Dr Bretschneider takes each name in succession, supplies all the information given by native commentators on these ancient writers, and by lexicographers, then he gives all that can be gleaned from Japanese authorities, and follows this by the identifications of European students, concluding with the results of his own study and observation Those whom Dr Bretschneider's labours for the past twenty five years have taught to expect profound learning, research, and thoroughness from him will not be disappointed in this work

AMONG the contents of the new number of the Journal of the Royal Horticultural Society are the interesting papers read at the Conference on asters and perennial sunflowers, held at Chiswick in October last. The proceedings of the Conference were opened by an address by Mr J. G Baker, which is now printed In this excellent address, in which the general botanical outlines of the subject are sketched out, Mr Baker mentions that aster as it stands at present contains 200 or 300 species, and is concentrated in the United States. Nearly all our garden Michaelmas daisies belong to the species that grow wild in the Eastern United States There are forty species of aster in the Rocky Mountains and fifteen in California, most of which are different from the eastern species, and have not been brought into cultivation The papers published with Mr Baker's

address are on the genus aster, by Prof G L Goodale, the Michaelmas daisy as a garden plant, by the Rev C W Dod, perennial sunflowers, by Mr D Dewar, and the culture of sunflowers, by Mr E H Jenkins

THE "University Extension" movement has spread to the United States We learn from the *Botanical Gazette* that Prof J. M Coulter, President of the University of Missouri, is lecturing to large University Extension classes in Evansville and New Albany, Indiana, and Louisville, Kentucky Each course includes twelve lectures on the general morphology and physiology of plants

AUSTRALIANS have had bitter experience of the mischief which rabbits are capable of doing, and now they seem likely to have trouble of a similar kind from the introduction of foxes An Australian journal, quoted in the May number of the *Zoologist* says that foxes have already spread over a wide area, and are most destructive both to lambs and poultry They attain greater size and strength in Australia than in England, and the mild climate is highly favourable to the increase of their numbers "It must be very disheartening," says the writer, "to all who have stock of any kind to lose, to find themselve confronted by some new enemy introduced by thoughtless or selfish persons If some energetic steps are not soon taken, nothing can prevent the spread of foxes over the whole continent"

MR D L THORPE writes from Carlisle to the *Zoologist* that starlings in that district often reproduce the notes of the oystercatcher and curlew with wonderful accuracy On April 3 he was surprised to hear the call of the landrail, it appeared to be the familiar "crake-crake" of that bird undoubtedly, but on further investigation he ascertained that a starling was reproducing the call-note of the rail The bird had remembered his lesson of last summer remarkably well Mr Thorpe also mentions that, during severe weather in January last, a friend of his (the Rev H A Macpherson) was astonished one day to hear the call-note of the common sandpiper repeated with such nicety as to completely deceive him, until the starling was detected in the act of rehearsing this summer cry

A CAPITAL lecture on Egyptian agriculture was delivered by Prof Robert Wallace at the meeting of the Society of Arts on April 27, and is printed in the current number of the Society's Journal Referring to the Tewfikieh College of Agriculture, Prof Wallace says that it was named in honour of the late Khedive (Tewfik Pasha), who took a special interest in its success It had its origin in a desire which sprang up little more than two years ago in the Egyptian Government to develop the agricultural resources of the country by calling in the aid of science The result has been a success far beyond the most sanguine anticipations. During the first year of its existence the College contained about 60 students, selected from about 300 applicants, and the numbers of the second, the current year, which began last October, have not fallen off A number of the sons of large land-owners have taken advantage of the instruction offered, and it is hoped by this means to spread in all directions a knowledge of improved varieties of crop plants, improved rotations, improved implements, and improved methods, not necessarily altogether new to the country, but deserving of being more widely known.

MR. W. F. LIESCHING, writing in the new number of the Selborne Society's Magazine on ants in Ceylon, says he saw one day a string of ants streaming forth, evidently in search of "pastures new" He flicked away the leader, and waited to see the result. An immediate halt was made by the foremost ants, and a scene of the utmost confusion ensued. The ants from behind kept arriving at the scene of the catastrophe, and there was soon a black crowd of ants huddling and jostling one another Some detached themselves from the main group and took a turn round, trying to find traces of their leader At last the tail end of the line arrived, and after brief consultation they all started off again, and a line soon began to unravel itself from the tangled mass moving back to the hole from which the whole company had so lately started on "pleasure bound or labour all intent" While Mr Liesching was watching the return journey, a leech stung his leg He took the creature off, and put it down in the line of march Ants will carry off a worm, why not a leech? It was, however, most amusing to see how carefully all avoided the leech

HENRY BRUGSCH PASHA read an interesting paper on Lake Mœris at the meeting of the Société de Géographie Khédiviale on April 8 He had just returned from a visit to the neighbourhood of the supposed site of the lake, so that the subject was fresh in his mind The *Times* has given a good abstract of the paper M Brugsch said there was abundant monumental evidence that at a very early period of Egyptian history there existed near the plateau of Hawara an immense basin of water, which gave its name to a whole province, the Fayûm, or "lake district" In ancient times there were forty two divisions or nomes of Egypt, each having its own capital, local government, and *cultus*, and all more or less worshipping Osiris From these the Fayûm was excluded It was divided like the parent country into nomes with their governors, and save in the necropolis at Hawara was given over to the worship of Sebak, the crocodile god It was known in the hieroglyphs as To She, the lake district, which in Coptic became P-ium, the maritime district, and survives to day in the Arabic Fayûm It is evident from the celebrated Fayûm papyrus, of which there are two copies, that the term Mer uer, the great water or lake, was also applied to it, and perhaps herein lies the origin of the name "Mœris" The waters of this lake must have reached to the plateau of Hawara, the necropolis of the inhabitants of a town called Shed, on the site of which stands the modern city of Medinet-el Fayûm It was in ancient times a Royal residence, and contained a magnificent temple dedicated to Sebak, whose dimensions far exceeded those of the temples at Thebes Tradition gives Amen-em-hat III of the twelfth dynasty as the constructor of Lake Mœris, and his burial-place is the crude brick pyramid at Hawara, but fragments bearing the cartouches of Amen em-hat I and Usertsen II, found near Medinet, would prove it of more ancient date Moreover, it was hardly possible that a town of such dimensions as Shed would be built at any distance from water A canal named Hune, or Hunet, cut from the Nile, fed the lake and provided for the needs of the city, the mouth of it was called in the hieroglyphs La Hune, "the opening of the canal," a name which survives in the modern "El-Lahûn" There is an interesting allusion to this "opening of the canal" in the celebrated Stela of Piankhi, written about the eighth century B C M Brugsch also suggested that Ra-pa ro hunet, "the temple of the mouth of the canal," might give us the derivation of the word labyrinth

WE have received the third number of *Natural Science*, the new monthly review of scientific progress Among the contributors are Prof. G Henslow, Mr G A. Boulenger, Sir J W Dawson, and Prof W. C Williamson

MESSRS CHARLES GRIFFIN AND CO have published the "Year-book of the Scientific and Learned Societies of Great Britain and Ireland" This is the ninth yearly issue. It presents lists of papers read before various Societies during the year 1891, together with information as to official changes In most cases the Societies themselves have contributed the lists of papers. The names of those Societies concerning which no information has been received are entered in the index only.

MESSRS. W AND A. K JOHNSTON have issued, under the authority of the Royal Agricultural Society of England, a valuable series of eight diagrams representing the life history of the wheat plant The diagrams are reproductions of original drawings by Francis Bauer, now in the Botanical Department of the British Museum, and are printed in colours With each set is sent a pamphlet by William Carruthers, F R S, consulting botanist to the Society, entitled "The Wheat Plant How it Feeds and Grows" This pamphlet consists of notes explanatory of the diagrams

DR L MESCHINELLI AND DR S. SQUINABOL announce for publication a Tertiary Flora of Italy

FOUR lectures upon recent stellar spectroscopy and the new star in Auriga will be delivered in Gresham College, by the Rev Edmund Ledger, at 6 p m on the evenings of May 10, 11, 12, and 13

ANOTHER contribution to our knowledge of the sugars and their related compounds is published by Prof Emil Fischer in the current number of the *Berichte* It relates to the constitution of the group of substances at the head of which stands dulcitol, $CH_2OH-(CHOH)_4-CH_2OH$, the hexahydric alcohol obtained from Madagascar manna, and prepared artificially by the reduction of milk sugar. It has already been established that the aldehyde corresponding to dulcitol is galactose, $CH_2OH-(CHOH)_4-COH$, the glucose obtained from many gums, and which is formed when milk sugar is boiled with dilute acids Moreover, it has long been known that, when either dulcitol or galactose are oxidized by means of nitric acid, a dibasic acid of the composition $COOH-(CHOH)_4-(COOH)$ is produced This acid, although expressed by the same formula as saccharic acid, the acid obtained by the oxidation of common cane sugar, differs considerably in properties from that acid, and has been termed mucic acid It is now known to be a geometrical isomer of saccharic acid—that is to say, the two compounds only differ with regard to the relative positions of the atoms comprising their molecules Saccharic acid, as obtained from cane sugar, is probably unsymmetrically built up, for its solution rotates the plane of polarization of light to the left The main result of the work now described has been to show that the molecules of mucic acid are, on the contrary, symmetrically constructed, and that its observed optical inactivity is due to this fact Theoretical considerations, based upon the postulates of the Van 't Hoff-Wislicenus hypothesis concerning the arrangement of carbon, hydrogen, and oxygen atoms in space, lead to the view that, of the ten possible geometrically-isomeric dibasic acids of the constitution $(CHOH)_4(COOH)_2$, two must be optically inactive These two optically inactive isomers would be represented respectively by the formulæ

$$\begin{array}{ccccccccc} & & H & & H & & H & & H & & \\ & & | & & | & & | & & | & & \\ COOH & - & C & - & C & - & C & - & C & - & COOH \\ & & | & & | & & | & & | & & \\ & & OH & & OH & & OH & & OH & & \end{array}$$

and

$$\begin{array}{ccccccccc} & & H & & OH & & OH & & H & & \\ & & | & & | & & | & & | & & \\ COOH & - & C & - & C & - & C & - & C & - & COOH \\ & & | & & | & & | & & | & & \\ & & OH & & H & & H & & OH & & \end{array}$$

One of these two was presumably mucic acid. It was evident that if the molecules possessed a configuration similar to that roughly indicated in one plane by either of the above formulæ, upon reduction to a monobasic acid there would be an equal number of chances of each of the two end carboxyl groups being attacked by the reducing agent and converted to CH_2OH groups. Consequently it was to be expected that equal quantities of two geometrically isomeric monobasic acids would be obtained, one dextro- and the other lævo rotatory Such has, indeed, been found by Prof Fischer to be the case, for, upon reducing either the ethyl ester or the lactone of mucic acid (the acid itself being unattacked) by means of sodium amalgam, an optically inactive acid of the constitution $CH_2OH-(CHOH)_4-COOH$ was obtained, which formed a salt with strychnine yielding two distinct kinds of crystals, resembling the well-known complementary racemates of Pasteur From these two kinds of crystals solutions of the free acids were obtained, which were respectively dextro- and lævo rotatory, and each was again converted into mucic acid upon oxidation One of these, the right-handed variety, was identical with the common galactonic acid prepared by oxidation of galactose Moreover, by further reduction of the inactive acid, an inactive glucose was obtained, from which eventually common dextro and also lævo-galactose were isolated by fermentation, and finally, by still further reduction of the galactose, dulcitol itself was obtained Hence, the symmetrical structure of the dulcitol group may be considered as proved, and the work also completes the artificial synthesis of these compounds, for, given the synthesis of any one by the method previously described by Prof Fischer, any of the others may be prepared from it by the processes now described

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Miss Beatrice Raymond, a Wild Swine (*Sus scrofa* ♀) from Tangiers, presented by Mr E H Banfather, a Great Kangaroo (*Macropus giganteus*) from Australia, presented by Mrs Frazer, a Purple Heron (*Ardea purpurea*), European, presented by Captain Woodward, a Bateleur Eagle (*Helotarsus ecaudatus*), a Tawny Eagle (*Aquila naevioides*) from Africa, presented by Captain Webster, a Raven (*Corvus corax*), European, presented by Mr F J Stokes, seven Common Vipers (*Vipera berus*), British, presented by Mr T A Cotton, F.Z S, a Rufous necked Weaver Bird (*Hyphantornis textor*) from West Africa, purchased, an English Wild Bull (*Bos taurus*), born in the Gardens

OUR ASTRONOMICAL COLUMN

SUN-SPOTS —In the March number of the *Memorie della Società degli Spettroscopisti Italiani*, there are some interesting notes relating to spots and prominences Prof Tacchini gives a tabulated statement of the solar observations made at the Royal Observatory for the last three months of the year 1891 The most frequent records of faculæ occurred in the zones $\pm 10° \pm 30°$, only one being seen as high as the zone $+ 40° + 50°$. As regards the spots, the greatest frequency of groups took place in the zones $\pm 10° \pm 20°$, 23 and 10 being observed in the north and south respectively

Profs A Mascari and J Fenyi both contribute some notes on the large group of spots visible in February last, the latter pointing out that the relation of the eruption to the large group was such that its centre was situated very near the side of the great nucleus of the south spot, but was entirely outside the spot itself.

M H Deslandres records also his observations with respect to the remarkable protuberance visible on March 3 at about 10 a.m From spectroscopic observations he obtained a radial velocity of 200 kilometres per second, using the hydrogen and helium lines. He also obtained a photograph of the invisible ultra violet region, which furnished him with "an exact image" of this protuberance The H and K lines were extraordinarily brilliant, and the negative contained the entire series of ultra violet rays of hydrogen It may be mentioned that at the appearance of this large protuberance no special indication was registered on the curves of the magnetic instruments which M. Deslandres obtained from M Wolf

Prof. Tacchini communicated to the Paris Academy on April 25 the results of solar observations made at the Roman College during the first three months of this year. Spots and

faculæ were observed on 56 days, viz. 19 in January, 19 in February, and 18 in March. The results are shown below:—

1892	Relative frequency: of spots	of days without spots	Relative magnitude: of spots	of faculæ
January	19·63	0·00	79·79	56·58
February	23·31	0·00	153·61	60·28
March	13·12	0·00	61·67	86·39

The following are the results for prominences:—

1892	Days of observation	Mean number	Mean height	Mean extension
			"	
January	13	6·39	39·6	1·6
February	13	7·00	36·0	1·6
March	14	8·14	36·4	2·3

The frequency and magnitude of spots during these months are much greater than during the preceding quarter, but prominences do not show a marked increase. No augmentation of this class of phenomena appears to have accompanied the great spot of February, if the mean numbers for the month be taken.

ECLIPSE OF THE MOON, MAY 11.—A partial eclipse of the moon will occur on May 11, and, if weather permits, it should be widely observed. The magnitude of the eclipse is 0·953, the moon's diameter being represented by 1. But although it is not total, important naked-eye observations can be made on the darkness of the shadowed moon for comparison with previous eclipses, and possessors of telescopes will doubtless take advantage of the occasion to obtain some new facts. The following times are from the "Nautical Almanac":—

		G.M.T. h. m.
First contact with the penumbra,	May 11	7 55·9
,, ,, ,, shadow	,,	9 10·2
Middle of the eclipse	,,	10 53·4
Last contact with the shadow	,,	12 36·6
,, ,, ,, penumbra	,,	13 50·9

The first contact with the shadow occurs at 82° from the most northern point of the moon's limb, counting towards the east; the last contact at 41° from the same point, counting towards the west.

SPECTRUM OF SWIFT'S COMET (*a* 1892).—Mr. W. W. Campbell observed the spectrum of Swift's comet on April 6, by means of a spectroscope having one prism of 60° attached to the 36-inch of the Lick Observatory (*Astronomical Journal*, No. 262). The spectrum could be distinguished from about C to G. Three bright bands had the wave-lengths of their less refrangible edges determined as 5630, 5170·4, and 4723, by comparison with spark spectra of iron and magnesium. The intensities of the bands were estimated to be in the ratio 1 : 6 : 2.

COMET SWIFT, 1892.—*Astronomische Nachrichten*, No. 3087, contains the following ephemeris of Swift's comet:—

For 12h. Berlin Mean Time.

1892		R.A. h. m. s.	Decl. ° '	log *r*	log Δ	B
May	5	22 45 25	+23 41·7			
,,	6	22 48 19	24 21·5			
,,	7	22 51 12	25 0·5	0·0608	0·1115	0·70
,,	8	22 54 3	25 38·7			
,,	9	22 56 53	26 16·2			
,,	10	22 59 41	26 52·9			
,,	11	23 2 28	27 28·9	0·0723	0·1236	0·62

The brightness on March 10 is taken as unity.

On the 5th the comet will be found to form very nearly an equilateral triangle with the stars λ and μ in Pegasus, while on the 11th it will be near β in the same constellation.

COMET SWIFT, 1892.—The spectrum of this comet has been observed by Prof. Konkoly, who contributes his observations to the *Astronomische Nachrichten*, No. 3087. The spectrum on April 1 appeared very bright, and showed five bright lines whose intensities were as follows:—I = 0·4, II = 0·3; III = 1·0, IV. = 0·2, V. = 0·1, the continuous spectrum extending from λ = 580 to λ = 440.

The following measures are the means of five direct scale readings of the above-mentioned lines:—

I = 558·82 μμ
II = 544·94
III = 516·30
IV = 472·54
V = 468·78

Similar observations were also repeated the next night only by means of a larger telescope and spectroscope. The continuous spectrum was found to extend from λ = 559 μμ to λ = 449 μμ. The intensities were I = 0·5, II = 0·3, III = 1·0, IV = 0·2, V = 0·1.

The mean values of the five measures obtained for each line were:—

I = 558·40 μμ
II = 543·82
III = 516·26
IV = 472·70
V = 468·10

NOVA AURIGÆ.—*Astronomische Nachrichten*, No. 3083, contains some measurements and remarks by Prof. Konkoly relative to the spectrum of this Nova. Five lines were, according to him, very satisfactorily measured on March 20, and the means of six measures for each were as follows:—

I = 531·80 μμ
II = 516·50
III = 501·95
IV = 492·30
V = 486·15

Using a 10-inch objective prism on the 21st, he found that II was the brightest line, III being somewhat feebler, I was very weak, while IV was not bright, but broad; V, again, seemed quite visible. With regard to the dark lines, he was only able to suspect them in the region of C and F (especially the latter), owing to their feebleness. The hydrogen lines on the 21st appeared feebler than those in γ Cassiopeiæ.

A NEW VARIABLE.—A circular (No. 32) that we have received from the Wolsingham Observatory contains the following:—

The star D.M. + 55° 1870—

16h. 39m. 49s., +55° 12'·9.2

was found 7·3, 7·7, April 26, 29. Variable. Spectrum like Mira.

T. F. ESPIN.

THE TEMPERATURE OF THE BRAIN

THE Croonian Lecture was delivered this year by Prof. Angelo Mosso, Professor of Physiology in the University of Turin. His subject was the temperature of the brain, especially in relation to psychical activity. Prof. Mosso's earlier investigations on the human brain only related to the blood circulation.[1] He then found that the blood pressure rises during psychical work, and that during such more blood is sent from the peripheral parts of the body. Prof. Mosso also found that the blood circulation in the brain showed fluctuations which are not dependent on psychical activity. These and other variations in the brain circulation led him to suspect that Dr. Schiff's theory about brain temperature as introduced into physiology required revision. In a published work on fatigue,[2] Prof. Mosso gave his views on the influence of psychical work on the organism, especially on the muscular force. We do not yet know what form of phenomena subserves the first condition of thought. Fatigue caused by psychical activity acts as a poison, which affects all organs, but especially the muscular system. This is clearly demonstrated by Prof. Mosso's investigations on men who have been subjected to great mental strain. The blood of dogs, fatigued by long racing, acts as a poison, and when injected into other dogs they exhibit all the symptoms of fatigue. The characteristic phenomena of fatigue depend more on nerve-cell products than on a deficiency of suitable material.

During investigation into the physical conditions during psychical activity, Prof. Mosso's attention was directed to the subject of the temperature of the brain. To avoid errors arising from blood changes he endeavoured to keep the blood temperature and that of the organs in agreement with that of the brain. For such a purpose he found that the thermo-electric pile which Dr. Schiff employed would not suffice, and he had

[1] "Kreislauf des Blutes in menschlichen Gehirne," Leipzig, 1881.
[2] "Die Ermudung," Leipzig, 1891.

therefore made by Baudin, of Paris, some very sensitive mercurial thermometers. The investigations made with the help of these instruments on the brain and blood temperatures bring to light new evidences of activity in the nerve centres. There are sometimes very extensive temperature developments under the influence of special excitements quite independent of psychical activity. The change in the nutrition of the nerve cells, and not their specific activity, seems to be the most important source of heat in the brain. Thus Prof. Mosso would explain the marked effect on brain temperature of ordinary irritants where the increase is far higher upon the introduction of such than upon any psychical work done by the brain.

The following is an abstract of Prof. Mosso's Croonian Lecture:—

In his investigations on the temperature of the brain the author has employed, in preference to the thermo-electric pile, exceedingly sensitive mercurial thermometers, constructed specially for the purpose. Since each thermometer contains only four grams of mercury, the instruments respond very rapidly to changes of temperature, and a change of not more than 0°·002 C. can easily be measured by means of them. The author has studied the temperature of the brain, comparing it with that of arterial blood, of the muscles, and of the interior of the body. His observations were made on animals under the influence of morphia or various anæsthetics, and also on man.

The curves of the observations made show that in profound sleep a noise, or other sensory stimulus, is sufficient to produce a slight development of heat in the brain, without the animal necessarily awakening.

In profound sleep the temperature of the brain may fall below that of the blood in the arteries. This is due to the very great radiation of heat which takes place from the surface of the head.

The brain when subjected to the action of the ordinary interrupted current rises in temperature. The rise is observed earlier in the brain than in the blood, and the increase is greater in the brain than in the general blood-current or in the rectum. During an epileptic seizure, brought on by electrical stimulation of the cerebral cortex, the author observed within twelve minutes a rise of 1° C. in the temperature of the brain.

As a rule the temperature of the brain is lower than that of the interior of the body; but intense psychical processes, or the action of exciting chemical substances, may cause so much heat to be set free in the brain that its temperature may remain for some time 0°·2 or 0°·3 C. above that of the interior of the body.

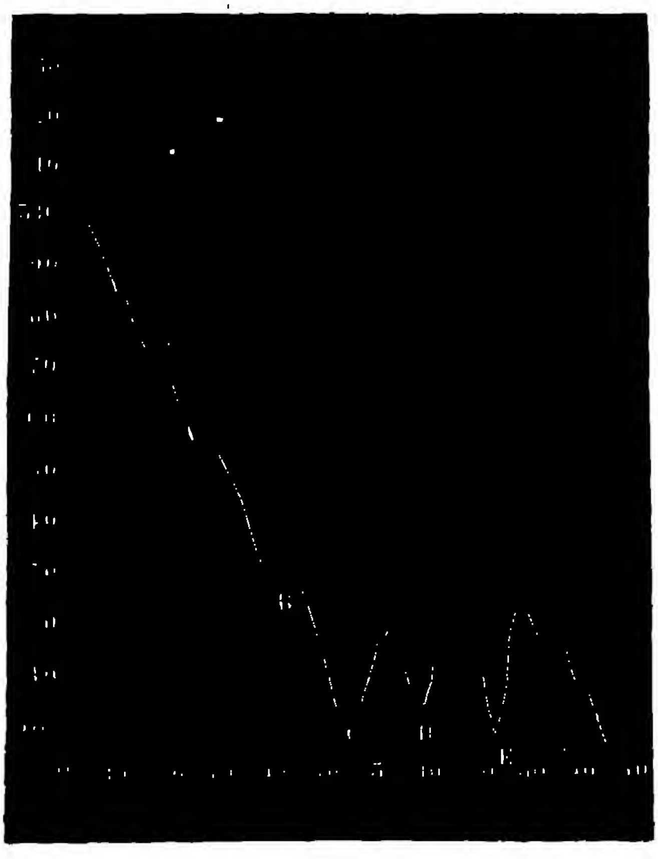


Fig. 1.—Dog rendered insensible with laudanum. The upper (thin) line represents the temperature of the interior of the body, the middle (thin) line the temperature of the blood in the carotid artery, the third (thick) line the temperature of the brain. A, injection of 3 c.c. laudanum; B, blast of a trumpet; C, D, E, electric stimulation of the brain. The ordinate is marked in tenths of a degree Centigrade, the abscissa in periods of ten minutes.

When a dog is placed under the influence of curare, the temperature of the brain remains fairly high, while that of the muscles and that of the blood falls. The difference of temperature thus brought about is great and constant. In one instance, the temperature of the brain was 1°·6 C. above that of the arterial blood in the aorta. Such observations warn us not to regard the muscles as forming, *par excellence*, the thermogenic tissue of the body.

In order to show how active are the chemical processes in the brain, it is sufficient to keep the animal in a medium whose temperature is the same as that of the blood. When the effects of radiation through the skull are thus obviated, the temperature of the brain is always higher than that of the interior of the body, the difference amounting to 0°·5 or 0°·6 C.

Observations made while an animal is awake tend to show that the development of heat due to cerebral metabolism may be very considerable, even in the absence of all intense psychical activity The mere maintenance of consciousness belonging to the wakeful state involves very considerable chemical action

The variations of temperature, however, observed in the brain, as the result of attention, or of pain or other sensations, are exceedingly small The greatest rise of temperature observed to follow, in the dog upon great psychical activity was not more than 0 01 C When an animal is conscious, no sensible by an anæsthetic, one no longer obtains a rise of temperature upon stimulating the cerebral cortex with an electric current These results cannot be explained as merely due to the changes in the circulation of the blood The physical basis of psychical processes is probably of the nature of chemical action

In another experiment, in an animal rendered insensible with chloral, the curves of temperature show that when the muscles of a limb are made to contract, the temperature of the muscles rises, but falls rapidly as soon as the stimulation ceases, soon returning to the normal. This is not the case, however, with

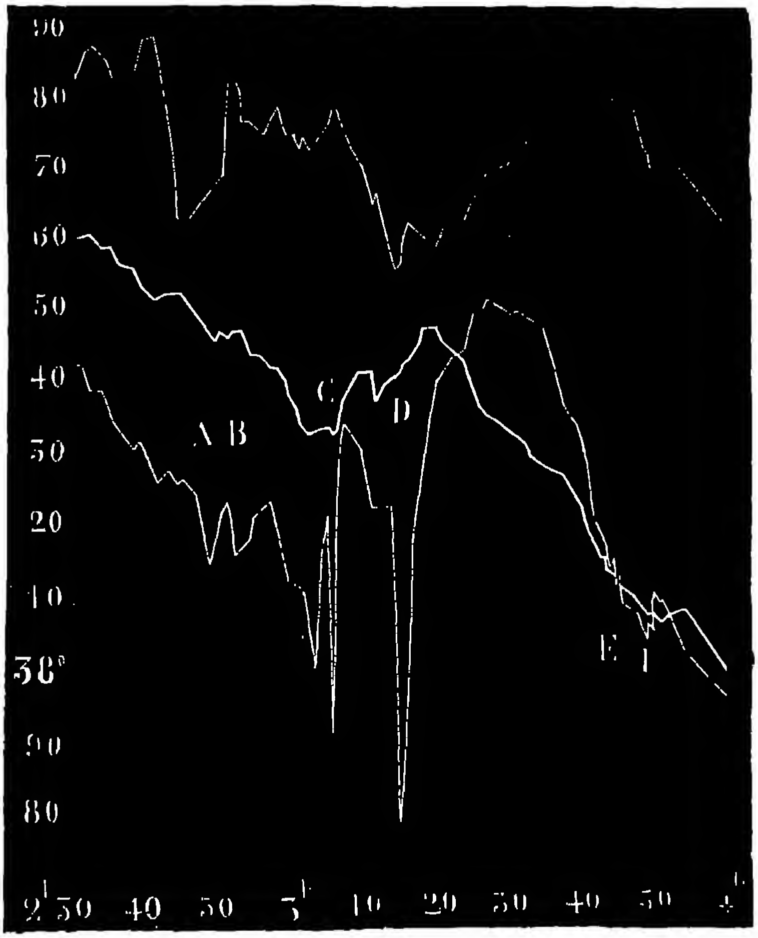


FIG 2—Dog (female) rendered insensible with chloroform and then with laudanum The upper line represents the temperature of the vagina the middle (thicker) line that of the brain the lower that of the arterial blood in the carotid artery A and B psychical emotion C, electric stimulation of the brain, D injection of 14 c c laudanum (intravenous), E and I, electric stimulation of the brain

change of consciousness, no psychical activity, however brought about experimentally, produces more than a slight effect on the temperature of the brain

The author shows an experiment by which it is seen that, as part of the effect of opium, the brain is the first organ to fall in temperature, and that it may continue to fall for the space of eighteen minutes, while the blood and the vagina are still rising in temperature.

The author discusses the elective action of narcotics and anæsthetics He shows that these drugs suspend the chemical functions of the nerve-cells. In a dog rendered completely in-the brain excited by an electric current Here the stimulus gives rise to a more lasting production of heat, the temperature may continue to increase for several minutes after the cessation of the stimulation, indeed, often for half an hour This may possibly explain why, upon an electric stimulation of the cerebral cortex, the epileptiform convulsions are not immediately developed, but only appear after the lapse of a latent period of several minutes.

This experiment may be made to show the elective action exercised upon the brain by stimulant remedies. The injection of 10 centigrams of cocaine hydrochlorate produces a rise of

temperature in the brain of 0° 36 C., without any change in the temperature of the muscles or of the rectum being observed. In a curarised dog, the intervention of the muscles being thereby excluded, the action of the cocaine may produce a rise of as much as 4° C. in the temperature of the brain, the author having observed a rise from 37° to 41° C. This shows that in arranging the calorific topography of the organism a high place must be assigned to the brain.

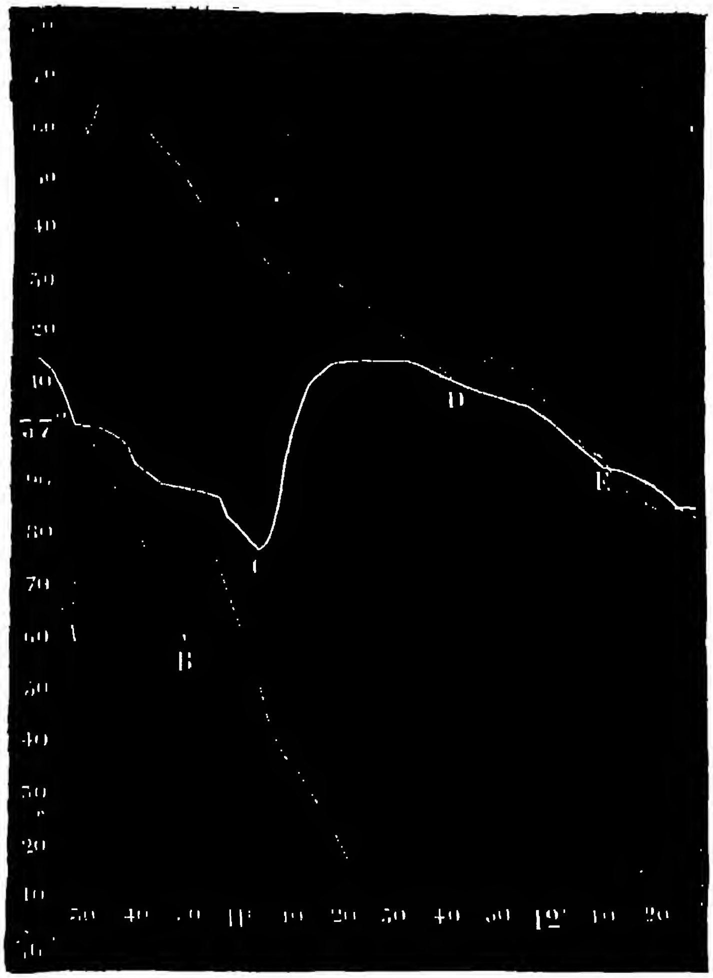


FIG. 1.—Dog rendered insensible with chloral. The upper line represents the temperature of the rectum, the middle (thicker) line that of the brain, the lower line that of the muscles of the thigh. A and B, electric stimulation of the muscles. C, injection of 10 centigrams of cocaine into the saphena vein. D, E, spontaneous variations in the temperature of the rectum.

THE MAGNETIC STORM OF FEBRUARY IN MAURITIUS.

AT a meeting of the Meteorological Society of Mauritius, that took place on April 7, Mr. Meldrum read a short paper on the sun-spots, magnetic storm, cyclones, and rainfall of February 1892. The photographs of the sun that he exhibited, which were taken at the Royal Alfred Observatory from February 5 to 18, showed the very large group of spots, their approximate latitude on the 9th being from 6° to 16° south. Leading on to the occurrence of the great magnetic storm which began at 8h. 55m. on the 13th, he states that its commencement was distinctly recorded on the three curves, the horizontal force suffering the greatest disturbance. Up to 14h. the magnet was in oscillation, the force increasing, and reaching a maximum at 13h. 43m., after which it began to decrease, the minimum being reached at 0h. 15m. on the 14th. Further abrupt movements occurred at 4h. 30m. on the 14th, the oscillations, as shown by the curves, being very numerous, but at 19h. the magnets became more steady, and were quiet by 3h. on the 15th. The ranges obtained at the Mauritius Observatory were the largest ever recorded there.

Cyclones were not absent during this month. One [illegible] from the 11th to the 14th, and another from the 25[illegible] 28th, while a third was also experienced on the 21st [illegible], about 550 miles south of Mauritius. The rainfall for F[illegible] shown by returns from the numerous stations, was fr[illegible] to 16.96 inches above the average for periods of 7 to [illegible] At Antoinette the fall for the month amounted [illegible]2.53 inches, while that at Cluny came to 34.37 inc[illegible] St. Aubin and Nouvelle France came in for a co[illegible]erable quantity of rain, the falls in the 24 hours ending [illegible] 8 a.m. on the 13th reaching the figures 5.00 and 18.20 inches respectively. Referring lastly to the magnificent displays of auroræ that have been observed both in Europe and America, he mentions that, although at Mauritius the sky was overcast, under similar conditions with respect to solar activity and terrestrial magnetism, a great display was visible in 1872, Mr. Meldrum,

in his concluding remarks as to whether "there is a causal connection between solar activity (as indicated by outbursts on the sun) and magnetic disturbances, auroras, cyclones, and rainfall," remarks that with regard to the two former there can hardly be any doubt, but with regard to the two latter he is of opinion that a very close connection does exist, there being a considerable preponderance of evidence in its favour.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—*Annual Abstract of Accounts.*—The abstract of accounts of the University for the year ending December 31, 1891, has just been published. It exhibits both the accounts of the Curators of the Chest and the financial position of the University institutions. The receipts show an income of £66,986 12s. 9d., against £65,175 17s. 2d. last year. The principal sources of internal income include estates £9978 12s. 8d., the University Press £5000, University dues £11,153 5s., examination fees £5659 1s., degree fees £9600. The Proctorial fines amount to only £313, nearly £100 less than last year. In connection with the present agitation against Proctorial jurisdiction this item is interesting. The total payments amounted to £64,557 6s. 3d. There was transferred to capital account £2225 16s. 4d., and a balance carried forward of £203 10s. 2d. In this item of expenditure, we find institutions and public buildings cost £19,085, the largest item under this head being the Bodleian Library £7772 4s. 4d., while the Taylor Institution absorbed £2245. The expenses in connection with lectures in large towns amounted to £729 11s. 8d., and the interest and sinking fund on loans for University purposes came to £6157 8s. 4d.

The loans account shows that the amounts remaining to be paid are £36,000 at 4 per cent. on the £60,000 New Schools Loan, and £7666 13s. 4d. at 2½ per cent. on the £10,000 Physiological Laboratory Loan.

The University and the County Councils.—The report on the peripatetic teaching in scientific and technical subjects carried on in various country districts under the supervision of the Oxford Delegates for University Extension, acting in concert with the Technical Instruction Committees of County Councils during last winter, has just been published. The report states that the Oxford Delegates for University Extension were requested by the representatives of eight County Councils in England to provide for the delivery of 227 courses, embracing 2271 lectures, on chemistry, agriculture, geology, botany, veterinary science, physiology, and hygiene. These courses have been regularly attended by more than 10,000 persons in all grades of society.

The relations between the University Extension Committees of the different Universities and the County Councils, in reference to the matter of technical instruction, has now become so important, that a Conference was summoned last week, under the presidency of the Provost of Queen's College, to consider this connection, and to profit by the experience already gained, an experience, which in some cases extends over two years. It was felt that there are certain mistakes, inevitable in the commencement of any large scheme, which might be advantageously removed, so as to promote greater harmony, and possibly more economy in the fuller development of the scheme. Many organizing secretaries and others interested in the scheme attended the Conference, which extended over two days.

Two principal subjects were under discussion, first, the provision of summer courses of instruction in Oxford, Cambridge, and other University towns for teachers in elementary schools; secondly, the methods of organization of peripatetic teaching in regard to hours of lectures, classes, cost, and local management. In connection with the first point, it was announced that Oxford, Cambridge, and the Yorkshire College, Leeds, would be prepared to offer accommodation to students this summer; the Victoria University has, however, made no such provision. The method of procuring instruction in practical agriculture and experimental farming occupied much of the attention of the meeting, and much stress was laid upon the importance of securing the co-operation of farmers to look after the experimental stations.

On the matter of peripatetic teaching, it was felt by some that no very great assistance could be expected from the elementary teacher, and that reliance must be placed upon the teacher supplied by the Universities, in some cases advantageously supplemented by the teachers in secondary schools.

Not the least important feature in the Conference was the anxiety displayed by all present to urge on to the utmost of their power the great work of the dissemination of technical and scientific instruction, influenced solely by disinterested motives for the public service.

CAMBRIDGE.—Prof. Bonney, F.R.S., Fellow of St. John's College, will this year deliver the Rede Lecture in the Senate House, on Wednesday, June 15, at noon. The subject is "The Microscope's Contributions to the Earth's Physical History."

The Adams Memorial Committee have issued a circular inviting contributions towards the erection of a monument to the late Prof. J. C. Adams in Westminster Abbey. These may be paid to one of the treasurers (Dr. Searle, Master of Pembroke, and Prof. Liveing), or to one of the secretaries (Dr. Porter, Master of Peterhouse, Dr. Donald MacAlister, St. John's, and Dr. Glaisher, Trinity), or to the account of the Adams Memorial Fund at Messrs. Mortlock's Bank, Cambridge. We do not doubt that the invitation will meet with a generous response from the admirers of the great astronomer.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 28.—"On a Decisive Test-case disproving the Maxwell-Boltzmann Doctrine regarding Distribution of Kinetic Energy." By Lord Kelvin, Pres. R.S.

The doctrine referred to is that stated by Maxwell in his paper "On the Average Distribution of Energy in a System of Material Points" (Camb. Phil. Soc. Trans., May 6, 1878, republished in vol. ii. of Maxwell's "Scientific Papers") in the following words:—

"In the ultimate state of the system, the average kinetic energy of two given portions of the system must be in the ratio of the number of degrees of freedom of those portions."

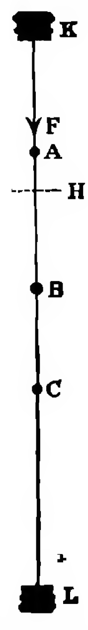
Let the system consist of three bodies, A, B, C, all movable only in one straight line, KHL.

B being a simple vibrator controlled by a spring so stiff that when, at any time, it has very nearly the whole energy of the system, its extreme excursions on each side of its position of equilibrium are small.

C and A, equal masses.

C, unacted on by force except when it strikes L, a fixed barrier, and when it strikes or is struck by B.

A, unacted on by force except when it strikes or is struck by B, and when it is at less than a certain distance, HK, from a fixed repellent barrier, K, repelling with a force, F, varying, according to any law, or constant, when A is between K and H, but becoming infinitely great when (if at any time) A reaches K, and goes infinitesimally beyond it.



Suppose now A, B, C to be all moving to and fro. The collisions between B and the equal bodies A and C on its two sides must equalize, and keep equal, the average kinetic energy of A, immediately before and after these collisions, to the average kinetic energy of C. Hence, when the times of A being in the space between H and K are included in the average, the average of the *sum of the potential and kinetic energies of* A is equal to the average kinetic energy of C. But the potential energy of A at every point in the space HK is positive, because, according to our supposition, the velocity of A is diminished during every time of its motion from H towards K, and increased to the same value again during motion from K to H. Hence, the average kinetic energy of A is less than the average kinetic energy of C!

This is a test case of a perfectly representative kind for the theory of temperature, and it effectually disposes of the assumption that the temperature of a solid or liquid is equal to its average kinetic energy per atom, which Maxwell pointed out as a consequence of the supposed theorem, and which, believed to be thus established, has been largely taught, and fallaciously used, as a fundamental proposition in thermodynamics.

It is, in truth, only for an approximately "perfect" gas—that is to say, an assemblage of molecules in which each molecule

moves for comparatively long times in lines very approximately straight, and experiences changes of velocity and direction in comparatively short times of collision—and it is only for the kinetic energy of the translatory motions of the molecules of the "perfect gas," that the temperature is equal to the average kinetic energy per molecule, as first assumed by Waterston, and afterwards by Joule, and first proved by Maxwell

"Researches on Turacin, an Animal Pigment containing Copper, Part II" By A H Church, M A, F R S, Professor of Chemistry in the Royal Academy of Arts, London

This paper is in continuation of one read before the Society in May 1869 (Phil Trans, vol clix pp 627-36) It contains an account of observations made by other investigators on turacin and on the occurrence of copper in animals, a table of the geographical distribution of the Touracos, and a list of the twenty-five known species, a chart of turacin spectra (for which the author is indebted to the kindness of Dr MacMunn), and a further examination of the chemical characters and the composition of turacin The more important positions established by the present inquiry are these —

1 The constant occurrence in eighteen out of the twenty-five known species of *Musophagidæ*, of a definite organic pigment containing, as an essential constituent, about 7 per cent of copper

2 The "turacin-bearers" comprise all the known species of the three genera, *Turacus*, *Gallirex*, and *Musophaga*, while from all the species of the three remaining genera of the family *Musophagidæ*—namely, *Corythæola*, *Schizorhis*, and *Gymnoschizorhis*—turacin is absent Furthermore, the zoological arrangement of the genera constituting this family is in accord with that founded on the presence of turacin

3 The spectrum of turacin in alkaline solution shows, besides the two dark absorption bands previously figured, a faint broad band on either side of line F, and extending from λ 496 to λ 475

4 The spectrum of *isolated* turacin in ammoniacal solution shows, besides the three bands already named, a narrow fourth band, lying on the less refrangible side of line D, and extending from λ 605 to λ 589 It probably arises from the presence of traces of the green alteration product of turacin formed during the preparation of that pigment in the isolated condition, an alteration product which is likely to prove identical with Krukenberg's turacoverdin

5 Turacin in ammoniacal solution remains unchanged after the lapse of twenty three years

6 Turacin in the dry state, when suddenly and strongly heated, yields a volatile copper-containing red derivative, which, though undissolved by weak ammonia water, is not only soluble in, but may be crystallized from, ether

7 Turacin in the dry state, when heated in a tube surrounded by the vapour of boiling mercury, becomes black, gives off no visible vapour, is rendered insoluble in alkaline liquids, and is so profoundly changed that it evolves no visible vapour when afterwards strongly heated

8 The accurate analysis of turacin offers great difficulty. The percentage composition, as deduced from those determinations which seem most trustworthy, is—

Carbon	53 69
Hydrogen	4 60
Copper	7 01
Nitrogen	6 96
Oxygen	27 74

These numbers correspond closely with those demanded by the empirical formula $C_{82}H_{81}Cu_2N_9O_{32}$, although the author lays no stress upon this expression

9 Turacin presents some analogies with hæmatin, and yields, by solution in oil of vitriol, a coloured derivative, turacoporphyrin The spectra of this derivative, both in acid and alkaline solution, present striking resemblances to those of hæmatoporphyrin, the corresponding derivative of hæmatin But copper is present in the derivative of turacin, while iron is absent from its supposed analogue, the derivative of hæmatin

Chemical Society, April 7 —Dr W H Perkin, F.R S, Vice-President, in the chair —The following papers were read —The separation of arsenic, antimony, and tin, by J Clark. The mixed sulphides of arsenic, antimony, and tin obtained in the ordinary course of quantitative analysis are dissolved in a strong solution of ferric chloride in hydrochloric acid, and the arsenic distilled off and weighed as trisulphide. The residual liquor contains the antimony as trichloride, and the tin as stannic chloride, together with ferrous and ferric chlorides Without removing the iron salts, the antimony is precipitated with hydrogen sulphide in a tepid solution containing from one quarter to one-third of its volume of hydrochloric acid and a considerable quantity of oxalic acid The precipitate, which is free from tin, is washed first with water, then with alcohol, and finally with carbon disulphide, and weighed as Sb_2S_3 after being dried at 130° When the antimony precipitate is large, it must, after drying, be digested in carbon disulphide to extract the whole of the sulphur To obviate this, the author reduces the excess of ferric chloride with thin sheet-iron, as soon as the yellow colour has disappeared the undissolved iron is removed, and the antimony which has come down is redissolved by cautiously adding ferric chloride till the solution is distinctly yellow, showing that all the tin is in the stannic state, a warm solution of oxalic acid containing about one-third of its volume of hydrochloric acid is then added, and the precipitated antimony trisulphide washed and weighed as above After removal of the antimony, the hydrogen sulphide is expelled by boiling, the oxalic acid decomposed with potassium permanganate, the tin precipitated in a hot solution with hydrogen sulphide, and allowed to stand till cold The stannic sulphide thus obtained is filtered, washed, ignited, and weighed as SnO_2 —Platinous chloride and its use as a source of chlorine, by W A Shenstone and C R Beck The authors have examined chlorine prepared from six specimens of platinous chloride of independent origin, and have found oxygen and hydrogen chloride to be present in them all From these results they conclude that platinous chloride made by any of the processes hitherto recommended, including that lately suggested by L Pigeon, contains a very perceptible quantity of some basic compound, which gives off water, together with the gases previously mentioned It was also noticed that after mercury has been exposed to the action of chlorine, in the presence of a trace of water, it becomes capable of absorbing hydrogen chloride, it is not yet certain whether this action depends on the presence of oxygen or not —Note on the adhesion of mercury to glass in the presence of halogens, by W A Shenstone The author finds that carefully purified chlorine, bromine, and iodine affect mercury like ozone, causing it to adhere to glass in a remarkably perfect manner —The decomposition of mannitol and dextrose by the *Bacillus ethaceticus*, by P F Frankland and J S Lumsden The authors find that the products of fermentation of both mannitol and dextrose by *B ethaceticus* consist of ethyl alcohol, acetic acid, carbon dioxide, hydrogen, and traces of succinic acid A considerable quantity of formic acid is also formed when the fermentation proceeds in a closed space, whilst, in fermentations conducted in flasks merely plugged with cotton wool, formic acid, except in traces, is an exceptional product This phenomenon has previously been found to occur with fermentations by means of *B ethacetosuccinicus* Formic acid is doubtless a primary product of the fermentation, but tends to break down into carbon dioxide and hydrogen In the closed space, however, equilibrium is soon established between the formic acid and its decomposition products, and part of the formic acid is subsequently found in the solution This view is supported by the fact that carbon dioxide and hydrogen are found in almost equal volumes The proportions in which the several products are obtained from mannitol are approximately represented by the equation—

$$3C_6H_{14}O_6 + H_2O = C_2H_4O_2 + 5C_2H_6O + 5CH_2O_2 + CO_2$$

In the case of dextrose the products occur in the proportions $2\cdot5C_2H_6O$ $1\cdot5C_2H_4O_2$ $3CH_2O_2$ CO_2 There is a close qualitative and quantitative resemblance between fermentations by *B ethaceticus* and those occurring by means of the *Pneumococcus* (Friedlander), which renders it probable that this ethacetic decomposition is a very general and typical form of fermentative change —The preparation of glycollic acid, by H G Colman Glycollic acid may be readily prepared by boiling concentrated potassium chloracetate solution for 24-30 hours The liquid is then distilled under reduced pressure, and the residue mixed with acetone On evaporation of the filtered solution, glycollic acid crystallizes out in colourless crystals, containing only about 0 5 per cent of ash This acid would seem to be dimorphous. Glycollic amide may be prepared by heating glycollic acid for some time to 240°, and boiling the product with aniline —Researches on silicon compounds and their derivatives, Part vi The action of silicon tetrachloride on substituted phenylamines, by J E Reynolds Diphenylamine combines with silicon tetrachloride to form an unstable addition compound,

which is decomposed below the boiling-point of benzene Ethylaniline is easily acted on by the tetrachloride, ethylaniline hydrochloride separates, and a compound having the composition $Si(PhNEt)_4$ is formed Diethylaniline is but feebly acted on by silicon tetrachloride, the compound $PhNEt_2HCl$ is formed, and probably a substance of the composition $Si(C_6H_4NEt_2)_4$ —Chemistry of the compounds of thiourea and thiocarbimides with aldehyde ammonia, by A E Dixon The alkyl and allied thiocarbimides react with aldehyde-ammonia, in accordance with the following equation—

$$R\,NCS + 2R'CH(OH)NH_2 = CSN_2H_2R(CHR')_2 + 2H_2O$$

It was suggested that some connection might exist between the class of substances so formed and the compounds obtained by the action of thiourea on the aldehyde-ammonias From the great similarity in behaviour of the compounds derived from the two sources, the author infers that they are members of the same class Though thiourea and aldehyde-ammonia readily interact, it was found impossible, under any conditions, to cause substituted thioureas to act on aldehyde ammonia The author considers that this fact indicates that the monosubstituted thioureas are of the form $HN\,C\begin{cases} NH_2 \\ SH \end{cases}$ and not $CS\begin{cases} NHR \\ NH_2 \end{cases}$ —The atomic weight of boron, by J L Hoskyns Abrahall The deceased author determined the atomic weight of boron by estimating the amount of silver necessary to precipitate the bromine from a known weight of boron bromide The mean atomic weight obtained is $10\,816 \pm 0\,0055$ Silver is taken as 107 923, and bromine as 79 951

Physical Society, April 8 —Dr J H Gladstone, F R S, Past President, in the chair —Mr Walter Baily read a paper on the construction of a colour map By the term "colour map," the author meant a diagram, each point of which defines by its position some particular colour Captain Abney had shown that all colours, except the purples, could be formed by adding white light to some spectrum colour, whilst all except the greens could be made to produce white by the addition of some spectrum colour There were, therefore, two ways in which colours, other than greens and purples, could be indicated In one of these, the ordinate of a point might represent the spectrum colour by its wave-length, and the abscissa, measured to the right of a vertical spectrum line, the amount of white light to be added to the spectrum colour to produce the colour represented by the point In the other, the abscissa of a point situated on the left of the spectrum line represents the quantity of white light produced by the addition of the spectrum colour to the colour indicated by the point Regarding the spectrum colours as formed by mixing three primary colours (red, green, and violet) in varying proportions, three curves were drawn to the left of the spectrum line whose abscissæ represented respectively the proportions of the three primary colours present in the corresponding spectrum colour Horizontal distances from any point to these curves show the proportions in which the primary colours are to be mixed produce to the particular colour defined by that point For points between the curves, the horizontal distances are not measured all in one direction, and therefore indicate abnormal or imaginary colours. The principle of the map was further illustrated by a sort of colour staff, consisting of three horizontal lines representing the three primary colour sensations (see figure) of such luminosities that equal lengths of

the three lines indicate white light If points, R, G, V, be taken in these lines, then a cross line A will cut off lengths A R, A G, A V, whose mixture will produce a certain colour If now A be moved parallel to itself towards the right, the colour will change by the addition of white light, moving A to the left means a subtraction of white light When R, G, and V are properly chosen, a certain position, S, of the cross line, corresponds to a spectrum colour The whole of the series of colours which can be obtained by adding white light to that spectrum colour can then be represented by sliding A towards the right Positions S' and A' give colours complementary to S and A The distinguishing features of such a series of colours are the differences R – G and G – V, and the author calls the ratio $\frac{R-G}{G-V}$ the "colour index." Passing up the spectrum from red to violet, the index, which is first large and positive, diminishes and becomes negative between yellow and blue; it then passes through infinity, and becomes positive and decreases to zero The subject of determining the indexes of colours resulting from the mixture in various proportions of two other colours whose indexes were known, was considered, and diagrams showing the various curves, exhibited Experimental methods of determining the proportions of the primary colour sensations constituting the spectrum tints were described A visitor inquired how the author's system provided for the class of colours outside the red and violet He also desired a definition of "white light" He himself had never been able to produce pure white by mixture of colours, for a reddish violet generally resulted On the other hand, he found it possible to match any other colour by mixture Prof Carey Foster thought Helmholtz was the first to propound the law which the author had attributed to Captain Abney He wished to know how the amounts of colour sensation were supposed to be measured White light he considered ought to be defined as light in which a normal eye, not fatigued, could perceive no preponderance of any colour Mr Blakesley said that if white light was a mixture, and only two unknowns were necessary, then any colour could be produced by the mixture of two other colours Dr Sumpner pointed out that white light was by no means a constant colour, but depended greatly on the source He thought the author's map of a more absolute nature than that proposed by Maxwell Dr Hoffert inquired whether the intensities of each spectrum colour had been considered equal or otherwise taken into account, and also whether the results arrived at would be true for intensities other than those chosen Mr. Baily, in reply, said Captain Abney had found the light from the crater in the positive carbon of an electric arc to be the most constant white, and in his method of experimenting errors due to variations of the source cancelled The quantity of any spectrum colour was defined by the breadth of the band used, the breadth being small and measured on the scale of wave-lengths —A paper on a mnemonic table for changing from electro static to practical and C G S electro-magnetic units was read by Mr W Gleed In the table, which is given below, the abbreviations *Stat* and *Mag* are used to denote the electro-static and electro-magnetic units respectively, and v stands for 3×10^{10} —

	Units of				
	Capacity	Resistance	Potential	Current	Quantity
Powers of 10 for practical and magnetic units	9	9	8	1	1
Small unit	Stat	Mag	Mag	Stat	Stat
Practical unit	Farad	Ohm	Volt	Ampere	Coulomb
Large unit	Mag	Stat	Stat	Mag	Mag
Factor for Stat and Mag	v^2	v^2	v	v	v

To form the table, the numbers 981 in the middle of the second line give the value of g The end numbers are duplicated, giving 99,811 Below them in the fourth line come the names of the practical units, the initials forming the word *fovac* Remembering that the electro magnetic units of resistance and potential were too small for practical use, one places Mag above both Ohm and Volt. Ohm's law and definitions then show that the practical units of capacity, current, and quantity must be less than the electro magnetic units, hence Mag must be written below Farad, Ampere, and Coulomb Since the practical units are intermediate in magnitude between Stat and Mag, the vacant spaces are then filled in by Stat The v's in the bottom line are added from memory Several examples showing the use of the table are worked out in the paper accompanying the table —A paper on the law of colour in relation to chemical constitution, by William Akroyd, was read by Mr Blakesley The author has observed that, in cases of compounds having a constant radical, R, and a variable radical R, the effect of an increase in the molecular weight of R is to make the colour of the compound tend towards the red end of the colour scale Exceptions are, however, noted Mr. H. M Elder questioned the author's conclusions, saying that in many cases the colours tend towards blue.

Anthropological Institute, April 26 —Dr Edward B Tylor, F R.S, President, in the chair.—Prof R K Douglas read a paper on the social and religious ideas of the Chinese, as illustrated in the ideographic characters of the language. The paper begins with a short introduction, showing that the Chinese ideographic characters are picture-writings, and that as such they supply an interpretation of the meaning of words as these were understood by the inventors of the

characters representing them. Following on this is an account of the earliest or hieroglyphic form of the writing, with examples, and the development of this resulting in the ideographic characters These are taken as being illustrative of the ideas of the people on political, social, scientific, and religious ideas. For example, the importance which was attached to the qualities of a sovereign is exemplified in the choice of the symbol employed to express a supreme ruler, the component parts of which together signify "ruler of himself" By means of the same graphic system a kingdom is shown as "men and arms within a frontier" Passing to the social habits of the people, their domestic life is illustrated by a number of ideograms descriptive of their household arrangements and relationships In succession are traced in the written characters the ideas associated with men and women, their virtues and their failings; the notions associated with marriage, and the evidences of pastoral as well as of agricultural habits among the people Turning to the popular religious faiths it is shown how prominent is the belief in the god of the soil, whose presence brings blessings, and whose averted countenance is followed by misfortune The ideas associated with objects of nature are next treated of, and the paper concludes with references to the coinage of the country as described in the ideograms employed to represent its various forms —Mr Joseph Offord, Jun., read a paper on the mythology and psychology of the ancient Egyptians

Entomological Society, April 27 —Mr Robert McLachlan, F R S, Treasurer, in the chair —Mr C G Barrett exhibited, for Mr. Sabine, varieties of the following species viz. one of *Papilio machaon*, bred by Mr S Baily, at Wicken, in 1886, one of *Argynnis lathonia*, taken at Dover in September 1883, one of *A euphrosyne*, taken at Dover in 1890, and one of *A selene*, taken at St. Osyth, in 1885, by Mr W H Harwood. He also exhibited a long series of *Demas coryli*, reared by Major Still from larvæ fed exclusively on beech, which he said appeared to be the usual food of the species in Devonshire, instead of hazel or oak Mr Barrett also exhibited, for Mr Sydney Webb, a number of varieties of *Arge galathea*, *Lasiommata megæra*, *Hipparchia tithonus*, and *Cœnonympha pamphilus*, from the neighbourhood of Dover —The Rev J Seymour St John exhibited a variety of the female of *Hybernia progemmaria* taken at Clapton in March last, in which the partially developed wings were equally divided in point of colour, the base being extremely dark and the outer portion of the wing very pale —The Rev. Canon Fowler made some remarks on the subject of protective resemblance His attention had been recently called to the fact that certain species of *Kallima* apparently lose their protective habit in some localities, and sit with their wings open, and Dr A R Wallace had informed him that he had heard of a species sitting upside down on stalks, and thus, in another way, abandoning its protective habits. Mr W. L Distant referred to certain species of South African butterflies, which, when at rest, were protected by their resemblance to the plants on which they reposed, or by their resemblance to the rocks on which they settled, but which frequently abandoned their protective habit and sat with open wings. Mr Barrett Mr McLaclan, Mr. Jacoby, Mr Champion, Mr. H. Goss Canon Fowler, and Mr Frohawk continued the discussion —Mr Goss informed the meeting that, in pursuance of a resolution of the Council passed in March last, he and Mr. Elwes had represented the Society at the recent Government inquiry as to the safety and suitability of the proposed rifle range in the New Forest, held at Lyndhurst by the Hon. T W H. Pelham, on the 20th, 21st, 22nd, and 23rd inst., and that they had given evidence at such inquiry

PARIS

Academy of Sciences, April 25 —M d'Abbadie in the chair —On the photography of colours (second note), by M G Lippmann. In his first communication on colour photography, M. Lippmann remarked that the results would have been much better if isochromatic films had been employed He has now obtained some new pictures, and presented them to the Academy Silver bromide films, stained with azalin and cyanin, were used in connection with the arrangement previously explained. The solar spectrum appears to have been photographed in all its beauty with an exposure of about thirty seconds. On two of the plates the colours viewed by transmitted light are seen to be complementary to those given by reflected light. A photograph of a window containing red, green, blue, and yellow glasses appears to be very satisfactory. Others of a group of drapery and a parrot were obtained with an exposure of from five to ten minutes. Several hours' exposure were given to a plate of oranges surmounted by a poppy, diffused light being employed. In all cases the forms of the objects were reproduced as well as the colours —On the means employed in producing rain artificially, by M Faye. The author states Espy's opinions on the formation of cyclones and other atmospheric disturbances, and quotes a letter on rain-making experiments carried out in Florida in 1857. He is of opinion that the theory which led to the experiments is wrong For, according to M. Faye, (1) water spouts, tornadoes, and cyclones move quickly during calm weather ascending columns of heated air do not move (2) Tornadoes and water-spouts whirl vigorously in a certain direction ascending columns of air do not rotate, or only do so very faintly (3) Tornadoes and water spouts are cold in the centre ascending columns of air are warm. (4) Tornadoes and water-spouts descend from clouds ascending columns rise towards the clouds, &c —On the division, according to terrestrial latitudes and longitudes, of the geological groups on the earth, by M Alexis de Tillo The following are the sums of the distribution of groups of rocks, &c, given in the tables for every ten degrees of latitude, the dimensions are expressed in millions of square kilometres —

Pre Cambrian	19 85	Glaciers		1 94
Primary	17 18	Igneous rocks		3 96
Secondary	19 85	Coral islands		0 02
Tertiary	8 71	Region	Explored	98 03
Quaternary	19 17		Unexplored	36 16
Gravels	7 35	Total		134 19

Tables are also given showing the proportion of the known surface of the globe occupied by each of the above groups, and also showing the distribution in longitude —Observations of two new planets, discovered at Nice Observatory on March 22 and April 1, by M Charlois Observations for position are given —Photography of the Ring Nebula in Lyra, by M F Denza.—Solar observations made during the first quarter of 1892, by M Tacchini (See Our Astronomical Column) —On a problem in mathematical analysis connected with equations in dynamics, by M R Liouville —Direct and indirect measures of the angle which the surface of a liquid makes with glass which it does not wet, by M C Maltézos —On thermo-electric phenomena produced by the contact of two electrolytes, by M Henri Bagard —Addition to the law of the position of nervous centres, by M. Alexis Julien —Analysis of a chromiferous clay from Brazil, by M A Terreil —On the waters and muds of the lakes of Aiguebelette, Paladru, Nantua, and Sylans, by MM L Duparc and A Delebecque.

CONTENTS.

THURSDAY, MAY 12, 1892

BRACHIOPODS OF THE ALPINE TRIAS

Brachiopoden der Alpinen Trias. Von A. Bittner. *Abhandl. d. k. k. geologischen Reichsanstalt*, Bd. xiv. 4to, 325 pages, 41 plates, and numerous zincotypes in the text. (Vienna: A. Holder, 1890.)

BOOKS on Triassic fossils, helping as they do to bridge over the gap in our knowledge of those life-forms that led from the ancient times to the middle ages of earth-history, will always be welcomed by both geologist and biologist, especially when, as in the fine work before us, they show signs of wide learning and elaborate research, and are accompanied by such figures and diagrams as place their stores of information within easy reach of all.

The Triassic rocks and Brachiopods best known to English collectors, and indeed to geologists in general, through the writings of Munster, v. Klipstein, and Laube on the one hand, and Suess and Zugmayer on the other, are those of the St. Cassian argillaceous beds and of the Hallstatt limestone. Besides these, the Brachiopods of the Alpine Muschelkalk have been largely worked out by Schauroth and Boeckh. In addition to those from these well-known horizons, Mr. Bittner surveys the Brachiopod faunas from a large number of other beds, including the Rhætic, few of which beds have been systematically worked before, but all of which may be compared with those of the above-mentioned better-known types.

Mr. Bittner has divided his work into two parts: the first, of 287 pages, being devoted to the description of species and the comparison of faunas; the second dealing with the morphology and distribution of the several genera. It will be convenient to follow a similar order in this article.

Part I. follows primarily a stratigraphical, and secondarily a topographical arrangement, so that the species are described under various faunas. In one place, however, the author stops to give us two interesting essays, one on his new genus *Halorella*, the other on the Triassic species of *Rhynchonella*, both of which should by rights have come in the second part of his work.

The descriptions are based chiefly on materials in the Museum of the Geologische Reichsanstalt and the Hofmuseum in Vienna, although a very large number of other collections—private and public—have been consulted by the author. Among these, however, we fail to notice the British Museum, which contains many of v. Klipstein's types. Mr. Bittner, it should be mentioned, invites collectors and others to send him all their material, and promises to determine the species carefully and to describe any new ones. The present volume is sufficient guarantee that the work will be carefully done.

It may well be imagined that the task set before our author was no light one. There appear to be 398 species of Brachiopods in the Trias of the Alps, and of these 216 are named for the first time in this work. But we wish that Mr. Bittner had made his book a little more of what one expects it to be from its size and scope—namely, a monograph of the Brachiopods of the Alpine Trias. Such a monograph would have included a diagnosis, if not a figure, of every species of Brachiopod known to occur in these beds; it would have summarized the literature of the subject, and it would have shown at a glance under each species in what beds and at what localities it occurred. Such a work, which need not have been a page longer than the present, would have been worth a library to students of these fossils. The author, however, has elected merely to crowd our shelves with one more book, and not even a book in the highest sense of the word. He has unfortunately not thought it necessary to give even descriptions of previously named species, unless he has something new to say about them, while his whole volume is innocent of any serious attempt at a diagnosis. Here is an example—no unfavourable one—of his method:—

"*Rhynchonella Attilina*, nov. sp."

"A small *Rhynchonella* occurring in numbers, which at first sight reminds one of the above-described *Rh. trinodosi m.* The simplest examples are very near that species and easily confused with it."

He then goes on to contrast *R. Attilina* with *R. trinodosi*, point by point, for twenty-seven lines, and so ends without any independent description of his new species, and with nothing to say how it differs from the ninety other Triassic species of the genus, not to mention the rest. And there are many worse instances than this.

We are aware that Mr. Bittner is by no means the only offender in this respect; were he so, our complaints would be unnecessary. He is merely an example of a body of writers, far too numerous in our own country, who seem to have the notion that this sort of thing is science. It is what science has to put up with, and if possible to make science out of, but there is generally about as much science in it as in an auctioneer's catalogue. The writers in question seem never to have heard of Linnæus. Had they studied his writings, they would understand that, for systematic purposes, the diagnosis is everything, that every new species described often necessitates a re-diagnosing of all other species in the genus, and in many cases involves a fresh diagnosis of the genus itself. Were this appreciated, fewer synonyms would disgrace our lists.

To return to Mr. Bittner, whose work is after all more scientific than that of most of these name-mongers. It is noticeable that he, as a rule, gives no measurements, leaving it to readers to gather these from the plates. The task of calculating average measurements is of course irksome; still it is often possible to compare species more accurately by their means than by any other.

Neither does our author ever take the trouble to inform us of the meanings of his trivial, or even generic names. "Why *R. trinodosi?*" we ask, and infer—though from nothing under the head of the species itself—that it is due to the association of the species with *Ceratites trinodosus*. But there are many names that still remain to the present writer unsolved enigmas: such are *S. pia*, *S. avarica* (unless this means *avaricensis*), and *R. generosa*. It is also rather difficult to understand why three species of Rhynchonella, all from the same district, should be called *R. cambrica*, *R. teutonica*, and *R. venetiana*. We venture to think, however, that the climax of nomenclatural aberration is reached in such a name as "*Ko-*

ninckina Leopoldi Austriæ nov spec" Here the author is following the bad example of "*Spiriferina Maximiliani Leuchtenbergensis* Klipstein *sp*," and similar preciosities of the older writer If emperors and dukes need such distinctive appellations, what must be done for ordinary mortals? Some day we shall see "*Robinsonia Gulielmi-Smithi-South-Kensingtonensis* Jones *sp*" Seriously, no amount of snobbishness can make these names binomial Mr Bittner will need no apology for these remarks, for he has written —

"Es wäre nur zu wünschen, dass man sich auch gegen andere Uebelstände und Missbräuche in der Nomenclatur in so eifriger Weise aussprechen möchte"

In his investigations into the internal structure of some of these Brachiopods the author has received much help from the researches of Mr H Zugmayer, many of which are here published for the first time Like the Rev Norman Glass, Mr Zugmayer has devoted much attention to the shape of the lophophoral support While Mr Glass, however, works his specimens out by careful dissection, Mr Zugmayer adopts the fashionable method of cutting a series of sections Morphologists, as we know, look down on palæontologists, and their real reason is that the latter cannot use the Caldwell microtome, but the figures here published will go far to remove that reproach One could wish, however, for more diagrams elucidating the results obtained by the sections

The author has made a large number of new subgenera and a few new genera, the details of which are too technical for reproduction here The following forms may be noted as strictly characteristic of the Trias —The Koninckinidæ, especially *Koninckina* and *Amphiclina*, the Thecospiridæ, certain Rhynchonellidæ, viz *Halorella*, *Dimerella*, and the subgenera *Austriella* and *Norella*, *Camerothyris* and *Cruratula*, which are two subgenera of *Waldheimia*, *Nucleatula* and *Juvavella*, two new genera of the Centronelline type of Terebratulidæ, long beaked forms of *Retzia*, most of the diplospire *Spirigeræ*, the septate *Spirigeræ* (*Amphitomella*), *Mentzelia*, a subgenus of *Spiriferina*, the doubtful *Badiotella*, and some peculiar *Cyrtinæ*

Turning now to Part II of the work, we may note the following details concerning some of the above forms

The numerous groups of *Spiriferina*, though convenient, are of uncertain value, for it is uncertain whether, in determining affinities, more weight should be attached to the structure of the beak or to the ribbing Ribbing varies greatly in forms with the same beak-structure, *e g* the *Hirsuta* group This is an instructive instance of the difficulty of classifying on other grounds than those of phylogenesis.

The *Cyrtinæ* are interesting *C Fritschii* is a new species in which the pseudo-deltidium, which in other Brachiopods is a single plate closing in the peduncular aperture, consists of two rows of separate scale-like plates alternating with one another *C Buchii* and *C Zitteli* appear to have been attached, at least in youth, by the apex of the larger valve, which is often curiously distorted This fact may explain the pseudo-deltidium of *C Fritschii*, for it may have been flexible to allow of the passage of a short peduncle or byssus. These forms lead up to *Cyrtotheca*, which was attached by one of the broad surfaces supporting the beak of the larger valve The unique original of this genus has unfortunately been lost

The genus *Spirigera* is divided into numerous groups, many of which have a secondary lamella running alongside of the main lamella that supports the spires of the lophophore, they are therefore said to be "diplospire." This structure is extremely rare in Palæozoic species of the genus

The Koninckinidæ form the most widely distributed family of the Upper Alpine Trias, and of it, as well as of the four genera belonging to it, a complete description is given In Mr Bittner's opinion this family has been shown by the researches of Mr Zugmayer to be closely allied to the Spiriferidæ The lophophore support is diplospire *Amphiclinodonta*, a new genus of this family, has an extremely complicated hinge and teeth

Badiotella is a remarkable genus founded on a single unsymmetrical large valve Its resemblance to *Streptorhynchus* suggests that it is probably a relic of the Strophomenidæ

Juvavella and *Nucleatula* are two new genera of the Centronellinæ found in the Hallstatt limestone This group has not hitherto been found in rocks of so late an age

The general relations of the Triassic Brachiopods of the Alps may be summarized as follows —

In the Lower Trias there are only two species, a *Lingula* and a *Discina*

In the Muschelkalk there are forty-two species, referable to *Lingula*, *Discina*, *Terebratula*, *Waldheimia*, *Rhynchonella*, *Spirigera*, *Retzia*, *Spiriferina*, and *Mentzelia* All these, in closely allied or even identical forms, appear again in the Upper Trias

The Upper Trias contains over 300 species, including all the types already mentioned This, therefore, is a truer representation of the Brachiopod fauna of the Triassic period. The faunas of the Lower and Middle Trias are less, merely because the conditions were not so favourable in the Alpine area

In the Triassic fauna hingeless genera are very rare

Among the hinged genera two families, each containing over 100 species, are noticeable the Spiriferidæ for the large number of genera, subgenera, and minor groups, combined with a paucity of individuals, the Rhynchonellidæ for the large number of individuals, with few well-marked genera or subgenera. The philosophic naturalist is tempted to suggest that the few divisions recognized in the latter family may be due to the very richness of the material

The spire-bearers almost exactly equal the non-spire-bearers in the number of species The latter, however, exceed in individuals, and, from this period onwards, increase in importance, while the spire-bearers soon disappear from the rock record It is, therefore, very noteworthy that, just before their extinction, the spire-bearers should not only develop new branches—the Koninckinidæ and (?) Thecospiridæ—but should also break up into so many genera, subgenera, and minor groups A similar efflorescence, as Mr. Bittner observes, marked the later history of the Terebratulidæ, a family now almost extinct

These facts are certainly opposed to the statement of Hyatt that stems give off numerous forms in their early youth, when the field is free, but not in old age, when they begin to be crowded out by the struggle for existence Possibly, however, the opposition is more apparent than real, and will disappear when the Brachiopoda shall have been studied under the guidance of modern principles of evolution. Such a study has begun in America, but we regret to see little sign of it in the present work No doubt Mr Bittner is only waiting to complete his knowledge, before entering on a field where he will meet with worse obstacles than hard rocks and battered specimens—with illusion and ignorance, prejudice and envy, obstinacy and superstition When he does start, we shall be the first to wish him good speed

F A BATHER

A TEXT-BOOK OF POLITICAL ECONOMY

Elements of Economics of Industry Being the first volume of "Elements of Economics" By Prof Alfred Marshall (London Macmillan and Co, 1892)

THE nomenclature of this work reminds us of the ancient custom according to which the alternate generations of a family were named alike As the son of Hipponicus was called, not after Hipponicus, but after Hipponicus' father, Callias, so the "Economics of Industry," though sprung from the "Principles of Economics," of which it is a miniature, yet does not derive its title from that work, but from the predecessor of that work, the well-known text-book which saw the light some thirteen years ago The first and the second "Economics of Industry" are unlike in form, but a general family resemblance may be traced between the two generations A sort of reversion is presented by the circumstance that trades unions are discussed in the latest as in the earliest of our author's books, but not in the intermediate "Principles of Economics" The character of the "Economics of Industry" the younger, and its position in the family group, may best be indicated if, comparing it with its immediate predecessor, the second edition of the "Principles of Economics," we notice what has been retained what has been omitted, and what has been added

The fundamental principles of political economy as enounced by Prof Marshall in his *magnum opus*, have been transferred to the pages before us without alteration The conception of economics as he science of measurable—not necessarily selfish—motives is again the starting-point Thence we are led to the construction of demand-curves, and that construction by which the benefit which the consumer derives from fall in price is represented Corresponding to demand-curves and "consumer's rent" are, on the other side of the counter, so to speak, supply curves and rent proper But the correspondence is not close, and the diagrammatic representation of the conditions of supply presents peculiar difficulties. It is perplexed by the principles of "increasing" and "decreasing returns" Difficulty is caused by the distinction—first clearly indicated by Prof. Marshall—between "long periods" and "short periods." An effort is required to realise the idea of supply, as it were, projected through time—the vast conception of skilled work put upon a future labour-market by parental providence for vicarious remuneration The forces of demand and supply determine price, acting simultaneously, in the sense in which equations are called simultaneous "Just in the same way, when several balls are lying in a bowl, they mutually determine one another's position" The law of demand and supply—the gravitation of the economic system—governs widely distant spheres, not only exchange in the proper narrow sense, but also distribution Prof Marshall was, we believe, the first clearly to discern this identity But, while contemplating the unity of the genus, he has not lost sight of the diversity of the species No one else has so fully enumerated and allowed for what may be called the *propria* of the different markets, such as the circumstance that many of the disadvantages in bargaining to which the workman is subject are *cumulative* It is this union of wide general views with minute knowledge of concrete details which imparts peculiar weight to Prof Marshall's recommendations respecting questions of practical moment, such as the limitation of the hours of labour

These lessons have now been made easier by the omission of much that is accessory and abstruse in the original volume, in particular, the literary criticisms and the mathematical demonstrations Among the latter class of omissions two seem conspicuous the difficult formula for discounting future pleasure, and what may be called the higher theory of the supply-curve, including its possible plural intersection with the demand-curve. Difficult, the present writer may well call these theories, for he has to confess that he was mistaken in some strictures passed upon them in a review of the first edition of the "Principles of Economics" (NATURE, August 14, 1890) The fuller statements about those subjects contained in the second edition made it evident that there had occurred what more frequently occurs than is acknowledged the author was right, and the critic was wrong The little incident may be referred to as justifying the plan of abridgment which has been adopted—by omission rather than compression of difficult demonstrations "It seemed that the difficulty of an argument would be increased rather than diminished by curtailing it and leaving out some of its steps" There results a text-book eminently fitted for the purpose of education, embodying the result of original reflections in a shape adapted to the needs of beginners, complete in itself, yet capable of being supplemented by the judicious teacher who, referring to the "Principles of Economics," may point to that higher world of thought and lead the way

Practical exigencies have induced Prof Marshall to forestall the discussion of trade unionism which may be expected in the second volume of the "Principles of Economics" In the work before us he thus states the claim of unions to make economic friction act in favour of the workman —

"A viscous fluid in a vessel tends to form a level surface; but, if from time to time an artificial force pushes down the left side, which we may take to correspond to wages, it may reasonably be maintained that the average position of the left side is lower than it would have been without such interference, in spite of the in-

disputable fact that the force of gravitation is constantly tending to reinstate the position of equilibrium What unions claim to be able to do corresponds to applying frequent and stronger pressure on the right-hand side, thus causing profits to yield the higher level to wages"

To this argument there is opposed a preliminary objection, that friction is not strong in the labour-market, that competition is much more effective than unionists assume There is wanting, indeed, an exact measure of this friction, as in the case of so many economic forces, one must be content with a rough mean between the divergent statements of experienced persons. The claim on behalf of the unions may now be considered under two heads—with reference to a single trade, and where the union is supposed to be extended to all the trades of a country But we cannot here follow the subtle argument into all the intricacies of the subject We shall refer only, or chiefly, to the latter case—which, in view of the developments of the new unionism, cannot be regarded as imaginary—the case of a supposed universal union The main argument against this sort of unionism is that a rise of wages obtained at the expense of profits tends to cause a diminution, or at least a check to the growth, of those accumulations from which the remuneration of the labourer is derived "This old argument has both gained and lost strength in recent times" Upon a balance of considerations, it still appears weighty, it is even cumulative, the diminution of the national dividend being progressive from year to year Two counter-arguments are urged by unionists First, they claim that through their policy the machinery of the labour-market works more smoothly, thus it saves the employer trouble and anxiety to be able to buy his labour—just as it does to buy his raw material—at wholesale prices (a fixed minimum rate of wage) After a detailed consideration of the policy of trade unions, Prof Marshall concludes that in some cases—especially where the invigorating effect of foreign competition is felt—"trade unions, on the whole, facilitate business" It is sometimes otherwise with trades which have a monopoly of some special skill A second great argument in favour of trades unions is that they have increased the efficiency of workmen, thereby increasing the total produce The beneficial effect on the standard of life is to be admitted in cases like that of the London Docks "But this answer is not open to those unions or branches of unions that in effect foster dull and unenergetic habits of work" Where reasons are so conflicting, it were to be wished that direct observation were available But here, as elsewhere in economics, history is difficult to interpret There is, indeed, the patent fact that those occupations in which wages have risen most in England are those in which there are no unions namely, the kinds of domestic service and the employments of women for which there has been an increase of demand and a check of supply On the other hand are urged cases in which higher wages have attended stronger unions. But we cannot be quite certain that the gain of one trade is not obtained at the expense of a greater loss to some other trade Also prosperity may be rather a cause than a consequence of the prevalence of trades unions The general conclusion appears to be that unions are not to be condemned or extolled in the abstract, but only after attending to the particular character of each, and considering whether its policy complies with the conditions of success Where the consequences for good or evil are so widespread, and the issues are to a large extent moral—whether unionists are procuring a small good immediately and for themselves at the expense of a greater loss in the future or to other classes—it is natural to appeal to public sympathy and criticism "Public opinion, based on sound economics and just morality, will, it may be hoped, become ever more and more the arbiter of the conditions of industry" Among the means of educating public opinion we should place high the study of the "Economics of Industry"

F Y E

OUR BOOK SHELF

Elements of Materia Medica and Therapeutics including the whole of the Remedies of the British Pharmacopœia of 1885 and its Appendix of 1890 By C E Armand Semple, B A, M B (Cantab), M R C P Pp 480 (London Longmans, Green, and Co, 1892)

When a knowledge of medical botany was absolutely necessary to the student of materia medica, such works as Pereira's "Elements" and Bentley's "Text-book of Organic Materia Medica" supplied a real want in this direction But with the altered ideas of modern teaching there is a growing tendency among examiners to demand rather a thorough knowledge of the chemistry and intimate action of the active principles of drugs than of their botanical sources This being the case, it is a little difficult to understand why the work at present under notice has been written Mr Semple thinks that by the aid of his book and of the illustrations contained therein, the student will be able to master the subject, and will have the facts impressed upon him more vividly by the pictures We think, however, that most will agree with us that one of the already well-known text-books, such as the excellent one by Mitchell Bruce, or the larger and more comprehensive one by Brunton—used in connection with a materia medica museum—will make the subject at least equally interesting, and enable the worker to pass a far better examination Since the 440 illustrations included in the text appear to be brought forward as the strong point of Mr Semple's cram-book, we must draw attention to a few of their peculiarities noticeable at a glance In the first place, non-officinal parts of plants are sometimes illustrated, and not the officinal parts. Again, some of the plates, though good enough in themselves, such as those illustrating the extraction of tar and the collection of asafœtida, narrowly escape being ludicrous in a work on materia medica Others, such as that showing a sulphuric acid factory, give the student no idea of the principles involved in the processes of preparation, and it is these alone which are of importance to him Many sketches are evidently inserted simply because the blocks were at hand Lastly, in the inorganic portion we regret to notice the complete absence of chemical equations and formulæ, without a knowledge of which the student's knowledge is indeed rudimentary

Elementary Lessons in Heat By S E Tillman, Professor of Chemistry, U S Military Academy. Second Edition (New York. John Wiley and Sons London · Gay and Bird 1892)

The "Lessons" presented in this volume were originally prepared for the use of students at the U S. Military Academy They are well fitted for students who can devote only a limited time to this branch of science, for

the author not only knows his subject thoroughly, but understands how to deal with it in a way that shall be readily intelligible His main object has been to direct attention only to important facts and principles, and to bring out the various links by which they are logically connected with one another There are eleven chapters, in which he treats of thermometry, dilation of bodies, calorimetry, production and condensation of vapour, change of state, hygrometry, conduction, radiation, thermo-dynamics, terrestrial temperatures, aerial meteors, and aqueous meteors Few changes have been made in the present edition, but the author has introduced a collection of elementary problems, which, as he says, may be "advantageously solved in connection with the subject-matter to which they appertain"

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

Aurora

THERE was a fine aurora visible in this locality on Saturday night, April 23 It was seen at intervals, whenever the clouds broke away, until after midnight This display is specially interesting, because it forms the continuation of a series of recurrences, at the precise interval of twenty-seven days, which began in December, the dates being as follows December 9, January 5, February 2, February 29, March 27, and April 23 Some of these displays have been brilliant, and all of them have been well defined In the table of auroras which I have constructed, based upon a periodicity corresponding to the time of a synodic revolution of the sun—namely, twenty-seven days, six hours, and forty minutes—there was, for several years preceding the sun spot minimum in 1889 and 1890, a return each spring of series of recurrences associated with the same part of the sun as that above described A corresponding systematic tabulation of the records of solar conditions shows that this association bears a direct relation to reappearances at the eastern limb of an area which has been much frequented by spots and faculæ, and which has been located persistently south of the sun's equator In like manner there are other areas located in the sun's northern hemisphere which have been much disturbed, and whose reappearances at the eastern limb have been attended year after year by series of recurrences of the aurora, in the autumn months chiefly, if not exclusively From this it would appear that, in order that a solar disturbance may have its full magnetic effect upon the earth, it is necessary that it should be at the sun's eastern limb, and as nearly as possible in the plane of the earth's orbit It appears, also, that the disturbances which recur upon certain parts of the sun so persistently year after year have greater magnetic effect than those of comparatively sporadic character located elsewhere

Lyons, N Y, April 25 M A VEEDER

The White Rhinoceros

IN my "Naturalist in the Transvaal" (p. 5), I recently deplored the supposed fact that a perfect skin or skeleton of *Rhinoceros simus* was unknown in any Museum, and I relied for my information on the interesting communication in your columns made by Dr Sclater (vol xliii p 520).

I have just received a very welcome letter from Dr Jentink, the Director of the Leyden Museum, stating that there are two skins to be found in that collection, "one in a rather bad state, but the other a beautiful stuffed specimen, measuring more than 3½ metres."

Dr Jentink had published this information in *Notes from the Leyden Museum* (October 1890), a communication I had not seen when I returned from the Transvaal and wrote on the matter

This is a most gratifying fact for all zoologists, and the Leyden Museum appears to have a unique treasure

Purley, Surrey, May 3. W L DISTANT

The Line Spectra of the Elements.

IN Prof Runge's article on the spectra of the elements in last week's issue of NATURE (p 607) he refers to my explanation of double lines in the spectra of gases ("Cause of Double Lines in Spectra," Trans of the Roy Dublin Soc, vol iv 1891, p 563), and says —"I do not understand the decomposition of the arbitrary curve" [rather, of the actual motion of the electric charge within the molecules of the gas] "in a series of superposed ellipses" [rather, into a series of pendulous motions in ellipses] "For the movement is supposed not to be periodical" [rather, is not known to be periodical], "and Fourier's theorem then would not apply, at least the periods of the superposed ellipses would not be definite, as long as there are no data except the arbitrary curve itself" [rather, no data except those furnished by the positions and intensities of the spectral lines]

Prof Runge will pardon me if I say that this objection seems to me to be of the same kind as a doubt with respect to the value of tables of logarithms on the ground that many logarithms are incommensurable with integer numbers, and therefore cannot equal decimal fractions

Take, for example, a simple vibratory movement of an electron within the molecules, represented by

$$x = a\sin\left(2\pi\frac{mt}{j}\right) + b\sin\left(2\pi\frac{\pi mt}{j}\right), \qquad (1)$$

which would give rise to two lines in the spectrum with oscillation frequencies m and πm in each jot of time This, Prof Runge objects, cannot be analyzed by Fourier's theorem, because it is not periodic But

$$x = a\sin\left(2\pi\frac{mt}{j}\right) + b\sin\left(2\pi\frac{3\ 14159\ mt}{j}\right), \qquad (2)$$

$$x = a\sin\left(2\pi\frac{mt}{j}\right) + b\sin\left(2\pi\frac{3\ 141593\ mt}{j}\right), \qquad (3)$$

$$x = a\sin\left(2\pi\frac{mt}{j}\right) + b\sin\left(2\pi\frac{3\ 1415927\ mt}{j}\right), \qquad (4)$$

&c, &c, &c,

being periodic, can be so analyzed The motion represented by the first of these (Equation 2) approximates for a certain time to the actual motion which is represented by Equation 1 The motion represented by the next (Equation 3) approximates more closely and for a longer time, and so on So that Fourier's theorem can be applied to motions which approximate to the non periodic motion represented by Equation 1, in any assigned degree and for any assigned time, just as a decimal can approximate in any assigned degree to the value of log 8, although no decimal can equal that logarithm

G JOHNSTONE STONEY

9 Palmerston Park, Dublin, May 1

On a Proposition in the Kinetic Theory of Gases

IN last month's *Philosophical Magazine* there is a paper by Lord Rayleigh criticizing a demonstration by Maxwell of the equality of the products $dp_1 \ldots dp_n, dq_1 \ldots dq_n$, and $dP_1 \ldots dP_n, dQ_1 \ldots dQ_n$, where the p's and P's are the momenta, and the q's and Q's the co-ordinates, of a system at the beginning and end of any interval of time.

Lord Rayleigh correctly points out that the assumption of E, the total Energy, as an independent variable, vitiates the proof, and he suggests the substitution of Hamilton's principal function S for the characteristic function A, with t, the time, as an independent variable

Prof. Boltzmann took a similar objection to Maxwell's demonstration in a paper to the *Philosophical Magazine* in the year 1882, in the course of some comments on my use of the proof in a small treatise on the kinetic theory of gases, and I then privately suggested to him the substitution of S for A, with t independent, as proposed by Lord Rayleigh But unfortunately, as I now see, the proposition $dp_1 \ldots dq_n = dP_1 \ldots dQ_n$, with t independent, although doubtless true, has no application to the particular problem in the kinetic theory of gases to which I was applying it

My object was to abbreviate and simplify the proof of a fundamental theorem in the subject originally given by Boltzmann, and which may be fairly well illustrated by the following simple case:—

Suppose that in the plane of a projectile there are two infinite

parallel straight lines, A and B, and we introduce such a relation between x_0, y_0, x, and y as will express that when the former is a point on the line A the latter will be a point on B, each of the four quantities x, y, u, v may then be expressed as a function of x_0, y_0, u_0, v_0, and it may be proved that

$$dx\,dy\,du\,dv = \frac{V_0}{V} dx_0\,dy_0\,du_0\,dv_0,$$

where V_0 and V are the resolved parts of the projectile's velocity perpendicular to the two lines as it crosses A and B respectively

For instance, let the lines be vertical $x = a$ and $x = b$, where $b - a = c$ Our equations are—

$$x - x_0 = c = u_0 t$$
$$y - y_0 = v_0 t - \frac{gt^2}{2}$$
$$v = v_0 - gt$$
$$u = u_0$$
$$t = \frac{c}{u_0}, \quad v = v_0 - \frac{gc}{u_0}, \; u = u_0, \; x = x_0 + c, \; y = y_0 + \frac{v_0 c}{u_0} - \frac{gc^2}{2u_0^2},$$

and

$$\Delta = 1 = \frac{u}{u_0}$$

Also here $t = \frac{c}{u_0}$ is *not* constant, as it depends upon u_0

Next let the lines be horizontal, $y = a$, $y = b$, $b - a = c$ We then have

$$(1) \quad y - y_0 = c = v_0 t - \frac{gt^2}{2}$$
$$(2) \quad x - x_0 = u_0 t$$
$$(3) \quad u = u_0$$
$$(4) \quad v = v_0 - gt$$

From (1)

$$t = \frac{v_0 - \sqrt{v_0^2 - 2cg}}{g}, \qquad x = x_0 + \frac{u_0}{g}\left(v_0 - \sqrt{v_0^2 - 2cg}\right),$$
$$y = y_0 + c, \qquad u = u_0, \qquad v = \sqrt{v_0^2 - 2cg},$$

and our determinant Δ is

$$\begin{vmatrix} 1, & 0, & \frac{v_0 - \sqrt{v_0^2 - 2cg}}{g}, & \frac{u_0}{g}\left\{1 - \frac{v_0}{\sqrt{v_0^2 - 2cg}}\right\} \\ 0, & 1, & 0, & 0 \\ 0, & 0, & 1, & 0 \\ 0, & 0, & 0, & \frac{v_0}{\sqrt{v_0^2 - 2cg}} \end{vmatrix}$$

$$= \frac{v_0}{v}$$

If our lines were $y = mx$ and $y = mx + c$, our additional condition would be

$$y - y_0 = m(x - x_0) + c,$$

and the result mentioned could be arrived at, although with a little additional work

The actual problem proposed by Boltzmann is the same as this in principle, although of much greater complexity, and it is treated by him with the utmost generality The important thing here is to show that the S function with t constant is of no application, inasmuch as in both of these very simple illustrations we have t a dependent variable depending upon u_0 or v_0.

I am only pointing out that the S method, with t independent, would not help to establish the particular proposition to which I am referring It may lead to the determination of a law of permanence of distribution independently of this proposition and by a simpler treatment The Boltzmann treatment, however, avoids the difficulty which may arise from the fact that *encounters*, whether of finite or infinitely short duration, involve the assumption of discontinuous forces, and, therefore, of a corresponding discontinuity in the form of the S function

A little consideration shows that the condition E constant cannot lead to any determinate relation between the differential products $dp_1 \ldots dq_n$ and $dP_1 \ldots dQ_n$

For to take again the simple case of the projectile Here we get four equations between the nine quantities, $x_0\, y_0\, u_0\, v_0$, $x\, y\, u\, v$ and t, whence it is clear that the elimination of t does not enable us to arrive at more than three equations between the remaining eight quantities, and therefore that we cannot express x, y, u, v separately as determinate functions of $x_0\, y_0\, u_0\, v_0$ To enable us to do this we need one additional condition, and this may be supplied in an infinite number of ways. It may be one of the conditions above considered leading to the equation $dx\,dy\,du\,dv = \frac{V_0}{V} dx_0\,dy_0\,du_0\,dv_0$, or it may be the condition t constant leading to the equality of these differential products, and so forth, but the condition E constant supplies no additional relation between the eight variables This conclusion holds equally for n degrees of freedom, following from the two partial differential equations in $q_1 \ldots q_n$, $Q_1 \ldots Q_n$, to which the characteristic function A is subject, so that the condition E constant leads to no determinate relation between the differential products

This conclusion is not inconsistent with Maxwell's proof That proof takes the form—

$$dp_1 \ldots dq_n = \frac{\Delta}{\Delta'} dP_1 \ldots dQ_n,$$

where Δ is equal to Δ', but it may be proved that in this case Δ and Δ' are separately zero, and therefore that, as stated above, no relation can be established between the two differential products

H W. WATSON.

Berkeswell Rectory, Coventry

Palæonictis in the American Lower Eocene

PALÆONTOLOGISTS will welcome Dr T L Wortman's discovery of a nearly complete skull of *Palæonictis* in the Wahsatch Lower Eocene of Wyoming The only specimens of this form known hitherto are the two fragmentary lower jaws from the Suessonian lignites of France upon which De Blainville founded the genus in 1841 This specimen includes the facial region of the skull and the complete lower jaws in fine preservation We owe it to the expert skill of Dr Wortman, for the fossil was found completely dissociated, he carried several sacks of the *débris* surrounding the fragments fifteen miles to the nearest river, and by careful washing recovered all the teeth

The skull is about the size and form of that of the Puma (*Felis concolor*), without the long muzzle so characteristic of all the early Carnivores or Creodonts The dental series is remarkably compressed and reduced, especially in the upper jaw, the formula being I $\frac{3}{3}$, C $\frac{1}{1}$, P $\frac{4}{4}$, M $\frac{2}{2}$ The third upper molar has entirely disappeared, the second is as small as the little tubercular in the modern cats, the first is smaller than the fourth premolar The latter tooth, in conjunction with the first true lower molar, is in course of transformation into a *sectorial* This and many other features point to the conclusion that *Palæonictis* is closely related to the Eocene ancestors of the Felidæ—which have hitherto been considered a gap in the fossil series

The type, which we may call *P occidentalis*, will soon be fully figured and described HENRY F OSBORN

American Museum of Natural History, April 19

WATERSTON'S THEORY OF GASES

ON the 11th of December, 1845, a paper by Mr J J Waterston, entitled "On the Physics of Media that are composed of Free and Perfectly Elastic Molecules in a State of Motion," was communicated by Captain Beaufort, R.N, to the Royal Society.

This paper was not published at the time, but was relegated to the Archives. It now, however, has just been issued as a part of the current volume of Philosophical Transactions.

It is preceded by an introduction by Lord Rayleigh, one of the Secretaries of the Royal Society, and we cannot do better—in order to call attention to this remarkable paper, which anticipates the present theories in many respects, and to explain how it is that it now appears—than print Lord Rayleigh's introduction as it stands, and also the introduction to the memoir itself.

"*Introduction by Lord Rayleigh, Sec R S*

"The publication of this paper after nearly half a century demands a word of explanation , and the opportunity may be taken to point out in what respects the received theory of gases had been anticipated by Waterston, and to offer some suggestions as to the origin of certain errors and deficiencies in his views

"So far as I am aware, the paper, though always accessible in the Archives of the Royal Society, has remained absolutely unnoticed Most unfortunately the abstract printed at the time (Roy Soc. Proc , 1846, vol v p 604 ,) gave no adequate idea of the scope of the memoir, and still less of the nature of the results arrived at The deficiency was in some degree supplied by a short account in the Report of the British Association for 1851 ( ), where is distinctly stated the law, which was afterwards to become so famous, of the equality of the kinetic energies of different molecules at the same temperature

"My own attention was attracted in the first instance to Waterston s work upon the connection between molecular forces and the latent heat of evaporation, and thence to a paper in the *Philosophical Magazine* for 1858, 'On the Theory of Sound' He there alludes to the theory of gases under consideration as having been started by Herapath in 1821, and he proceeds —

"'Mr. Herapath unfortunately assumed heat or temperature to be represented by the simple ratio of the velocity instead of the square of the velocity—being in this apparently led astray by the definition of motion generally received—and thus was baffled in his attempts to reconcile his theory with observation If we make this change in Mr Herapath's definition of heat or temperature, viz that it is proportional to the *vis viva*, or square velocity of the moving particle, not to the momentum, or simple ratio of the velocity, we can without much difficulty deduce, not only the primary laws of elastic fluids, but also the other physical properties of gases enumerated above in the third objection to Newton's hypothesis. In the Archives of the Royal Society for 1845 46, there is a paper "On the Physics of Media that consist of Perfectly Elastic Molecules in a State of Motion," which contains the synthetical reasoning upon which the demonstration of these matters rests. The velocity of sound is therein deduced to be equal to the velocity acquired in falling through three-fourths of a uniform atmosphere This theory does not take account of the size of the molecules It assumes that no time is lost at the impact, and that if the impact produce rotatory motion, the *vis viva* thus invested bears a constant ratio to the rectilineal *vis viva*, so as not to require separate consideration It also does not take account of the probable internal motion of composite molecules , yet the results so closely accord with observation in every part of the subject as to leave no doubt that Mr Herapath's idea of the physical constitution of gases appproximates closely to the truth M Kronig appears to have entered upon the subject in an independent manner, and arrives at the same result , M Clausius, too, as we learn from his paper "On the Nature of the Motion we call Heat" (*Phil Mag* , vol xiv , 1857, p 108)'

"Impressed with the above passage and with the general ingenuity and soundness of Waterston's views, I took the first opportunity of consulting the Archives, and saw at once that the memoir justified the large claims made for it, and that it marks an immense advance in the direction of the now generally received theory The omission to publish it at the time was a misfortune, which probably retarded the development of the subject by ten or fifteen years It is singular that Waterston appears to have advanced no claim for subsequent publication, whether in the Transactions of the Society, or through some other channel At any time since 1860 reference would naturally have been made to Maxwell, and it cannot be doubted that he would have at once recommended that everything possible should be done to atone for the original failure of appreciation

"It is difficult to put oneself in imagination into the position of the reader of 1845, and one can understand that the substance of the memoir should have appeared speculative, and that its mathematical style should have failed to attract But it is startling to find a referee expressing the opinion that 'the paper is nothing but nonsense, unfit even for reading before the Society' Another remarks 'that the whole investigation is confessedly founded on a principle entirely hypothetical, from which it is the object to deduce a mathematical representation of the phenomena of elastic media It exhibits much skill and many remarkable accordances with the general facts, as well as numerical values furnished by observation The original principle itself involves an assumption which seems to me very difficult to admit, and by no means a satisfactory basis for a mathematical theory, viz that the elasticity of a medium is to be measured by supposing its molecules in vertical motion, and making a succession of impacts against an elastic gravitating plane' These remarks are not here quoted with the idea of reflecting upon the judgment of the referee, who was one of the best qualified authorities of the day, and evidently devoted to a most difficult task his careful attention , but rather with the view of throwing light upon the attitude then assumed by men of science in regard to this question, and in order to point a moral The history of this paper suggests that highly speculative investigations, especially by an unknown author, are best brought before the world through some other channel than a scientific Society,which naturally hesitates to admit into its printed records matter of uncertain value Perhaps one may go further, and say that a young author who believes himself capable of great things would usually do well to secure the favourable recognition of the scientific world by work whose scope is limited, and whose value is easily judged, before embarking upon higher flights

"One circumstance which may have told unfavourably upon the reception of Waterston's paper is that he mentions no predecessors Had he put forward his investigation as a development of the theory of D Bernoulli, a referee might have hesitated to call it nonsense It is probable, however, that Waterston was unacquainted with Bernoulli's work, and doubtful whether at that time he knew that Herapath had to some extent foreshadowed similar views

"At the present time the interest of Waterston's paper can, of course, be little more than historical What strikes one most is the marvellous courage with which he attacked questions, some of which even now present serious difficulties To say that he was not always successful is only to deny his claim to rank among the very foremost theorists of all ages. The character of the advance to be dated from this paper will be at once understood when it is realized that Waterston was the first to introduce into the theory the conception that heat and temperature are to be measured by *vis viva*. This enabled him at a stroke to complete Bernoulli's explanation of pressure by showing the accordance of the hypothetical medium with the law of Dalton and Gay-Lussac In the second section the great feature is the statement (VII), that 'in mixed media the mean square molecular velocity is inversely proportional to the specific weight of the molecules' The proof which Waterston gave is doubtless not satisfactory , but the same may be said of that advanced by Maxwell fifteen years later The law of Avogadro follows at once, as well as that of Graham relative to diffusion. Since the law of equal energies was actually published in 1851, there can be no hesitation, I think, in attaching Waterston's name to it The attainment of correct results in the third section, dealing with adiabatic expansion, was only prevented by a slip of calculation.

"In a few important respects Waterston stopped short There is no indication, so far as I can see, that he recognized any other form of motion, or energy, than the translatory motion, though this is sometimes spoken of as vibratory. In this matter the priority in a wider view rests with Clausius According to Waterston the ratio of specific heats should be (as for mercury vapour) 1 67 in all cases Again, although he was well aware that the molecular velocity cannot be constant, there is no anticipation of the law of distribution of velocities established by Maxwell

'A large part of the paper deals with chemistry, and shows that his views upon that subject also were much in advance of those generally held at the time

"The following extract from a letter by Prof McLeod will put the reader into possession of the main facts of the case —

"'It seems a misfortune that the paper was not printed when it was written, for it shadows forth many of the ideas of modern chemistry which have been adopted since 1845, and it might have been the means of hastening their reception by chemists

"'The author compares the masses of equal volumes of gaseous and volatile elements and compounds, and taking the mass of a unit volume of hydrogen as unity, he regards the masses of the same volume of other volatile bodies as representing their molecular weight, and in the case of the elements he employs their symbols to indicate the molecules

"'In water he considers that the molecule of hydrogen is combined with half a molecule of oxygen, forming one of steam, and he therefore represents the compound as $HO_{\frac{1}{2}}$ He does not make use of the term "atom" (although he speaks of atomic weight on p 18, but thinks it divisible), and if he had called the smallest proportion of an element which enters into combination an atom, he would probably have been led to believe that the molecules of some of the simple bodies contain two atoms, and he might have adopted two volumes to represent the molecule, as is done at the present time The author calls one volume or molecule of chlorine Cl, one volume or molecule of hydrogen H, and one volume or molecule of hydrochloric acid $H_{\frac{1}{2}}Cl_{\frac{1}{2}}$ If he had regarded the molecules as containing two indivisible atoms, these bodies would have been represented, as now, by the formulæ Cl_2, H_2, and HCl respectively, all occupying two volumes § 15 shows how near he was to this conception Gerhardt, in the fourth part of his "Traité de Chimie Organique," published in 1856, points out the uniformity introduced into chemical theory by the adoption of this system.

"'For carbon he makes C = 12, as now accepted, although I do not find how he arrives at this number He seems to have anticipated one of Ramsay's recent discoveries, that nitrous anhydride (hyponitrous acid, $ON_{\frac{2}{3}}$, No 26 in the table) dissociates on evaporation into nitric oxide (binoxide of nitrogen, No 23) and nitric peroxide (nitrous acid, No. 25)

"'The values for the symbols for sulphur, phosphorus, and arsenic, taken from the vapour densities (and which are multiples of what are believed to be the true atomic weights), cause some complexity in the formulæ of their compounds.

"'There seem to be errors in the formulæ of alcohol and ether on p 49, for they do not agree with those in the table They ought probably to be written

$$2(HC_{\frac{1}{2}}) + O_{\frac{1}{2}}2H_{\frac{1}{2}} \text{ and } 4(HC_{\frac{1}{2}}) + O_{\frac{1}{2}}2H_{\frac{1}{2}}$$

"'Considering how nearly Waterston approached what is now believed to be the true theory, it is disappointing to read his controversy with Odling in 1863 and 1864 (*Phil Mag*, vols xxvi and xxvii), where he seems to oppose the new formulæ then being introduced He is very dogmatic about the constitution of hydrate of potash he very properly insists that we can only obtain a knowledge of the molecular weight of bodies that can be volatilized, and of which the vapour densities can be determined, but he does not see the analogy between the hydrate and oxide of potassium with alcohol and ether, probably because he regards these latter bodies as combinations of water with different quantities of olefiant gas He writes water $HO_{\frac{1}{2}} = 9$, alcohol $CH_2HO_{\frac{1}{2}} = 23$, and ether $C_2H_4\ HO_{\frac{1}{2}} = 37$, whilst he considers potassic hydrate $KO_{\frac{1}{2}}\ HO_{\frac{1}{2}} = 56$, and oxide of potassium $KO_{\frac{1}{2}} = 47$, the hydrate having a higher molecular weight than the oxide If we regard these compounds as derived from water by the replacement of hydrogen by ethyl and potassium respectively, the analogy between the two series is complete (ethyl was discovered in 1849, and is mentioned by Waterston)

$$\begin{array}{ll} H_2O = 18 & H_2O = 18. \\ (C_2H_5)HO = 46 & KHO = 56 \\ (C_2H_5)_2O = 74 & K_2O = 94 \end{array}$$

"'From a remark in the *Phil Mag* (vol xxvi p 520), I imagined that Waterston had arrived at the double atomic weights of many of the metals now adopted, for he gives that of iron as 56 and that of aluminium as 27, calculated from their specific heats, but there is an error in his arithmetic, for 3 3 divided by the specific heat of iron 1138 gives 28 998, and 3 3 divided by the specific heat of aluminium 2143 gives 15 399'

"With the exception of some corrections relating merely to stops and spelling, the paper is here reproduced exactly as it stands in the author's manuscript —December 1891"

The author's own introduction to his memoir, which occupies eighty pages of the Philosophical Transactions as now printed, runs as follows —

"Of the physical theories of heat that have claimed attention since the time of Bacon, that which ascribes its cause to the intense vibrations of the elementary parts of bodies has received a considerable accession of probability from the recent experiments of Forbes and Melloni It is admitted that these have been the means of demonstrating that the mode of its radiation is identical with that of light in the quantities of refraction and polarization The evidence that has been accumulated in favour of the undulatory theory of light has thus been made to support with a great portion of its weight a like theory of the phenomena of heat, and we are, perhaps, justified in expecting that the complete development of this theory will have a much more important influence on the progress of science, because of its more obvious connection and intimate blending with almost every appearance of Nature Heat is not only the subject of direct sensation and the vivifier of organic life, but it is manifested as the accompaniment of mechanical force. It is related to it both as cause and effect, and submits itself readily to measurement by means of the mechanical changes that are among the most prominent indications of its change of intensity The undulatory theory at once leads us to the conclusion that, inasmuch as the temperature of a body is a persistent quality due to the motion of its molecules, its internal constitution must admit of it retaining a vast amount of living force Indeed, it seems to be almost impossible now to escape from the inference that heat is essentially molecular *vis viva* In solids, the molecular oscillations may be viewed as being restrained by the intense forces of aggregation. In vapours and gases these seem to be overcome, vibrations can no longer be produced by the inherent *vis insita* of the molecules struggling with attractive and repellent forces; the struggle is over and the molecules are free, but they, nevertheless, continue to maintain a certain temperature, they are capable of heating and being heated; they are endowed with the

quality heat, which, being of itself motion, compels us to infer that a molecule in motion without any force to restrain or qualify it, is in every respect to be considered as a free projectile. Allow such free projectiles to be endowed with perfect elasticity, and likewise extend the same property to the elementary parts of all bodies that they strike against, and we immediately introduce the principle of the conservation of *vis viva* to regulate the general effects of their fortuitous encounters. Whether gases do consist of such minute elastic projectiles or not, it seems worth while to inquire into the physical attributes of media so constituted, and to see what analogy they bear to the elegant and symmetrical laws of aeriform bodies.

"Some years ago I made an attempt to do so, proceeding synthetically from this fundamental hypothesis, and have lately obtained demonstration of one or two points where the proof was then deficient. The results have appeared so encouraging, although derived from very humble applications of mathematics, that I have been led to hope a popular account of the train of reasoning may not prove unacceptable to the Royal Society.—September 1, 1845."

REPORT OF THE ROYAL SOCIETY'S COMMITTEE ON COLOUR VISION

A COMMITTEE, consisting of Lord Rayleigh as Chairman, Lord Kelvin, Mr. Brudenell Carter, Prof. Church, Mr. J. Evans, Dr. Farquharson, M.P., Prof. Michael Foster, Mr. Galton, Dr. Pole, Sir G. Stokes, and Captain Abney, as Secretary, was appointed by the Council of the Royal Society in March 1890, to consider the question of testing for defective colour vision. Their report has just been presented to the Royal Society, and it possesses great practical interest for all classes, considering that on the average one male out of every twenty-five suffers more or less from this form of blindness.

The Committee have taken evidence as to the tests in general use on the railways, and also as to those which have been for some time adopted by the Board of Trade for the mercantile marine service, and have supplemented it by carrying on practical examinations on their own account. Experts have also given evidence as to the different forms of colour-blindness to be found, and the fact that it may be induced by disease as well as be congenital has been brought prominently forward by Dr. Priestley Smith, of Birmingham, and Mr. Nettleship, of St. Thomas's Hospital, and we have it on their authority that this type is not a negligible one. As an outcome of their investigations, the Committee have unanimously agreed to the following recommendations:—

(1) That the Board of Trade, or some other central authority, should schedule certain employments in the mercantile marine and on railways, the filling of which by persons whose vision is defective either for colour or form, or who are ignorant of the names of colours, would involve danger to life and property.

(2) That the proper testing, both for colour and form, of all candidates for such employments should be compulsory.

(3) That the testing should be intrusted to examiners certificated by the central authority.

(4) That the test for colour vision should be that of Holmgren, the sets of wools being approved by the central authority before use, especially as to the correctness of the three test colours, and also of the confusion colours. If the test be satisfactorily passed, it should be followed by the candidate being required to name without hesitation the colours which are employed as signals or lights, and also white light.

(5) That the tests for form should be those of Snellen, and that they should be carried out as laid down in Appendix VI. It would probably, in most cases, suffice if half normal vision in each eye were required.

(6) That a candidate rejected for any of the specified employments should have a right of appeal to an expert approved by the central authority, whose decision should be final.

(7) That a candidate who is rejected for naming colours wrongly, but who has been proved to possess normal colour vision, should be allowed to be re-examined after a proper interval of time.

(8) That a certificate of the candidate's colour vision and form vision according to the appointed tests, and his capacity for naming the signal colours, should be given by the examiner; and that a schedule of persons examined, showing the results, together with the nature of the employments for which examinations were held, should be sent annually to the central authority.

(9) That every third year, or oftener, persons filling the scheduled employments should be examined for form vision.

(10) That the tests in use, and the mode of conducting examinations at the different testing stations, should be inspected periodically by a scientific expert, appointed for that purpose by the central authority.

(11) That the colours used for lights on board ship, and for lamp signals on railways, should, so far as possible, be uniform, and that glasses of the same colour as the green and red sealed pattern glasses of the Royal Navy, should be generally adopted.

(12) That in case of judicial inquiries as to collisions or accidents, witnesses giving evidence as to the nature or position of coloured signals or lights should be themselves tested for colour and form vision.

These recommendations have been framed after duly weighing all the evidence they have collected, and from the results of the experiments they have carried out during the last two years; and the reasons for adopting them are set forth at some length in the report. The Committee have, perhaps wisely, refused to endorse any particular hypothesis of colour vision, though they have described two, those of Young and Hering, in some detail, no doubt considering that everything which might be debatable had better be avoided when practical recommendations alone were in question. It is, however, a matter of some regret that this should be the case, as a Committee so strongly constituted should have been able, if not to convince every one, at least to lead opinion into proper channels. What little they have said in the notes to the report leads one to suspect that they are not satisfied that either Young or Hering has given a theory which will satisfy all requirements. Leaving, however, the question of theory, we may point out that the practical necessity of insisting, on the grounds of public safety, that certain posts on railways and on board ship should only be filled by persons possessing normal colour vision, no sane man would call in question. The peril that must arise, for instance, if an engine driver could by any possibility mistake a red signal of danger for a green signal of safety, or if a look-out man on board ship should be liable to make a similar error, is self-evident; and it is to prevent any such risks being run that the Committee buckled to the task of recommending tests which should be efficient and perfectly trustworthy. There has been for a long time a suspicion, if not more than a suspicion, that the examinations carried on for colour vision by the Board of Trade in the mercantile marine were inadequate in both respects; and what little was known regarding the tests employed by the various railway companies engendered the same feeling of distrust, in those who had considered the subject in a scientific spirit. The evidence shows that the Board of Trade examiners have passed on a second

or third examination candidates who have been rejected on their first trial This is a proof of one of two things (1) either that the tests employed were bad, or else that colour-blindness had been cured or mitigated There is no evidence to show that congenital colour-blindness is curable, in fact, what there is is in exactly the contrary direction For although it is true that reds and greens may be correctly named by a colour-blind person, by making him notice certain slight difference in the intensity or purity of the one colour which represents both of these to him, yet no amount of education or coaching would enable him to distinguish between them under the varying atmospheric conditions under which the signals are seen The Committee had practical trials of various tests made before them at Swindon and elsewhere, with the result that the Board of Trade tests for the mercantile marine allowed several individuals to be passed as possessing normal colour vision whom other tests distinctly proved to be markedly and probably dangerously colour-blind Under these circumstances it is not surprising that they have condemned such a system of testing, more especially as it is one which necessitates the naming of colours, and recommend those of Holmgren, which have long given practical proof of their ability to discriminate between normal and even slightly defective colour-perception

The Holmgren test consists in requiring a candidate to select from a large assortment of wools those colours which appear to him to match a skein of pale yellowish green, a pale pink, and a bright crimson These pale colours are sure to be matched by the colour-blind with colours which are totally different in hue, and the nature of the mistakes made infallibly indicate the character and danger of the blindness

The evidence shows that some railways have been under the impression that they were using the Holmgren test, but when the colours were examined critically it was found that the hues of the test-skeins of wool were perfectly different from those determined by the distinguished Swedish investigator If the two trial test-colours of Holmgren were more brilliant and of rather different hues, it is quite possible that persons with defective colour sense might make correct matches, and pass an examination which they really never should do It is for this reason that the Committee recommend that the standard test-colours should be officially passed by an expert attached to the Board of Trade, as also those colours with which the colour blind would most probably match them

There are several of the recommendations which are especially valuable, for instance, that one by which the test should only be intrusted to examiners certified as competent to conduct the examinations It is obvious that to have an efficient examination, not only should the test be efficient, but also the examiner We have heard of a railway foreman being armed with a variegated bunch of wools, and insisting on candidates for employment naming them, and rejecting those who failed to give the name which he considered should be given Such a test by such an examiner is evidently useless and cruel The right of appeal by the rejected candidates is also wholesome, though it will probably be very rarely exercised, and as the tribunal to whom such an appeal can be carried is an expert, we may be certain that substantial justice will be meted out

The whole report is valuable, but the labour will be thrown away unless legislative measures are taken to render it effective It is no use telling railways what they ought to do, but only what they *must* do, in such examinations as are in question The subject of colour vision is one which is so open to fads that the public require to be safeguarded from faddists who might happen to have ear of Boards of Directors or general managers, for this reason we hope that reasonable legislative action may be taken within a reasonable time.

THE GREAT EARTHQUAKE IN JAPAN, 1891[1]

WHILE the occurrence of a great earthquake in a district intersected by railways, and traversed by telegraph wires, brings forcibly before the mind—even of the most casual reader of newspaper reports—the awful and destructive results of such a catastrophe, the scientific man cannot fail to note that it is under such conditions as these the best opportunities will be found for obtaining the necessary data upon which to reason concerning these terrible and still little understood movements of the earth's crust In connection with the Seismological Society of Japan, a system of reporting the times and chief features of earthquake-shocks has been for some years in successful operation, and all station-masters and Post Office agents are required to transmit their records to a central office, the electrical control of the clocks of course giving these reports a value which they would not otherwise possess

Two considerable earthquakes in recent years have occurred in areas where it was possible to obtain a great mass of accurate time and other observations, and these can scarcely fail to be of great value to the seismologist The terrible earthquake of Charleston, on August 31, 1886, was felt over a great part of the United States, and at the railway stations, post offices, and other places where the accurate time was kept, many valuable observations were made The vast mass of material collected has been dealt with by Prof Simon Newcomb and Captain C E Dutton, and from the Report published by the United States Geological Survey, some remarkable and striking conclusions regarding the rate of movement of earthquake waves would appear to have been established The Gifu or Ai-Gi earthquake of October 1891 has yielded data which the able seismologists of Japan may be trusted to make the fullest use of, when sufficient time has elapsed for the comparison and discussion of the reports

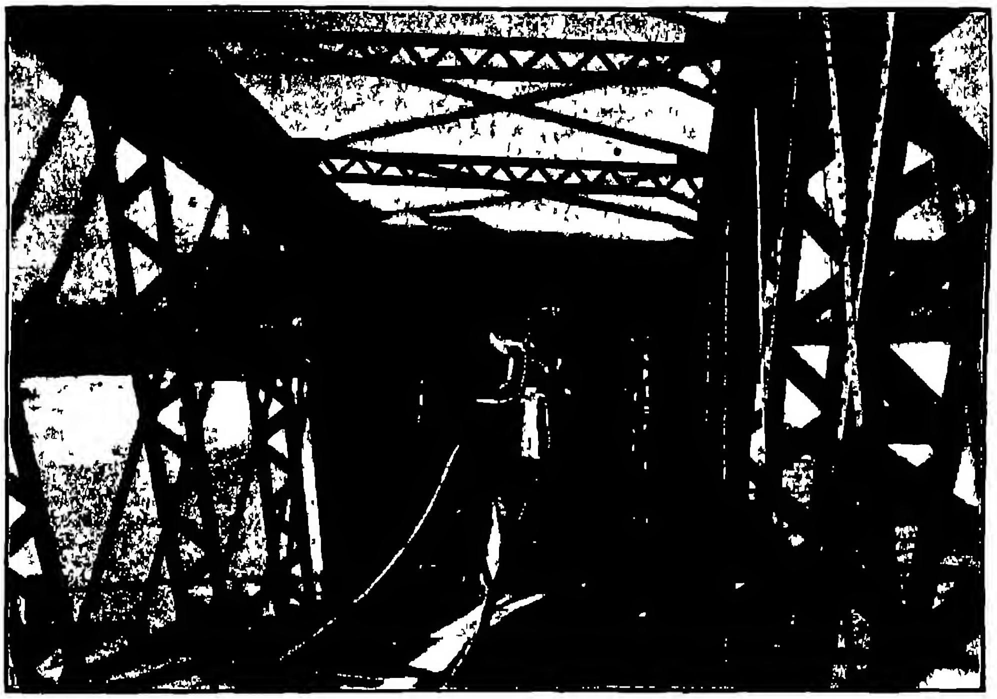
As a preliminary notice and striking memorial of the catastrophe, the beautiful volume now before us will be gladly welcomed The book consists of twenty-nine permanent photographic plates, printed on excellent paper, and forty-six pages of letterpress The energetic authors of the book were on the scene of the earthquake immediately after its occurrence, and all the plates, except three, are reproductions of photographs taken by Prof Burton for the Imperial University It is difficult to realize that the collection of the materials for this handsome book, with the execution of its luxurious typography, illustrations, and binding have been all completed within the short space of two months, and it says much for the enterprise and activity of the Japanese publishers, as well as of the authors, that such a result should have been possible

One of the most striking effects of the Charleston earthquake, as described in Captain Dutton's report, was the twisting laterally of the permanent way on railway lines On Plate x of the work before us a similar serpentine twisting of the railway, suggesting a permanent compression in the line of the rails, is shown to have been effected, and the photograph constitutes a beautiful permanent record of the result Still more striking are the phenomena displayed at some of the railway bridges, especially that of Nagara Gawa, which is very fully illustrated in Plates xxii., xxiii, xxiv, xxv, and xxvi Our illustration is a reproduction of one of these plates Not only have the lattice-work sections of the bridge been snapped asunder, but the great tubular piers have been thrust through the floor on which the railway lines are laid, these latter being forced up in

[1] "The Great Earthquake in Japan" By John Milne, F R S, Professor of Mining and Geology and W K Burton, C.E, Professor of Sanitary Engineering, Imperial University of Japan With Plates by K Ogawa. (Yokohama, Japan Crawford and Co London E. Stanford, 1892)

great curves Many of these photographs tell, incidentally, a very sad story of the loss and suffering endured by the people of the district

In the short descriptive remarks which accompany the plates, Prof Milne has succeeded in giving us much valuable information concerning the earthquake The Gifu plain is situated about the centre of the Japanese Empire, and consists of a thick alluvial deposit resting on metamorphic rocks, the district being highly cultivated and thickly populated The severely shaken district, in which complete destruction of buildings and engineering works occurred, measured 4200 square miles, but the effects were felt over an area of 92,000 square miles, and ten thousand people lost their lives, while fifteen thousand



were wounded The earthquake is believed to have originated in the Mino Mountains, but it was in the soft alluvial plain adjoining that the earth-movements were most severely felt. The district thus violently affected supported a population of about 800 to the square mile Earthquakes have been recorded as occurring in this area, which lies quite away from any volcanic centres, in 1826, in 1827, in 1859, and in 1880, and during the last ten centuries there have been many terrible catastrophes affecting this area which are noticed in the Japanese records

We look forward with much interest to the publication of the full account of this destructive, and in many respects remarkable, display of seismic energy, which is promised to us by the Professors of the Imperial University of Japan. J W J

THE ROYAL SOCIETY SELECTED CANDIDATES

THE following fifteen candidates were selected on Thursday last (May 5) by the Council of the Royal Society to be recommended for election into the Society The ballot will take place on June 2, at 4 p m We print with the name of each candidate the statement of his qualifications

ROBERT YOUNG ARMSTRONG, Lieut.-Colonel R.E,

From 1870 to 1875 was Assistant Instructor in Submarine Mining and Electricity, and from 1875 to 1882 was Instructor From 1884 to the present date, Inspector of Submarine Defences of the United Kingdom, Military Ports, and Coaling Stations From June 1883 to December 1888, adviser to the Board of Trade in electrical matters connected with the Electric Lighting Acts Was connected with the development of the present apparatus and electrical and mechanical processes employed in submarine mining, and with the compilation of the army instructional books and methods on electricity and submarine mining since 1870 Distinguished as an electrical engineer. It may be said that the present satisfactory state of defensive torpedo warfare in this country is very largely due to his ability and energy.

FRANK EVERS BEDDARD, M.A. (Oxon),

Lecturer on Comparative Anatomy, Guy's Hospital Prosector to the Zoological Society Author of the following papers — "Report on the Isopoda, collected by H M.S *Challenger*" (Parts xxxiii, xlviii), "Nephridia of Acanthodrilus and of Perichæta" (Proc. Roy Soc, 1886–87), "Structure of Megascolex" (Trans Roy Soc Edin, 1883), "Minute Anatomy of the Ovary of Echidna", "Subdivision of the Cœlom in Birds and Reptiles" (Proc. Zool Soc., 1886–88), "Visceral and Muscular Anatomy of Scopus" (*ibid*, 1885); "Anatomy of various little known Types of Birds" (*ibid*) With other papers on Comparative Anatomy in *Ann and Mag. Nat Hist*, *Ibis*, and *Quart Journ. Micros. Sci*

JOHN AMBROSE FLEMING, M A (Camb),

D.Sc. (Lond.) Professor of Electrical Engineering in University College, London. Late Fellow of St. John's College, Cambridge. Fellow of University College, London. Some time Demonstrator in Applied Mechanics in the University of Cambridge Author of the following papers, among others — "The Polarisation of Electrodes in Water free from Air" (Proc. Phys. Soc., 1874); "A New Form of Resistance

Balance" (Proc. Phys Soc, 1880), "On the Characteristic Curves and Surfaces of Incandescent Lamps", "On Molecular Shadows in Incandescent Lamps", "On the Use of Daniell's Cell as a Standard of Electromotive Force", and "Problems in the Distribution of Electric Currents in Networks of Conductors" (Proc Phys Soc, 1885), "On the Necessity for a National Standardising Laboratory for Electrical Instruments" (Proc Inst Elect Engs, 1885), "A Design for a Standard of Electrical Resistance" (Proc Phys Soc, 1889), "On Electric Discharge between Electrodes at different Temperatures in Air and in High Vacua" (Proc Roy Soc, 1889), "On Some Effects of Alternating Current Flow in Circuits having Capacity and Self-induction" (Proc Inst Elect Engs, 1891) Delivered Friday Evening Discourses at the Royal Institution in 1890-91 Author of "Short Lectures to Electrical Artisans," four editions, and of "The Alternate Current Transformer in Theory and Practice",

CLEMENT LE NEVE FOSTER, D Sc (Lond),

F G S, Professor of Mining in the Royal College of Science, and H M Inspector of Mines. A R S M He is distinguished for his knowledge of mining in its various scientific aspects; and is the author of numerous papers bearing on Geology, Mineralogy, and Mine-engineering He has carried on explorations and mining works in Italy, Egypt, and Venezuela, and was for some years a Member of the Geological Survey of England and Wales, in connection with which he made important discoveries bearing on the question of the denudation of the Weald His papers are published in the Journals of the Geological and Statistical Societies, and other journals

HANS GADOW, Ph D (Jena),

Hon. M A Cantab Strickland Curator and Lecturer on the Advanced Morphology of Vertebrata in the University of Cambridge A naturalized British subject, engaged in research in Animal Morphology Author of "Versuch einer vergleichenden Anatomie des Verdauungssystemes der Vogel" (Inaugural Dissertation, *Jenaische Zeitschr*, xiii, 1879), "Zur vergleichenden Anatomie der Musculatur der Beckens und der hinteren Gliedmasse der Ratitæ" (4to, Jena, 1880, 5 plates), "Untersuchungen über die Bauchmuskeln der Krokodile, Eidechsen und Schildkroten" (*Morphol Jahrb*, vii, p 57), "Beitrage zur Myologie der hinteren Extremität der Reptilien" (*ibid*, p 329), "Observations on Comparative Myology" (*Journ of Anat*, 1882, p 493), "Catalogue of Birds in the British Museum" (vols viii. and ix) "On the Colours of Feathers as affected by their Structure" (Zool Soc Proc, 1882, p 409), "On the Reproduction of the Carapace in Tortoises" (*Journ of Anat*, 1886, p 220), "On the Cloaca and Copulatory Organs of Amniota" (Phil Trans., 1887), "On the Modifications of the First and Second Visceral Arches, with Especial Reference to the Homologies of the Auditory Ossicles" (Phil Trans., 1888), Volume "Aves" in Bronn's "Klassen und Ordnungen des Theirreichs" (in publication) Conjointly with Dr. Gaskell — "On the Anatomy of the Cardiac Nerves in certain Cold blooded Vertebrates" (*Journ of Physiol*, v). "Suctorial Apparatus of the Tenuirostres (1883), "On the Anatomical Differences in the Three Kinds of Rhea" (1885), "On some Points in the Anatomy of *Pterocles arenarius*, with remarks on its Systematic Position (1882) "Introduction to the Osteology of the Mammalia," by W H Flower, F R S, third edition revised with the assistance of Hans Gadow (1885)

ROBERT GIFFEN, LL D (Glasc),

Assistant Secretary (Commercial Department) Board of Trade Author of "Stock Exchange Securities an Essay on General Causes of Fluctuation of their Price" (1878) "Essays in Finance," 1st series (1879), 2nd series (1885), "The Growth of Capital" (1889), also of numerous papers communicated to the British Association, Statistical Society, Bankers' Institute, &c. As head of the Statistical Department of the Board of Trade (since incorporated with the Commercial Department) has been examined by Royal Commissions and Parliamentary or Treasury Committees on the following subjects (among others) Depreciation of Silver (1876), Hall Marking, Wine Duties, Agricultural Depression, Trade Depression, Stock Exchange, Gold and Silver, Channel Tunnel, Emigration and Immigration; Corn Averages, &c. Has given great attention to the theory and practice of the use of Index Numbers in the study of Prices and their history, and first invented and used the plan of an Index Number of a purely objective and not an arbitrary character, especially one based on the actual proportion of the different articles of Import and Export to the total Has explained with regard to numerous branches of statistics, such as imports and exports, the condition and nature of the data, and the way in which they can be used in public discussions Has also explained in numerous papers the way in which common statistics can be used in stating and solving problems for the politician, *e g* statistics of the growth of population, of the growth of incomes and capital Has also given attention to the problems relating to the incidence of taxation, upon which several papers are included in the "Essays in Finance" Author of numerous official reports, including reports on wages, prices of imports and exports, emigration, &c

FRANCIS GOTCH, M R C.S,

B A, B Sc (Lond), Hon M A. (Oxon) Has made researches of value into the physiology of the nervous system, and is the author of the following papers.—"On the Electromotive Properties of the Electrical Organ of Torpedo" (Phil Trans, 1887, B, p 487, and 1888, B, p 329), "On the Electrical Organ of the Skate," with Dr Burdon Sanderson, F R S. (*Journ of Physiol*, vol ix, p 137, and vol x, p 259), "On the Electromotive Changes in the Mammalian Spinal Cord following Electrical Excitation of the Cortex Cerebri," with Prof Horsley, F R S (Roy Soc Proc, vol xlv, p 18), as well as of other shorter papers on similar subjects

WILLIAM ABBOTT HERDMAN, D Sc,

F R S F, F.L S Professor of Natural History in University College, Liverpool Distinguished as a Zoologist, and especially for researches into the structure and relations of the Tunicata Author of the following, amongst other papers —"Report on the Tunicata of the *Challenger* Expedition," Parts I, II, and III (*Challenger* Rept, Zool, vol vi, 1892, vol xiv, 1886, vol xxvii, 188), "On the Invertebrate Fauna of Lamlash Bay" (Roy Phys Soc Edin Proc., vol v, 1879, and vol vi, 1880), "On the Olfactory Tubercle &c, in Simple Ascidians" (*ibid*, 1881), "On Individual Variations in the Branchial Sac of Ascidians" (Linn Soc Journ, vol xv, 1881), "The Hypophysis Cerebri in Tunicata and Vertebrata" (Roy Soc Edin Proc, 1883) "Report on the Tunicata of the *Triton* Expedition" (Roy Soc Edin Trans, vol xxxii, 1883), "Report on the Tunicata of the *Lightning* and *Porcupine* Expeditions" (*ibid*, 1884); "On the Phylogeny of the Tunicata" (Roy Soc. Edin Proc., 1885-86),) "On the Structure of Sarcodictyon" (Roy. Phys Soc Edin Proc, 1884); "On the Structure and Functions of the Cerata or Dorsal Papillæ in some Nudibranchiate Mollusca" (*Quart Journ Micros. Sci*, 1890), and of important Reports on the Fauna of Liverpool Bay, 1886-90

FREDERICK WOLLASTON HUTTON, Captain, R E,

Professor of Geology in Canterbury College F.G S, C M Z S, Cor du Mus d Hist. Nat Paris, Cor Mem Roy Soc Tas, Hon Mem Roy. Soc N S W Cor Acad Nat Sci Philad, Cor Ornith Ver Wien, Cor. K K Geol Reichsanst Wien Author of numerous reports, papers, &c, published by the New Zealand Government, the Geological and Zoological Societies, the New Zealand Institute, &c., and in the *Phil Mag* Amongst them are —"Fishes of New Zealand," 1872, "Geology of the Thames Gold Field (Government Report, 1868 69), "Sketch of the Geology of New Zealand" (Quart Journ Geol Soc), "Birds inhabiting the Southern Ocean" (*Ibis*, 1865); "On *Peripatus N Zealandiæ*", "On the Structure of *Amphibola avellana*", "Origin of the Fauna and Flora of New Zealand" (*Ann and Mag Nat Hist*), "Eruptive Rocks of New Zealand," Oscillations of the Earth's Surface (Aust Assoc Advt Sci, 1889), "On Dimensions of Dinornis Bones" (Trans. N Z Inst), "New Zealand Land Shells", "Revision of the Land Mollusca of New Zealand" (*ibid*, vol. xvi) Author of a Class-book of Geology, and of Zoological Exercises for Students in New Zealand Author of eleven papers in Proc. Linn Soc. N S W Has done much valuable work in other ways for the advancement of science in New Zealand

JOHN JOLY, M A,

Assistant to the Professor of Civil Engineering in the University of Dublin Has discovered (*a*) by direct measurement a

variation of specific heat at constant volume of various gases with density, (*b*) Iolite in the Granites of Leinster, (*c*) a heterogeneous Beryl Felspar mineral; (*d*) the reversal of *Oldhamia antiqua* and *radiata* impressions in the Slates of Bray Head. Is the author, amongst other papers, of the following:—"On the direct experimental determination of Specific Heats of Gases at Constant Volume" (Proc. Roy. Soc., vol. xlviii., in abstract, recommended for Phil. Trans.), "On the Method of Condensation in Calorimetry" (Proc. Roy. Soc., vols. xlv. and xlvii.), "On the Specific Heats of Minerals" (*ibid.*, vol. xli.), "Observations of Spark Discharge over Surfaces of Dielectrics" (*ibid.* vol. xlvii.), "On the Volcanic Ash of Krakatoa" (Proc. Roy. Dubl. Soc., vol. iv.). Has invented (*a*) the Method of Steam Calorimetry (Trans. and Proc. Roy. Soc., as above), (*b*) a Diffusion Photometer (*Phil. Mag.*, July 1888), (*c*) a Hydrostatic Balance (*ibid.*, Sept. 1888), (*d*) an Instrument for measuring Melting and Boiling Points of Solids, &c., up to a very high temperature (NATURE, vol. xxxiii., and *Industries*, vol. vi.), (*e*) a Method of measuring the Density of a Gas (*Phil. Mag.*, vol. xxx.), (*f*) a Method of reading Distant Meteorological Instruments (Proc. Roy. Dubl. Soc., vol. iv.), (*g*) a Method of measuring Specific Gravities of Minute Quantities of Porous and other Solids (*Phil. Mag.*, July 1888.

JOSEPH LARMOR, M.A.,

D.Sc. Fellow of St. John's College, Cambridge. University and College Lecturer in Mathematics. Senior Wrangler, 1880. Formerly Professor of Mathematics, Queen's College, Galway. Fellow of the Royal University of Ireland. Examiner in Mathematics at the University of London. Author of the following papers:—"Application of Generalized Space Coordinates, Potentials, and Isotropic Elasticity" (Trans. Camb. Phil. Soc., vol. xiv.), "Least Action" (Proc. Lond. Math. Soc., vol. xv.), "Flow of Electricity in Linear Conductors" (*ibid.*, vol. xvi.), "Characteristics of an Asymmetric Optical Combination" (*ibid.*, vol. xx.). "Electro-magnetic Induction in Conducting Sheets and Solid Bodies" (*Phil. Mag.*, 1884), and other papers on Pure and Applied Mathematics.

LOUIS C. MIALL,

Professor of Biology in the Yorkshire College. Prof. Miall has published the following papers and books:—Reports on Labyrinthodonts (Rep. Brit. Assoc., 1873-74); the first translated as introduction to S. Anton Fritsch's "Fauna der Permformation Bohmens", Fossil Teeth of Ceratodus (Palæont. Indica), Sirenoid and Crassopterygian Ganoids, Part I. (Palæont. Soc.), papers on Labyrinthodonts, Rhizodus, Ctenodus, and Megalichthys (Quart. Journ. Geol. Soc.). Studies in Comparative Anatomy: I. Skull of Crocodile, II. Anatomy of the Indian Elephant (jointly with F. Greenwood), III. The Cockroach (jointly with H. Denny), Vertebrate Palæontology in Geol. Record (Sub-editor). In 1875 received the Wollaston Donation from the Geological Society.

BENJAMIN NEVE PEACH,

F.R.S.E., F.G.S. District Surveyor of the Geological Survey of Scotland. Past President of the Physical Society of Edinburgh. Recipient of the Wollaston Donation Fund of the Geological Society in 1887. For thirty years actively engaged on the Geological Survey, during which time he has mapped many of the most complicated districts of Scotland. Has charge of the surveying of the North-West Highlands, and has taken the leading part in unravelling the remarkable structural complications of that region. Author of various papers on palæontological subjects:—"On some New Crustaceans from the Lower Carboniferous Rocks of Eskdale and Liddesdale" (Trans. Roy. Soc. Edin., vol. xxx., p. 73), "On some new species of Fossil Scorpions from the Carboniferous Rocks of Scotland" (*ibid.*, p. 399), "Further Researches among the Crustacea and Arachnida of the Carboniferous Rocks of the Scottish Border" (*ibid.*, p. 511), "On some Fossil Myriapods from the Lower Old Red Sandstone of Forfarshire" (Proc. Roy. Phys. Soc. Edin., vol. vii. p. 179). Joint author with Mr. J. Horne of many papers on stratigraphical and physical geology, including:—"The Glaciation of the Shetland Isles" (Quart. Journ. Geol. Soc., vol. xxxv. p. 778), "The Glaciation of the Orkney Islands" (*ibid.*, vol. xxxvi. p. 648), "The Old Red Sandstone of Shetland" (Proc. Roy. Phys. Soc. Edin., vol. v. p. 30), "The Glaciation of Caithness" (*ibid.*, vol. vi. p. 316); "Report on the Geology of the North-West of Sutherland" (NATURE, vol. xxxi. p. 31), "The Old Red Sandstone Volcanic Rocks of Shetland" (Trans. Roy. Soc. Edin., vol. xxxii. p. 539), "Report on the Recent Work of the Geological Survey in the North-West Highlands of Scotland, based on the Field Maps of B. N. Peach, J. Horne, W. Gunn, C. T. Clough, L. Hinxman, and H. M. Cadell" (Quart. Journ. Geol. Soc., vol. xliv. p. 378).

ALEXANDER PEDLER,

F.C.S., F.I.C., Fellow of the University of Calcutta, Professor of Chemistry, Presidency College, Calcutta, Meteorological Reporter to the Government of Bengal, and Curator of the Bengal Government Museum at Calcutta. Author of papers on "An Isomeric Modification of Valeric Acid," "Calcutta Coal Gas," "The Use of the Radiometer as a Photometer," "Cobra Poison," "The Past and Present Water Supplies of Calcutta," "Technical Education for Bengal," "The False Point Cyclone of September 22, 1885," published in the Proc. Roy. Soc., the Journ. Chem. Soc., the Journ. Asiat. Soc. Beng., and elsewhere.

AUGUSTUS D. WALLER, M.D.,

Lecturer on Physiology at St. Mary's Hospital Medical School. Distinguished as a Physiologist. Lauréat de l'Institut de France (Prix de Physiologie Expérimentale). Contributions to the Royal Society: "On the Influence of the Galvanic Current on the Excitability of the Motor Nerves of Man" (with Dr. de Watteville, Phil. Trans., 1882), "On the Influence of the Galvanic Current on the Excitability of the Sensory Nerves of Man" (Roy. Soc. Proc., 1882), "On the Action of the Excised Mammalian Heart" (with Dr. Reid, Phil. Trans., 1887), "On the Electromotive Changes connected with the Beat of the Mammalian Heart" (Phil. Trans., 1889). Contributions to the *Journal of Physiology*: "On the Rate of Propagation of the Arterial Pulse Wave" (vol. iii., 1880), "A Demonstration in Man of Electromotive Changes accompanying the Heart's Beat" (vol. viii., 1887). Contributions to other journals, English and foreign:—"Die Spannungen in den Vorhöfen des Herzens" (*Arch. f. Anat. u. Physiol.*, 1878), "On Muscular Spasms known as Tendon Reflex" (*Brain*, 1880), "Nouvelles Expériences sur les Phénomènes nommés Réflexes tendineux" (with Dr. Prévost, *Rev. Méd. de la Suisse Romande*, 1881), "Sur la Contraction de l'Ouverture" (*Journ. de Physiol.*, 1882), &c.

NOTES

THE Council of the British Association for the Advancement of Science have nominated Dr. J. S. Burdon Sanderson, F.R.S., Waynflete Professor of Physiology in the University of Oxford, President for the meeting of the Association which will be held next year at Nottingham. Dr. Sanderson has accepted the nomination.

THE Gold Medal of the Linnean Society has this year been awarded by the Council to Dr. Alfred Russel Wallace for his important contributions to the literature of zoology. The medal will be presented at the forthcoming anniversary meeting of the Linnean Society, to be held at Burlington House on the 24th inst.

WE regret to have to record the death of the illustrious chemist, August Wilhelm Hofmann. He died on May 5. Prof. Hofmann was well known in England, where he spent many of his best years. On Liebig's recommendation he was appointed in 1848 Superintendent of the Royal College of Chemistry, in London. This institution, which made great progress under his care, was in 1853 merged in the Royal School of Mines as the Chemical Section. He became a Warden of the Royal Mint in 1855. In 1864 he accepted the chair of chemistry at Bonn, and in the following year he was called to Berlin, where he spent the rest of his life as Professor of Chemistry. He made many contributions to the *Annalen der Chemie*, to the Transactions of the Chemical Society, and to the Philosophical Transactions of the Royal Society, of

which latter institution he was made a Fellow in 1851, in recognition of his services to science In 1854 he was awarded a Royal Medal for his "Memoirs on the Molecular Constitution of the Organic Bases" Some of his discoveries led to industrial results of the highest importance The high respect in which Prof Hofmann was held in Germany was shown at his funeral, which took place on Monday It was very largely attended, and, according to the Berlin correspondent of the *Standard*, "was in all respects worthy of a prince of science" The correspondent says —"The Empress Frederick, immediately on receiving the news of the Professor's death, telegraphed to his widow, 'My deepest sympathy in your great, your irreparable loss. I am deeply shocked by the quite unexpected news of your dear husband's death.' Her Imperial Majesty sent a splendid laurel wreath bearing her initials, to be placed on the coffin, and a Court Chamberlain represented Her Majesty at the funeral. The Minister of Education and numerous officials of his Department, all the members of the Berlin Academy, and almost all the professors and students of the University, accompanied the funeral procession to the cemetery"

WE regret also to have to announce the death of Dr James Thomson, F.R S., Emeritus Professor of Civil Engineering in the University of Glasgow, Lord Kelvin's brother Dr Thomson died on Sunday last He was seventy years of age

THERE are vacancies for zoological students at the Cambridge University's tables in the Zoological Station at Naples, and in the Marine Biological Society's Laboratory at Plymouth Applications are to be sent to Prof Newton, Chairman of the Special Board for Biology and Geology, by May 30

GENERAL ISAAC T. WISTER, President of the Philadelphia Academy of Sciences, has placed in the hands of trustees for the benefit of the University of Pennsylvania, 100,000 dollars for the erection of a Museum with laboratories, to contain the Wister and Horner Museum of Human and Comparative Anatomy He has also given an endowment of 3000 dollars a year for the maintenance of a curator, whose occupation shall consist largely of original research

WE referred lately to the interesting Horticultural Exhibition for which preparations were being made at Earl's Court The Exhibition was formally opened on Saturday last by the Duke of Connaught, and promises to be a great success

A GERMAN scientific expedition under Dr Erich von Drygalski started from Copenhagen for West Greenland on May 1 Dr. von Drygalski is accompanied by Dr H Stade, the meteorologist, and Dr E Vanhoffen, the zoologist They were to make in the first instance for Umanak Fjord They do not intend to return until the autumn of 1893.

WE are glad to welcome a third edition of Clerk Maxwell's great "Treatise on Electricity and Magnetism" (Clarendon Press) The task of seeing the proofs through the press could not be undertaken by Mr W D Niven, who had charge of the second edition, so the duty has been fulfilled by Prof. J. J. Thomson, who, we need scarcely say, has done his work admirably Twenty years have passed since the work was written, and during that time the sciences of electricity and magnetism—thanks in part to the influence exerted by this treatise—have made rapid progress. Prof Thomson explains that when he began to prepare the present edition he intended to give in foot-notes some account of the advances made since the publication of the first edition, not only because he thought it might be of service to students, but because all recent investigations have tended to confirm in the most remarkable way Maxwell's views. He soon found, however, that if this intention were carried out the book would be disfigured by a disproportionate quantity of foot-notes. His notes have accordingly been thrown into a slightly more consecutive form, and will be published separately A few foot notes relating to isolated points which could be dealt with briefly are given. Prof Thomson has added something in explanation of the argument in those passages in which he has found from his experience as a teacher that nearly all students find considerable difficulties He has also attempted to verify the results which Maxwell gives without proof He has not in all instances succeeded in arriving at Maxwell's results, and in such cases he has indicated the difference in a foot-note Maxwell's method of determining the self-induction of a coil is reprinted from his paper on the dynamical theory of the electro-magnetic field.

AT the time of our last issue, an anticyclone lay over the whole of the British Islands and part of the Atlantic, with north and north east winds of some force, under the influence of a depression existing over North Germany Daily temperatures were, generally, considerably below the normal values, slight snow fell on the south coast on the morning of the 6th, and the grass thermometer fell as low as 18° on that night in London The anticyclone afterwards moved southwards, while a depression, which had set in at the northern stations, spread towards the North Sea, the winds shifted to west and north-west, and temperatures gradually increased, the maxima exceeded 60° over the inland parts of England on Sunday, and even reached 70° at several stations on Monday, with fine weather generally The amount of rainfall is considerably below the average The Weekly Weather Report for Saturday last shows that the deficiency, since January 3, amounts to 7 7 inches in the west of Scotland and to 5 3 inches in the south west of England During the last few days this country has again been under the influence of an anticyclone, with fine, warm weather generally

THE Pilot Chart of the North Atlantic Ocean, in its review of weather during April, says that the storms on the Atlantic, like those of the preceding month, were confined almost entirely to the American coast and the western part of the ocean, and they again followed somewhat abnormal northerly tracks Two of the most severe storms whose tracks are plotted on the chart, occurred during the last few days of March During the first week of April, pleasant anticyclonic weather prevailed along the American coast south of Hatteras, but two severe storms moved eastward over Labrador on the 3rd and 6th respectively, the first of which was followed by a storm of slight energy that formed south of Cape Race on the 4th, and the second by one that reached Hatteras from inland the morning of the 8th, but neither of these, nor those of the 9th to 11th, and 15th to 16th, along the Nova Scotia coast, were at all severe The only remaining storms of any noteworthy severity, so far as indicated by data received at the office of the Pilot Chart up to date of publication, were those that originated between the Grand Banks and Bermuda on the 13th and 18th respectively The track of a depression of considerable energy is indicated near the Azores on the 6th, 7th, and 8th, and another, but of slight energy only, in the English Channel on the 15th and 16th The persistent anticyclonic weather over the British Isles and Central Europe during the last week of March and the first half of April, may be said to have turned to the northward the storms that formed over the ocean, and it seems probable that the persistent northerly winds thus caused off Labrador and Newfoundland helped along the ice that is now working its way southward off the Grand Banks. Fog has been reported in increasing quantities, also, and it will continue to increase until midsummer

WE note the publication of two new monthly meteorological bulletins for Russia, which are issued nearly closely up to date, viz by Prof. A Klossovski, Odessa, with Russian and German

next, and by Prof. P Brounof, Kieff, in Russian, with a few notes in French Both bulletins contain observations taken three times daily, with daily and monthly means, while the Odessa publication contains monthly rainfall values, and maximum and minimum temperatures for about a hundred stations in South-West Russia The Kieff observations are preceded by some remarks (in Russian only) on the temperature and density of snow at various depths

A remarkable aurora borealis was seen at Moscow during the night of April 26-27 It began at 11 50 p m with a dark segment fringed by a bright border, the summit of which stood a few degrees to the west of the meridian Bright rays were projected to the constellations of Auriga, Perseus, and Cassiopœia, while the longest rays reached the Pole star It attained its maximum at 11 56, but four minutes later it began to die away, no traces of it being seen at 12 15 a m At 2 a m three beams of light appeared again for a few seconds It is worthy of note that on April 26 a large accumulation of sun-spots was observed at Moscow, it consisted of ten groups of spots It may also be added that another aurora borealis, much brighter than the above, was seen at Moscow on March 12, at 4 a m It lasted for nearly half an hour

All who have occasion to use the magic lantern will be interested in the fact that a lantern may now be seen at the Crystal Palace finely illuminated by the arc-light This instrument was designed by Mr T C Hepworth, F C S, who uses it to illustrate lecture entertainments in connection with the Crystal Palace Electrical Exhibition The lamp employed is the Brockie Pell, which has been modified by Messrs Newton to make it more suitable for the particular work required It gives a pure white light, and its brilliance is said to be several times that of the lime-light The electric arc light has before been applied to lantern projection, but it is claimed that the Crystal Palace lantern is on quite an unprecedented scale

M Mesdran, of Paris, sends us a prospectus, in which he sets forth the merits of a machine he has invented for the proper boiling of eggs. Hitherto, it seems, mankind have boiled eggs on a wholly false principle M Mesdran claims that he has solved the problem, and that his invention is nothing short of "a revelation both from the hygienic and the gastronomic point of view" The invention has been patented in England

An interesting trace of Palæolithic man has lately been discovered in Hermann's Cave in the Harz Excavations were being carried on in the cave, under the superintendence of Herr Grabowsky, when a flint which had all the appearance of having been fashioned into the form of a knife was found among the remains of reindeer and other glacial or Arctic animals The object could not have been brought into the cave by non human means, as flint is not found anywhere in the neighbourhood A paragraph on the subject appears in the current number of *Globus*, the editor of which appends a note to the effect that the flint (which lay before him as he wrote) has undoubtedly been artificially worked into its present shape

Dr Daniel G Brinton has issued an interesting pamphlet, in which he urges the claims of anthropology as a branch of University education He gives an account of the aims and methods of the science, and then sketches a general scheme of anthropological instruction Dr Brinton would begin with lectures on somatology, including internal somatology, external somatology, psychology, and developmental and comparative somatology Then would come ethnology, in connection with which he would deal with sociology, technology, religion, linguistics, and folk lore. Under ethnography he would discuss the origin and subdivisions of races; and archæology he would divide into "general" and "special" Laboratory work would include (in the physical laboratory) such tasks as the comparing and identifying of bones, the measuring of skulls, &c; and (in the technological laboratory) the study of stone and metal implements, textile materials, &c. There would also be library work and field work. Students who might wish to obtain an adequate notion of the science would have to attend a course of thirty or forty lectures, and give twice as many hours to laboratory work That would be the minimum amount of study Those who might desire to instruct others, or to prepare for independent research, would devote to the science the greater part of their time during two or three years

The structure of the cells of Bacteria continues to occupy the attention of biologists, and a communication on the subject to the St Petersburg Society of Naturalists (*Memoirs*, vol xxi, Botany), by W K Wahrlich, is worthy of notice Careful study of several species of Bacteria has led the author to the conclusion that only two substances are to be detected in the cell—chromatin, and linin, which surrounds the former The leading part in the formation of spores belongs to chromatin, which is used entirely for this purpose, while the linin substance is used for the formation of the exosporium As to the involutional forms, the author can only confirm the opinions of De Bary, Nageli, and Buchner as to their being representative of a pathological state, or of a degeneration of the cell; chromatin disappears in such cells, and two or three vacuoles appear in their linin part The bacterial cells thus appear to be simple nuclei, surrounded by membranes, but devoid of cytoplasm, chromatin is their most important part, and when it disappears the cell can no longer reproduce itself or continue an independent life

A report was lately spread in the United States to the effect that the Government intended to introduce the mongoose in the West to exterminate the rodents which annoy farmers there The editors of the *Naturalist* wrote to the Department of Agriculture for information on the subject, and received in reply a letter to the effect that no such "rash act" had ever been contemplated, the introduction of exotic species being contrary to the Department's policy The *Naturalist* expresses cordial approval of this answer, evil having, it maintains, "invariably resulted from the introduction of exotic animals into countries when no adequate natural restriction to their increase exists"

Mr F W Ward was commissioned last year by the Hon Sydney Smith, then Minister of Agriculture in New South Wales, to report upon the relations of fruit production in that colony to the English market The report was presented some time ago, and is printed in the February number of the *Agricultural Gazette of New South Wales* Mr Ward is convinced that London offers an attractive market for the fruit products of Australasia in their green, dried, and canned forms All testimony, and most emphatically that of the European growers, is, he says, to the effect that London is, and always will be, the great fruit market of the world There is also, he adds, a consensus of opinion to the effect that Australasia will gain the largest share of the advantage in regard to this market, consequent upon the reversal of the seasons Other territories in the southern hemisphere will dispute the market with Australasia, but Mr. Ward anticipates that the energy and intelligence of Anglo-Saxon communities, operating upon good and cheap soil, an unsurpassed, if not an unrivalled, climate for fruit production, and splendid facilities of over-sea carriage, will fully or more than compensate for the one great disadvantage of geographical distance. The London market for Australasian fruit resolves itself, for the most part, into a question of carriage What needs to be done is to minimize the cost of conveying

green fruit from (say) Sydney to London, and to solve the chemical problems attaching to the attempt to utilize the cool chambers of swift steam ships in such a way as to preserve the appearance and flavour of so perishable a commodity as fruit through the unavoidable space of time and varying latitudes of the journey Mr Ward is of opinion that there are sound reasons for expecting that "these problems will be solved and that the market will be captured"

THE Echinoderm fauna of Kingston Harbour, Jamaica, seems to be remarkably numerous and varied Mr George W Field, who has been investigating it, contributes some notes on the subject to the April number of the "Johns Hopkins University Circulars" About twenty eight species of Echinoderms were found in Kingston Harbour and about the cays at its mouth, and a longer residence and dredging in the deeper waters would probably, Mr. Field thinks, have increased the number considerably The difficulties of dredging were very considerable, arising in part from the nature of the bottom, from the unmanageableness of the boat, and chiefly from the wind There always seemed to be a perfect calm or a gale, the calm periods between exceedingly short However considerable dredging was done by various members of his party The surface tow-net showed a wonderful richness of the larval Echinoderms in the pelagic fauna, chiefly however, during their stay, confined to Ophiurid, Echinid, and Spatangid plutei, the relative abundance being in the order named During the month of June they were abundant, and in early July they were extremely numerous They were found in greatest numbers in tows made about sunrise In the evening towing they were invariably absent These larvæ, says Mr Field, appear to come to and remain at the surface from midnight until about sunrise, after that to gradually disappear until three hours after sunrise, when they are rarely found at the surface Their appearance seemed to be little or not at all influenced by the tide, but did depend very much upon the quantity of flood water poured into the harbour by the various rivers In its general aspect the Echinoderm fauna shows no very considerable variation from that of the Bahamas and Southern Florida, though apparently richer in species and in individuals

ACCORDING to an official report published in the *Deutsches Kolonialblatt* for April, the Germans have every reason to be satisfied with the way in which the resources of Cameroon are being developed The industry and trade of the colony are said to be in a flourishing condition The chief products are palm oil and palm kernels There are many elephants in the territory, and ivory is still exported Caoutchouc is also obtained in considerable quantities, and ebony fetches good prices In 1891 there were in Cameroon 166 Europeans, of whom 10 were women There were 109 Germans and 31 Englishmen The exact number of natives is not yet known, but it is calculated that there are 20,000 Dualla on the Cameroon river, 25,000 Bakwiri in the Cameroon Highlands, and 20,000 Bamboko towards the west of the hilly district

A VALUABLE paper presenting a revision of the American species of Rumex occurring north of Mexico, by William Trelease, appears in the third annual report of the Missouri Botanical Gardens, and has also been issued separately Rumex is a genus which has been held to include from 100 to about 130 species, the greater part of which belong to the north temperate region of both continents "Of the twenty-one species," says Mr Trelease, "recognized by me as occurring within our flora, eleven were characterized and named by Linnæus in the first edition of the 'Species Plantarum,' and only five have been named by American botanists." The biological interest of the genus arises chiefly, as he points out, from the protective acidity of the sorrels and some docks, and the occurrence of tannin and a bitter principle in others, their protandry and exclusive adaptation to wind pollination, and the adaptation of the greater number of species to wind dissemination, by the enlargement of the inner segments of the perianth during ripening, although some of those with fimbriate valves may profit by attachment to animals.

IN the latest instalment of the Proceedings of the Academy of Natural Sciences, Philadelphia, Messrs H Skinner and L W Mengel give an account of some of the insects taken by the expedition which the Academy sent to Greenland in 1891 The insects captured were divided among the different orders as follows —Hymenoptera 25 specimens, Coleoptera 4 specimens, Lepidoptera Rhopalocera 143 specimens, and Heterocera 143 They were captured by Mr L W Mengel, entomologist to the expedition, and Dr W L Hughes, ornithologist The specimens are all from the West Coast, and were taken at three principal localities, McCormick Bay, Herbert Island, and Disco

ACETYL FLUORIDE, CH_3COF, has been prepared by M. Maurice Meslans, and is described by him in the current number of the *Comptes rendus* As was to be expected, it is a substance considerably more volatile than acetyl chloride Its boiling point is 19°5, very near that of hydrofluoric acid itself, and hence upon a warm day it takes the form of a gas, while at temperatures below 19°5 it assumes the liquid state It has been prepared by M Meslans by causing various inorganic fluorides to react upon acetyl chloride Thus when silver fluoride and acetyl chloride are heated together in a sealed tube to 260°, a small quantity of acetyl fluoride is formed The acetyl chloride, however, is much more completely converted to fluoride when it is passed in the state of vapour through a long silver tube filled with dry silver fluoride and heated to 300° Upon allowing the issuing vapour to pass into a strongly cooled receiver, acetyl fluoride condenses in the liquid form Another mode of preparation consists in allowing arsenic fluoride to fall drop by drop upon acetyl chloride contained in a copper vessel, when energetic action at once occurs in the cold The exit tube is attached to a spiral of leaden tubing, arranged as an inverted condenser, in order to retain either of the liquid reacting substances, and the last traces of acetyl chloride are removed by subsequently allowing the escaping vapour to pass through a copper U tube filled with fragments of silver fluoride and heated in a bath of nitrates to 300 The acetyl fluoride may then be condensed in a strongly cooled receiver Instead of arsenic fluoride the solid trifluoride of antimony may be employed, and the operation performed in a glass flask, an ordinary inverted glass condenser being used to retain any escaping acetyl chloride By far the most advantageous mode of preparation, however, consists in reacting with acetyl chloride upon zinc fluoride One hundred grams of zinc fluoride are introduced in successive portions of ten grams each into a strong glass flask cooled by a freezing mixture and containing a hundred and fifty grams of acetyl chloride. The flask is then sealed, warmed to 40°, and again cooled It is subsequently opened, while surrounded by the freezing mixture, and placed in connection with a leaden worm whose extremity passes down into a second flask surrounded by ice and containing a little dry zinc fluoride The acetyl fluoride is then distilled over into the second flask, and upon redistillation over the zinc fluoride contained in the flask it is obtained in an almost pure condition The liquid may be preserved unchanged in a dry glass vessel, but if moisture obtains access the glass is rapidly attacked If the vessel containing the liquid is placed in connection with a tube standing over mercury, and the liquid warmed by holding the vessel in the hand, the new fluoride may be collected in the gaseous state, and preserved as a gas, provided the temperature of the room is superior to 19°5 Both the liquid and the gas are colourless.

They burn with a blue flame upon ignition producing water vapour, carbon dioxide, and hydrofluoric acid They possess an odour somewhat resembling that of carbonyl chloride Water dissolves about twenty times its volume of the gas, but the liquid does not mix with water a very small proportion only being dissolved, and suffering slow decomposition Alcohol, ether, benzene, and chloroform dissolve it in all proportions

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mr C Drew, a Grivet Monkey (*Cercopithecus griseo viridis* ♀) from North east Africa, presented by Mr George Conquest, a Grey Ichneumon (*Herpestes griseus*), from India, presented by Mr J E Barber, a Common Fox (*Canis vulpes* ♀), British, presented by Miss Nora Dunn; a Song Thrush (*Turdus musicus*), British, presented by Mr Baldwin M Smith, an Alexandrine Parakeet (*Palæornis alexandri* ♂) from India, presented by Mr E Bond, two Cerastes Vipers (*Vipera cerastes*) from Egypt, presented by Colonel Holled Smith, a —— Lizard (*Amphibolurus* sp inc, from Australia, presented by Mr Herbert E Swayne, a Guinea Baboon (*Cynocephalus sphinx* ♀) from West Africa, a Rhesus Monkey (*Macacus rhesus* ♂), a Grey Ichneumon (*Herpestes griseus*) from India, two Punctated Agoutis (*Dasyprocta punctata*), a King Vulture (*Gypagus papa*) from Central America, a White-eyebrowed Guan (*Penelope superciliaris*) from South east Brazil, deposited, a White faced Heron (*Ardea novæ hollandiæ*) from Australia, eight Ruffs (*Machetes pugnax* 4 ♂ 4 ♀), British, purchased, a Reindeer (*Rangifer tarandus* ♀) born in the Gardens

OUR ASTRONOMICAL COLUMN

PHOTOGRAPHIC AND VISUAL MAGNITUDES OF STARS At the Amsterdam Academy of Sciences on April 2, Prof J C Kapteyn communicated the results of an investigation on the systematic differences between the photographic and visual magnitudes of stars in different regions of the sky The comparison of the photographic diameters of stars of equal visual magnitude (according to Gould and Schonfeld's estimations) on 370 plates of the southern sky, shows that the actinic effect of stars in or near the Milky Way is much greater than that of stars in high galactic latitudes Prof Kapteyn has examined the different causes which lead to this variation There is, first of all, the influence of different meteorological conditions, next, systematic errors in the catalogue of visual magnitudes used for comparison, and thirdly, peculiarities in the light of the stars The discussion leads to the conclusion that the difference of magnitude is not appreciably affected by the first of these causes And since, taking everything into consideration, the errors of estimated visual magnitudes could not possibly exceed 0 3 magnitude, there is no doubt that the difference of half a magnitude or more, indicated by the photographs, is due to the quality of light emitted It is said that Prof Pickering's idea that the Milky Way ought to be considered as an aggregation of stars of the first type is only sufficient to account for a difference of about 0 1 magnitude Thus it appears that the light of stars in or near the Milky Way, like those of Group IV, is richer in violet rays than that of other stars

PHOTOGRAPHS OF THE LYRA RING NEBULA —In addition to the work on the Carte du Ciel, Prof Denza, of the Vatican Observatory, has taken up the photography of nebulæ Beginning with the Ring Nebula in Lyra, he has made five exposures on this object, from half an hour up to nearly two hours' duration. To bring out the fine detail, development has been carried on for about twenty minutes in each case The negative which had received the longest exposure was presented to the Paris Academy on April 25 Viewed microscopically, the star at the centre of the nebula is seen to be joined to a smaller one near the nebulosity, and each of them can be broken up into other more or less brilliant points A large number of condensed regions are well visible in the nebula The location of these leads Prof Denza to agree with Secchi that "L'anneau se prolonge dans le sens du plus grand axe, et que les parties les plus denses sont dans la direction du petit axe"

DETERMINATION OF THE CONSTANT OF ABERRATION — Prof G C Comstock contributes the provisional results of a determination of the constant of aberration to the *Astronomical Journal*, No 261 The method adopted in the investigation is a modified form of that used by M Lœwy, three reflecting surfaces being placed in front of the objective of the telescope instead of two Images of stars in different portions of the heavens are thus simultaneously produced in the focal plane of the objective, and a micrometer is used to measure the distance between those of two given stars, when each pair of surfaces is successively employed Then, if d represent the distance between the images of two stars as measured with the micrometer, Δ the angle subtended at the earth by the stars, R the effect of refraction in changing the true Δ into an apparent Δ', and K a correction depending upon the squares of the errors of adjustment of the mirrors, we have—

$$\Delta = 120 + K + d + R$$

The provisional value of the aberration constant derived from Prof Comstock's observations is—

$$20''494 \pm 0''017$$

An investigation of the refraction has also been made, resulting in the detection of a real variation The refraction is at a maximum near the time of the winter solstice and a minimum near the summer solstice, but the exact epoch and amplitude have not yet been determined

STAR MAGNITUDES —"The Estimation of Star Magnitudes by Extinction with the Wedge," was the subject of an interesting paper by Captain Abney before the Royal Astronomical Society, many of the experiments from which his conclusions were drawn being made from a paper which he and General Festing communicated to the Royal Society on colour photometry In the experiment for determining the amount by which the intensity of any ray of the spectrum would have to be reduced before it became invisible, the absolute intensity of the D line was fixed upon for the basis, from which all the other intensities could be directly calculated With the arrangement he described, the D line was reduced to the 350 ten millionths part of a standard amyl lamp, while under the same conditions the green light E had to be reduced to 65, F to 150, G to 3000, and the red to 110,000 ten millionth part By making the rays equal to one amyl lamp the numbers obtained were for D 350, E 35, F 17, G 15, and for C 22,000 ten millionths part

These numbers showed that to produce extinction for two lights of equal luminosity, say of colours C and G respectively, the latter was nearly 1500 times greater than that required for the other He then referred to the extreme persistency of the violet sensations, they being 1500 times more persistent than the red and about 25 times more than the green, pointing out that the violet sensation would be the last to be extinguished The function of the wedge, then, was not to obliterate the spectrum but to eliminate the violet sensation contained in its light By determining star magnitudes by this method of extinction, the results obtained, he says, "should agree better with those obtained by photography than those obtained by eye estimation,' the first being obtained by estimation of the E light, the second of the light between G and F, and the third from that near D

Referring to colour extinction he mentions that although most of the faint stars are known to be of a bluish colour it does not follow that "they are not red The blue tint is brought about by the faintness of the light, which makes all colours appear grey, and "as the violet sensation disappears last, it frequently happens that you get the red and green sensations as grey, and the violet just above the colour limit, thus giving a grey blue" He suggests that with telescopes of large aperture these stars might be seen in colours

THE INSTITUTION OF MECHANICAL ENGINEERS

AN ordinary general meeting of the Institution of Mechanical Engineers was held on the evenings of Thursday and Friday of last week There were two items of exceptional interest on the programme, the first being the inaugural address

of the new President, Dr William Anderson, F R S, and the second the report of the Committee appointed by the Institution to make trials on marine engines The President in his address gave a brief review of the progress of the Institution since its foundation in 1847 For the first thirty years of its existence the Institution was a provincial Society, having its head-quarters in Birmingham In 1877 it was determined to remove to London, as it was thought that the wealth and influence that had been acquired was sufficient to give a position of national importance which could hardly be held by a Society having its head quarters in any other city than the metropolis There was naturally a strong opposition to the migration, but the change was made, and since then the importance of the Institution has gone on steadily increasing, until at the present day it is second only to the Institution of Civil Engineers The Institution was started in 1847 with 107 members, the annual income being £515 During the first thirty years the membership increased about tenfold, but at the end of the fourteen years that the head-quarters have been in London it has increased to twenty-fold, that is to say, in 1877, when the migration was made, the numbers were about one thousand, whilst last year they were over two thousand—actually 2077 The annual income was last year £7212, and the accumulated investments of the Institution are now £22,536

A somewhat acrimonious correspondence has been published lately in the pages of a weekly journal, and the President, somewhat unnecessarily perhaps, thought fit to reply to this A complaint had been made that the papers were few and poor Dr Anderson referred to the large number of scientific Societies now existing, and the difficulty of providing good papers "We have been spoiled and cloyed," he says, "by the rapid progress of mechanical engineering, so that papers which are not revelations of something new are condemned as unworthy of the Institution Is there any form of steam engine, for example, which it would be worth while now to describe, unless it be some monster of exceptional proportions, the details of which we should like to see in our Transactions? Who would like to read a paper on a bridge of even 800 feet span, and to illustrate it with all the type and plates which characterized the two accounts of the Britannia Bridge, when the Forth Bridge, a structure of more than double that opening, has recently become familiar to us? I am afraid that, in consequence of the state at which we have arrived, and, in respect of originality, the untoward age in which we live, we must be content with many papers that may justly be termed poor so far as novelty alone is concerned We must, therefore, rely for excellence on a more scientific treatment of our subjects, and on the care with which the details of construction are worked out and presented in the illustrative drawings Our critics should remember also that originality is not our only quest—that we are not all veterans to whom design comes almost by instinct we have a large body of younger and less experienced members, and to them I feel sure, from my past experience, that our proceedings offer practical examples and guidance which are appreciated all over the world, and the desire to possess which is, I take it, the main cause of the ever increasing strength of the Institution "

The President next referred to the work done by the different Research Committees of the Institution which have been engaged for some years past in investigating engineering subjects upon which information appeared most desirable There have been Committees on riveting, on friction, on steam-jacketing engine cylinders, and other matters, including marine engine trials, the last report of the Committee on the latter subject having been presented at the meeting now under notice It would be difficult to imagine a more useful and legitimate purpose upon which the funds of the Institution could be spent The work that is over and over again done, generally in a partial and imperfect manner, by private firms, in getting information on many points of engineering practice, represents a sad loss of time and money The work of the Research Committees of the Institution should put an end to a great deal of this, and will so help the advance of engineering practice, to the benefit not only of engineers, but of the whole civilized world The President made another suggestion which would tend to the same end, and which it is hoped may be carried out "There is," he said, "another sphere of usefulness in which our abundant means would enable us to do good service, it is in the compilation of a brief reference index to all mechanical matters at home and abroad Were we to establish a staff—and it might be a very modest one—whose duty it would be to index under proper heads every important article relating to mechanical science which comes out week by week, we should in time, and at moderate cost, form an invaluable record, from which an inquirer would be able to find in a few minutes where to look for complete information on any subject connected with our special branch of engineering." The Royal Society is doing a similar work for scientific papers generally, and in the United States Messrs Haferkorn and Heise have compiled a most useful index of books printed in English relating to technical matters, but the work stops at 1888, and does not contain references to the isolated letters and papers which appear in English and foreign journals

Dr Anderson, as every one knows, holds the important post of Director General of Ordnance Factories, and it was natural he should make some reference to the various establishments—the chief of which, of course, is Woolwich Arsenal—under his control Here, again, public criticism has been exercised of late, not altogether favourably, and a good part of the address was taken up with an apology for Woolwich Taking the side of the case selected by Dr Anderson for discussion, there is no doubt he made out a very good case It is perfectly impossible that all inventions should be adopted, and therefore it is evident the authorities with whom these matters rest must reckon with a great many hostile critics The address gave some interesting details of the way in which the Ordnance departments are managed, but into this question we need not now enter The difficulty of finding subjects for papers which were altogether novel had been previously referred to in the address, but, notwithstanding that there is little scope for originality, Dr. Anderson pointed out that some problems still remain to be solved Among them is one which is of the greatest practical importance to mechanical engineers, while at the same time it is of extra ordinary theoretical interest This was the question of the nature and composition of steel, and alloys generally Since the year 1879 the Institution had been engaged in trying to unravel the mystery which surrounds the behaviour of steel in connection with its chemical and molecular composition, combined with changes of temperature The researches of Sir Frederick Abel, Dr Sorby, Mr Osmond, Mr Hadfield, and Prof Roberts-Austen, aided by the Le Chatelier pyrometer, have given the inquiry new life Dr Anderson expressed great hope that the active measures taken by the Institution, through the Alloys Research Committee, would result, at no distant time, in the solution of the enigma, and in the *establishment of definite laws* The problem, however, is excessively involved It amounts, in fact, to a consideration of the number of permutations or combinations possible among some ten variables, the relations of which to each other are also dependent, not only on actual temperature, but also on the rate of its changes, and on the uniformity of these changes, throughout the mass The address next made reference to the fact that pure iron is allotropic, and exists in both the hard and soft state Carbon also exists in two forms in steel, either combined or suspended in the mass, and there are other ingredients necessary to take into account In consequence of changes due to temperature also, the chemist is impotent to pronounce from mere analysis what the quality of steel may be On the other hand, the ordinary mechanical tests are not of much avail, because the specimens are not and cannot be in the same condition of internal stress—on which again the molecular arrangement appears to depend—as the masses from which they are cut Moreover, specimens for mechanical testing cannot always be taken from the central parts of the huge forgings and castings now in use for many purposes. Under these circumstances Dr Anderson considered that the method of noting the rate of cooling by curves automatically traced—as now so ingeniously worked out by Roberts-Austen—affords the best promise of placing in the hands of the mechanic a means of judging at any rate of the uniformity in composition of the material, and even perhaps of its actual chemical nature, so far as this affects his wants As additional advantages the thermo electric autographic apparatus is cheap, it occupies but little space, it can be employed in an ordinary room, and the results sought can be obtained in a few minutes.

The use of petroleum or mineral oil next occupied a place in the address, the author being of opinion that as a source of power it would rapidly gain ground In 1888, Priestman Bros brought out their engine, working with a heavy oil having a high flashing temperature That engine was tested by the present Lord Kelvin (then Sir William Thomson) and the author independently, and gave an efficiency of one brake horse-power

to 1·73 lb. of oil. At the next year's show the consumption fell to 1·42 lb., in 1890, to 1·243 lb., and Prof. Unwin this year reports that a brake horse-power has been obtained by the combustion of 0·946 lb. Much yet remains to be done. The useful work on the brake is under 14 per cent. of the energy latent in the fuel, while the heat carried off by the water jacket round the cylinder, and by the exhaust is equivalent to 75 per cent. of the total thermal capacity of the fuel. Dr. Anderson was of opinion that a combination of the direct combustion engine with the spirit engine of the Yarrow type would give the best results, especially if a more advantageous cycle than that of the Otto gas engine can be adopted.

The address next proceeded to deal with the question of the capacity of the earth to supply the ever increasing demand for petroleum, and to enquire whether it would be possible to substitute it largely for coal as a source of heat, owing to the fact that we should have to go deeper and deeper in the future to reach workable coal measures. In connection with this problem the address gave particulars of the researches of Mendeleeff, and described his theory of the continuous formation of petroleum by the action of water on the molten rocks in the interior of the earth. The speculation is one of great interest, but has already been dealt with in these pages.

The vote of thanks to the President for his address was moved by Sir Frederick Bramwell and carried with acclamation.

After the reading of the address the Report of the Marine Engine Trials Research Committee, which had been prepared by the Chairman of the Committee, Prof. Alexander B. W. Kennedy, was read. This report dealt with the trials of the Belgian channel steamer *Ville de Douvres*, which had been generously placed at the disposal of the Committee by the Belgian Government. This vessel is one of the line which carries the mails between Ostend and Dover, and was built and engined by the Société Cockerill, of Seraing, Belgium, and is a comparatively new vessel, having been delivered in the year 1890. The propelling machinery consists of a pair of compound surface-condensing paddle engines. Vessels of this class are mainly designed with a view to speed, as the chief object desired is to carry passengers and mails quickly from port to port. As the run is only of three hours' duration, it would obviously not pay to enter into any refinements with a view of economizing fuel. The time under way is comparatively small when considered in relation to the time spent in raising steam and cooling down again. This is a point which should be borne in mind, but which some critics appeared to forget during the discussion. Perhaps engineers are apt to base their estimates of efficiency, especially in marine practice, too much on an economy basis. It is a good thing to save fuel if it can be done without too much sacrifice. An examination of the details of the various trials of steamships made by the Research Committee illustrates this important point. We hardly know how to deal with this paper. It is full of information of the most valuable description, but its very fullness renders it extremely difficult to make an abstract, and we have not space to give all the details in full. Perhaps the best plan will be to give some of the leading facts, and, although these may appear somewhat bald standing alone, they will enable our readers to form an estimate of the scope of the trials, and those who are especially interested will go to the original, in the Transactions of the Institution, for fuller details. The *Ville de Douvres* is 271 feet long, 29 feet broad, and 15·5 feet deep, moulded. Her registered tonnage is 855 gross, and her displacement 1090 tons. She was run for nine hours especially for the trial in the North Sea. The engines are of the compound inclined, surface-condensing type, with cylinders 50·12 inches and 97·12 inches in diameter, with 72 inches stroke. Neither cylinder is steam jacketed, but there is an intermediate receiver encircling the high-pressure cylinder, an arrangement which certainly does not tend towards efficiency. The air, feed, and bilge pumps are driven from the main engines. The circulating pump is separate, and is estimated to develop 47 indicated horse-power. The surface condenser contains 6540 square feet of tube surface, and it is so arranged that the circulating water passes three times through the condenser. The course of the water is such that the coldest water meets the hottest steam. This is naturally not the best arrangement, for the circulating water would still be efficient for taking heat from the hottest steam, even after it had been somewhat raised in temperature by the coldest steam. On the other hand, circulating water having been heated by the steam at highest temperature, will be comparatively inefficient to further cool down steam already cooled to a great extent. In any case, if a good vacuum be ultimately obtained, the refrigerating surface will be far less effective. The paddle wheels are 22 feet 10 inches over the floats, the latter being 10 feet broad and 4 feet 4 inches deep. The immersion on trial was 17 inches. There are four single ended return-tube boilers, 13 feet by 10 feet. The grate area is 236 square feet, and the total heating surface 7340 square feet. There is forced draught on the closed stokehold system. The total weight of all machinery, exclusive of paddle-wheels, and all water is 361 tons. Block fuel was used throughout the trial. The calorific value, calculated from analyses made, was 14,390 thermal units per pound. This corresponds to an evaporation of 14·90 pounds of water from and at 212° F. A number of samples of furnace gases were collected and analyzed, with the following mean results:—

	Carbonic Acid	Carbonic Oxide	Oxygen	Nitrogen
By volume per cent.	11·55	0·00	7·95	80·50
By weight per cent.	16·84	0·00	8·44	74·72

There was a little uncertainty about the temperature of the chimney gases, but the mean temperature was assumed to be 910° F. The mean draught was equal to a pressure of from 0·92 to 1·22 inches on the water-gauge. A notable feature about these trials was that the feed measurement was made by meters. This is a vast improvement, in one respect at least, and that of great importance, on the measuring tank system. Measuring tanks are always cumbersome and difficult to fit; so much so that they generally prove the greatest bar to proper trials being made of the efficiency of marine machinery. The meters used were of the Kennedy type, and appear to have answered the purpose admirably. There is no trouble in taking a meter reading, whilst the measuring tanks require constant attention. We look on the introduction of the water meter for this purpose as a most important step in advance, and one which will lead to engineers obtaining more frequent information on the efficiency of marine engines. It is most desirable that the performance of the boiler should be separated from that of the engine. The indicated horse-power and coal consumption give the economy of the whole machine, but when results are not satisfactory it is often difficult to say whether the fault rests in the boiler compartment or the engine room. Another step in advance is the effort made to measure the amount of priming water. In the present day we do not have so much trouble from priming as in past times, when lower pressures were in use and the steam space was practically what it is now. Still, there are yet large quantities of unevaporated water often carried over to the engines by the rush of steam. It is obviously useless to exercise great care in measuring the feed if a considerable part of it is carried from the boiler to the condenser simply as water. In such a case the boiler is credited with a high evaporative efficiency by reason of its very fault, and the engine is debited with steam which it never receives, but on the contrary is having its action impaired by the presence of water in the cylinders. The method of testing for priming is as follows:—A quantity of steam from the main steam pipe is condensed in a special surface condensing apparatus, and collected, and at the same time a sample of water is taken separately from the boilers. Both of these samples are carefully analyzed to determine the quantity of salt present in each. As the whole of the salt found in the sample from the steam pipe must have come over from the boiler in conjunction with priming water, and not with steam, a simple calculation will show how much boiler water corresponds with the quantity of salt, if any, found in the steam pipe sample. From this it is easy to determine what percentage of the whole feed water has passed from the boilers in the form of water, or, in other words, what percentage there is of priming. The chemical determination for salt is a very simple one, and is capable of being carried with ease to an exceptional degree of certainty. The observed and calculated data of the trial are given in a full table appended to the report. The mean boiler pressure was 105·8 lbs. above atmosphere, the vacuum 10·12 lbs. below atmosphere, the revolutions 36·82 per minute, the mean indicated horse-power 2977, the fuel per square foot of grate per hour 31·3 lbs., and the feed-water per indicated horse-power per hour 20·77 lbs., allowing for auxiliary engines. The efficiency of the boiler was 66·1 per cent., and of the engines 11·7 per cent. The combined efficiency of engine and boilers was 7·7 per cent.

A very interesting discussion followed the reading of the report, but a great part of this it would be useless to give, as many details of the trial have necessarily been omitted from our brief abstract

A paper was next read "On Condensation in Steam Engine Cylinders during admission" This was a contribution by Lieutenant Colonel English, of Jarrow In former papers on this subject the author had given experimental data, but it was objected that he had left out of account the range of temperature in the cylinder In order to show that this was not the case, he submitted the following formulæ, which, he claimed, proved his case The former papers, a study of which is necessary to a proper understanding of the facts, may be found in the Transactions of the Institution for the years 1887 and 1889

In jacketed cylinders the weight of steam condensed per stroke and not re-evaporated at cut off is represented by the expression

$$\frac{56}{\sqrt{\text{revs per second}}} \times \frac{(S_c - S_1)}{L}\rho_1,$$

where S_c is the unjacketed clearance surface in square feet, S_1 the fresh surface exposed during admission up to cut off, ρ_1 the initial density of the steam in pounds per cubic foot, and L the latent heat of evaporation in thermal units If d be the diameter of the cylinder in feet, l the length of stroke in feet, m the proportion of stroke up to cut-off, $\mu = \frac{S_c}{2 \times \text{area of cylinder}}$, and N the number of revolutions per minute, then S_c = unjacketed clearance surface $= \frac{\mu\pi d^2}{2}$, $S_1 = \pi d m l$, $\sqrt{\text{revs per second}} = \frac{\sqrt{N}}{7.75}$, and the foregoing expression may be written

$$\text{Weight condensed} = \frac{56 \times 7.75}{L \times \sqrt{N}}\left(\frac{\mu\pi d^2}{2} - \pi d m l\right)\rho_1$$

$$= \frac{868}{L\sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right)\frac{\pi d^2 m l}{4}\rho_1$$

But $\frac{\pi d^2 m l}{4}\rho_1$ is the weight of steam per stroke uncondensed at cut off, and 868 may be taken as an approximate value for L, therefore for jacketed cylinders,

$$y = \frac{\text{weight condensed}}{\text{weight uncondensed}} = \frac{1}{\sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right).$$

For unjacketed cylinders a similar approximate expression is

$$y = \frac{1.5}{\sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right).$$

The author supported his views by means of a voluminous table, in which he gathered together the observed data on a number of steam engine trials made by various well-known authorities, to which he attached the results obtained by calculation on his system

A short discussion followed the reading of this paper, and the meeting was then brought to a conclusion by the usual votes of thanks

The summer meeting of the Institution will be held at Portsmouth, on July 26 to 29

THE ROYAL SOCIETY SOIRÉE

THE annual *soirée* of the Royal Society, which took place on Wednesday, May 4, may be said to have been the most successful that has been held for many years All the necessary arrangements, which were by no means few in number, were carried out without a hitch, while the exhibits were of a most attractive nature. As regards the latter, the following are a few notes of the most novel and important objects displayed —

Prof T E Thorpe exhibited a model to illustrate the general phenomena of explosions as brought about by the presence of dust particles, in explanation of the causes of colliery explosions. This apparatus consisted of two long narrow boxes, fitted together in the form of a cross On the bottom of these boxes was thinly strewn a quantity of fine Lycopodium powder, while at one end of the longer box there was a small chamber in which a blank cartridge was fired The firing of this cartridge corresponded to the direct action of a "blow out shot," while the dust raised by the concussion, which carried the flame throughout the entire apparatus, took the place of the fine coal dust The apparatus also showed that the progress of such an explosion was always accompanied with increase of violence.

Prof Clowes showed an ordinary miner's safety-lamp which had, by a very simple contrivance, been converted into a delicate instrument for detecting minute proportions of fire-damp. To the ordinary burner an additional tube is made to pass through the oil reservoir, one end of it being connected, by means of a flexible tube, with a small portable bottle of compressed hydrogen The hydrogen when turned on becomes ignited close to the oil burner, the flame of which is extinguished by turning down the wick, by adjusting the flame of hydrogen to the standard height, a luminous column of light is seen vertically over it, from the behaviour of which the amount of inflammable gas can be directly estimated At the conclusion of the experiment the wick is simply turned up, and ignited from the hydrogen flame, the latter is then disconnected from the bottle From 0.25 to 3 per cent of fire damp has in this way been estimated, while greater quantities than these have been measured by reducing the size of the flame.

Vacuum tubes without electrodes, exhibited by Dr Bottomley. These tubes, which were of a variety of shapes and kinds, illustrated very beautifully all the phenomena of stratification They were sensitive also to magnetic and electro-dynamic influence, and showed the phenomena of molecular bombardment The brilliant illumination of a piece of Iceland spar contained in a glass sphere afforded an excellent means of displaying the electrical excitements [For an account of experiments with vacuum tubes, see a letter by Mr Bottomley in NATURE, January 6, 1881, vol xxiii p 218]

Mr Cecil Carus Wilson exhibited some natural and artificial sands, from which he was able to produce many musical notes These notes, as he explained, were the results of the rubbing together of the surfaces of the grains of sand, but he had met with several sands from which he could not obtain a vestige of a note One special artificial sand sang only when rubbed in some sort of vessel

Apparatus for measuring degrees of incompleteness of colour vision, exhibited by Mr Brudenell Carter The object used for the tests is a group of various colours, which were such that they could be seen by either reflected or transmitted light The amount of illumination that was required to recognize the colours distinctly was a measure of the "degree of incompleteness" In order to control this amount of illumination, light of known intensity had to pass through a variable aperture before it fell on the test object, the size of this aperture being read off in square millimetres

Captain Weir's azimuth diagram was exhibited by Mr J D Potter It is claimed for this diagram that besides being most ingenious, it furnishes one of the most successful modes of graphic solution of a mathematical problem that has ever been invented It is used for finding the true azimuth of a heavenly body, taking into account the ever-changing errors of the compass, which in our days of iron ships have to be so carefully watched and recorded The errors as usually determined are obtained from observations made of the compass-bearing of a heavenly body (the sun generally being taken) with its true bearing, and it is for the simplification of this method that this azimuth diagram has been found to be practically useful.

Prof Oliver Lodge had three exhibits. The first was the projection of interference bands on a screen, being produced by a modified method of Michelson Very striking also were the electric sparks in and to water, illustrating lightning effects and multiple flashes In a shower, with too great spark-length for a strong discharge, a multitude of violet streams or spurts filled the air, resembling somewhat lightning flashes The spark to water spread itself out over the surface, showing that the surface layer was a feeble dielectric, while the spark under water was brief but very violent, treating the water as a dielectric, and producing concussion The electric retina, illustrating the possible meaning of the rod and cone structure, was very interesting; radiation from spheres which were in a suddenly disturbed and oscillatory electrical condition falling upon a graduated series of end on cylinders, which responded by vibrating transversely

Mr W. Crookes repeated many of those beautiful experiments of electric currents of high potential and extreme frequency that were first carried out by Tesla The discharges from a battery of Leyden jars were sent through the primary

wire of an oil induction coil The frequence of alternation amounted to no less than 1,000,000 a second, while the electromotive force reached the enormous amount of 100,000 volts Perhaps it was as well that this frequency was great, otherwise the physiological action might have been rather surprising to those who trusted implicitly in Mr Crookes The resistance offered by the sheet of vulcanite to the strong current produced some fine flashes, while very pretty were the examples of brush discharges, St Elmo's fires, &c, at the secondary poles of the oil induction coil

The electrical apparatus shown by Captain Holden, R A, consisted of some very important new instruments, among which we may mention the high speed chronographic pen for taking a number of successive records of short intervals of time, the pen being automatically reset after each record, an improved simple compensated voltmeter on the hot wire system, and the dead-beat alternating current ammeter worked by a heated metal strip and free from self-induction

Prof Roberts-Austen exhibited a new electrical method for the exact determination of very high temperatures, which has rendered possible the construction of a very simple instrument, devised by Prof H Le Chatelier, that can be placed in the hands of any workman The latter depends on the comparison of the intensity of the radiation emitted by a glowing body (the temperature of which has to be determined) with that of a standard source of light To use the instrument it is pointed in such a direction as to have the light from the heated mass of metal in its field of view, so that the colour can be distinctly observed, in the same field of view a series of standard colours can also be made apparent (situated side by side with the heated metal), by turning a milled head screw which carries a pointer over a graduated scale By matching the colours a direct reading of the position of the pointer gives the required temperature

The Rev. F. J Smith exhibited an electric tram chronograph which he had devised for measuring small periods of time, varying from one-fourth to one-twenty thousandth part of a second This instrument consists of a metal girder furnished with a T-shaped end, carries two steel rails, and is supported on a V-groove, hole, and plane system The carriage, on which is fixed a slightly smoked glass plate, runs on these rails, driven either by a weight or by a coiled spring A metal pillar, carried on a V-groove, hole, and plane system, is placed in front of the moving surface, and supports electro magnetic styli which can be brought into contact with the smoked surface, a tuning-fork also is so placed that the traces are found to be recorded on the smoked plate so as to afford a means of measuring the time intervals The two motions of the pillar, of rotation and vertical translation, allow a large number of observations to be made on the same plate There are also continuous contact breakers, whereby, when a photographic plate is fixed in the carriage, spark photographs of moving objects may be obtained This instrument has been applied to the measurement of the velocity of projectiles, and small periods of time in physiological research, and to the photography of insects and falling drops of liquids

Perhaps the most unique exhibit of the evening was the series of photographs of flying bullets which Mr Boys had obtained by a modification of an old method. The photographs showed beautifully the waves in the air caused by the rapid flight of the bullet analogous to those produced by a fast going steamer In one slide the small pieces of paper through which the bullet had passed were also seen ploughing their way through the air, producing quite as definite waves as the projectile itself, only of not such large dimensions The passage of a bullet through a piece of wire was also very curious, the piece of wire that was cut off not having time to fall before it was seized by the lightning eye of the camera. The photograph showing a magazine rifle bullet piercing a glass plate brought out some very interesting facts The glass appeared to be thoroughly scattered in a direction opposite to that in which the bullet was proceeding, the greatest scattering taking place on the side which the projectile touched first. The waves set up on the glass plate gave measures of the wave, length of the tremor caused, and the velocity of travel The bullets used for these pictures were of various kinds, and the velocities varied from 750 to as much as 3000 feet per second, the former from a pistol and the latter from a magazine rifle, the bullet being composed of aluminium to obtain this great velocity

The Committee of the Kew Observatory exhibited a testing camera for photographic objectives that had been designed by Major L Darwin With this instrument all the most important features of a lens can be accurately and swiftly determined We may mention here that arrangements are being made that any lens sent to them will be thoroughly examined in all respects under the superintendence of Mr G M. Whipple, certificates of examination being made out, as is at present done in the case of other instruments

We must now pass on to the photographs

Astronomy was well to the fore with the exhibits of Messrs Lockyer and Roberts The former showed a fine spectrum of Nova Aurigæ, that had been enlarged twenty five times from a negative taken with only a 6 inch object glass and prism by the Brothers Henry and Hilger respectively several fine photographs of stellar spectra illustrating the main evolutionary types according to the meteoritic hypothesis, and photographs of the 3 foot reflector at Kensington that is now near completion Mr Roberts showed some photographs of celestial objects, the original negative of Nova Cygni, taken with a 20 inch reflector with a two hours' exposure, showing the Nova as a star of the thirteenth magnitude An enlargement of the region in which Nova Aurigæ was situated when the star was of the fourth magnitude was also displayed, together with the original photograph taken with the instrument before mentioned, but with an exposure of three hours

The photographs showing the great sun-spot of February last, exhibited by the Solar Physics Committee, may be said to be the best series that has ever been obtained The series included nine days, and showed the remarkable changes that occurred during the interval from February 5 to February 17

Mr W Saville Kent exhibited a series of photographs, over a hundred, taken by himself, enlargements of the same, and water-colour sketches, illustrating coral reefs, coral animals, and the marine fauna generally of the Great Barrier district of Australia A lantern exhibition illustrating the same subject was also included in the evening's programme The reef views, which portrayed extensive areas of growing corals of innumerable varieties, were, as explained by the exhibitor, taken at abnormally low spring tides, and are as a matter of fact very rarely visible to the extent depicted Among the more important points associated with this exhibit were the facts that in a large number of instances accurate measurements had been taken of the individual corals that composed the reefs photographed, such reefs being in easily accessible positions, where their subsequent amount and rate of growth could be periodically determined This exhibit, more particularly with relation to the illustrations of living coral polyps—those of the mushroom corals, genus *Fungia*, being particularly noteworthy—represented the first occasion in which photography has been systematically applied to this highly interesting biological subject A second novelty exhibited by Mr Saville Kent was a pearl of fine quality and considerable size that the exhibitor had caused the mother-of-pearl shell animal, *Meleagrina margaritifera*, to produce by means of a delicately-manipulated operation on the living animal

From the Zimbabwe ruins, Mashonaland, some very valuable finds in the shape of pottery, gold crucibles, weapons, ingot moulds, &c., were exhibited by Mr Theodore Bent and the Royal Geographical Society, while by the same exhibitors were shown a model of the circular temple at Zimbabwe, built of small blocks of granite without mortar, and several plans of ruins in Mashonaland No less interesting also were the photographs of ancient Central American monuments and buildings from the ruins at Chichén Itzá (Yucatan), Palenque (Chiapas), &c, exhibited by Mr Alfred P Maudslay, and a selection from the proof-plates to the first memoir of the archæological survey of Egypt that is being undertaken by Mr Percy E Newberry. One of these proof-plates showed all the successive stages of a wrestling match between a black and a white man, more than a hundred different positions being recorded, the white man, we are sorry to say, seemed to be getting the worst of it in many of them

Several important discoveries were made during the Royal Dublin Society's survey of the fishing grounds on the west coast of Ireland, specimens of several fish then obtained were exhibited by Prof A C Haddon and Mr E W. L. Holt Many new to British waters were found, while one quite new to science (*Nettophichthys retropinnatus*, Holt) was caught

Some very curious worms composed Mr F E Beddard's exhibit They were specimens of *Branchiura Sowerbii*, and were found in a tank in the Regent's Park Botanical Gardens

They possess a dorsal and ventral series of contractile gills, which make them differ from all other known fresh-water worms

To summarize shortly a few of the other exhibits, we may mention Messrs Pike and Harris's high tension apparatus, Mr H L Callendar's platinum resistance pyrometers, the original specimen of *Asteropecten Orion* (Forbes), and a specimen of a slab of mountain limestone Bolland showing the passage of a foraminiferal ooze into crystalline calcite, by Prof W C Williamson, Prof Percy Frankland's crystals of active calcium glycerate (lævorotatory), and the two exhibits of turacin, one by Dr C A MacMunn, showing the very remarkable spectrum it produces, the other by Prof A H Church who discovered this red pigment in the wing-feathers of certain plantain eaters or Touracos A very ingenious process of so-called colour photography was explained by Mr F Ives, of Philadelphia, who showed several pictures by means of a special optical lantern

THE SOUTH LONDON ENTOMOLOGICAL AND NATURAL HISTORY SOCIETY

THE annual Exhibition of this Society was held on the 5th and 6th inst, at "The Bridge House," London Bridge, S E The President, Mr C G Barrett, F E S, in opening the Exhibition, gave a short account of the history of the Society from its formation by eleven South London entomologists in 1872, and he referred to the work done by members in rendering popular the study of biological science

The exhibits were arranged in four rooms, and were very varied, including examples of nearly every order of the animal and vegetable kingdoms

In the first room Mr C S Cooper exhibited an almost perfect collection of British wild flowers and leaves, the Lambeth Field Club, Mollusca, Mr J T Carrington, land shells from the Riviera, arranged so as to show variation, Mr C H. Collings and Mr D W Collings, British and Australian birds' eggs and British birds, Mr H J Turner and Mr Rice, nests and eggs of British birds, the latter having a double nest of the great titmouse (*Parus major*) The tables around this room were set apart for the exhibition of objects by aid of the microscope, and among so many it is difficult to make a selection, but the more important objects were those of Mr T D Ersser, who showed the circulation of the blood in a gold carp, a most interesting subject, Mr J H Stanley, spawn of perch, Mr H Groves, the circulation of sap in Nitella, Mr R Macer, heads and eyes of various species of spider, Mr West, fresh-water Polyzoa, Mr E Hinton, preparations of the Hydroids, including the beautiful sea pen, killed with the tentacles fully extended, Mr W B Medland, the pulsation in the heart of a snail, Mr J. B Medland, a section of the jaw of a mole, with the teeth *in situ* (polarized)

In the second room Mr J A Cooper's birds' nests and eggs in natural clutches occupied one end, and were much admired one of the principal features of this collection being that it is arranged to show the variation in different clutches of the eggs in one species This was particularly noticeable in those of the red backed shrike Among the eggs there were white varieties of those of the chaffinch, lapwing, and great black-backed gull, variable series of the guillemot, razorbill, lapwing, and golden plover, also a series of nests containing eggs of the cuckoo, including nests of the wagtail, tree pipit, chaffinch, greenfinch, hedge sparrow, robin, flycatcher, yellow bunting

In the class Insecta some of the more important exhibits were those of Mr J H. Leech, with sixteen drawers containing Palæarctic Lepidoptera. This collection attracted considerable attention Mr. J Jenner Weir showed exotic Rhopalocera, illustrating forms of mimicry, and fine examples of South African Ornithoptera Mr S Edwards also contributed a large exhibit of exotic Rhopalocera Adjoining these, was the Society's typical collection of Canadian Lepidoptera Four drawers of European Neuroptera were shown by Mr R. McLachlan Mr H Moore exhibited a number of wasps' nests. Mr T R Billup's exhibit comprised British Coleoptera, containing types of nearly all the known species, three drawers of Hemiptera-Heteroptera and one of Homoptera were beautifully arranged, and the adoption of a system of labelling giving the name of the species, the locality where taken, and date of capture, is much to be commended, seven drawers of Hymenoptera Aculeata, containing many rare species, also long series of Ichneumonidæ, many of the specimens being new to science, and others new to Britain, also two drawers of life histories of Hymenopterous and Dipterous parasites, together with the larvæ and imagines of the Lepidopterous host This last exhibit was one of the most interesting and instructive of the exhibition Of British Lepidoptera there was a magnificent display, there being some forty exhibitors Mr R South showed nearly the whole of his collection of *Pyrales*, *Crambi*, *Pterophori*, and *Tortrices*, a selection of *Noctuæ*, among which were extreme series of most of the polymorphic species in the group, a drawer of *Lycæna icarus*, showing the colour range of both sexes, one very blue female without black discoidal spots was especially interesting, a drawer of Geometræ showing that the colour and ornamentation of the female parent is transmitted to a large proportion of her offspring, Mr C G Barrett, *Pieris napi*, one female of a light canary-yellow colour from Norfolk, others suffused with grey from South Wales, others with black spots and tips and dark nervures from the north of Ireland, varieties of *Anthocharis cardamines*, long series of *Odonestis potatoria*, showing extreme variation, the colour in the males ranging from chocolate to a pale buff, also extensive series of varieties of *Agrotis cursoria* and *A tritici*, from the east coast of England Mr Barrett also exhibited a drawer of varieties of Rhopalocera lent to him for the purpose of figuring in his book on the British Lepidoptera, by the Rev Joseph Greene, the Rev O Pickard Cambridge, Dr Wheeler, Mr J E Robson, Mr E Sabine, and Mr Sydney Webb It is doubtful whether such a collection of varieties has been seen before, and those Lepidopterists who pay special attention to the question of variation were much interested in the extraordinary varieties shown Mr F Merrifield, examples of *Selenia illustraria*, *S illunaria*, *S lunaria*, *Eugonia alniaria*, *Vanessa urticæ*, *Platypteryx falcataria*, *Arctia caia*, *Bombyx quercus* and var *callunæ*, bred by him in his experiments on the effect of temperature on the pupa of certain species in causing variation Labels were attached to each specimen showing the conditions to which the pupæ had been subjected, and the results obtained from these It appeared that a lower temperature produced examples which were darker and more intense in colour than those subjected to higher temperatures A third drawer of *S illustraria* and *S illunaria* was shown, as illustrations of the effect of temperature applied for a very few days to pupæ at a sensitive stage, *i e* just before they began to show the colour, the forcing temperature was about 77°, the natural temperature about 40° to 50°, a range of 15° or less (at a point which it appeared was not yet actually ascertained between 57° and 73°) was sufficient to produce the full temperature effects shown in the first two cases, but a range of much less than 13°, if at the right part of the thermometric scale, produced substantial difference of colouring Mr W Farren contributed examples from Cambridge including fine yellow specimens of *Bryophila perla*, and extensive series of *B muralis* and *B impar* of Warren, these gave rise to considerable discussion among visitors as to whether *impar* was a true species or only a variety of *muralis* Mr R S Standen, a small box showing extreme varieties of *Argynnidæ* Mr Tugwell, a selection from his cabinet, including long series of *Eugonia alniaria*, Esp, melanic forms of *Phigalia pedaria*, *Boarmia repandata*, *Tephrosia biundularia*, &c, and striking varieties of *Abraxas grossulariata* Mr C G Gregson also put in a magnificent series of varieties of this last-named species, some of the specimens being entirely suffused with the black markings, in others the yellow-coloured markings were wanting, and many were very pale forms, the black markings being absent, Mr Gregson also showed *Dianthœcia conspersa*, from various localities, to illustrate the local variation in that species—many of the forms were so extreme that he had given them varietal names Mr J R Wellman, his collection of Dianthœcia and Acidalia, also a drawer of *Cidaria russata*, bred and captured from various parts of Great Britain, a most interesting drawer as showing local variation Mr F. W. Hawes, Rhopalocera, reared in 1890 and 1891, chiefly from ova obtained by searching or from the captured female, thus enabling Mr Hawes to ascertain the early life-histories of this group, among them were examples of *Hesperia lineola*, the species recently added to the British list by Mr Hawes Variation in *Arctia caia* was shown by Mr Goldthwait, Mr T W Hall, and Mr. A Mera. Mr C. H. Williams included in his series a gynandrous specimen of *Argynnis paphia* taken by him last summer in the New Forest, and much attention was paid to this beautiful specimen Life-histories, the larvæ being mounted on

the natural food-plant, were shown by Mr J A Simes, Mr A Quail, and Mr A J Croker, the latter gentleman's *Phorodesma smaragdaria* being especially noticeable Mr R Adkin exhibited a collection of British Sphinges and Bombyces, arranged with a view to showing local variation, such variation being well defined in some of the species of the genus *Spilosoma* Also a collection of Macro Lepidoptera made at Rannoch, Perthshire, in 1891, illustrating an article on the local variation prevailing in that district recently contributed to the *Entomologist* Mr Tutt, extremely long and variable series of Noctuæ Mr Machin four drawers from his cabinet, among the rarer species were *Dicranura bicuspis* and *Drepana sicula*

In the third room there was a large exhibit of marine Mollusca, by Mr Conisbee Mr Step's exhibit of living Mollusca afforded a capital opportunity for comparing the mollusks as well as their shells Between thirty and forty species were thus shown, each in a separate glass, and ranged from the substantial *Helix pomatia* to the graceful *Clausilia rugosa* among land snails, and from the large *Anodons* to the fragile *Planorbis lineatus* among the aquatic species Pond life was shown by Mr Perks, living newts, &c, by Mr R Adkin, Jun, and living snakes, &c, by Mr Gee. A gigantic sponge was exhibited by Mr Kedgley

In a fourth room Mr Reeves exhibited and explained an original set of diagrams, showing the correct positions of horses' legs while walking, trotting, and galloping, and to demonstrate their correctness the diagrams were transferred to a zoetrope

A large room was set apart for lectures, and during each evening crowded audiences listened to Mr F Enock, who lectured on "The Life-history of the British Trap-door Spider" The lecture was illustrated by Mr Enock's original micro photographic slides, shown by means of the oxy hydrogen lantern Mr E Step's "Talk about Toadstools" was listened to attentively on each evening The figures thrown on the screen were from Mr Step's own photographs and drawings A third lecture was given by Mr George Day, illustrated by micro-photographic slides, entitled "Domestic Friends and Foes"

IMÈRINA, THE CENTRAL PROVINCE OF MADAGASCAR

ON Monday evening the Rev James Sibree read a valuable paper on Imèrina, the central province of Madagascar, before the Royal Geographical Society After an account of the work of recent explorers, of whom the French surveyors, MM Catat and Maistre, and the English missionary, Mr Baron, are the most important, Mr Sibree came to the main subject of his paper, of which the following is an abstract

M Grandidier, who is now completing a splendid atlas of Madagascar, published a map of Imèrina on the scale of 1 200,000 in 1880, and in 1883 an orographical map coloured according to the contour lines The road from the port of Tamatave to Antananarivo, the Hova capital, in the centre of the Imèrina province remains a mere footpath, impassable either to wheeled vehicles or to beasts of burden, and now, as 300 years ago, porters are the only means of transport

Imèrina ("the elevated") is bounded on the east by the steep ridge of forest-girdled mountain sloping to the Indian Ocean The other boundaries are indistinct, and the total area of the province may be estimated at 7000 square miles The general level of the province is from 4000 to 4500 feet above the sea It is a mountainous region, abounding in peaks, which rise high above the breezy plateau, and marked also by many valleys The most prominent summits are Angàvokely to the east, Ambòhimiangàra in the extreme west, Ihàranandriàna to the south, Milangàna, Ambòhimanòa, and Andringitra more central, and Ambòhipanìry and Vòhilèna to the north The south-west of the province is dominated by the central mass of Ankàratra, a denuded volcano of great size, its peaks forming the culminating points of the island, and reaching nearly 9000 feet above the sea. The mountain peaks are usually granite or gneiss, sometimes occurring in great rounded bosses, sometimes in fantastically carved pinnacles resembling from a distance Titanic forts, castles, and cathedrals Decomposed granite covers a great part of the country with thick deposits of clay, sometimes white but more often tinted deep red by ferric oxide Iron is abundant, gold has recently been discovered, graphite, galena, copper, and other useful minerals are also found in Imèrina The watershed of the island lies much nearer the east coast than the west, and the two chief rivers rising in the extreme east traverse the breadth of the province on their way to the Mozambique Channel The Ikòpa, fed by the Sisaony, the Andròmba, the Màmba, and other streams, flows north westward through the fertile plain of Betsimitàtatra, and farther north is joined by the Betsibòka, under which name the united stream runs on to the sea at the Bay of Bembatòka Lake Itàsy is the only large body of water in Imèrina, and probably owes its origin to volcanic subsidence

On account of its altitude Imerina has a pleasant temperate climate, although lying within the tropics The south east trade winds, blowing fresh and moist over the forest belt and the wooded plains of the east, make the atmosphere peculiarly bracing in the cooler season The annual rainfall at Antananarivo is about 53 inches Through the clear pure air distant landscapes stand out with remarkable sharpness of outline Towards sunset Imerina is seen in its most attractive aspect, the hills, range beyond range, assume the richest shades of purple, the sky flames with crimson and gold, and the long clay walls of the native compounds glow like streaks of vermilion

The general aspect of the province is bare, except for patches of primæval forest in the northern districts Moor like hills, which would look utterly dreary but for the marvellous atmospheric effects, predominate Near Antananarivo the dried up bed of an ancient lake, known as Bètsimitàtatra, forms a great plain, covered with rice fields, which support a dense population The steep sides of the river valleys are terraced, like great green staircases, with rice plots, where the grain is sown broadcast, and whence the young plants are transplanted in the larger fields along the river plains and in the meadows left by dried up lakes

The political subdivisions of Imerina are mainly tribal, and are used for purposes of taxation, and for the apportionment of military levies and forced labour No census has been taken, but an estimate based on the number of villages and houses justifies the estimate of the population at about 1,100,000 Except Antananarivo, there are only small villages in the province, but these are clustered very closely together, especially to the north and north west of the capital Several of these were formerly tribal capitals, and Ambohimànga still retains nominal equality with Antananarivo in royal speeches The old villages were always built on hills for purposes of defence, and surrounded by double or treble lines of fosses and embankments dug out of the hard red clay A narrow bridge of the red clay leads to the gateway, which is formed of blocks of rock, either a circular slab 10 or 12 feet in diameter, which was rolled between upright gate posts so as to block the way, or massive upright monoliths bearing strong wooden gates In recent times the Hovas have largely deserted these fortresses, and built themselves villages close to the rice fields Graves of the aboriginal Vazimba are scattered over the province, but local feeling prevents any examination of these from being made

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, May 2 —M d'Abbadie in the chair —The movements of minute organisms analyzed by means of chronophotography, by M Marey Using an arrangement described in the *Revue Générale des Sciences* in November last, and in NATURE, vol. xlv p 228, M Marey has obtained photographs of the movements of blood corpuscles in the capillaries, and has analyzed the movements of zoosphores in the cells of a Cladophora Enlargements from these negatives have been presented to the Academy By taking a series of pictures at intervals of about one-tenth of a second, and projecting them upon a screen at about the same rate, the effect of the real motions of the object can be reproduced The arrangement for doing this will be described in a future communication —Observations of Swift's, Denning's, and Winnecke's comets, made at Algiers Observatory with the *coudé* equatorial, by MM Rambaud and Sy Observations of position are given —On the approximation of functions of very large numbers, by M Maurice Hamy —On the tautochronism in a material system, by M Paul Appell —On the laws of electrolysis, by M A Chassy When a substance having the formula M_pR_q is electrolyzed, M designating an electro-positive and R an electro-negative radicle, one equivalent of the radicle R, and $\frac{p}{q}$ equivalents of the radicle M

are disengaged when one equivalent of hydrogen is set free in a voltameter included in the circuit Wiedemann and others have found exceptions to this law, for in the case of some salts, $\frac{q}{f}$ equivalent of the radicle R and one equivalent of the other radicle are disengaged M Chassy proposes to substitute the following law for those previously enunciated, all cases being included in it "Lorsqu'on electrolyse une substance quelconque il se dégage toujours l'equivalent d'hydrogene ou la quantité correspondante du radical electropositif"—A new case of abnormal solution saturated solutions, by M F Parmentier The author finds that the solubility of ethyl bromide in ether decreases rapidly with increase of temperature —The occurrence of fluorine in different varieties of natural phosphates, by M Ad Carnot From the results of the analyses of a number of sedimentary phosphates it is concluded that in the sedimentary phosphates the proportion of fluorine is sensibly equal to that in apatites having an equal percentage of phosphorus Phosphorites of fibrous, semi crystalline structure have almost the same composition as crystallized apatites Earthy or compact phosphorites contain a less proportion of fluorine Concretionary, zoned, and mammillated phosphorites contain barely any fluorine Estimation of small quantities of carbon monoxide by means of cuprous chloride, by M L de Saint-Martin —Thermal study of the value of the replacement of hydrogen in phenolic hydroxyl, by M de Forcrand C_6H_6O sol + Na sol = C_6H_5 ONa sol + H gas + 39 10 cal This is practically the mean value for the replacement of H by Na in tertiary alcohols and acids, for $\frac{27\ 89 + 50\ 17}{2} = + 39\ 03$ —On an ethylnitroketone and an acetylnitroketone derived from camphosulphophenols, by M P Cazeneuve —Determination of the surface of ebullition of normal paraffins, by M G Hinrichs —Action of pyridine bases on certain sulphites, by M G Denigès Compounds of the type SO_3M'', C_5H_5N have been obtained and examined —Preparation and physical properties of acetyl fluoride, by M Maurice Meslans (See Notes) —Diamido phenyl sulphone and some of its derivatives, by M Ch Lauth —Colouring matters and azo and alkyl compounds derived from chrysaniline, by MM A Trillat and De Raczkowski —On a soluble naphthol derivative, by M Stackler —Remarks on some fishes from Upper Tonkin, by M Léon Vaillant —On *Cerataspis petiti*, Guérin, and on the systematic position of the species *Cerataspis*, Gray (*Cryptopus*, Latreille), by MM A Giard and J Bonnier —On an embryological law for the orders *Rhabdocœlida* and *Triclada*, by M Paul Hallez.—On the circulation of the blood in young spiders, by M Marcel Causard —On the discovery of *Bactryllium* in Meurthe-et Moselle Trias, by MM Bleicher and P Fliche —Applications to normal physiology and pathology of the temporary loss of the activity of tissues by local cocainisation, by M C A François-Franck —Observation of a meteor, by M L Simon (extract from a letter to M Wolf) The meteor was observed on April 24, at 11h 55m in the evening It moved from east to west at an altitude of about 70° or 80°

DIARY OF SOCIETIES.

LONDON

THURSDAY MAY 12

ROYAL SOCIETY, at 4 30 —Transformers Prof Perry, F R S —On the Probable Effect of the Limitation of the Number of Ordinary Fellows elected into the Royal Society, to Fifteen in each Year, on the Eventual Total Number of Fellows General Strachey, F R S —On the Shoulder-girdle in Ichthyosauria and Sauropterygia J W Hulke, F R S —On the Embryology of Augiopteris evecta (Hoffm) J B Farmer —Note on Excretion in Sponges G Bidder —On the Development of the Stigmata in Ascidians W Garstang

MATHEMATICAL SOCIETY, at 8 —On an Operator that produces all the Co variants and Invariants of any System of Quantics Dr W F Story —Applications of a Theory of Permutations in Circular Procession to the Theory of Numbers Major MacMahon, F R S

INSTITUTION OF ELECTRICAL ENGINEERS at 8 —Notes on the Light of the Electric Arc A P Trotter (Discussion)—On the Cause of the Changes of Electromotive Force in Secondary Batteries Dr J H Gladstone, F R S , and W Hibbert

INSTITUTION OF CIVIL ENGINEERS.—Students' Visits to the Beckton Gas Works, the Northern Outfall Sewer, the Victoria and Albert Docks, and the P and O s s *Oceana* Leave Fenchurch Street at 9 18 a.m.

ROYAL INSTITUTION, at 3.—The Chemistry of Gases Prof Dewar, F R S

FRIDAY, MAY 13

ROYAL ASTRONOMICAL SOCIETY, at 8

PHYSICAL SOCIETY, at 5 —An Instrument for Drawing Parabolas R Inwards —Some Electrical Instruments F H Nalder —An Instrument for Measuring Magnetic Fields E Edser and H Stansfield.

INSTITUTION OF CIVIL ENGINEERS —Students' Visits to Woolwich Arsenal, the Works of the London Electric Supply Corporation at Deptford, and the Tower Bridge Leave Charing Cross at 9 40 a.m.——At 7 30 —Students' Annual Dinner at the Holborn Restaurant

ROYAL INSTITUTION, at 9 —The New Star in Auriga Dr William Huggins, F R S

AMATEUR SCIENTIFIC SOCIETY, at 7 —Exhibition of Objects of interest ——At 8 —Recent Additions to Botanical Science L A Boodle —The Copper Production of North America W Semmons

SATURDAY, MAY 14.

ROYAL BOTANIC SOCIETY, at 3 45

ROYAL INSTITUTION, at 3 —J S Bach's Chamber Music (with many Musical Illustrations) E Dannreuther

MONDAY, MAY 16

VICTORIA INSTITUTE, at 8 —On Primitive Man Sir W Dawson and Rev J Mello

TUESDAY, MAY 17

ZOOLOGICAL SOCIETY, at 8 30 —On the Geographical Distribution of the Land Mollusca of the Philippine Islands Rev A H Cooke —Resultats des Recherches Ornithologiques faites au Pérou par M Jean Kalinowski Graf Hans von Berlepsch, C M Z S , and M Jean Stolzmann —On Lucioperca marina G A Boulenger —On the Antelopes of the Genus Cephalophus Oldfield Thomas

INSTITUTION OF CIVIL ENGINEERS, at 8 —The Distribution and Measurement of Illumination A P Trotter (Discussion.)—The Measurement of High Temperatures Prof W C Roberts Austen F R S

ROYAL INSTITUTION, at 3 —Photography in the Colours of Nature Frederick E Ives

WEDNESDAY, MAY 18

ROYAL METEOROLOGICAL SOCIETY, at 7 —Results of a Comparison of Richard Anemo Cinémographe with the Standard Beckley Anemograph at the Kew Observatory G M Whipple —Rain drops E J Lowe, F R S —Levels of the River Vaal at Kimberley, South Africa, with Remarks on the Rainfall of the Watershed W B Tripp

ROYAL MICROSCOPICAL SOCIETY, at 8 —On the Organs of Oviposition in certain Cattle Ticks R T Lewis —The Penetrating Power of the Microscope F M Nelson —The Rings and Brushes of Crystals E M Nelson

THURSDAY, MAY 19

ROYAL SOCIETY, at 4 30

CHEMICAL SOCIETY at 8 —Magnetic Rotation of some Acetyl Derivatives W H Perkin, F R S —Studies on Isomeric Changes, No IV Halogen Derivatives of Quinone Part I A R Ling —Note on Diastatic Action E R Moritz and T A Glendinning —Formation of the Hydrocarbon $C_{18}H_{12}$ from Phenylpropionic Acid Dr Kipping

INSTITUTION OF ELECTRICAL ENGINEERS, at 8

ROYAL INSTITUTION, at 3 —The Chemistry of Gases Prof Dewar, F R S

FRIDAY, MAY 20

ROYAL INSTITUTION, at 9 —Electro-Metallurgy J Wilson Swan

SATURDAY, MAY 21

ROYAL INSTITUTION, at 3 —J S Bach's Chamber Music (with many Musical Illustrations) E Dannreuther

CONTENTS.

THURSDAY, MAY 19, 1892

THE TELL EL-AMARNA TABLETS IN THE BRITISH MUSEUM

The Tell el-Amarna Tablets in the British Museum, with Autotype Facsimiles (London Printed by order of the Trustees, 1892)

DURING the summer of 1887, a woman belonging to the household of one of the "antica" dealers who live at or near Tell el-Amarna, in Upper Egypt, set out to follow her usual avocation of digging in the sand and loose earth at the foot of the hills for small antiquities Every man, woman, and child in the neighbourhood spent, and probably still spends, a large portion of each day in this profitable pursuit, for in the winter season they were able to sell at good prices the scarabs, rings, fragments of beautifully glazed Egyptian porcelain, and other objects of this nature, of which there seemed to be an endless supply in the ground round about From the time when Wilkinson made his first journey to this place, until quite recently, every traveller who has visited the spot has been able to bring away with him interesting and important antiquities, which have either revealed new facts in Egyptian history, or have served to illustrate and explain processes in the technical arts known to the Egyptians In the early years of this century, when the scientific staff attached to Napoleon's expedition to Egypt was compiling the materials for the splendid map of Egypt afterwards edited by Jacotin, it was noticed that the "ruins of a large town" existed at Tell el-Amarna, and it is said that a superficial search made over this part of the country resulted in the finding of a number of fine objects which have since filtered into several European collections of Egyptian antiquities But whatever things have been dug out from these ruins, or from the ground round about them, or however great their importance, nothing possessing the historical and scientific value of the antiquities discovered by the Tell el-Amarna woman in 1888 hath ever rewarded searcher before The exact details of her search will never be known, neither can the exact spot where she made her great discovery be identified (for the Arabs took care to obliterate all traces of the diggings made by them on the spot after her "find"), but it is certain that in a small chamber at no great depth below the surface, she found a number of clay tablets the like of which had never been before dug up in Egypt The number of these tablets and fragments is variously given, but it seems that the outside limit may be set at three hundred and thirty, in this matter, however, and indeed in making any statement which is based upon the word of many sellers of "anticas" in Egypt, the writer (and the reader) must protect himself by saying after the manner of the pious Muhammedan, "But God knoweth" Of this "find" the Trustees of the British Museum secured eighty-two tablets, the Gîzeh Museum in Egypt about sixty, and the Berlin Museum about one hundred and sixty pieces, of which a large number are fragments which give no connected sense The authorities of this last institution published the texts from their own collection together with those from the tablets at Gizeh by lithography under the editorship of Drs. Abel and Winckler, but the results already gleaned by scholars from this edition appear to be meagre when compared with the quantity of material which the originals offer for study

The Tell el-Amarna tablets are different from all other known cuneiform documents They lack the symmetrical form of the tablets from the libraries of the old Babylonian temples, or of those from the library at Kouyunjik, founded by the mighty kings of the last Assyrian Empire — Sargon, Sennacherib, Esarhaddon, and Assurbanipal, the material is, in many cases, ill kneaded, and contains fragments of flint or other coarse materials, the colour of the clay varies from a light to a dark dusk tint, and from a flesh colour to dark brick-red They are written in a hand which, to some extent, resembles the Neo-Babylonian writing used commonly in Babylonia and Assyria for about seven centuries before Christ It possesses, however, characteristics different from those of any other style of cuneiform writing of any period now known to exist, and nearly every tablet contains forms of characters which have hitherto been thought peculiar to the Ninevite or Assyrian style of writing The large, bold hand found upon some of the tablets suggests the work of the unskilled scribe, but more careful examination shows that it is the result of unconventionality rather than ignorance The details of the peculiarities of spelling need not be discussed here, but the expert will find many rare and important examples of Assyrian orthography never dreamt of before The Semitic dialect in which the tablets are written is very closely related to the Hebrew of the Old Testament, and the "Canaanite" forms of pronouns, &c, are of peculiar interest for the student of the Bible, for many of them are new, and they afford the means of explaining certain difficulties which now exist in Semitic grammar Although these tablets offer a satisfactory solution of some difficulties, they raise many questions which will probably remain unanswered for some time, and among these there is one, not the least important, of how it happens that a governor of Egypt, who was a vassal, and ruling in Syria, should bear the name of Itagamapairi, which is neither Semitic nor Egyptian?

The Tell el-Amarna tablets are unique as an archæological "find," and they are also unique as a means of weaving together the threads of the histories of two or three of the greatest nations of antiquity at a critical period As we are able to say, with comparative certainty, that they were all written between the years 1500–1450 B C, they have an authority possessed by few of the documents coming down from this remote period They partly fill, moreover, a gap in the history of the dynasties of Mesopotamia and Syria, for although much comparatively is known concerning the period in which the Assyrian Empire was founded—about B C 1800—and although we have annals of many kings between B C 1320 and 620, the history of the period between B C 1800 and 1320 is almost unknown

The Tell el-Amarna tablets in the British Museum consist of a series of despatches written from kings of Babylonia, Alashiya, Mitani, Phœnicia, Syria, and Palestine to Amenophis III, and to his son, Amenophis IV, frequently named Khut-en-aten, or Khu-en-aten, and the

"heretic king", among them also is the draft of a despatch from Amenophis III. to a king of Karaduniyash. Many of them are of a personal and private nature, and these are, of course, the most interesting, for they reveal details of the family life of the great kings of the East, which the ordinary inscriptions have failed to preserve for us; the remainder refer to State business, and show beyond all doubt how close was the connection between the kings of Babylonia, Mitani, and Karaduniyash and the kings of Egypt, and also how great was the commerce and intercourse between these countries. It will be remembered that the Egyptians gained their first foothold in Syria under Amasis I., who, about B.C. 1700, brought the war of independence to a successful close, and marched into Sharuhen, a city to the south of Gaza, mentioned in Joshua xix. 6. His successor, Amenophis I., made no further advance into Syria or Mesopotamia; but Thothmes I., about B.C. 1633, marched into Northern Syria, called Ruthen, and set up a tablet to mark the limit of the frontier of Egypt. His son made no attempt to "enlarge the borders" of Egypt in this direction, and the "wild woman" Hatshepset was too much occupied with fitting out her expedition to Punt to trouble about such things; but when Thothmes III. ascended the throne of Egypt, about B.C. 1600, he at once set out to crush the rebellion which had broken out all over the country to the north-east of Egypt. Making his way by the peninsula of Sinai, he passed into Syria, and within a month from the time he set out he defeated the rebels, whose head-quarters were at Megiddo, and captured the city. During the next few years he marched through the country round about, carrying off spoil, and establishing the worship of Amen-Rā and other Egyptian gods in the principal cities. At a city on the Euphrates called Ni, he set up a tablet near one set up by his grandfather several years before, and it is clear that his hold upon Western Mesopotamia was no shadowy power. Indeed his conquest of the city of Ninip, and the worship of the gods of Egypt established there by him, is referred to by the inhabitants of that place when they write to Amenophis III. more than one hundred years later. When Amenophis III. ascended the throne of Egypt about B.C. 1500, he was, thanks to the bloody victories of his predecessors, able to assume the sovereignty of Western Mesopotamia and Syria without much fighting, and it seems that his expeditions to these parts were undertaken as much for the sake of the lion hunts which he conducted there as for the purposes of conquest. He boasts on his scarabs that in the first ten years of his reign he slew 102 lions with his own hand. That the country of Mitani offered fine opportunities for sport we know from one inscription which says that Thothmes III. slew 120 elephants there; and Tiglath-Pileser I. (B.C. 1120) boasts in his annals that on foot he slew 120 lions with his own hand in Mitani (Rawlinson, "Cuneiform Inscriptions," i. pl. 16, 76–79). While on one of these semi-warlike expeditions he fell in love with a fair-haired, blue-eyed, graceful girl named Thi, the daughter of parents whose names were Iuaa and Thuaa, and she was brought to Egypt in the tenth year of the king's reign, accompanied by another wife of Amenophis, and 317 of her ladies. Thi was evidently the Egyptian monarch's favourite wife; she became *par excellence* the "Queen of Egypt," and her son Amenophis IV. became King of Egypt. Amenophis III. also married a sister and daughter of Kallimma-Sin, King of Karaduniyash, and made proposals for another of his daughters, named Sukharti, while she was still a child, and he took to wife also the sister and daughter of Tushratta, the King of Mitani. A letter from Burraburiyash also reveals the hitherto unknown fact that his son married a daughter of the King of Egypt. One of the most interesting of these tablets is the draft of a letter from Amenophis III. to Kallimma-Sin, King of Karaduniyash, a country conterminous with Assyria; it is the only known letter of Amenophis in Babylonian, and is written upon a tablet of Nile mud. The subject of the letter is a proposal for the hand of Sukharti, whose father, Kallimma-Sin, writes back to Egypt asking what has become of his sister who married the King of Egypt many years before? In reply to this Amenophis invited Kallimma-Sin to send messengers to see and to converse with the lady, and to carry back news of her to her brother. An embassy was sent to Egypt, but its members were too young to be able to remember what the lady had been like, and they failed to identify her satisfactorily. Kallimma-Sin is not unwilling to discuss the marriage of his younger daughter Sukharti, but he points out that he usually gives his daughters to the "kings of Karaduniyash," who make handsome presents to himself and his messengers. Not to be defeated in his desire by the paltry question of gifts to the wife's relatives, Amenophis says that he is not only willing to give for Sukharti as much as all the other suitors could or would give put together, but he will send a gift to Kallimma-Sin in honour of this king's sister, who is now living with him in Egypt. This point satisfactorily settled, Amenophis proceeds to discuss the proposal of Kallimma-Sin for an Egyptian princess, and he plainly but forcibly tells him that "the daughter of the king of the land of Egypt hath never been given to a 'nobody.'" Kallimma-Sin replies, "Why not? Thou art king, and canst act as thou pleasest"; but, willing to be satisfied with a lady of less rank than a princess, he adds, "Surely there be daughters of nobles who are beautiful women in Egypt. Now, if thou knowest a beautiful lady, I beseech thee to send her unto me; for who here could say that she is not a princess?" What Amenophis finally arranged for "his brother Kallimma-Sin" we know not, but it seems that he gave him a large quantity of gold, and that he married Sukharti after all. The letters of Burraburiyash to Amenophis III. are scarcely less interesting, for they refer to old intrigues of the Canaanites, to commercial treaties, and they give some account of this king's gifts to the daughter of Amenophis who was about to marry his son.

The most important correspondent of Amenophis in the land of Mitani was Tushratta, whose sister and daughter he married, and who writes to his son-in-law with a mixture of affection and avarice amusing to contemplate. For example, having acknowledged the receipt of a letter from Amenophis, and said that its "contents pleased him so greatly that even if it were possible to dissolve all the friendship which had existed between them in times gone by, the words of this message alone would, for himself, suffice to re-establish their friendship for ever," he next begs him to send him much gold, and artfully refers to a gold libation bowl and vessels profusely decorated with

gold ornaments which Amenophis had sent to his father, thereby hinting that similar gifts would be most acceptable to himself In true Oriental fashion he says, "When my brother has sent the gold, if I ask, 'Is it enough?' the answer may be, 'Fully enough', or I may ask, 'Is it the full amount?' and the answer may be, 'It is more than the full amount'" In the latter case Tushratta declares that he will be "very glad"! In another letter Tushratta gives an account of his accession to the throne It appears that when his father Shutarna died, his brother Artashumara became king, but was shortly after slain by rebels Though quite young, Tushratta rallied his friends and supporters, and after some trouble succeeded in slaying his brother's murderers Facts of this nature are of great importance for restoring the history of this long-forgotten country It is an interesting fact that together with such letters there always arrived gifts, which consisted of horses, chariots, gold vessels, ornaments made of gold and lapis-lazuli, eunuchs and ladies for the king's household, and the relatives of the Mesopotamian princesses who had become wives of the King of Egypt never forgot to send them gifts of earrings of gold, choice oil for anointing, &c Sad to relate, however, some of the writers of these letters complain that Amenophis did not send them gifts in return In a third letter Tushratta mentions that the goddess "Ishtar of Nineveh, lady of the world," had gone down into Egypt during his own reign and during that of his father, and he begs Amenophis to increase the worship of this goddess in Egypt tenfold A fourth letter of Tushratta is sent to the "Queen of Egypt," who can be none other than the blue-eyed, fair-haired Thi

Passing from the letters which refer to Amenophis's marriages contracted with Mesopotamian princesses, we come to those relating to the matter-of-fact business of the Egyptian Government of that day These consist of reports of disasters to the Egyptian power and of successful intrigues against it, coupled with urgent entreaties for help, pointing to a condition of distraction and weakness in Egypt and her dependencies Some of them must have been addressed to Amenophis III towards the close of his long reign of about thirty-six years, but the greater number clearly belong to the reign of his son Amenophis IV, for the disorganized condition of the Egyptian provinces in Phœnicia and Syria which they reflect could only have come into existence when Egypt herself was torn by the rival factions which sprang up when that king endeavoured to substitute the worship of the Disk for that of Amen, the mighty god of Thebes The chief cities of Phœnicia, Tyre, Sidon, Byblos, Aradus, and Simyra (which commanded the road to Aradus), representing the Egyptian power, were being daily attacked by the ever-increasing forces of the enemy, who, seeing the impotence or supineness of Egypt, grew bolder and bolder Nor did the brave and loyal defence of such men as Rib-Adda, governor of Byblos, and Abi-Milki, King of Tyre, stave off for long the overthrow of the Egyptian power in Phœnicia The desperate position of this latter loyal officer is almost pathetic in its hopelessness In one letter to the King of Egypt he says, "My lord, my sun, my god, seven times and seven times do I prostrate myself at the feet of the king, my lord. I am the dust beneath the feet of the king, my lord, and that upon which he treadeth O my king and lord, thou art like unto the god Shamash and to the god Rimmon in heaven Let the king give counsel to his servant Now the king, my lord, hath appointed me the guardian of the city of Tyre, the 'royal handmaid,' and I sent a report in a tablet unto the king, my lord, but I have received no answer thereunto" He then announces the delivering of the city of Simyra into the hands of Aziru the rebel, by Zimrida, governor of Sidon, who had also captured the city of Sazu, wherefrom Abi-Milki drew his supplies of wood and water, for neither existed naturally on [the bleak rock of Tyre, in consequence many Tyrians died of want Moreover, Zimrida, Aziru, and the people of Aradus attacked the forces of Abi-Milki in chariots by land and in ships by sea In conclusion he sadly adds, "I am surrounded on all sides with foes, and I have neither wood to warm myself, nor water to drink, I send this tablet to the king by the hands of a common soldier, and may the king send me an answer speedily" When his condition becomes more desperate he sends another despatch, and with it a gift of five talents of copper, hoping thereby to extort an answer from the king of Egypt, in this he reports events with a Cæsar-like brevity thus —"The king of the land of Danuna is dead, and his brother has succeeded him, there is peace in his land One half of the city of Ugarit has been destroyed by fire The soldiers of Khatti have departed Itagamapairi of Kadesh and Aziru have rebelled, and are fighting against Namyawiza. Zimrida, governor of Sidon and Lachish, is gathering together ships and men"

A letter of considerable importance is that of Akizzi, governor of Katna (Cana), for it refers to the origin of the worship of the sun in Egypt It appears that the King of Khatti came to Katna, and carried off the image of the Sun-god, and Akizzi writes to Amenophis III, asking for money to ransom the image, he makes his appeal on the ground that Shamash the Sun god, the god of his fathers, became also the god of the ancestors of Amenophis, and that they called themselves after his name Now this clearly has reference to the title "son of the Sun," which was adopted by nearly every king of Egypt, and indicates that Akizzi believed that the worship of the sun was introduced into Egypt from Asia

Space forbids our quoting more from these interesting documents, but sufficient has been said above to show what an important contribution to our knowledge of Oriental diplomacy about 1500 B C the Tell el-Amarna tablets offer Incidentally they reveal many new facts of history, they offer a new field for the researches of the geographical student, and the identification of many towns and countries mentioned in the Bible and in the Egyptian inscriptions has already been obtained, they give us for the first time the names of Artatama, Artashumara, and Tushratta, kings of Mitani, and of Kallimma-Sin, king of Karaduniyash, they supply the reasons why and show how the Semites came to have such power in Egypt, and depict the inevitable anarchy which prevails in dependencies or colonies when the dominant power totters or declines.

We have already said that the Tell el-Amarna tablets are different from any other cuneiform documents known, and it is precisely this difference which has made their publication a difficulty To make a satisfactory edition

of these texts it was necessary to unite the skill of the Assyriologist with the accuracy of the photographer, for the former could only transcribe the characters more or less accurately, being powerless to give their exact shape and form, and the latter, while reproducing their exact shape and form, could only show the characters on the flat-sided tablets, those on the rounded edges remaining invisible The Trustees of the British Museum, then, decided to print in cuneiform type a full transcript of the texts in characters as closely resembling the originals as possible, and in addition to give a number of characteristic specimens reproduced by the autotype process, so that the student who is unable to visit the Museum may be able to make himself thoroughly acquainted with the various complex and unusual forms of characters in which these tablets are written In addition to the printed texts and autotype plates, a summary of the contents of each tablet is given, accompanied by notes, chiefly philological and geographical, which we believe will be of use to the reader The summary is preceded by an introduction, in which the finding of the tablets and many points of interest concerning them are discussed in brief paragraphs It will be remembered that some thirty years ago, when Sir Henry Rawlinson began to publish his monumental work, the "Cuneiform Inscriptions of Western Asia," he contemplated adding translations of all the texts given therein It was, however, found impossible to do this satisfactorily, and notwithstanding Sir Henry's thirty years' additional labour on the Assyrian inscriptions, it would still be somewhat rash to publish word-for-word translations of such difficult texts as those from Tell el-Amarna Plain, historical narrative, like the great Tiglath-Pileser inscription, could be and was well enough rendered into English by Sir Henry Rawlinson so far back as *1857*, but letters and despatches of a new kind, containing words and forms hitherto unknown, cannot be thus treated The summary of each tablet will tell the general reader what the tablet is about, and will help the student more than a literal translation of the verbose Oriental phrases would have done. In publishing these texts with autotype reproductions and summaries of contents, the Trustees of the British Museum have made a new departure, and we believe that the edition will be as useful to the general student of antiquity as to the cuneiform expert

A TEXT-BOOK OF PHYSICS

A Manual of Physics By William Peddie, D Sc, F R.S E (London · Baillière, Tindall, and Cox, 1892)

THE attempt made by Dr Peddie to supply a manual of physics suitable for English students and English teachers is altogether worthy of praise, and his effort has undoubtedly been, on the whole, successful. The best works at present in use in higher schools and in colleges as text-books of physics are the well-known English translations of two French books, Ganot and Deschanel These are, no doubt, excellent books in their way, and in the hands of able English translators the original French compilations have received great improvement. A recommendation also of these French books is to be found in the beautiful diagrams and pictures of experimental apparatus These we miss in every English book, including the book before us Nevertheless, even the modified and improved English translations are not altogether satisfactory for English teaching purposes, and Dr Peddie's work, supplying a need which is very generally felt, will be most warmly welcomed

The subject has been, on the whole, judiciously treated It is compressed in an admirable way into very moderate compass If, now and then, one feels regret that some particular portion has not been more fully dealt with, reflection on the moderate size of the book, and on the way in which each part is treated in the space prescribed to it by the author, often affords a timely and sufficient consolation

While speaking about size and form, it may be remarked that the paper, the printing, and the binding, make this a pleasanter text-book to hold and to use than any which has appeared for many a day In this respect the book can scarcely be too highly praised

Commencing with four preliminary chapters, in which general laws are stated and explanations given as to certain necessary mathematical ideas and formulas, the author proceeds in chapter v to the treatment of elementary kinematics, and in chapter vi to the general principles of dynamics, including the general equations of fluid motion and of the equilibrium of a fluid It is needless to say that these subjects are very briefly touched upon, but teachers will at any rate find a very succinct indication, to say the least, of the parts of mathematics and of dynamics which are most essential to a proper understanding of the physics which is to follow

Chapters vii to xiii inclusive are devoted to properties of matter general properties of solids, liquids, and gases are dealt with, a good account of gravitation is given, elasticity, diffusion, and the allied subjects, as well as cohesion and capillarity, are discussed, while in chapters xii and xiii we find a very fair account—short, of course—of atomic theories, including the modern kinetic theory of matter Perhaps the chapters just referred to, on properties of matter, constitute the most thoroughly successful portion of the book We cannot call to mind any book in which an account of these subjects so good, and in itself so complete, can be found The remaining chapters—with the exception of the last two, which are devoted to the electro magnetic theory of light and "the ether"—treat in detail of sound, light, heat, electricity, and magnetism It is in the last-named portion of the book that students will feel a want of fuller and more complete treatment The subject of heat in particular will be felt by many to be unduly compressed, and the same must be said of parts at least of electrodynamics and electromagnetism

A book such as we have described, covering so wide a field, and brought into the narrow limits of 500 small octavo pages, must obviously, if it be well arranged and well written, be an important contribution to our scientific literature We have no hesitation in giving it high commendation There is, perhaps, not much that is absolutely novel in the treatment of the subjects, or in the matter, but that is hardly to be expected in a manual of this kind the novelty is rather to be seen in the idea of the production of such a book

While thus giving to the author warm praise and congratulation, we cannot avoid noticing serious faults both of commission and omission. First it seems simply deplorable to drag quaternion notions and notation into an elementary book of this kind, unless it be to show how ridiculous the riders of the quaternion hobby can at times become. The explanations and definitions at the commencement of chapter v will be nothing to the majority of learners and teachers but a mass of confusion thrown over one of the simplest and most important of subjects. To prove by quaternions the formula $S = VT$ (space described in a given time with constant velocity), which needs only a knowledge of the multiplication table, or the formula $s = \frac{1}{2}gt^2$ for falling bodies, which can be explained by common-sense (but not by quaternions) to a boy of twelve in half an hour, is simply inexcusable. Wherever quaternions are introduced in this book we find an easy matter made difficult—if not, as in the case of simple harmonic motion, absolutely unintelligible. Unfortunately, Dr. Peddie is not the first writer who has contrived, by means of quaternions, to make a subject unnecessarily difficult and repulsive.

But by far the most serious defect of this book, and it is one which will greatly mar both its usefulness as a text-book and also its popularity as a somewhat elementary work for reading and consultation, arises from the failure of its author to catch, even in a remote degree, the spirit which has animated and directed the whole of the best experimenting in physics for the last twenty-five or thirty years. *Et ignem regunt numeri* is the motto of Fourier's great work; and a realization of the fact that numbers (not merely numerical ratios) must be sought for as the crown of physical laws is that which has given pre-eminent value to the labours of experimenters during the last half-century, and has forced workers in this great field into precision and definiteness. The example set by Gauss and Weber, Joule and Thomson, and by the British Association Committee on Standards of Electrical Resistance appointed in 1861, has revolutionized ideas as to what is the ultimate object of experimenting in physics; and we can no longer be satisfied with knowledge as to almost any physical phenomenon until we are able to apply to the phenomenon and to our laws the searching test of arithmetical calculation in absolute numbers.

Unfortunately, in the book before us there is no recognition of these necessary conditions for completeness of knowledge, and very little recognition of recent investigations of the kind here indicated. The failure will be felt most seriously in the important subjects of heat, magnetism, and electricity.

In electricity there is not to be found the resistance, whether in ohms or in C.G.S. units, of any wire of any material! There are pages of algebra on dimensions of units, to puzzle the unfortunate learner, but nowhere can he find what an ohm, or ampere, or volt is; unless, "*ohm* = 10^9 *C.G.S.*" can be taken as a definition, when the meaning of a C.G.S. unit is not explained. Faraday's laws of electrolysis, got fifty years ago, are stated; but the determinations of Lord Rayleigh and Kohlrausch of the amount of silver deposited by an ampere current in a second are not even referred to. Tait's thermo-electric curves, and some forms of galvanic cells are described; but how to find the electromotive force of any one combination in volts is not indicated. We must not multiply instances. It would be only wearisome. Magnetism, electro-dynamics, are treated in precisely the same way; and the student would find it impossible to calculate from data in this book how much heat is conducted across a stone slab in an hour under given conditions, or how much heat is lost from the surface of a sooted globe in a minute, though there is a great deal of exposition of laws of heat exchanges, and of the algebra pertaining thereto. Diffusion of matter is another subject which suffers from defective treatment in a similar way. The word "diffusivity," introduced by Thomson, is correctly defined on p. 131; but ten lines lower down the definition is departed from, and a column of relative numbers is substituted for the now fairly known absolute diffusivities. A very thorough change of all these parts of the book ought to be made in a reprint or new edition, in order to make the work conformable to modern knowledge and requirements.

It would be ungracious to point out too many minor faults in a first edition; but a few must be mentioned. Faraday seems to have been forgotten in connection with liquefaction of gases; and Melloni, though not perhaps absolutely trustworthy, surely deserved to have his name mentioned in connection with radiation of heat. Mayer's name is not mentioned; and, whatever Dr. Peddie may think on the subject of the celebrated controversy, no one will agree with him that the name should be *omitted*. We cannot help feeling that there is too much local colouring about many parts of the book. A book of this kind is sadly marred by want of proportionate distribution of treatment; even the occupation of space with minute treatment of a favourite subject becomes an injustice with regard to those subjects which are unduly curtailed for want of more space. We trust it will not hurt the feelings of anyone if we remark that the book should be a little more cosmopolitan, and a good deal less Scotch.

On p. 337, there is a mistake which will bear comparison with Lord Brougham's celebrated idea that people carry weights on their heads to have them farther from the centre of the earth, and therefore less attracted. The formation of ice in "very hot" countries on shallow pools is compared with Faraday's experiment of freezing mercury in a white-hot crucible. It is radiation, not forced evaporation, which is the cause of the phenomenon referred to.

We regret, also, that Dr. Peddie has thought it advisable to follow the example of Maxwell and others in changing Andrews's diagram right for left. There is no reason for doing so. The diagram was much better as Andrews originally gave it; and it would be better also without the dotted line said to separate the region in which liquid and gas can exist together from the regions in which the substance is entirely liquid or entirely gaseous. The former is a region concerning which there has been much speculation of an unprofitable sort. The elementary student need not be troubled with it, and it cannot be explained to him in a single sentence.

On p. 95 there is a diagram of a cord being pulled through a tube. Perhaps it cannot be asserted that the diagram is absolutely wrong, because the cord is said in the text to be perfectly flexible. But the cord, passing

round corners which look as if they were sharp angles, is so strikingly unlike anything which can be realized (and the results explained in this section can to a great extent be experimentally realized), that the diagram becomes at least misleading If the corners are sharp by intention, then the diagram *is* absolutely wrong

In spite of the faults and defects we have been obliged to notice, this book is, as we have said, an admirable attempt at a very worthy object, and with some remodelling it can be made into an excellent text book We wish it all success, feeling well satisfied that it meets a decided want

OUR BOOK SHELF

The Dietetic Value of Bread By John Goodfellow, F R M S (London Macmillan and Co)

THIS book is another addition to the useful series of "Manuals for Students," published by Messrs Macmillan and Co The author states in his preface that the object of the work is twofold First, to lay before the general public an account of the various kinds of bread, by which their merits may be judged, and, secondly, to afford technical information to students and others on the important subject of the true value of bread as a food These objects have in every way been fulfilled No one is more qualified to write such a book than Mr Goodfellow, who by his previous writings has shown such a grasp of the subject with which he has to deal

The first section of the volume is concerned with "Food, Diet, and Digestion" This is a very difficult matter to treat in a popular manner It involves some of the most complicated problems of physiology The author, however, has not shirked his task, anyone, however ignorant he may formerly have been on the processes by which food matters are rendered suitable for absorption and after-use by the human organism, if he reads through these pages carefully, cannot but help gaining much knowledge on the functions of the stomach and intestinal canal, and of the waste and work of the body

The nature of the digestive fluids is not, of course, considered with the minuteness of detail necessary for a medical examination, but enough is said to render the following sections perfectly intelligible, although they are treated in a scientific manner

"White Bread" is first considered An introductory chapter is given describing the structure of the wheat grain, and the changes which flour undergoes when exposed to heat and the process of fermentation Not only are the chemical and physiological properties of bread considered, but economical principles are gone into, and it is shown "that bread is one of the cheapest foods, not only with regard to the actual weight of nourishment obtained, but also with regard to the variety of the nutrient constituents, and the purchaser who expends his modest 2½*d* in a 2-lb loaf may rest assured that he could not spend his money to better advantage"

We further learn, however, that white bread is not a perfect food, those who partake of it should take care to supplement it largely with other foods, in order to make up for the lack of calcareous matter On no account should it form part of the diet of children unless supplemented by milk or other foods rich in lime and phosphates

Turning to "Whole-meal Bread," full descriptions are given of its composition, amount and nature of the salts present and their solubility; its digestibility, the waste present, and the action of bran on the intestine, its flavour, satiety, and dryness, and its effects on infants and children

The ordinary whole-meal bread is not a desirable food, and far inferior to good white bread as regards the weight of actual nourishment and the thoroughness of the digestion Its ingestion is often followed by diarrhœa, and the action of the bran increases the waste of food

After a short consideration of some special forms of bread, such as "aerated," "bran," "rye" bread, &c, Mr Goodfellow proceeds to speak of Meaby's Triticumina bread, of which he has a very high opinion, and believes that it is as near a perfect food as such a bread can be, and deserves the universal commendation which has been accorded to it by the medical and analytical world "Germ," "diastase," "gluten" bread, &c, are then described, and the book finishes with short chapters on the diseases of bread and its medicinal properties

To all who are interested in this subject, or wish to extend their knowledge of "the staff of life," we heartily recommend this volume

Graduated Mathematical Exercises Second Series By A T Richardson, M A (London Macmillan and Co, 1892)

ON a previous occasion we have referred to the first series of exercises by Mr Richardson In these he led the student through a set of graduated examples, commencing with arithmetic and reaching those on cube root, compound interest, and quadratic equations

In the present series, which is intended to be a continuation of the first, the relatively higher flights of mathematics have been dealt with The problems have been arranged on the same lines, the more difficult of them being reached as advance is made, and include those on algebra, logarithms, trigonometry, mechanics, and analytical geometry

An idea of the range over which each subject spreads can be gathered from the fact that all the problems will about suffice to cover such examinations as those of the Oxford and Cambridge Locals, and Army and Navy, allowing a small margin of safety

Great care seems to have been taken to insure accuracy, every example having been worked out at least twice For class work these examples will be found handy and a great saving of time, while for use at home the book should be widely employed

Bibliothek des Professors der Zoologie und vergl Anatomie, Dr Ludwig von Graff, in Graz (Leipzig Wilhelm Engelmann, 1892)

PROF VON GRAFF is the lucky owner of a fine scientific library, which was formed mainly by Carl Theodor von Siebold, his father, and his grandfather, all of whom were professors This library came into the possession of Prof von Graff in 1882, and as it was too large for the modest dimensions of a German professor's house, he exchanged many books relating to practical medicine for zoological monographs and periodicals At Graz the library is freely used by his assistants, pupils, and colleagues, and it is mainly for their benefit that the present catalogue has been issued It consists of 337 closely printed pages, and is a compilation of considerable value, not only because it gives lists of authors and their works, but because of the admirable way in which the lists are arranged The contents of the library are grouped under four headings—periodicals, auxiliary books (including works on University systems, bibliographical writings, dictionaries, &c), *zoologia generalis*, and *zoologia specialis*

The Canadian Guide-book. By Charles G. D Roberts. (London William Heinemann, 1892)

TOURISTS and sportsmen in Canada ought to be very much obliged to Mr Roberts for having provided them with this excellent Guide-book The method he has adopted is that of Baedeker's Hand-books, and the result is in every way worthy of the models he has chosen The work includes full descriptions of routes, cities, points of

interest, summer resorts, fishing places, &c, in Eastern Ontario, the Muskoka district, the St Lawrence region, the Lake St John country, the maritime provinces, Prince Edward Island, and Newfoundland In an appendix are given fish and game laws, and official lists of trout and salmon rivers and their lessees The author generally compresses his information into as small a space as possible, but in dealing with the more interesting Canadian scenes has sought to make his descriptions lively and attractive The volume is prettily printed, and is well supplied with maps and illustrations

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

A Question in Physics

CAN there be a crowding of the particles of a gas to a much smaller compass without its being markedly heated? Can a gas expand without being cooled? It is probable that nearly every physicist will give negative answers to these questions, and yet the fact that such conditions may occur sometimes seems well established The present writer, in 1889, attempted to determine the actual heating of air when compressed by a pump connected with the cylinder by a long tube, and found that the temperature was raised about 4° F for a compression of 10 inches above atmospheric pressure In like manner, on expanding this compressed air into the free atmosphere, it was found that the cooling was about 4° These results were published in *Science*, vol xv p 387, and were strongly combated by Prof Ferrel and Prof Marvin Prof Ferrel advanced, as applicable in this case, the well known thermodynamic formula for the computation of the heat developed in a gas when compressed, as follows —

$$\frac{t}{t'} = \left(\frac{p}{p'}\right)^{.291}$$

in which t and t' are the absolute temperatures corresponding to the pressures p and p' Sir Wm Thomson has given this formula in slightly different form, and with a larger exponent (see "Encyclopædia Britannica," vol vii p 814) Prof Ferrel found that, under the experimental conditions above, the heating should have been 43°, and the cooling 45°? (38°) (see *American Meteorological Journal*, vol xii pp 339 and 340)

It seems very evident, however, that this formula can be used only when all the heat due to the work of compression is concentrated in the compressed air, and conversely when the air expands against an external resistance An experiment by Joule will serve to elucidate this point He determined the mechanical equivalent of heat by immersing the cylinder into which the air was to be compressed and the compressing pump in the same water-bath, and then determining the amount of compression and the total heat developed This enables us to advance the proposition *If air when compressed is to be raised to the temperature indicated by theory*, it is very *essential that all the heat developed in the work of compression should enter the air* This seems self-evident, nevertheless, nearly all the errors that have entered the various discussions of this question have arisen from a neglect of this very obvious consideration

In Joule's experiment let us suppose that the compressing pump had been in one bath, and the cylinder into which the air was compressed in another Under these conditions, if no heat were lost, the first bath would have received very much the greater amount of heat Now, if the compressed air in passing from the pump to the cylinder became cooled to the outside temperature, it is evident that all the heat due to the work of compression would have been disposed of outside the cylinder, and would not have been available for raising the temperature of the compressed air

Instead of connecting the pump directly with the cylinder, let us take two cylinders of the same size, and connected by a tube Compress the air in the first cylinder (A), to three atmospheres, the air in the other (B) being at atmospheric pressure If we cool the air in A to the outside temperature, and then open the connection with B, the compressed air will rush from A to B, and an equilibrium will be established very quickly, the pressure in each cylinder being at two atmospheres The air in A will be slightly chilled because of the work of imparting a certain velocity to the particles entering B, and the air in B will be slightly warmed from the impact of the particles rushing from A, but there will be no heating due to the work of an external force making the compression

Instead of allowing the air in A to rush into B, suppose we open communication with the outside air The resistance to the rush of air will be much less than before, and the chilling in A, due to the work of imparting a certain velocity to the air, would be slightly greater than in the previous case, but it is obvious that this will be vastly less than that given by the formula We may say, then, that the conditions suggested by the questions above may be very easily brought about

The compressed air in a cylinder has a potential energy or capacity to do work, and this energy may be transmitted to another cylinder having air at atmospheric pressure without loss, and plainly without imparting or losing any heat We might compare it to the head of water in a pond This water has a certain capacity to do work depending upon its head We may enlarge the pond somewhat, and the capacity for doing work will remain almost unchanged The extremely important bearing of these views upon problems in meteorology is very apparent The convection theory of storms demands a cooling from the work of expansion in an ascending column of moist warm air, it would appear, however, that the cooling must be vastly less than has generally been considered probable.

H A HAZEN

Aurora.

PERHAPS it may interest some of your readers to see a short abstract of the observations of aurora made here during the last months, this winter having been by far the richest in well-developed northern lights since the winter 1870-71 Beginning with the magnificent display of February 13, which lasted almost the whole night, sometimes with vivid red and green tints (it was first noted at 6h 45m, and faded away in the moonlight between 15h and 16h astronomical time), and whose beams converged several times from a large part of the horizon towards the magnetic zenith (formation of corona was noted at 7h 2m, 10h, and 13h), we have had aurora on February 14, 15, 24, 25, March 1 (at 7h high arch, with the highest part through α and β Cephei, 7h 55m corona, between 8h and 10h pulsating and flashing light, sometimes with apparently screw formed motion), March 2, 3, 6 (at 10h curtains and corona, yellow green colours), March 24, 25, 26, 27, April 23, 24 (at 10h 10m curtains, yellow-green) April 25 (strong light visible through small openings in cumulo-stratus in the north) The last display was on May 1, with corona at 9h 40m, after 10h flashes, curtains, and beams, at 13h beams. About 11h there was a peculiar downward motion of reddish light near the north horizon

The magnetic disturbances of February 13 were also the greatest we have had for some years The magnetometers, of the Gaussian construction, are generally observed at 2h and 21h, but on February 13 observations were made every hour from 11 p m, in correspondence with Bosekop in Finmarken, where the German observers, MM Brendel and Baschin, were taking magnetical observations and photographs of the aurora during February and part of January In Christiania the perturbations were comparatively small in declination (westerly maximum 12° 35′ noted at 12h 10m, minimum 11° 42′ at 15h 18m, but neither of them absolute, the observations not being continuous), but the horizontal intensity, which had already begun to increase a little at 21h, February 12, varied by more than 0 03 C G S units, a maximum of 0 171 having been noted at 2h, 30m, and a minimum of about 0 140 from 12h 0m to 13h 20m, as the mirror of the magnet was in both cases outside the scale, the values could only be roughly measured At 16h 0m the bifilar had returned to the small end of the scale, but a nearly constant value of the horizontal intensity was only attained after 5h, February 14. The inclination had a maximum of 73° 18′ at 13h 10m, from which it gradually diminished, with some fluctuations, towards the normal value, about 71° 0′

With reference to Mr. Backhouse's observation of nacreous

clouds in the morning of January 30 (Nature, xlv. p 365). I may add that the same beautiful but as yet mysterious phenomenon was seen here January 30 and 31, both days in the south-west after sunset. Since the display of December 1885 mentioned by Mr Backhouse, it has been seen here every year, except 1888, mostly for a day or two in January or February.

H. Geelmuyden.

University Observatory, Christiania, May 3

Wave-Propagation of Magnetism

In an interesting article in last month's *Philosophical Magazine*, Mr Trowbridge has given an account of some experiments made by him with the view of examining for any indication of a definite rate of propagation in the magnetization of iron. In these experiments no indication was observed.

It seems to me, however, that nothing of this sort is likely to be observed where the magnetizing force is as great as that used by Mr Trowbridge, and that there are two classes of disturbances to be carefully distinguished. For example, in Prof. Ewing's well known magnetic model, something which looks very like a definite rate is to be seen in the case of a disturbance not sufficiently large to cause toppling over of the "molecule magnets", that is to say, to cause the little magnets to pass through their positions of unstable equilibrium. On the other hand, with a larger disturbance the phenomenon visibly partakes of a different character. Here, throughout the medium, there are to be seen at irregular moments what may be considered as cases of precipitation of energy, owing to the occurrence of these positions of unstable equilibrium.

These two stages should be carefully distinguished, for an essential in wave propagation as opposed to a rate of precipitation of energy (such as a rate of ignition, &c.) is obviously that the medium should not be permanently altered.

In some experiments made by me, very much smaller alternating currents than those used by Mr Trowbridge were employed. But the occurrence of spurious effects, simulating to a remarkable degree the interference nodes looked for, must have effectually obscured in my experiments the true phenomenon, supposing its existence. So that, considering the conditions of both our experiments, I still think the subject requires further investigation before coming to a decision in the matter. Indeed, when larger currents are used, no indication is to be found of even these spurious effects.

In Prof. Ewing's model, when the magnets point on the whole the same way (representing a high state of magnetization), the rate of propagation of a small disturbance affords a more definite problem. Tried experimentally, this latter case might afford more satisfactory results.

Fred. T. Trouton.

Correction in "Island Life"

In Dr. Merriam's recently published paper on "The Geographical Distribution of Life in North America," an important, and to me almost inexplicable error in my work "Island Life" is pointed out. It occurs at page 41 in the first edition, and is unfortunately repeated at the same page in the recently published new edition, and consists chiefly in stating that the moles (Talpidæ) are almost confined to the Palæarctic region. But a little further on in the same work (page 48 of first edition, and page 49 of second edition) it is correctly stated that there are three peculiar genera of moles in North America, and the same statement is made at page 115, and again at page 190 of vol. ii. of my "Geographical Distribution of Animals." At page 182 of vol. i. of the latter work, however, the error first appears, and it is this erroneous passage that has remained unnoticed till now, and was unfortunately repeated in "Island Life." In the same paragraph an error of a similar kind also occurs as to the distribution of the lynxes. To correct these errors pages 41 and 42 of the new edition of "Island Life" are being reprinted, and will be sent to all who possess the volume if they will forward a stamped and directed envelope to the publishers.

Alfred R. Wallace.

THE INTERNATIONAL CONFERENCE ON CHEMICAL NOMENCLATURE.

At the meeting of the International Chemical Congress, held in Paris in the summer of 1889, a special Section was appointed to consider the unification of chemical nomenclature, and, after discussing a variety of propositions, some of which were adopted, it was decided to form an International Commission for the further study of the subject.[1]

The members resident in Paris, having been constituted a permanent committee of the Commission, have devoted an immense amount of time and care to the preparation of a scheme, and it was to discuss their report[2] that we met at Geneva on Easter Monday last. The French Committee had issued invitations, not only to members of the Commission, but also to many other prominent chemists, so that the meeting was a thoroughly representative one. It is worth mentioning, as an illustration of the sympathetic treatment accorded by public bodies in France to men of science, that the Paris-Lyons-Marseilles Railway Company granted a reduction of one-half on the fare over their line to members of the Congress.

Very happily, the local committee had arranged that all might stay at the one hotel—the Métropole—and it was here that we first met in friendly union on the Monday evening.[3] The next morning the Congress assembled at the Hôtel de Ville, M. Richard, the Cantonal Minister of Education, being in the chair. After an admirable address of welcome from this gentleman, who appeared to thoroughly appreciate the importance of the object in view, on the motion of Prof. Cannizzaro it was wisely decided not to follow the complimentary, but somewhat unbusinesslike, Continental practice so frequently adopted, of appointing a different chairman each day, but to have only one. M. Friedel, who had taken the chair at all the numerous meetings of the Paris Committee, having been chosen by acclamation President of the Conference, formal business was at once entered into, and, after the necessary interval for lunch, the sitting was resumed in the afternoon. We met in like manner on the two following days, and the final sitting took place on the Friday morning, but many had left before this. On Tuesday evening, by invitation of the local committee, we visited the theatre, a very beautiful building. On the Wednesday evening, we were entertained by them at a dinner at the Hôtel Métropole, on which occasion a very striking speech was delivered by Prof. von Baeyer, who, after point-

[1] The following chemists eventually consented to serve on the Commission:—MM. Béhal, Berthelot, Bouveault, Combes, Fauconnier, Friedel, Gautier, Grimaux, Jungfleisch, Schutzenberger (all representing France), Graebe (Switzerland), Alexejeff and Beilstein (Russia), von Baeyer and Nolting (Germany), Lieben (Austria), Paterno (Italy), Franchimont (Holland), Armstrong (England), Istrati (Roumania), Calderon (Spain), Cleve (Sweden), Boukowski-Bey (Turkey), Ira Remsen (United States) and Mourgues (Chili).

[2] This report had been prepared by the following:—MM. Friedel (President), Béhal, Bouveault, Combes, Fauconnier, Gautier, and Grimaux.

[3] The following is the official list of those who took part in the Conference:—MM. H. E. Armstrong, professeur à la Central Institution, Londres, secrétaire de la Chemical Society; A. Arnaud, professeur au Muséum, à Paris; Adolphe von Baeyer, professeur à l'Université de Munich; Barbier, professeur à la Faculté des sciences de Lyon; Aug. Behal, professeur à l'École supérieure de pharmacie de Paris; Louis Bouveault, docteur ès sciences, Paris; Stanislas Cannizzaro, professeur à l'Université de Rome; Paul Cazeneuve, professeur à la Faculté de médecine de Lyon; Alphonse Combes, docteur ès sciences, Paris; Alphonse Cosso, directeur de la Station expérimentale d'agriculture, à Turin; Maurice De Lacre, professeur à l'Université de Gand; Michel Fileti, professeur à l'Université de Turin; Emile Fischer, professeur à l'Université de Würzbourg; A.-P.-N. Franchimont, professeur à l'Université de Leide; Charles Friedel, membre de l'Institut, professeur à la Sorbonne, Paris; Dr. J. H. Gladstone, F.R.S., Londres; Carl Graebe, professeur à l'Université de Genève; Philippe Auguste Guye, professeur à l'Université de Genève; Istrati, professeur à l'Université de Bucarest; Albert Haller, professeur à la Faculté des sciences de Nancy; Maurice Hanriot, professeur agrégé à la Faculté de médecine, Paris; A.-R. Hantsch, professeur à l'École polytechnique de Zurich; Achille Le Bel, docteur ès sciences, à Paris; A. Lieben, professeur à l'Université de Vienne; Léon Maquenne, docteur ès sciences, aide naturaliste au Muséum, Paris; von Meyer, professeur à l'Université de Leipzig; Denis Monnier, professeur à l'Université de Genève; R. Nietzki, professeur à l'Université de Bâle; Emilio Noelting, directeur de l'École de chimie de Mulhouse; Emmanuel Paterno, professeur à l'Université de Palerme; Amé Pictet, privat docent à l'Université de Genève; William Ramsay, F.R.S., professeur à l'Université de Londres; Zdenko-H. Skraup, professeur à l'Université de Graz; Ferdinand Tiemann, professeur à l'Université de Berlin.

Le Comité local d'organisation se composait de:—MM. Emile Ador, H.-W. de Blonay, Alex. Claparède, Professeur C. Graebe, Professeur Ph.-A. Guye, Alex. Le Royer, Professeur Denis Monnier, Amé Pictet, Fréd. Reverdin, Professeur Albert Rilliet, Edouard Sarasin.

ing out that experimental chemistry had been carried, early in the century, into Germany from France by Liebig, who was tutored by Gay-Lussac, proceeded to say that, although the science had now undoubtedly reached its highest development in Germany, it was more than probable that, in the future, circumstances would arise which would lead to some other nation—France, Russia, Italy, or England—coming to the fore On this occasion, on the motion of M Le Bel, it was unanimously decided to appoint M Marignac Honorary President of the Congress, and a letter to him expressing our regret that ill-health prevented his taking part in its work was at once signed by all present We were indebted in many other ways to the local committee, and there is no doubt that the success of the meeting was in large measure due to the forethought and hospitable care exercised by them on our behalf, absolute amity prevailed throughout, and it was clear that all were bent on co-operating to secure the carrying out to a successful issue of a very difficult but most important work The great advantage to be derived from the personal intercourse which such meetings promote was soon apparent gradually, the doubts which many entertained as to the possibility of devising a practical rational scheme of nomenclature were dispersed, and ere many hours had elapsed the sympathies of all present were enlisted on behalf of the work, thus a mission has been sent forth which will explain the enterprise to chemists generally

The resolutions passed at the meetings are appended to this article These, I think, are in no way to be taken as in all respects final, but they will serve to prepare the way and to indicate the lines on which the work is to be carried out The position in which we found ourselves placed, in fact, was not one which justified our arriving at decisions which could fairly be regarded as binding The report of the French Committee was placed in our hands only on the morning of the first meeting, and it was impossible to master its contents at so short a notice, and still less to criticize and test the application of its recommendations in detail That the scheme would serve but as the basis for discussion was soon evident, when at the very outset a system of nomenclature for the hydrocarbons was adopted very different and far more significant than that recommended in the report, and numerous other departures from its recommendations were carried in the course of the proceedings Again, some of the most active members of the Congress had confessedly paid attention only to special groups of compounds, and had not tested the application of proposals which they strenuously advocated to compounds of other groups, but as a nomenclature admirably adapted to one class may be open to all sorts of objections when applied to another, the general bearing of recommendations made with reference to special groups will have to be fully considered before they can be finally adopted The resolutions relating to fatty acids (Nos 18, 19) are of this kind, and their adoption was warmly opposed by an important minority on the ground that, however well they might be adapted to acids pure and simple derived from open-chain hydrocarbons, their application to acids derived from closed-chain hydrocarbons and acids containing other radicles in addition to carboxyl was beset with difficulty In order to name an acid in accordance with this resolution, the formula of the corresponding hydrocarbon must be constructed from that of the acid by changing carboxyl into methyl, for example, citric acid, $CH_2(CO_2H)$ $C(OH)(COOH)$ $CH_2(COOH)$, would have to be regarded as a derivative of methylpentane, and would be named methylpentanoltrioic acid, numerals being added to indicate the positions of the hydroxyl and carboxyl groups, in like manner, mellithic acid, $C_6(COOH)_6$, would be named hexamethylbenzenehexoic acid, although no methyl is present in it The mental effort involved in visualizing the formulæ from such names as these would appear to be far greater than if they were respectively named propanoltricarboxylic acid and benzenehexacarboxylic acid, or simply propanoltri-acid and benzenehexacid, the use of the term *acid* being understood to imply the presence of carboxyl A decision on points such as these can only be arrived at after careful study of the general effect of such a proposal, and there was no time for such a comparison during the brief debate possible at a Conference In some cases, there can be no doubt that the full force of objections raised to proposals in favour of which a majority subsequently voted was not felt, owing to the difficulty which necessarily arises at an international Conference if the language used be not equally familiar to all present, and consequently full expression cannot be given by all to their views Moreover, although it is easy to criticize destructively even at short notice, constructive criticism under such circumstances is very difficult, consequently a proposal may be accepted even in face of serious objections to its adoption simply because nothing better can be suggested at the time An instructive case of the kind arose on discussing thio-compounds The proposals in the French report were not regarded as altogether satisfactory, and an amendment was suggested and carried which to many appeared most undesirable the next morning, when the time came to confirm the resolutions arrived at on the previous day, the discussion was reopened, and a slight modification of the original proposal was suggested, which was recognized to be an improvement, and the objectionable resolution was rescinded Clearly at such meetings much must depend on the right expression being found by happy inspiration at the right moment

The one resolution which covers all others and which defines the nature of the task to be undertaken is the first Whatever name we may choose to apply to a substance colloquially, it is clearly an absolute necessity of the times that every compound should bear a *systematic* name of such a character that it can be at once translated into the corresponding formula, and that, *vice versa*, a name corresponding to any particular formula may be devised which we may count on finding in the *official* register, if the compound thought of have been described The value of such a systematic nomenclature to original workers as well as to students cannot be over-estimated, and few who are qualified to take part in such a work will grudge the time they may spend on it There was considerable difference of opinion at the meeting as to whether a systematic nomenclature should be devised merely for the purpose of an official register, or whether the object aimed at should be a system of wider application the majority, I believe, came to the conclusion that it should certainly subserve the one, but if possible both purposes There can be little doubt, however, that the future student will cut the knot by declining to burden his memory with a double vocabulary in the case of all but the commonest substances, and that therefore there is but one course open to us (cf Res 26)

Although sufficiently conservative to retain methane, ethane, propane, and butane, the Congress decided not to adopt the proposal to continue the use of the names formic, acetic, propionic, and butyric for the first four acids of the acetic series, which was advocated by a substantial minority on the ground that their retention would facilitate the change from the old to the proposed new system This is one of the questions demanding careful consideration Many will, no doubt, prefer to retain old unsystematic names as far as possible, but it is easy to see that the desire to avoid change may carry us too far in this direction, it will undoubtedly be very inconvenient to the present generation of chemists to abandon familiar and cherished names, but nevertheless it may be a wise course to boldly face the difficulty, rather than inflict on coming generations a partially illogical and unsystematic nomenclature. The argument that the present familiar names

may still be used colloquially is, as I have already said, scarcely a justification of the dismissal of such names from the official nomenclature, as our successors may be expected to object more and more decidedly to a multiplex system as chemical science progresses, and to insist on the adoption of the official as the sole system the extent to which familiar trivial names shall be retained in the official system is therefore a matter of great importance

As one aim and object must be to devise a system which is significant and logical throughout, no considerations must be allowed to prevail which will defeat this, and it will not suffice to quote present usage in support of illogical proposals; but this has been done Thus the Congress decided (Res 46) to name compounds of the type $R' N_2 R'$ *azo*-compounds, while retaining the name *diazo*-chloride for $C_6H_5 N_2Cl$ It matters not to us that the manufacturers have chosen to call the colours derived from *diazo*-compounds azo-dyes, if substances such as $(C_6H_5)_2S$ are termed *thio*, and compounds such as $(C_6H_5)_2S_2$ *dithio*-compounds (Res 43), we are bound to be consistent, and apply the significant term diazo- to substances containing two nitrogen atoms Resolution 46 ought therefore to be in part rescinded I call attention to this case as an illustration of the tendency to break away from uniformity in favour of what may fairly be termed popular prejudice, which will require to be most carefully guarded against if the various sections of our system are to harmonize

It will be gratifying to English chemists that the principle advocated for many years past by our Chemical Society, and enforced in its "Instructions to Abstractors"—that particular terminations should be regarded as indicative of particular functions, and should therefore be restricted to particular classes of compounds—has been legalized and extended by the Congress This is a step of great importance, as we may expect that it will affect even trivial names, and that in future names will be given to new substances which will to a certain extent afford a clue to their nature, the hopeless confusion which now reigns supreme in the pages of the *Berichte*, for example, owing to the disregard of this principle by our German colleagues—who have hitherto been, as a rule, almost uniformly neglectful in matters of nomenclature—will, it may be hoped, ere long give way to more orderly treatment

But the importance of applying this principle logically was not fully grasped even at the Congress, inasmuch as it was decided to affix the termination *ine* to acetylenic hydrocarbons, notwithstanding that this termination is admittedly indicative of basic properties If, however, a suitable suffix ending in *ene* could be thought of, there would probably be little difficulty in securing its acceptance, in which case unsaturated hydrocarbons generally would have names ending in *ene*, and saturated hydrocarbons names ending in *ane*, and these terminations could be reserved exclusively for hydrocarbons

It will be obvious from the foregoing remarks that although a solid foundation for our future system of nomenclature has been laid, much remains to be done before a mature design, perfect in all its details, can be presented for adoption At the meeting the hope was expressed that a decision might be speedily taken, to enable Beilstein to utilize the proposals in the preparation of the third edition of his marvellous work; but it is clear that we are not yet so far advanced as to make this possible or even desirable, and it would be most unfortunate if Beilstein were at the present juncture to promulgate a system which is manifestly incomplete nothing can be worse in such a case than to consent in haste, when it is evident that this would surely involve repentance at leisure

Those of us who are interested in the work, and competent to advance it, must now test in detail the application of the proposals which have been provisionally adopted, and we must assist in contributing to the ultimate establishment of a system on the broad lines of policy laid down for our guidance at the Congress As it is not improbable that in the future, owing to the extended use of our language, the major proportion of chemical students will speak English, it is essential that due attention be paid to the matter here in England, so that a system may be devised which we can make use of without difficulty

HENRY E ARMSTRONG

Résolutions prises par le Congrès

1 A côté des procédés habituels de nomenclature, il sera établi un nom *officiel* permettant de retrouver chaque corps sous une rubrique unique dans les tables et dictionnaires

Le Congrès exprime le vœu que les auteurs prennent l'habitude de mentionner dans leurs mémoires, entre parenthèses, le nom officiel à côté du nom choisi par eux

2 On décide de ne s'occuper, pour le moment, que de ce qui concerne les composés de constitution connue, et de remettre à plus tard la question des corps à constitution inconnue

3 La désinence *ane* est adoptée pour tous les hydrocarbures saturés de la série grasse

4 Les noms actuels des quatre premiers hydrocarbures saturés (*méthane*, *éthane*, *propane*, *butane*) sont conservés, on emploiera les noms dérivés des nombres grecs pour ceux qui ont plus de quatre atomes de carbone Ces noms désigneront les hydrocarbures normaux

5 Les hydrocarbures à chaîne arborescente sont regardés comme dérivés des hydrocarbures normaux, et on rapporte leur nom à la chaîne normale la plus longue qu'on puisse établir dans leur formule

6 Le numérotage des chaînes latérales partira de l'atome de carbone terminal le plus rapproché d'une chaîne latérale, dans le cas où les chaînes latérales les plus voisines des extrémités seraient placées symétriquement, la plus simple décidera du choix

7 Lorsqu'un résidu se substitue dans une chaîne latérale, on emploie *métho-*, *étho-*, etc, à la place de *méthyl-*, *éthyl-*, préfixes réservés pour le cas où la substitution se fait dans la chaîne principale

8 Dans les hydrocarbures ayant une seule *double liaison*, on remplacera la terminaison *ane* de l'hydrocarbure saturé correspondant par la terminaison *ène* (ex éthène), s'il y a deux doubles liaisons, on terminera en *diène* (ex propadiène), s'il y en a trois, en *triène*, etc Si cela est nécessaire, la place de la double liaison est indiquée par le numéro du premier atome de carbone sur lequel s'appuie cette double liaison

9 Les noms des hydrocarbures à *triple liaison* se termineront pareillement en *ine*, *diine* et *triine* (ex éthine pour acétylène propine pour allylène, hexadiine pour dipropargyle)

10. Dans le cas où il y aurait simultanément des doubles et triples liaisons, on emploiera les désinences *énine*, *diénine*, etc

11 En ce qui concerne les hydrocarbures saturés à chaîne fermée, ils prendront les noms des hydrocarbures saturés correspondants de la série grasse précédés du préfixe *cyclo* (ex cyclohexane pour hexaméthylène)

12 Les atomes de carbone d'une chaîne latérale seront désignés par le même chiffre que l'atome de carbone auquel la chaîne est attachée Ils porteront un indice qui indiquera leur rang dans la chaîne latérale en partant du point d'attache

Dans le cas où deux chaînes seraient attachées au même atome de carbone, les indices de la plus simple d'entre elles seront accentués

Le même mode de numérotage est adopté pour les chaînes latérales des chaînes fermées

13 Les hydrocarbures non saturés seront numérotés comme les hydrocarbures saturés correspondants Dans le cas d'ambiguïté ou d'absence de chaîne latérale, on placera le n° 1 au carbone terminal le plus rapproché de la liaison d'ordre le plus élevé.

14. Le numérotage des hydrocarbures est conservé pour tous leurs produits de substitution.

15. On nommera les alcools et les phénols du nom de l'hydrocarbure dont ils dérivent, terminé par le suffixe *ol* (ex pentanol, penténol, etc)

16 Quand on a affaire à des alcools ou à des phénols polyatomiques, on intercalera, entre le nom de l'hydrocarbure fondamental et le suffixe *ol*, une des particules *di*, *tri*, *tétra*, etc, suivant l'ordre de la polyatomicité (ex. propane-triol pour glycérine).

17. Le nom de *mercaptan* est abandonné, et cette fonction sera désignée par le suffixe *thiol* (ex éthane-thiol)

18. Dans les acides de la série grasse, le carboxyle sera considéré comme faisant partie intégrante du squelette de carbone

19 Le nom de tous les acides monobasiques de la série grasse est tiré de celui de l'hydrocarbure correspondant suivi du suffixe *oïque*

On désignera les acides polybasiques par les terminaisons *dioïque, trioïque, tétroïque*, etc

20 Les résidus monovalents des acides seront dénommés en transformant en *oyle* la terminaison *oïque* de l'acide

21 Dans les acides monobasiques à chaîne normale saturée ou symétrique, le carbone du carboxyle porte le n° 1

22 Les acides dans lesquels un ou plusieurs atomes de soufre remplacent autant d'atomes d'oxygène du carboxyle seront désignés comme suit le soufre simplement lié à un atome de carbone sera désigné par le suffixe *thiol*, si la liaison est double, on emploiera le suffixe *thion* Exemples

CH_3 CO SH Acide éthane thiolique
CH_3 CS OH Acide éthane-thionique
CH_3 CS SH Acide éthane thionthiolique

23 Le Congrès donne son adhésion à la proposition suivante sans émettre de vote définitif à ce sujet

Les ethers oxydes seront designés par les noms des hydrocarbures qui les composent, reliés par le terme *-oxy-* (ex pentane oxy-ethane pour oxyde d'éthyle et d'amyle)

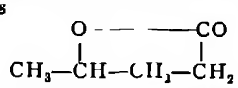
24. Les anhydrides d'acides conserveront leur mode actuel de désignation d'après le nom de leurs acides (ex anhydride éthanoïque)

25 (12 *bis*) Dans le cas de deux chaînes laterales attachées au même atome de carbone, l'ordre dans lequel ces chaînes seront énoncées correspondra à leur ordre de complication

26 Une discussion plus approfondie sur la nomenclature des composés à fonctions complexes est ajournée, et l'etude de cette question est renvoyée à la Commission internationale, pour qu'elle prépare sur ce point un projet qui sera presenté à un prochain Congres, la Commission cherchera à concilier les exigences de la nomenclature parlée avec celle d'une terminologie applicable aux dictionnaires

27 On conservera les conventions habituelles pour les sels ou éthers composés

28 Les lactones seront désignées par le mot *olide*, indiquant que c'est un anhydride interne d'alcool et d'acide La position de la fonction alcoolique, par rapport au carboxyle de l'acide alcool d'où dérive la lactone, pourra être exprimée par les lettres grecques α, β, γ, δ, à côte du numérotage habituel des chaînes laterales



1 4 pentanolide ou 1 4 γ pentanolide

29 Les acides lactoniques dérivant d'acides bibasiques seront nommés comme les lactones dont ils dérivent, en ajoutant le suffixe *oïque*, caractéristique des acides

30 La discussion sur les chaînes fermées est ajournée jusqu'au moment où la publication des idees de M Armstrong, sur ce sujet, aura permis à la Commission internationale de les comparer avec les propositions de M Bouveault

31 Dans la série aromatique et tous les corps renfermant une chaîne fermée, toutes les chaînes laterales seront considérées comme des substituants

32 Aldéhydes Seront designées par le suffixe *al* (méthanal, éthanal)

Aldéhydes sulfurées suffixe *thial*.

33 Acétones suffixe *one* (CH_3 CO CH_2.CH_3, butanone 2)

Diacétones, triacétones suffixes *dione, trione*.

Acétones sulfurées suffixe *thione*

34. Quinones Le suffixe *quinone* sera conservé pour les corps homologues de la quinone ordinaire

Les corps ayant plusieurs fois le chaînon CO CO seront des diquinones ou triquinones

35. Ammoniaques composées pas de changement (ex éthylamine, éthène-diamine)

Les corps où le groupe bivalent —NH— ferme une chaîne formée de radicaux positifs seront appelés *imines* (ex. éthène-imine)

Phosphines, arsines, stibines, sulfines : la nomenclature en usage est conservée

36 Hydroxylamine : ce nom est conserve

37 Oximes seront désignés en suivant les règles actuellement admises, les corps *isonitrosés* seront nommés comme oximes

(Ex CH(NOH) CH_2 $CH_2$$CH_3$ 1 Butanoxime
CH_3 CH_2.C(NOH) CH_3 2 Butanoxime)

38 Amides ce nom sera conserve (ex Ethanamide

NH_2.CO CH_2.CH_2 CO NH_2 Butane-diamide
COOH CO CH_2 CH_2 CO NH_2 Acide butanamidoïque)

Imides seront conservees •

Amidoximes ce nom sera conserve

(Ex CH_3 C(NOH) NH_2 Ethanamidoxime)

Uree le mot générique *urée* sera conservé, on l'emploiera comme suffixe pour les derives alcoylés de l'urée, tandis que les dérivés par substitution acide seront des *uréides*

Les corps derivant de deux molecules d'urée seront designes par les suffixes *diurée, diuréide* Les uréides acides prendront le nom d'*acides uréiques* On rejettera les desinences *uramique* et *urique*

39 Amidines ce suffixe sera conservé

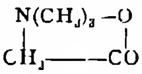
(Ex CH_3 C NH NH_2 Ethanamidine)

Pour les dérives, le nom sera dédouble, et l'on fera précéder du nom du groupe substituant, soit amino, soit amidine, suivant le cas

(Ex CH_3 C(NC_2H_5) NH_2 Ethanaminoéthylimidine
CH_3 C(NH) NHC_2H_5 Ethanethylamino imidine)

Guanidines le mot générique *guanidine* est conservé, mais differentes guanidines seront nommées comme dérivés substitués de la diamidocarbo-imidine

40 Bétaïnes suffixe *taïne*

(Ex  Ethanoyltriméthyltaïne)

41 Nitriles la question est laissée en suspens pour la série grasse Pour la série aromatique, on adopte le préfixe *cyano* (comme nom de substituant)

42 Carbylamines la nomenclature actuelle est conservée

43 Sulfones ce nom est conserve

(Ex C_6H_5 SO_2 C_6H_5 Benzène-sulfone benzène)

Sulfures On les designera en intercalant *thio* entre les noms des deux composés saturés (décision provisoire)

(Ex C_6H_5 S C_6H_5 Benzene-thio-benzene)

Disulfures seront désignés de même par *dithio*

44. Ethers isocyaniques suffixe *carbonimide* Ex Ethylcarbonimide designera le cyanate d'éthyle de Wurtz, on dira de même éthylthiocarbonimide pour le dérivé sulfuré correspondant

Cyanates ce nom est conserve aux vrais ethers qui, par saponification, donnent de l'acide cyanique ou ses produits directs d'hydratation On remplacera le nom de sulfocyanate par celui de *thiocyanate*

45 Corps nitrés rien à changer à la nomenclature actuelle

46 Corps azoïques les dénominations *azo* et *diazo* seront conservees, mais le mode d'énonciation de ces composés sera modifié comme suit

(Ex C_6H_5 N_2 Cl Chlorure de diazobenzène
C_6H_5 N_2.C_6H_5 Benzène-azo-benzène
C_6H_5 N_2 C_6H_4 N_2 C_6H_5 Benzene-azo benzène-azo benzène)

THE GEOLOGY OF BARBADOS[1]

THE oceanic series of Barbados forms a group of beds which is clearly marked off from the Scotland series below, and the coral limestone above The oceanic deposits do not, however, appear everywhere as a continuous band between the two other formations, because the elevation of the island from oceanic depths was accompanied by a considerable amount of faulting, and tracts of the oceanic deposits were dropped down between blocks of the Scotland series Although this faulting

[1] "The Geology of Barbados. Part II The Oceanic Deposits." By A J Jukes Browne and J B. Harrison. Abstract of paper printed in the Quarterly Journal of the Geological Society, May 1892

interferes with the continuity of the oceanic deposits, it is abundantly clear from numerous sections that they rest unconformably upon the Scotland series, and are as distinct in respect of age as they are in respect of lithological composition, and a greater contrast in all respects can hardly be imagined than these two formations present

The oceanic series is more than 300 feet thick, and is divisible into five portions, which, however, blend into one another These are, in descending order—

(1) Grey siliceous mudstones, consisting chiefly of fine volcanic dust, with a few fragments of siliceous organisms

(2) Very fine-grained argillaceous earths, often red or pink, but sometimes yellow or buff, these are analogous to modern oceanic "red clays"

(3) Pulverulent chalky marls and earths, being consolidated foraminiferal oozes passing down into calcareo-siliceous earth with Radiolaria, proportion of carbonate of lime, 80 to 44 per cent

(4) Siliceous Radiolarian earth, consisting mainly of Radiolaria, with sponge spicules and Diatoms, and a small amount of fine calcareous matter

(5) Calcareo-siliceous earths, with 25 to 40 per cent of carbonate of lime passing down into purer chalky earth, with 60 to 80 per cent, which is in some places converted into limestone by the infiltration of calcite

There is a considerable variation in the amount of chalky matter even on what appears to be the same horizon, and within short distances The whole series is more calcareous in the northern than in the southern part of the island

Interstratified layers of volcanic sand and dust occur at several horizons, some of them being light grey pumiceous and felspathic sand, and others a mixture of such material with Radiolarian earth stained brown by what seems to be petroleum

With respect to organic remains, the calcareous earths have yielded *Foraminifera* in abundance, a preliminary examination of six samples by the late Dr H B Brady resulting in the discovery of 81 species The siliceous earths have furnished the specimen of *Cystechinus crassus* recently described by Mr J W Gregory, and they abound in Radiolaria, as is very well known Certain marls and limestones on Bissex Hill prove to consist mainly of *Globigerina*

The bearing of these fossils is discussed with regard to (1) the age, (2) the conditions of depth, at which the deposits were formed The age is Pliocene, or Pleistocene, while stratigraphical considerations make it most probable that they are of Pliocene date

The depth of water indicated by the Foraminifera is from 500 to 1000 fathoms, according to Dr Brady The *Cystechinus* is considered by Mr Gregory as strong evidence for a depth of over 1000 fathoms, and is quite consistent with a depth of over 2000, while the Radiolaria are, in Prof Haeckel's opinion, most nearly allied to those which occur in the deepest parts of modern oceans, *i e* about 3000 fathoms

The coloured clays are remarkable for the almost complete absence of carbonate of lime, they correspond in all essential points to those modern argillaceous oozes which occur at from 2500 to 3000 fathoms, and have little or no carbonate of lime.

The available evidence points to the conclusion that the depth of water varied from 1000 to 2500 fathoms, and there may have been two epochs at which it was over 2000 fathoms.

Radiolarian deposits have for some years been known to exist in Trinidad, and the authors, having obtained samples, are able to announce that these closely resemble the Barbadian earths in general aspect, in chemical composition, and in microscopical structure Similar earths also appear to exist in Hayti.

Finally, they discuss the changes in physical geography which are indicated by the existence of these deposits, and their probable equivalent in part of the white limestone of Jamaica, and they infer that the whole Central American and Caribbean region was deeply submerged during the Pliocene period, and that during this time there was open and free communication between the Atlantic and Pacific Oceans The separation of the two oceans, and the deflection of the Gulf Stream, were changes accomplished by the upheaval of which evidence was adduced in a former paper, and this upheaval is a comparatively recent event

The minute structure of the rocks is described in reports presented by Mr W Hill and Miss C A Raisin, the former showing that the Barbados chalk is similar in all essential points to the Chalk of England

EDUARD VON REGEL

THE learned and genial Director of the St Petersburg Botanic Garden, Dr Eduard von Regel, died on April 27, in his seventy-seventh year He was the son of a Gotha parson, and developed a taste for gardening while still quite young During the hours that might have been given to play he was usually engaged at his favourite pursuit in his father's garden After the usual course of education, he spent several years in various botanic gardens, and about 1842 he was appointed "Obergartner" in the Botanic Garden at Zurich Here, in conjunction with Dr O. Heer, the celebrated palæontologist, one of whose daughters he subsequently married, he at once founded a Swiss journal for agriculture and horticulture, and was exceedingly active in promoting horticulture, both in writing and practically In 1852 he founded the now well-known and still flourishing *Gartenflora*, which, however, he ceased to edit after 1885 He soon gained fame, and when the important post of Scientific Director of the St. Petersburg Botanic Garden became vacant in 1855, it was offered to and accepted by Regel, and held by him to the last There he found a wide field for his energy and abilities but although he accomplished much meritorious botanical work, Russia is far more indebted to him for the improvements he effected in horticulture generally than for his botany At the time when he first went to St Petersburg, gardening was at a very low ebb, and the vast strides that have since been made in this industry are very largely due to his untiring efforts He wrote treatises, introduced superior varieties of fruits, vegetables, and flowers, and succeeded in gaining the influence and support of exalted persons for his projects both botanical and horticultural It was mainly through his exertions, we believe, that the first flower-show was held in St Petersburg This was in 1858, and now such a thing is no uncommon event He was also instrumental in getting botanists attached to the Russian exploring expeditions in Central and Eastern Asia, whereby the gardens and herbaria, not only of Russia, but of Europe, have been greatly enriched, and botanical science advanced Regel himself elaborated many of the dried collections thus obtained, besides describing a large number of plants cultivated in the garden from seeds or bulbs sent thither by various travellers One of the best of his numerous writings is a monograph of the genus *Allium*—"Alliorum adhuc cognitorum Monographia,"—the number of species described exceeding 250, including a large number previously undescribed, the fruits of the explorations in Asia He was also joint author of an enumeration of the plants collected in Siberia by Semenoff, Radde, Stubendorff, and others. Although gradually declining in health during the last year or so, he continued to discharge the duties of his office, and although not so active with his pen as formerly, he contributed some descriptions of new plants

to the *Gartenflora* as recently as February of the present year Dr Regel was the recipient of many honours in his adopted country, and he was elected a foreign member of the Linnean Society of London in 1890 This is the second of her few prominent botanists that Russia has lost within a year

NOTES

THE annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, 25 Great George Street, London, on Thursday and Friday, May 26 and 27, commencing each day at 10 30 a m Sir Frederick Abel, F R S, the President, will deliver an address on Thursday, May 26 The following papers will be read and discussed on the same day, as far as time permits (1) On experiments with basic steel, by W H White, F R S, Director of Naval Construction and Assistant Controller of the Navy, (2) on the production of pure iron in the basic furnace, by Colonel H S Dyer, Elswick Works, Newcastle on-Tyne, (3) on experiments on the elimination of sulphur from iron, by E J Ball, and A Wingham, London, (4) on platinum pyrometers, by H L Callendar, London On Friday, May 27, the following papers will be read and discussed —(5) On the manufacture and application of chilled cast iron (Gruson's system), by E Reimers, Technical Director of the Gruson Works, Magdeburg, (6) on valves for open hearth furnaces, by J W Wailes, Calderbank, near Glasgow, (7) on the calorific efficiency of the puddling furnace, by Major Cubillo, Trubia Arsenal, Spain, (8) on a practical slide rule for use in the calculation of blast furnace charges, by A Wingham, London, (9) notes on fuel, and its efficiency in metallurgic operations, by B H Thwaite, Liverpool

THE annual meeting of the Society of German Men of Science and Physicians will be held at Nurnberg from September 12 to 18 At the same time and place there will be a meeting of the German Mathematical Association In connection with these meetings there will be a mathematical exhibition, including models, drawings, apparatus, and instruments used in teaching and in research in pure and applied mathematics The project has the support of the Bavarian Government, and those who are organizing the exhibition have secured the co-operation of various competent men of science, and of the mathematical departments of some colleges, besides that of prominent publishers and well known technical institutions Space will be granted free of charge to exhibitors

PROF ELISHA GRAY, Chairman of the Committee on the Electrical Congress to be held in connection with the Chicago Exhibition, is about to visit all the important electrical centres in the Old World. He will attend meetings of the different electrical organizations, and hopes to strengthen the interest of European electricians in the Exhibition

WE learn from *Science* that Mr Timothy Hopkins has made provision for the endowment and maintenance of the seaside laboratory at Pacific Grove recently established under the auspices of the Leland Stanford Junior University The Hopkins Laboratory will be under the general direction of Profs Gilbert, Jenkins, and Campbell It will be open during the summer vacation, and its facilities will be at the disposal of persons wishing to carry on original investigations in biology, as well as of students and teachers Microscopes, microtomes, and other instruments necessary for investigations will be taken from the laboratories of the University.

THE great surgeon Richet has been succeeded in the Paris Academy of Sciences by Dr Guyon

THE distinguished mycologist, M Roumeguère, of Toulouse, died on February 29 at the age of sixty-three He had been for fourteen years sole editor of the quarterly *Revue Mycologique*, and was the author of a number of mycological works, the best-known being "Cryptogamie illustrée, Champignons d'Europe," with 1700 illustrations

AN interesting course of lectures is being delivered in connection with the Palestine Exploration Fund They are being given in the lecture room of the Royal Medical Society On Tuesday, Canon Tristram lectured on the natural history of Palestine The following are the remaining lectures of the course May 31, twenty-seven years' work, by Mr Walter Besant, June 7, the Hittites up to date, by Dr W Wright, June 21, the story of a "Tell," by Mr W M Flinders Petrie, June 28, the modern traveller in Palestine, by Canon Dalton

THE members of the Geologists' Association will make an excursion to Down on June 18 The directors will be Mr W E Darwin and Mr W Whitaker, F R S Having arrived at Orpington, the party will walk up the valley to Green Street Green, where shells and bones have been found in the gravel that forms the bottom of the dry upper part of the valley of the Cray The walk will be continued through High Elms Park to Down (3½ miles from the station) From Down a short stroll eastward gives a good view of a fine chalk valley An opportunity will be taken for examining the clay with-flints which caps the chalk over the higher grounds The formation of this clay will be discussed, with a notice of Darwin's remarks thereon, and with reference to other like deposits The general geology of the district will also be described, and the marked features caused by the clayey covering over the chalk, by the fine escarpment of the lower London Tertiaries, and by the London Clay hills beyond By permission of Mrs Darwin, the house and grounds rendered classic as the residence of Charles Darwin (Down House) will be shown to members, and Mr De B Crawshay will exhibit specimens of the flint implements that have lately been found over the high grounds of the neighbourhood Messrs Allen will exhibit others The return journey will be made across the Tertiary escarpment at Holwood Park, and then down the dip slope of the Blackheath Beds, over Hayes Common to Hayes (a walk of four miles)

ON Saturday afternoon, May 28, Prof H Marshall Ward will begin at the Royal Institution a course of three lectures on some modern discoveries in agricultural and forest botany

ORCHID-LOVERS find much to admire in the latest of Mr William Bull's exhibitions An enthusiastic writer in the *Times* describes Mr Bull's orchid house as "at present a dream of beauty"

EARLY on Tuesday morning some parts of West Cornwall were visited by an earthquake The *Times* says that in the village of Manaccan, in the Lizard district, the shock was so severe that the villagers almost without exception were awakened from their sleep by the shaking of their beds and the rattling of articles in their rooms Their houses, too, distinctly shook, and in one case a person who was awakened from his sleep saw the door of his bedroom thrown wide open At Redruth, some 12 or 15 miles distant, the shock was also felt At first it was thought there had been an explosion somewhere in the neighbourhood

DURING the past week a complete change of weather conditions has taken place over the British Isles The anticyclone which had lain over the country with such persistency for several weeks showed signs of giving way on the 12th, and during the two following days a large but shallow depression spread over the kingdom from west and north west, while the wind shifted to south-westward with unsettled and showery weather The temperature, though cooler, was somewhat high for the time of

year, the maxima varying from nearly 60° over Scotland to 65° and 70° over England and Ireland. Solar halos were observed on several days, and thunder was reported from the North Foreland on the 13th. Subsequently the westerly winds increased in force, especially in Ireland, and the sea became rough on our exposed western coasts. Some decrease of temperature also occurred, the maximum readings after Sunday only reaching about 60° in a few places. The conditions have been favourable to rain, but the fall has been slight, except in the north and west, and there is still a large deficiency in nearly all parts of the United Kingdom.

The Royal Meteorological Society has published a third edition of "Hints to Meteorological Observers" (42 pages large octavo). It is pointed out in the preface that meteorological observations, to be of scientific value, must be made on a uniform plan, otherwise the results will not be mutually comparable. The directions given are clear and concise, and the various instruments, both desirable or necessary, for a station of the second order, at which observations are taken at least twice daily, are plainly illustrated. The work also comprises several tables which are essential to the proper reduction of the observations recorded. No one can doubt that, notwithstanding the regulations laid down by several Conferences, there is still want of uniformity, not only when comparing observations of one country with another, but even among the observers of our own country. Take, for instance, the observation of rainfall, temperature, sunshine, cloud, and fog. It would be easy to show that the methods employed by various observers differ considerably, especially as to what constitutes a rainy day and how snow is measured, while the estimation of fog is very uncertain. Sunshine values by various kinds of instruments are hardly comparable *inter se*, and the accurate observation of clouds, whether of height, motion, amount, or description, is undoubtedly difficult, and presents a stumbling block to many observers. Therefore, we cannot but welcome the exertions of the Meteorological Society to obtain uniformity. The work in question will be found very useful for the purpose, and might perhaps be rendered more so, in future, by the addition of the most approved pictures of clouds, and fuller information as to the importance of their careful observation.

The Report of the Department of Marine (Ottawa) for the fiscal year ended June 1891, contains a report upon the Meteorological Service of Canada for the period extending from October 1, 1890, to October 31, 1891. This Service is divided into two branches: (1) the collection and utilization of observations taken simultaneously for the purposes of weather prediction, and (2) the reduction of observations taken by volunteer observers and others for climatological purposes. The publication of the results obtained from the second division has been continued annually, since the establishment of the Service in 1872, but it is now proposed to deal with the accumulated observations, and to publish them in a serviceable and readable form. This will be the first authoritative Government publication on the climate of Canada, and it will be useful for immigration purposes, and for showing the suitability of the climate, in various localities, for raising agricultural crops. It is expected that the work will require three years to complete. Among the stations in connection with the Canadian Service is one at Bermuda, towards the maintenance of which an annual contribution is paid to the Government of that island, and cable messages are received daily in the interests of the shipping on the Atlantic coast. The Cable Company transmit the messages at half the ordinary rates. Many severe storms have occurred in Canada since the last report, and in each instance warnings were issued from Toronto, of these 80·7 per cent. are stated to have been verified. Warnings of approaching snowstorms were also issued to railways, and it is proposed to extend this service to Manitoba, and as far west as Qu'Appelle.

An excellent paper on "The Art of Internal Illumination of Buildings by Electricity," was read by Mr. W. H. Preece, F.R.S., in the rooms of the Royal Institute of British Architects on Monday evening. In the course of his remarks Mr. Preece noted that the electric light was not always absolutely safe. Security was to be obtained only by good design, perfect materials, first-class workmanship, and rigid inspection. Imperfect materials erected by cheap contractors had led to many disasters. On the other hand, it was stated that no fire had occurred in buildings fitted up under the rules and regulations, and inspected by the officers, of the insurance companies in this country. In Mr. Preece's opinion, everything ought as much as possible to be kept in view, and the conductors ought not to be hidden under wainscots or floors or above ceilings. The glow lamp excited by three watts per candle was at present the most perfect source of domestic light, and when the patent expired—in a year or two—would be obtainable at about one third of the present price.

Mr. W. B. L. Hamilton, writing in the American journal *Electricity* on "Electricity in the United States Navy," says the latest use of the electric motor in taking the place of human energy in the manipulation of the death-dealing Gatling gun has been found to work with great success. The Crocker-Wheeler Motor Company, at the request of the United States Navy Bureau of Ordnance, constructed a special type of motor, which is attached to the breech of the gun. Hitherto the services of two men have been necessary in the working of these guns—the gunner, whose duty is to train the gun and drop the shot, and another man to operate the crank which sets in motion the mechanism which causes the balls to hail down upon the enemy. The adaptation of the Crocker-Wheeler motor not only does away with the services of the latter, but enables the gunner to train and operate the gun at will by touching an electric button. So completely is the Gatling gun under the control of the gunner, that he is enabled to fire either a single shot, or to fire them at the rate of 1200 per minute.

Science of April 29 prints the following account of a fire-ball, by C. C. Bayley:—"A telephone wire was supported on cedar posts 20 feet high and 20 rods apart. During August, 1889, we had a thunderstorm, during which there was a sharp and heavy crash. Several of the poles were found to have been struck, and portions to have been taken out through their entire length. One of these portions, of the size of a medium rail, was thrown into an adjoining field some rods from the pole. Portions from the others were smaller and more or less shattered. Near the southernmost pole struck, a family were in a house with doors and windows open, and a luminous ball seemed to leap from the wire, pass through the open door and a window, and pursue its course some rods through the open space behind the house. A boy in the room grasped his thumb and cried out, 'I'm struck,' and Mr. Hewett felt a sensation of numbness in his left arm for some time. A girl seized her shawl and rushed out of the house to chase the ball. She reported that she pursued it some distance, while it bounded lightly along, until it seemed to be dissipated in the air without an explosion. The size of the ball was about that of the two fists, and its velocity about that of a ball thrown by the hand."

We learn, from a Florentine source (*La Nazione*, May 3), that in the spring of the year 1890, Mrs. Zelia Nuttall, of the Peabody Museum of American Archæology and Ethnology, Cambridge, Mass.—whose interesting memoir on "Ancient Mexican Shields" was recently noticed in these columns—recognized the great importance of an anonymous Spanish-Mexican MS. preserved in the National Central Library of Florence.

This MS has never been published It is entitled "Libro de la vida que los Yndios antiguamente hazian, y supersticiones y malos ritos que tenian y guardavan" (*MSS Magl*, Class III, Pal II, Cod. 3). It treats of the costumes and religious rites of the ancient Aztecs, and is full of coloured designs which Mrs Nuttall has had reproduced in *fac-simile* by photographic lithography It is her intention to publish this MS, at her own cost, accompanied by a preface, an English translation of the text, and illustrative notes. It will be dedicated to the approaching Congress of Americanists, which will be held in Spain this autumn to celebrate the fourth centenary of the discovery of America. An edition of 200 copies will be issued, and held on sale at the Peabody Museum of American Archæology

AN interesting paper on the uses and applications of aluminium was read by Mr G L. Addenbrooke before the Society of Arts on May 11, and is printed in the current number of the Society's Journal Referring to the applicability of aluminium to opera and field glasses, he said there was an example on the table of a glass made in 1864, which had ever since been in constant use In 1870 the wheel of a carriage passed over it, but it was afterwards straightened out and made usable It has made two voyages across the Atlantic, two across the Pacific, and has had other shorter experiences of the sea air, besides lying on one occasion for some time in salt-water Mr Addenbrooke has kept strips of aluminium for two or three weeks in salt water, and has noted very little effect

TOWARDS the end of last year—from November 21 to December 5—the members of the Victoria Field Naturalists' Club made an excursion to the Australian chains of hills called the Grampians The excursion seems to have been remarkably pleasant, but the scientific results did not quite come up to the expectation According to an account given in the Club's Journal, the botanists were far and away the most successful A really good collection of plants of the district was obtained In bird life there was little observable that is not so elsewhere nearer Melbourne, neither was there any great variety of snakes or lizards, and to the collectors of these, as also to the entomologist, the excursion was especially disappointing From the well-known extensive variety of flowering shrubs in the Grampians, coupled with the fact that several are peculiar to the district, it was fully expected that at least a few clearly representative Lepidoptera or Coleoptera would be secured, but not a specimen of either family was seen that is not common in and around Melbourne

MR. E H PARKER, the British Consul at Kiungchow, in Hainan, a large island off the southern coast of China, mentions a curious phenomenon in connection with the tides of that port The tides inside the inner harbour, he says, require several years of careful observation before they can be tabulated It appears certain, however, that there are always two tidal waves a day, though one is so much more considerable than the other that the effect is often practically that of one single tide in the twenty-four hours The easterly and westerly currents through the straits are not necessarily connected with the rise and fall of the water, either there or in port The phenomenon of "slack water" (*morte eau*) is also observable every ten days or so at Haiphong, and is probably owing to much the same causes as at Hoihow At Tourane in Tonquin, too, it is popularly thought that there is usually but one tide within the twenty four hours This tide is felt away up to the citadel of Quangnam. In the Gulf of Tonquin the incoming tidal wave flows from the south, a fact which perhaps accounts for the singular circumstance that the westerly current in the Hainan Straits always sets for sixteen hours One at least of the tidal waves from the east which pass Hoihow cannot get through the straits to Tonquin so soon as that portion of the same wave which takes a circuitous course by way of Annam.

THE Pacific Coast Fisheries of the United States appear to be in a most flourishing condition According to a recent census bulletin, they employed 13,850 persons in various capacities in the last federal census year, 6,498,239 dollars were invested in them, and the products were valued at 6,387,803 dollars The canning of salmon is the most important fishery industry in the Pacific States.

SISAL grass, according to a Mexican authority quoted in the new number of the *Board of Trade Journal*, is likely to prove a very important source of wealth for Mexico It grows in long, narrow blades, often to the length of four or five feet, and these, when dry, curl up from side to side, forming a flexible string, stronger than any cotton cord of the same size ever manufactured It is in great demand among florists and among manufacturers of various kinds of grass goods, and it is said to be capable of being applied to many new uses Ropes, cords, lines of any description and any size may be manufactured of it, and a ship's cable of sisal grass is one of the possibilities of the future It is almost impervious to the action of salt water, and is not readily decayed or disintegrated by moisture and heat It takes its name from the port of Sisal, in Yucatan, through which it was formerly exported

A PAPER on modern aerial navigation was read by Captain J D Fullerton, R E, before the Royal United Service Institution on Friday last His object was to show that the science of aeronautics was based upon simple rules and common sense, and not upon wild and vague theories opposed to all principles of nature He divided aerial navigation into two distinct branches (1) ballooning, or navigation by means of machines lighter than air, and (2) aeration, or navigation by means of machines heavier than the air Proceeding to discuss the first branch, the lecturer sketched the history of attempts at propelling balloons Describing the requirements of a proposed war balloon, he said these were (1) that it should be able to carry three or four passengers, a supply of explosive shells, and a machine gun or two, (2) that it should be able to travel at the rate of about 30 miles an hour on a still day, which would enable it to keep up with almost any warship afloat In regard to aeration, Captain Fullerton said the chief characteristics of this system were that a large supporting surface, either in the form of wings or in that of an aeroplane, was used to carry the weight, that the lifting or supporting power of this surface was dependent upon its velocity and the angle of inclination which it made with the horizon, and that the horizontal resistance to motion depended upon the velocity and angle of inclination in the same manner The great difficulty both in ballooning and aeration was to get a sufficiently light motor

THE first number of a new journal, called the *Canal Journal*, has been issued Its aim will be "to assist the cause of canals and inland navigation generally" It promises to be of considerable value and interest to the class of readers for whom it is especially intended

THE German publisher, Friedrich Brandstetter, announces that he will issue in the course of the present year a second and improved edition of Dr J J Egli's "Nomina Geographica." The number of explained names has been much more than doubled.

FURTHER details concerning the nature and chemical behaviour of acetyl fluoride, CH_3COF, the new substance whose preparation and physical properties were described in our note of last week (p. 40), are contributed by M Meslans to the current number of the *Comptes rendus* It may be remembered that this interesting substance was shown to be liquid at temperatures below 19°.5, and gaseous at temperatures superior to this, its temperature of ebullition, both the liquid and the

gas being colourless, and endowed with an odour somewhat reminding one of that of carbonyl chloride In contact with water, acetyl fluoride is found to react eventually in a manner similar to its well-known analogue, acetyl chloride, forming hydrofluoric and acetic acids

$$CH_3COF + H_2O = CH_3COOH + HF$$

But there is a considerable difference in the degree of energy with which the decomposition occurs, for while the behaviour of acetyl chloride is almost violent, acetyl fluoride only reacts with great slowness When a small quantity of the fluoride if dropped into water the two liquids do not mix, and the globule of fluoride only disappears after long standing Strong solutions of potash or soda, however, decompose it rapidly, with formation of fluoride and acetate of the alkali The action of caustic lime upon acetyl fluoride is interesting, the gas is rapidly absorbed by it, and calcium fluoride and acetic anhydride formed

$$2CH_3COF + CaO = CaF_2 + (CH_3CO)_2O$$

Ammonia gas reacts with considerable energy with the liquid, producing a white crystalline mass, consisting of ammonium fluoride and acetamide, CH_3CONH_2 The latter may readily be isolated in good crystals by extraction with ether and subsequent evaporation The gaseous fluoride reacts with ammonia in the proportion indicated by equation—

$$CH_3COF + 2NH_3 = CH_3CONH_2 + NH_4F,$$

that is, two volumes of ammonia react with one volume of acetyl fluoride gas Aniline likewise acts with energy upon the liquid, forming hydrofluoric acid and acetanilide, $C_6H_5NH\,CH_3CO$ The action of absolute alcohol is peculiar, it dissolves the liquid fluoride in all proportions, but after an interval of a few hours, interaction occurs with production of hydrofluoric acid and acetic ether The latter may readily be separated by the addition of water

$$CH_3COF + C_2H_5OH = CH_3COOC_2H_5 + HF$$

Acetyl fluoride is much more stable in presence of alkaline acetates than its chlorine analogue Even after four hours heating in a sealed tube to 100 with sodium acetate, only a small proportion of sodium fluoride and acetic anhydride were formed Still more stable is acetyl fluoride towards sodium amalgam, there being no appreciable reduction to aldehyde or alcohol Metallic sodium is likewise without action upon liquid acetyl fluoride, but when heated to redness in the gaseous fluoride, the metal decomposes it with incandescence, sodium fluoride being formed and carbon deposited, together with a few drops of a liquid whose characters have not yet been ascertained From these reactions it is evident that acetyl fluoride is a substance of a much more stable character than its analogue, acetyl chloride

THE additions to the Zoological Society's Gardens during the past week include an Egyptian Ichneumon (*Herpestes ichneumon*) from North Africa, presented by Dr J Anderson, a Ring tailed Coati (*Nasua rufa*), a Kinkajou (*Cercoleptes caudivolvulus*), a Blue bearded Jay (*Cyanocorax cyanopogon*) from Brazil, presented by Mr J E Wolfe, C M Z S, two Laughing Kingfishers (*Dacelo gigantea*), from Australia, presented by Mrs. H M Stanley, two Grey Hypocoliuses (*Hypocolius ampelinus* ♂ ♀) from Scinde, presented by Mr W D Cumming, two Ravens (*Corvus corax*), British, presented by Mr Gregory Haines; a Crowned Horned Lizard (*Phrynosoma coronatum*) from California, presented by Mr R Thorn Annan, a Common Fox (*Canis vulpes*), British, three Palm Squirrels (*Sciurus palmarum*) from India, a Brown-throated Conure (*Conurus æruginosus*) from South America, deposited, a Grey-headed Porphyrio (*Porphyrio poliocephalus*) from Persia, purchased; a Persian Gazelle (*Gazella subgutterosa* ♂), a Vulpine Phalanger (*Phalangista vulpina* ♀), born in the Gardens

OUR ASTRONOMICAL COLUMN

LATITUDE OBSERVATIONS AT WAIKIKI —The *Hawaiian Gazette* for March 8 contains an account by Mr Preston, of the U S Coast Survey, of the latitude observations which are being made at Waikiki on the island of Oahu, Hawaii In it we read —" The motion of the pole is, of course, extremely small, and the effect is that here in Honolulu we are about 50 feet nearer the equator now than we were some months ago This change does not, however, go on indefinitely, but the motion is such that the pole returns at the end of a year to nearly its original position Besides this annual movement, there seems to be reason to believe that there is a secular change extending over a period of at least sixty years " But no definite conclusions can be arrived at until the observations made at Honolulu are discussed in connection with those made on this side of the earth In order to test the theory that changes of latitude are produced by the movements of large masses of molten matter in the interior of the earth, the force of gravity is measured on every night that latitude observations are made As this is done with the idea of detecting variations, the relative and not absolute intensity is all that is required The arrangement employed is such that if from any cause the acceleration due to gravity should be increased by only one five-hundredth of an inch, it could be easily measured The observations will be completed in the fall of the year, but the final results cannot be known before the latter part of 1893

MOTION IN THE LINE OF SIGHT —*Astronomy and Astro Physics*, No 104, contains a very important contribution by Mr W W Campbell, on the reduction of spectroscopic observations in the line of sight The paper contains an explanation of the construction and use of the tables, the limit of precision adopted being one hundredth of a mile per second The first table gives the velocities of the star corresponding to a known displacement of one tenth metre in the various parts of the spectrum, from which the velocity corresponding to any observed displacement can be directly obtained The formula

$$v = V_\lambda \Delta\lambda$$

gives this velocity corresponding to any measured $\Delta\lambda$, V_λ being taken directly from the tables

Table II gives the earth's orbital velocity, V_a, and the deviation, i, when the sun's longitude is $\odot$ These values are obtained from the formulæ—

$$\tan i = \frac{e \sin(\odot - \Pi)}{1 + e\cos(\odot - \Pi)}$$

and $$V_a = \frac{a}{\sqrt{1-e^2}} \frac{2\Pi}{T}[1 + e\cos(\odot - \pi)] \sec i,$$

and when found are substituted in the equation—

$$v_a = - V_a \sin(\lambda - \odot + i)\cos\beta$$

By tabulating V_a and i as functions of $\odot$, their values can be very easily found, and v_a consequently reduced from the last-mentioned equation

The value of the lunar correction has been taken into account here, omitting any errors due to ellipticity of the orbit and its inclination to the ecliptic. Its value is obtained from the formula—

$$v_d = - 0\ 29 \sin t \cos\delta \cos\phi,$$

the latitude used being that of Mount Hamilton, but corresponding corrections for any other latitudes can be found from these by multiplying them by $\frac{\cos\phi'}{\cos\phi}$, where ϕ' is the new latitude required

THE LATE PARTIAL ECLIPSE OF THE MOON —Fine weather was generally prevalent during the partial eclipse of the moon on May 11, affording many observers a good opportunity for noting any new features connected with such an occurrence Considering that the eclipse was only a partial one, it may be rather difficult to decide whether it should be classed in the category of "bright" or "dark" eclipses Undoubtedly it was not a very dark one, for during the greatest immersion the whole surface of the moon could be distinctly seen, especially with the help of a telescope, with which craters could be picked out On the hypothesis that "dark" and "bright" eclipses are brought about owing to the different states of the solar atmosphere, the present one should have been at any rate more inclined to be "bright" than "dark," for as we are approach-

ing a spot maximum the sun's atmosphere is becoming more and more disturbed. At the time of greatest obscuration the blood-red tinge, caused by the absorption of our atmosphere, became very apparent, but this gradually wore off as the brighter part of the moon made its appearance.

From a series of photographs of the eclipsed moon taken at intervals of about a quarter of an hour, the penumbra in some of them was very distinct, especially in those taken near the time of greatest obscuration, the exposures then being comparatively long. At mid eclipse an attempt was made to obtain a photograph of the whole disk of the moon, as it appeared so distinct and clear on the ground glass, but even an exposure of 12s., using extra rapid dry plates and a 30-inch reflector, was not sufficient to bring it out, although the extent of the bright crescent and penumbra was very much increased.

DECLINATIONS OF STARS FOR REDUCTION OF VARIATIONS IN LATITUDE.—No. 263 of the *Astronomical Journal* contains the declinations of thirty-six stars, which have been obtained with the prime vertical transit of the United States Naval Observatory. The observations were made for the determination of the constant of aberration, and consequently at the periods of maxima aberration effects, but their present publication, as Prof. S. J. Brown states, is owing to the "many requests for the observed declinations of these stars for use in discussing probable secular and periodical changes in latitude." The stars in this list are comprised in the zone 36° 37′—38° 40′. The communication contains a brief account of the methods of reduction employed, together with a reference to the instrumental adjustments.

The same number of the *Journal* contains also some results of the observations of α Lyræ, made during the years 1862–67 with the same instrument as mentioned above. The discussion of these observations was first made when Euler's value of 306 days for the periodical variation of the latitude was in vogue, but Prof. S. Newcomb, in the present case, has taken Mr. Chandler's new value, and gives, briefly, the following results:—

Mean declination of α Lyræ for 1865.0, assuming the latitude of the centre of the Observatory to be 38° 53′ 39″.25	38° 39′ 35″.56
Correction to Struve's constant of aberration	+ 0″.006
Hence, constant of aberration	20″.451
Parallax of α Lyræ	+ 0″.24
Coefficient of sun's azimuth in declination	+ 0″.507
Coefficient of sin N	s = + 0″.086
Coefficient of cosine N	c = − 0″.087

the value of N being assumed zero at 1864.50, increasing 308° annually.

The expression which he gives for the variation of the latitude of Washington is

$$\delta\phi = 0''.122 \cos 308^\circ (t - 1864.94),$$

the distance between the poles, or the semi-amplitude of the variation of the latitude, being 0″.122.

COMET 1892 DENNING (MARCH 18).—The following elements and ephemeris are given for this comet in the *Astronomische Nachrichten*, No. 3089, computed from three observations made at the Hamburg Observatory:—

T = 1892 May 11.22042 Berlin M.T.

$$\left.\begin{aligned} \omega &= 129^\circ\ 18'\ 34''.4 \\ \Omega &= 253\ 25\ 41.6 \\ \iota &= 89\ 42\ 4.3 \end{aligned}\right\} \text{M. Equator 1892.0}$$

$$\log q = 0.294619.$$

Ephemeris for 12h. Berlin M.T.

1892	α App. h. m. s.	δ App. ° ′	log r	log Δ	Br.
May 19	3 49 27	+52 13.5			
20	52 26	51 57.7			
21	55 22	51 41.8	0.2947	0.4423	0.80
22	58 15	51 25.9			
23	4 1 5	51 10.0			
24	3 52	50 54.1			
25	6 37	50 38.2	0.2948	0.4466	0.79
26	9 19	50 22.3			

The brightness at the time of discovery is taken as unity.

COMET 1892 SWIFT (MARCH 6).—The elements and ephemeris of this comet are given in the *Edinburgh Circular* (No. 26), from which we make the following extract:—

1892	R.A. h. m. s.	Decl. ° ′	log Δ	log r.	Br.
May 19	23 23 44	+31 52.2			
20	26 16	32 22.2			
21	28 47	32 51.6	0.1522	0.1035	0.53
22	31 16	33 20.4			
23	33 44	33 48.7			
24	36 10	34 16.5			
25	38 34	34 43.7	0.1628	0.1166	0.47
26	40 56	35 10.4			

The brightness at the time of discovery is taken as unity.

The comet is situated in the constellation of Pegasus, and on the 22nd will form very nearly an isosceles triangle with β Pegasi and α Andromedæ, the comet then lying nearly midway between η Pegasi and σ Andromedæ.

GEOGRAPHICAL NOTES.

M. LOUIS LÓCZY, in his annual address to the Hungarian Geographical Society at the commencement of the current session, expressed surprise that scientific geography was so little appreciated in England. "It is sad to see," he said, "that, despite the efforts of the oldest of Geographical Societies, the great Universities of Oxford and Cambridge have not yet established chairs of geography, and that lectureships even have only been established with difficulty."

IN the Report of the Mississippi River Commission, the extent of the levees confining the river below Cape Girardeau (Missouri) is given as 1300 miles. During the high water of 1891, the levees gave way in five places, and the total length of the breaches made in the embankment was about one mile. By far the most serious gap was that at Ames Plantation, opposite New Orleans, which attained a width of 1665 feet, and a maximum discharge of about 91,000 cubic feet per second. It overflowed 2000 square miles, one tenth being cultivated land. The cause of this crevasse was a badly constructed rice flume, and as the great Nita crevasse of 1890 had a similar origin, the Commission has resolved to discountenance the use of such flood gates in future. All of the crevasses of 1891 put together discharged less water than the Nita crevasse alone in the previous year, and it was only one out of about fifty breaks which occurred during the great floods.

A NEW map of Dahomey, on the scale of 1 : 500,000, has been prepared by M. A. L. d'Albeca, and published as a supplement to the new journal, *La Politique Coloniale*. All available data have been employed in its preparation, much being of course derived from itineraries unchecked by observation.

CAPTAIN GALLWEY, Vice Consul for the Oil Rivers Protectorate, has succeeded in tracing a channel navigable for canoes through the deltaic swamps between Benin and Lagos, a distance of 160 miles.

THE *Proceedings* of the Royal Geographical Society for May contains a letter from Mr. Gilbert T. Carter, Governor of Lagos, describing a recent journey into the interior. From the summit of a hill near Ode Ondo he obtained a magnificent view to the south-east over a foreground of rocky forest-clad hills, backed by a fine range of mountains about twenty miles away, which have not previously been reported. The height of the most conspicuous summits is estimated to be from 5000 to 8000 feet above sea-level.

THE VARIATION OF TERRESTRIAL LATITUDES.

IN a letter addressed to M. R. Radau by M. Antoine d'Abbadie, which appears in the March number of the *Bulletin Astronomique*, the writer gives an interesting historical account of the work that has been done with regard to this question. As it contains also some suggestions for future work, the following *résumé* may be of service.

The author states that M Fergola, the astronomer at Naples, may be looked upon as the one who first drew attention to this question. Of the earlier astronomers, Sir George Airy was led to the conclusion that the latitude was subject to a slight variation, and he published in 1854 and 1875 the greatest and least values for the co-latitude 38° 31′ 22″ 16, and 38° 31′ 21″ 35 respectively, obtained from observations of the pole Many other results were obtained by him, which caused him to assign reasons for the fluctuations, but he deemed it wiser to publish the results at a time when the measurement by graduated circles was considered more concise.

One of the first causes to which these variations were attributed was refraction, and it was with the intention of settling this point that Airy undertook with his zenith telescope the measurements of the zenith distance of γ Draconis, as this star culminated near the zenith at Greenwich M Faye, towards the year 1846, found out the advantages of such an instrument as that used by Airy, and his installation was composed of three instruments, a zenith telescope, a mercury trough, and a nadir telescope, the last two of which provided a means of obtaining the true nadir point

Porro, an Italian officer, adopted several of these improvements in his instrument he added to his telescope a trough with a glass bottom, the plane surface of which was placed in a horizontal position, and reflected feebly the image of the central thread of the zenith telescope By filling the trough with water, another image of the same wire was obtained, which remained visible during the transit of the star, and it was possible to take several measures of the distance between the star and image

The next observer we find occupied in this research was Respighi, who, in the year 1872, published the nadir distances of several stars measured at Rome The stars he observed were those which culminated so near the zenith that they could be seen in the telescope after reflection from mercury From a series of seventy-seven observations, taken during five months of the year 1869, he observed the transits of two stars reflected at his nadir During this interval he found a difference of 2′ 07 between the greatest and least of his results

In the method of Horrebow, the divided arc on his instrument gave a rough reading of the inclination of his telescope, while for greater precision he used the readings taken from a level fitted to the telescope

M d'Abbadie here condemns the use of levels altogether for really accurate work, and backs his opinion with facts which he has obtained from personal experience He mentions that, as far back as 1837, he made a study of their accuracy, but the levels he used were not good ones Later, after having purchased some from the best-known makers in Paris, Munich, London, and Hamburg, he repeated his experiments in a cellar in an old *château*, and he found that the results given were of a most unsatisfactory kind

Admitting, then, that there was a variation in the latitude, it was not long before periods were established Peters, in the year 1845, from observations at Pulkova, derived one of 303 9 days with a maximum on November 16, 1842 Mr Nyrèn extended this to 305 6 days, with a maximum on December 13, 1867, while Mr Downing, from ten years of observations made at Greenwich, deduced a period of 306 0 days, with a maximum on October 12, 1872 Leverrier, and Hough at Albany, also found variations that were confirmed at Abbadia

M d'Abbadie then refers to the variation of the true azimuth, which, as he says, did not escape the notice of Airy In the year 1848 he estimated it as 4″ or 5″, while fifteen years later he extended it to 6″ or 7″. Of course, if the pole suffers any displacement, such as an increase in elevation, at its two elongations it will be displaced by the same amount, and the azimuths in these cases would be increased The greatest displacement we have mentioned is 2″·07, but M d'Abbadie says "that if, by hypothesis, the north pole of the earth be elevated by 7″ by approaching the actual zenith, the true azimuth will be diminished by those 7″ in a place situated at 6h om of west longitude, and increased by the same quantity at 6h. om of east longitude." He then states how, if the pole was considered movable for places situated at opposite ends of a diameter of the earth, the values for the variation should be the same, but of opposite signs. To establish coincidences of this kind, it is suggested that observers in Asia and America should take their nadir readings at the same time as they are taken at Abbadia —that is, in the morning and evening at 6h. Paris mean time The results Chandler obtained from his latitude observations indicated a minimum on September 1, 1884, and a maximum on May 1, 1885, with a difference of about 0″ 7 By taking the 6 o'clock p m P M T observations made at Abbadia, it was found that a maximum value was obtained on September 1, 1884, and a minimum on May 1, 1885, with a difference of 0″ 74. Contemporary observations made at Berlin and Honolulu tended also to the same conclusion, but in spite of them M. d'Abbadie does not think it prudent to suppose a fluctuation of the earth's axis

After referring to some sudden changes that this variation has undergone, he goes on to mention Darwin's, Wolf's, and Paschwitz's instruments that were constructed for the measurement of very small displacements The last-named modified to a large extent Zollner's horizontal balance, and added to it a mirror, obtaining in this way, by the employment of photography, a continuous series of curves

Mr Nobile, in his memoir of 1883, related that, in 1820, Brioschi believed in the small changes in the terrestrial latitudes, and admitted two possible variations, one secular and another periodic He states, also, that Fergola, in 1871, supported this idea of Brioschi, and Peters, as well as Nyrèn and Gylden, confirmed this opinion Euler and Legendre are also said to have concluded from theory such a variation, giving it a period of ten months

Another memoir by M Nobile, contains a discussion on the observations that were made with the object of determining the latitude of the Observatory at Capo di Monte, near Naples, and from these, together with some others, he deduced a tendency in the latitude to increase in the summer and decrease in the winter months

It will be seen from the preceding summary that very little is definitely known as to the causes of this variation From the observations just referred to, it seems that refraction would be the cause of such a variation, but as this is not borne out in other observations, new theories must be advanced M d'Abbadie, knowing the importance that is attached to the inquiries into the causes of these variations, before concluding his letter adds a few suggestions relative to a means of settling some of these points, and the following is the plan which he proposes should be adopted

Three observers, A, B, and C, should be provided each with a good zenith telescope, and the same two stars, which it is proposed to use, should be observed by them B and C should be as near as possible on the same parallel of latitude, so as to have identical refractions when measuring the declination on the meridian of the chosen stars To insure greater accuracy in these declinations, he suggests that these stars should be observed at their elongations with a geodetical circle, the refraction in azimuth being zero, save in a few rare cases of lateral refraction The three observers should "notify at once, in a continuous way, if possible, the varying movements of the nadir, and, in every case, these variations at the precise moment where A would observe on the meridian"

To further complete this plan, two other observers, at D and and E, might be added, the former situated at 6h. east, and the latter at 6h west longitude, in the same relative positions as Paris is to Calcutta and Chicago The position of E or D could be chosen in the austral hemisphere, in order to determine whether the variation of the nadir agrees with that which should be observed simultaneously in the opposite hemisphere Still greater advantage would be gained if two other observers, situated at opposite points of the earth, were chosen to observe these phenomena at the same instant By adopting this plan, a definite control would be had over the hypothesis that the fluctuation was due to the movement of the terrestrial axis, and if only this point could be settled, we should have advanced a considerable step in its solution

We may mention here that quite recently Chandler has made the remarkable discovery that the earth's axis of rotation revolves round that of her maximum moment of inertia in a period of 427 days This, as Prof Newcomb says, seems at first to be quite contrary to the principles of dynamics, but, after having investigated the theory, he finds that it is in perfect harmony with the amount that the latitude varies, taking into account the elasticity of the earth itself and the mobility of the ocean Radau's investigations were based on a 306-day period, but he showed that the observed discordances would have to be multiplied three times before they agreed with those obtained by theory.

W J L.

MAGNETIC VARIATIONS[1]

IN this paper the author refers to the ordinary variations of the magnetic elements as observed at Greenwich , the annual progressive change , the diurnal variation—large in summer, small in winter, and also larger when sun spots are numerous and smaller when sun spots are few , the irregular magnetic disturbances and magnetic storms, and the accompanying earth currents , phenomena which are generally similar at other places

He then invites attention more particularly to magnetic disturbances Those at Greenwich may, after a calm period, arise gradually or commence with great suddenness When sudden, the movement is simultaneous in all elements The first indication may be a sharp, premonitory, simultaneous movement, followed after a time by general disturbance, or the movement may at once usher in the disturbance These initial movements are not always great in magnitude, sometimes, indeed, small, but they have a very definite character, and frequently occur nearly instantaneously, as is shown in the character of the photographic traces

It has been long known that magnetic disturbances occur at the same time over wide areas of the earth's surface, but the accidental comparison in past years of the times of commencement of one or two disturbances at Greenwich with the times at other places has led the author to suppose that the coincidence in time is much closer than had been before supposed, and the definite, and on occasions isolated, character of the initial movement induced him to undertake the collection and comparison of the times of such movements for a number of days at observatories geographically widely separated

The times of such movements cannot be caught by eye observation without continuous watching of the magnets, so that the photographic registers have to be relied upon, which is better, excepting that the scale of time is necessarily contracted, but, though in individual measures there might be variations, it was conceived that (supposing no systematic error to exist) the mean of a number of comparisons should give a good result Seventeen days, occurring in the years 1882 to 1889, were selected for comparison, the observatories being those of Toronto, Greenwich, Pawlowsk, Mauritius, Bombay, Batavia, Zi-ka wei, and Melbourne, and, for a less number of days, Cape Horn (as obtained from the Mission Scientifique du Cap Horn, 1882–83) It was desired to have times for Pola, but it was found that photographic registers during great part of the period did not exist The variation in time at each place from the mean of times for all places is given for each day The mean deviation at the different places varies from + 2 4 minutes to − 2 9 minutes, the agreement between four of the places—Greenwich, Pawlowsk, Mauritius, and Bombay—being very much closer, the mean values of deviation for Greenwich, Pawlowsk, and Bombay differing, indeed, by only 0 1 minute, equivalent to 6 seconds

The question arises, Are the differences real, or due (considering the contracted time scale) to accidental error? If the magnetic impulse is really simultaneous over the whole earth, it is a striking physical fact, and if not entirely so, the circumstance is no less interesting , but greater attention to accuracy of time scale, or a more extended scale, may be necessary before the point in question can be definitely settled

A table is added, showing the character of the magnetic movement at the several observatories, from which it appears that at any one place the movements on different days were in most cases similar, though different at different places, indicating on these occasions the occurrence usually of one general type of disturbance

Reference is made to the question of earth currents A comparison for thirty one days, between 1880 and 1891, of cases of sudden magnetic movement and earth current at Greenwich, shows the earth current to precede the magnetic movement by 0 14 minute, equivalent to 8 seconds The question of the relation between magnetic movements and earth currents is discussed

The desirability of being able temporarily to obtain, when occasion requires, a more extended time scale for all magnetical and meteorological phenomena is pointed out

The general result is that in the definite magnetic movements preceding disturbance the magnets at any one place are simultaneously affected , also that in places widely different in geographical position the times are simultaneous, or nearly so, a small constant difference existing at some places which may be real or may be accidental, but the character of which it seems desirable to determine It is shown also that at Greenwich definite magnetic movements are accompanied by earth current movements which are simultaneous, but that neither magnetic irregularities nor ordinary magnetic variations seem to admit of explanation on the supposition of being produced by the direct action of earth currents

[1] Abstract of paper "On the Simultaneity of Magnetic Variations at different places on occasions of Magnetic Disturbance, and on the relation between Magnetic and Earth Current Phenomena," by William Ellis, F R A S , Superintendent of the Magnetical and Meteorological Department, Royal Observatory, Greenwich Communicated to the Royal Society, on May 5, 1892, by W H M Christie, F R S , Astronomer Royal

SCIENTIFIC SERIALS

American Journal of Science, May —Radiation of atmospheric air, by C C Hutchins A stream of hot air was arranged so that it could be made to pass in front of one of the faces of a thermopile at a distance of 3 cm , and cause a deflection of a galvanometer needle, or the air could be discharged high above the thermopile, leaving it unaffected except by radiation from a large Leslie cube containing water at the temperature of the laboratory. There was no sort of agreement between measures made on eight different days to determine the absolute radiating power of a column of air 1 centimetre thick at a temperature near 100° C , but in an ordinary room and under average conditions the value came out = 0 000001133 + 0 00000000711 $(t-t')$, where $t-t'$ is the difference in temperature between the air and the cube Tyndall's result, that the radiation increases with the amount of moisture in the air, was confirmed, but no exact law of connection between the two was found This is probably due to the presence of accidental impurities in the air employed The increase of radiation proves to be proportional to the increase of temperature There was a small increase of radiating power when sheets of air more than 1 centimetre thick were used , with sheets less than this thickness, no difference of radiation could be detected —Atmospheric radiation of heat and its importance in meteorology, by Cleveland Abbe In this interesting and exhaustive paper Prof Abbe brings together practically all the conclusions that have been arrived at on atmospheric movements and their relation to radiation from the air In his words, "A comprehensive study of fluid motions shows that air and water alike may be forced to ascend without being warmer and lighter, or to descend without being colder and denser, than the surrounding fluid. The currents and whirls behind any obstacle in streams of air or water are almost wholly independent of differences of density, and are caused by differences of pressure as modified by simple kinetic laws These motions, which the air is forced to take for purely kinetic reasons, are specially discussed in detail, but it is impossible to enumerate, in an abstract, the many cases considered —Experiments upon the constitution of certain micas and chlorites, by F W Clarke and E A Schneider The minerals analyzed are waluewite, v of xanthophyllite, clinochlore, leuchtenbergite, diallage, serpentine, and mica from Miask, Ural —On the qualitative separation and detection of strontium and calcium by the action of amyl alcohol on the nitrates, by P E Browning —The age and origin of the Lafayette formation, by Eugene W Hilgard —On the influence of swamp waters in the formation of the phosphate nodules of South Carolina, by Dr Charles L Reese From the experiments it appears probable that both carbonic acid and the humus substances in fresh water swamps play an important part both in the accumulation and the concentration of calcium phosphate, and thus in the formation of phosphate nodules, these being considered to be phosphatised marls —Plattnerite, and its occurrence near Mullars, Idaho, by William S Yeates , with crystallographic notes by Edward F Ayres —On the occurrence of Upper Silurian strata near Penobscot Bay, Maine, by William W Dodge and Charles E Beecher —Zinc-bearing spring waters from Missouri, by W F Hillerbrand. The chief constituent salt in the spring in question is zinc sulphate It forms about 56 per cent of the total dissolved solids —A meteorite from Central Pennsylvania, by Prof W G Owens A chemical analysis of the meteorite gave Fe 91 36, Ni 7 56, Co 0 70, P 0 09, S 0 06, Si trace = 99 77 —On two meteoric irons, by G F Kunz and E Weinschenk One of the masses examined came from Indian Valley Township, Floyd County, Virginia , the other from Sierra de la Ternera, Province of Atacama, Chili —The molecular masses of dextrine and gum

arabic as determined by their osmotic pressures, by C E Linebarger The molecular mass of gum arabic is found to be about 2500, of dextrine 1134, and of colloid tungstic acid 1750 In each of these three cases the colloid molecule is seven times the simple molecule.

American Journal of Mathematics, vol xiv, No 2 (Baltimore, Johns Hopkins Press, April 1892)—The number before us opens with a paper entitled "Some Theorems relating to Groups of Circles and Spheres," by Prof W. Woolsey Johnson (pp 97–114) The title at once calls to mind Mr Lachlan's memoir "On Systems of Circles and Spheres" (Phil Trans, vol 177) The author thus puts the connection between the papers "(1) If there be 5 circles or 6 spheres in each group, the product or determinant of powers is equal to zero, and (2) if there be 4 circles or spheres in each group, the power determinant is the product of two determinants each of which depends upon one of the groups" Mr Lachlan's results are derived principally from the first of the above theorems, whereas it is Prof Johnson's object "to point out some other results derivable from the second theorem, and particularly to evaluate the power determinants for groups of smaller numbers of circles and spheres" The two memoirs are an interesting application of a "Theorem in the Geometry of Position" (the multiplication of two determinants) due to Cayley (*Camb Math Journ*, vol ii, 1841)—The next paper, by C H Chapman, is an "Application of Quaternions to Projective Geometry" (pp 115–40)—Then follows an adaptation of G W Hill's method (*American Journal of Mathematics*, vol i) "so as to include that class of inequalities which depends also on the ratio of the solar and lunar distances, and, in particular, the principal part of the parallactic inequality," by E W Brown The title of the paper is "On the part of the Parallactic Inequalities in the Moon's Motion, which is a Function of the Mean Motions of the Sun and Moon" (pp 141–60)—The two remaining papers were read before the New York Mathematical Society, viz. "On the Curves which are self reciprocal in a Linear Nul-system, and their Configurations in Space," by C P Steinmetz (pp 161–86), and "A Classification of Logarithmic Systems," by Irving Stringham (pp 187–94)—This last is an attempt to use the logarithmic spiral, defined as a geometrical locus, as the means for defining the logarithm and demonstrating its properties

Bulletin of the New York Mathematical Society, vol i Nos 6, 7 (New York March, April, 1892)—The first of these numbers opens with a discussion of the mechanical axioms, or laws of motion, as presented by Newton The author, Prof W Woolsey Johnson, examines at some length (pp 129–39) the views put forward in Thomson and Tait, "Natural Philosophy", Tait, "Mechanics" ("Encyc Brit"), and Williamson and Tarleton, "Dynamics" The article is a careful piece of reasoning, founded upon the principle that "it is desirable to include among the axioms of mechanics the smallest basis of postulated principles upon which it is possible to construct the science by rigid mathematical reasoning" Then follow short notices of an 8 figure logarithm table, published "par ordre du Ministre de la Guerre, Paris, 1891," and of "An Introduction to Spherical and Practical Astronomy, by Dascom Greene (Boston, 1891)" The usual "Notes" and list of new publications close this number and also No 7 This last-named number opens with a review of "The Laws of Motion, an Elementary Treatise on Dynamics, by W H Laverty" The writer's object in this, and similar articles that are to follow, is "by reviewing somewhat at length a few of the better recent works on elementary mechanics to 'fix the ideas' and arrive at some conclusions, at least, as to what is the best modern usage in treating the subject" (pp 145–50) The next contribution, by Dr C H. Chapman, entitled "Weierstrass and Dedekind on General Complex Numbers" (pp 150–56), is one of those that makes this *Bulletin* so interesting and valuable to the student The last article is a translation (pp 156–68) by Prof Ziwet of an *éloge* by M. Duhem on "Emile Mathieu His Life and Works"

Memoirs of the St Petersburg Society of Naturalists, vol xxi. (Section of Botany)—Besides the proceedings, the volume contains the first part of an excellent monograph, by M Aggéenko, on the flora of Crimea, being a description of the botanical geography of the peninsula. The orography and hydrography of Crimea, and its various soils, are shortly described, as also its climate. The periodical phenomena of blooming and fruit-bearing are next dealt with. The following chapter is devoted to the analysis of previous exploration, and the remainder of the work is given to the description of the character of vegetation in the Steppes of Crimea, on the northern slope of the highlands, the flat summits of the Yaila highlands, and especially the southern slope The influence of man and of the fauna on vegetation is briefly treated, and a new species, *Alyssum rotundatum*, as well as a new variety of Orchids (*Ophrys aranifera*, Hudson, var *taurica*) are described and figured on plates A very interesting geo-botanical map of Crimea is given—A paper on the pigments of Fungi, by A Nadson, must be rather considered as a preliminary communication, containing many valuable data on the pink, yellow, red, and orange pigments of some fifteen species—On the crystals in the leaves of the *Anonaceæ* and *Violarieæ*, by Prof Borodin

Vol xxii (Section of Zoology and Physiology)—Ornithological observations in the middle course of the Amu daria in the Tcharjui-kelif region, by A Yaschenko A list of 161 species of birds and their distribution in various regions (cultivated, mixed, deserts, and mountains) is given, each of the regions being described separately as to its most characteristic birds—On the hybrids between *Butydes flava* and *Butydes campestris*, by N Zaroudnoi—On the embryonal development of *Phyllodromia* (*Blatta*) *Germanica*, by N Kholodkovsky, being a very elaborate and valuable contribution to comparative embryology It is the fruit of a four years' laborious research, and is accompanied by five large well-drawn plates

Bulletin de l'Académie des Sciences de St Pétersbourg, Nouvelle Série, t ii, No 3—The ephemeris and the approximate elements of the comet of Encke for the year 1891, by O Backlund (in German) The ephemeris is calculated from July 2 to November 1, 1891, after having taken into account the perturbing influences of Venus, the Earth, Mars, and Jupiter in 1884–88, and Jupiter alone from March 7, 1888, to May 31, 1891—Additions to the Flora of the Caucasus 1 Two new varieties of *Rhamnus*, by N Kuznetsoff (in German, with two plates)—On the radiants of the Andromedides, by Th. Bredikhine (in French), with a plate The meteoric current of November 27, 1872, and 1885 is studied, the former on the ground of the observations of the Brera Observatory at Milan The positions of the radiants are given on a map, upon which the orbit of the comet of Biela (for 1859) is also traced The positions of the radiants being taken into account, the author compares the probable elements of the meteoric current with the orbit of the Biela comet Taking further into account the meteoric currents observed on December 7 and 8 in 1798, 1830, 1838, and 1848, the author concludes that those currents must have belonged to the orbit of the same comet before the severe perturbations it suffered through the influence of Jupiter in 1794.—Observations of 51 double stars, followed by a research into systematic errors, by F Renz, of Pulkova (in German) The observations and the catalogue based upon them are given—On some old and new catalogues of stars, by J Seyboth (in German) Before the printing of Romberg's catalogue a comparison of its data with those of previous catalogues was felt to be necessary A series of comparative measurements has been undertaken for that purpose, and their results are given in the introduction to Romberg's catalogue Further comparison is now made with the catalogues of Struve, Argelander, Pulkova (3542 stars), Becker, and Gould, and reduction tables are given—A new Bacterium, *Nevskia ramosa*, by A Famintzin (in German), with a plate. This strange organism, so widely different from all known Bacteria, but not unlike to Metchnikoff's *Pasteuria ramosa*, consists of a jelly-like ramified growth, the Bacteria cells appearing upon the ends of the branches. It forms colonies similar to those formed by some Algæ and Infusoria (*Urococcus*, *Gomphonema*, *Epistylis*)—On the libration of Hyperion, by H. Struve (in French) The last years' observations of this satellite of Saturn, which have been made with the aid of the great Pulkova refractor, having disclosed considerable discrepancies from the ephemerides calculated by Mr Marth, the Pulkova astronomer tried to explain them—and succeeded to a great extent—by a libration which has a short period of 641 days, and an amplitude of 9° in the average longitude—Revision of the Hymenopteres of the Zoological Museum of the Academy, by A Semenoff 1 Genus *Cleptes* (in Latin) The following new species are described: *Cleptes flammifer*, *obsoletus*, *Buyssonis*, and *Mocsarii*, ii. Genus *Abia* (new species) *A. symballophthalma*.—New Gentianæ from Asia, by N Kuznetsoff The following new species, some of which had already been recog

nized as new by Maximowicz, are described *Gentiana Maximowiczi*, *leucomelaena*, *purpurata*, *siphonantha*, *Regeli*, *glomerata*, and *G Kurroo*, var *brevidens* They are from Central Asia, North China, and Mongolia —Report of the International Meteorological and Polar Conferences, and the International Committee of Weights and Measures, by H Wild No 4 Remarks on Mr Kock's work, "Comicorum Atticorum fragmenta" (in German)

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 5 —"Transmission of Sunlight through the Earth's Atmosphere Part II Scattering at Different Altitudes" By Captain W de W Abney, C B, D C L, F R S

In this paper the results of observations made by exposing platinotype paper are recorded, and it is shown that the total intensity of light as thus registered is the same as if observations had been made on a ray of λ 4240 alone The observations were made at altitudes varying from sea level to 12,000 feet in different countries, at different times of the year, and during four to five years The instrument in which the exposures were made is described, as also the method of deriving the intensity of light from the developed prints The results of these observations agree closely with those obtained by the measures of the spectrum which was described in Part I of this subject The value of k in the formula (1) $I' = \epsilon^{-k\lambda^{-4}}$ (from which can be calculated the loss of intensity of a ray of any particular wave length) was found to be 0 00146 at sea-level It was also found that k apparently varied as h', h being the barometric pressure A table is attached, showing the value of the transmitted light in the formula (2) $I' = Ia^x$, where a is a constant and x the air thickness in terms of the vertical thickness, μ being the formula $I' = I\epsilon^{-\mu x}$, from which (1) and (2) are both shown to be derived

Bar in inches	μ	a	Bar in inches	μ	a
30	0 154	0 856	24	0 098	0 908
29	0 144	0 866	23	0 090	0 915
28	0 134	0 875	22	0 083	0 922
27	0 124	0 884	21	0 075	0 928
26	0 115	0 891	20	0 068	0 934
25	0 107	0 899	19	0 062	0 940

Linnean Society, April 21 —Prof. Stewart, President, in the chair —An example of an Australian bird (*Gymnorhina*), which had lately been shot near Tor Abbey, Devonshire, after being observed all the winter, and which had doubtless escaped from confinement, was exhibited on behalf of Mr W Else, Curator of the Torquay Museum —On behalf of Mr Charles Head, of Scarborough, two specimens of the Whiskered Bat (*Vespertilio mystacinus*) taken in that neighbourhood were exhibited —Mr W B Hemsley, F R S, read a paper entitled "Observations on a Botanical Collection made by Mr A. E Pratt in Western China, with descriptions of some new Chinese plants from various collections" Mr Pratt travelled in 1889–90 in Western China, close on the borders of Eastern Tibet, and though chiefly in search of zoological specimens, he fortunately secured the services of a native who had been trained to dry plants by Dr Henry, the result being that he was enabled to bring home a very interesting botanical collection The plants were obtained chiefly at elevations of 9000 to 13,500 feet, in the neighbourhood of Tat-sien-lu, a frontier town situated in about 30° N lat and 102° 15′ E long, and although Mr Hemsley reported that he had not finished working out the collection, he estimated that it contained about 500 species, of which perhaps 150 species were new to science The paper was criticized by Mr C B. Clarke, who remarked that the mountain ranges of Western China seemed to abound in showy herbaceous plants, rivalling in this respect the richest districts of the Himalayan region, of which, in fact, it is a continuation —Mr H. M Bernard then gave an abstract of a paper on the relation of the Acaridæ to the Arachnida, in which he argued that the former were fixed larval forms of the latter, though he found a difficulty in dealing with the segmentation, this being so profoundly modified and in some cases lost The paper was criticized by Mr A D Michael, Mr Breeze, and Prof G B Howes, all of whom, while testifying to the ingenuity of Mr. Bernard's reasoning, considered that there was hardly as yet sufficient evidence to justify the acceptance of his conclusions.

May 5 —Prof Stewart, President, in the chair —On behalf of Mr. Holt, Prof G B Howes exhibited and made remarks on a very interesting collection of the metamorphosing larvæ of flat fish —Mr Curtis showed a photograph of sections of the Silver and Douglas firs, illustrating the relative rate of growth in trees of the same age growing in the same soil and under similar conditions in all respects, the diameter of the one (*A Douglasii*) being nearly double that of the other —Mr George Murray exhibited spirit specimens of *Isothamnion intricatum*, an organism described as a siphoneous Alga, but ascertained to be identical with an animal—namely, *Zoobotryon pellucidum*, Ehrenberg He also exhibited two specimens of a palm (*Thrinax Morrisii*, Wright), peculiar to Anguilla in the Leeward Islands, and made some remarks as to the results of the recent cryptogamic collections made by Mr, W R Elliott for the West India Committee —Mr Holmes exhibited and made some observations on an abnormal development of the calyx in a primrose —The President exhibited and explained a collection of Lepidoptera containing several examples of mimicry between protected forms —On behalf of Dr J Muller, Mr Thiselton Dyer communicated a paper entitled "Lichenes Epiphylli Spruceani"—Mr W F Kirby gave an abstract of a paper on the family *Saturniidæ*, with descriptions of new species in the British Museum —In the absence of the author, Mr W Percy Sladen read a paper by the Rev Hilderic Friend, entitled "Observations on British Earthworms"—The President announced that the anniversary meeting of the Society would be held on May 24, at 3 p m

Royal Microscopical Society, April 20 —The President, Dr R Braithwaite, in the chair —Mr A W Bennett called attention to some slides received from Prof D P Penhallow, of Montreal, who sent them to illustrate an improved method of labelling Instead of writing upon the usual paper label, he writes directly upon the glass, and covers the writing afterwards with a thin coating of Canada balsam, which makes it permanent —Prof F Jeffrey Bell said that, the Council having concluded the negotiations with their landlords, the rooms of the Society would now be open for the use of the Fellows every Wednesday evening from 6 to 10 p.m, from November till June This order would take effect at once —Mr F Chapman's paper on the Foraminifera of the Gault of Folkestone was read —Surgeon P W Bassett-Smith's paper on the deep sea deposits of the Eastern Archipelago was read by Prof Bell H M S *Penguin*, to which Surgeon Bassett Smith was attached, made a passage during the latter part of 1891 from Port Darwin, North-west Australia, through the Arafora, Banda, Celebes, Sulu, and China seas to Hong Kong A continuous and close line of soundings was taken through the whole passage, the deepest water being 2880 fathoms in the Banda Sea In almost every instance specimens of the bottom were obtained They consisted mostly of "green muds," with a few "blue" and "brown muds" in the deeper parts The definition of "green mud" is a very wide one, broadly it may be divided into that in which calcareous organisms, chiefly Globigerina, predominate, and that in which the tests of Radiolarians have taken their place, this latter condition was almost always present in "brown muds" The inorganic materials were either fine quartz sand in the deeper and more distant positions, or, as the coast was approached, argillaceous matter together with sponge spicules and small shells In places the material was typically volcanic, as in the upper part of the Banda Sea, among the Moluccas, and on the coast of Luzon Only two specimens of pure Globigerina ooze were obtained, both being in the Molucca passage, one in 1885 fathoms and the other in 197 fathoms It would seem that in the deeper parts of the seas the bottoms consist of Radiolarian muds, and the shallower parts of Globigerina muds, the line being roughly drawn at 1500 fathoms In almost every case over 2000 fathoms the siliceous organisms were undoubtedly most abundant —A note was read from Dr E Giltay on the use of the camera lucida in drawing Bacteria,

in which he recommended the illumination of the drawing by a powerful lamp, and the testing of the drawing by a slight change in the position of the paper, so as to compare side by side the drawing made and the camera lucida outline Dr Giltay stated he had succeeded in drawing objects magnified 2500 times. Mr A D Michael thought the method of comparison would be likely to produce distortion —Prof Bell said a note had been received from Mr J C Wright on some rotifers which he had found attached to a newt The accompanying drawings did not render it sufficiently clear that what he had found were really rotifers, and he suggested they were Vorticellæ —A note from Mr W M Osmond was also read, descriptive of a new cheap photomicrographic stand Dr W H Dallinger thought that though it might be useful for low-power work, he doubted if it would be of value for high or even moderate powers He should be afraid that there would be too much vibration Mr C L Curties said he should be sorry to use it for anything beyond a half-inch objective

Geological Society, April 27 —Prof J W Judd, F R S, Vice-President, in the chair —The Chairman announced that the Organizing Committee of the International Geological Congress have arranged to convene the sixth meeting of the Congress at Zurich, about the commencement of September 1894. Any communications should for the present be addressed to Prof E Renevier, University, Lausanne —Prof W C Williamson, F R S, exhibited the following specimens slab of Carboniferous Limestone from Bolland, illustrating the passage of a foraminiferal ooze into crystalline calcite; *Asteropecten Orion*, Forbes, from the Kellaways rock, near Pickering, Yorkshire, and made the following remarks —The specimen before me is a slab of Carboniferous Limestone from the Bolland district of West Yorkshire In its centre is a magnificent section of a large Nautilus—beautiful as a fossil, but still more important because of what it teaches Its large terminal chamber is filled with foraminiferal ooze, the component objects of which are almost as perfect as when the organisms were living The surrounding limestone is chiefly in an amorphous state, but it contains innumerable evidences that it also consists of foraminiferal ooze, largely reduced to the amorphous state by the agency of carbonic acid, now known to be so abundant in the depths of the ocean The action of this acid upon the minute calcareous shells necessarily converted the water into a solution of carbonate of lime In this state it percolated by osmosis through the shell of the Nautilus, penetrating its closed chambers, which it gradually filled with calcareous spar The specimen is thus an epitome, within its limited area, of what has taken place on a gigantic scale in the deep sea. We have here first the organic mass, next its conversion into amorphous limestone, and lastly the production of the crystalline state of the same, so frequently seen filling the interiors of fossils The second object is the original type-specimen of Forbes's *Asteropecten Orion*, from a sandstone bed of the Kellaways rock in the neighbourhood of Pickering, in Yorkshire. This starfish had lived upon and became buried in a sandy matrix which contained no lime. When the rock was split open, the space originally occupied by the starfish was hollow, the sand contained no soluble material, like that which filled the chambers of the Nautilus But in the lowest beds of the Coralline Oolite at Filey Brigg, on the Yorkshire coast, we long ago found another species of starfish closely allied to the Pickering species. This was embedded in calcareous stone, which had once in all probability been foraminiferal ooze, and the processes which filled the chambers of the Nautilus also filled the cavity left by the decay of the starfish with crystalline carbonate of lime. These specimens, studied collectively, illustrate two of the most important and common of the processes by which the mineralization of fossil remains has been effected.—The following communications were read —Notes on the geology of the Northern Etbai or Eastern Desert of Egypt, with an account of the emerald mines, by Ernest A Floyer. The principal feature in the district is a long ridge of igneous upthrust running north north west and south-south-east, in which porphyry rises into lofty peaks, whilst the lower parts are formed of granites and sedimentary rocks. To the west of the watershed, sedimentary rocks occur dipping slightly to the west. The following succession of rocks in descending order is given by the author: limestone, sandstone, clay, "cataract" rock (corresponding to the *Stock-granit* of Walther), and compact hard granite. The sedimentary rocks are frequently metamorphosed, and the author states that every stage of metamorphism is shown, from sandstone to compact green granite The blue clay shows various kinds of metamorphism, and forms the pistachio-breccia containing topazes, and the mica-schist, mica-slate, and talcose blue clay of the mass of Zabbara containing emeralds The author discusses certain theoretical questions, and considers that the erosion of the valleys does not indicate the existence of a greater rainfall than the present one. He concludes by giving an account of the emerald mines The reading of this paper was followed by a discussion, in which Prof Hull, Prof Le Neve Foster, Mr Rudler, Mr J W Gregory, and Dr Blanford took part —The rise and fall of Lake Tanganyika, by Alex Carson (communicated by R Kidston) In this paper attention is called to certain recorded discrepancies concerning the discharge of Tanganyika by the Lukuja It is suggested that the rise of the lake is due to the blocking up of the river by vegetation, assisted by silting during the first rains, whilst the fall is produced by the destruction of the barrier formed in this manner.

Zoological Society, May 3 —Prof W H Flower, F R S, President, in the chair —The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of April, 1892, and called attention to a finely-marked Owl (*Pseudoscops grammicus*) from Jamaica, presented by the Jamaica Institute, being the first example of this Owl that has reached the Society —Mr Sclater exhibited and made remarks on a fine specimen of the egg of *Æpyornis*, the extinct giant bird of Madagascar, obtained from Southern Madagascar, and brought to this country by Mr Pickersgill, H B M Vice-Consul at Antananarivo —Mr Oldfield Thomas read a paper on the probable identity of certain specimens formerly in the Lidth de Jeude collection, and now in the British Museum, with those figured by Albert Seba in his "Thesaurus" of 1734.—Mr F E Beddard read some notes on various species of aquatic Oligochætous Worms that he had lately had an opportunity of examining Amongst these was a new form allied to *Acanthodrilus* from the saline waters of the Pilcomayo, discovered by Mr Graham Kerr during the Pilcomayo expedition —Dr Hans Gadow read a paper on the systematic position of *Notoryctes typhlops*, the newly-discovered Mammal of Central Australia, and came to the conclusion that this anomalous form should stand as a distinct family of Polyprotodont Marsupials, allied to the Dasyuridæ and the Peramelidæ —A communication was read from Captain H G C Swayne, R E, containing field-notes on the Antelopes of Northern Somali-land —Mr W Schaus read the second portion of his descriptions of new species of Lepidoptera Heterocera from Brazil, Mexico, and Peru —Mr W L Sclater read some notes on certain specimens of Frogs in the Indian Museum, Calcutta, and gave descriptions of several new species based upon some of these specimens

Entomological Society, May 11 — Frederick DuCane Godman, F R S, President, in the chair —The President announced the death, on May 4, of Dr C A Dohrn, of Stettin, one of the ten Honorary Fellows of the Society Mr Stainton, F R S, expressed regret at the death of Dr Dohrn, whom he had known for a great number of years, and commented upon his work and personal qualities.—Dr D. Sharp, F R S, exhibited drawings of the eggs of a species of Hemiptera, in illustration of a paper read by him before the Society, and also a specimen of a mosquito from the Amazon district, with the body, legs, and palpi furnished with scales as in Micro Lepidoptera —The Rev Canon Fowler, on behalf of Mrs Venables, of Lincoln, exhibited cocoons of a species of *Bombyx* from Chota Nagpur, India, also the larvæ-cases of a species of Psychidæ, *Cholia crameri*, from Poona, India, and a curious case, apparently of another species of Psychidæ, from the island of Likoma, Lake Nyassa.—Mr F W Frohawk, on behalf of the Hon Walter Rothschild, exhibited a specimen of *Pseudacræa miraculosa* mimicking *Danais chrysippus*, also a specimen of the mimic of the latter —*Diadema misippus*—and read notes on the subject —Mr C G. Barrett exhibited, and commented on, a long series of specimens of *Melitæa aurinia* (*artemis*) from Hampshire, Pembrokeshire, Cumberland, and other parts of the United Kingdom; also a long and varied series of *Coremia fluctuata* —Mr H. Goss exhibited, for Mr W. Borrer, Jun., of Hurstpierpoint, a photograph of a portion of a nest of *Vespa vulgaris* which had been built with the object of concealing the entrance thereto and protecting the whole nest from observation. He also read notes on the subject, which had been communicated to him by Mr. Borrer.

—The Hon Walter Rothschild communicated a paper entitled "Notes on a collection of Lepidoptera made by Mr William Doherty in Southern Celebes during August and September, 1891" He also sent for examination the types of the new species described therein —Dr Sharp read a paper entitled "On the eggs of an Hemipterous Insect of the family *Reduviidæ* Mr McLachlan, F R S, Mr. Poulton, F R S, and Mr Hampson made some remarks on the subject

Mathematical Society, May 12 —Prof Greenhill, F R S, President, in the chair —The following communications were made —A Newtonian fragment on centripetal forces, by Mr W W Rouse Ball The demonstrations given by Newton in his "Principia" are geometrical, though there is little doubt that in establishing the truth of some of his results he used fluxions (cf the "Commercium Epistolium," Rigaud's "Essay on the first publication of the 'Principia,'" and Brewster's "Life of Newton") To his contemporaries the language and methods of geometry were familiar, while to most of them the calculus was unknown, hence it was natural and reasonable that the proofs should be presented in a geometrical form It is probable that the fluxional analysis by which a result was obtained was generally thrown aside as soon as a synthetic geometrical proof had been found, apparently the only proposition in the book of which Newton's fluxional demonstration has been published is his determination of the form of the solid of least resistance, of which the result alone was given in Book ii, Scholium to Prop 35 (first edition). Among the numerous sheets of rough work and calculations which are preserved in the Portsmouth collection is a fragment on the law of centripetal force under which any orbit, and particularly a parabola of any order, can be described The theorem to which the analysis leads is so inconvenient of application as to be practically useless, and probably for that reason was not inserted in the "Principia" Such interest as it possesses lies rather in its illustrating the way in which Newton arrived at the law given (in the paper) for the description of any parabola under a central force The date of the fragment is put "about the year 1694," when we know that Newton was engaged in revising the first edition of the "Principia"—On an operator that produces all the covariants and invariants of any system of quantics, by Dr W E Story —Applications of a theory of permutations in circular procession to the theory of numbers, by Major MacMahon, F R S

OXFORD

University Junior Scientific Club, March 18 —Mr J A Gardner, Magdalen College, President, in the chair —A paper was read by Mr J E Marsh, Balliol College, on variations in the rotatory power of turpentine oil This was chiefly given up to the consideration of the probable explanation of the phenomenon The experiments were described at length in the Journal of the Chemical Society some months back —Mr T H Butler, of Corpus Christi College, read a paper on poisons, chiefly in relation to their physiological action —Mr H Balfour, of Trinity College, exhibited a whaling cross-bow from Greenland —Mr F Britten, of Christ Church, exhibited a specimen of incrustation

March 30 —Mr J A Gardner, President, in the chair — Mr E B Poulton, F R S, read a paper on a further investigation of the degenerate scales of Lepidoptera with transparent wings, which was illustrated by the magic lantern —Mr O V Darbishire, Balliol College, read a note on karyokinesis, illustrated by microscopical preparations.—A note was read by Mr. R. S Hughes, Jesus College, on the action of dried hydrogen sulphide on magnesia.

DUBLIN

Royal Dublin Society, April 20 —Sir Robert Ball, F R S, in the chair —The following communications were made — On a new mercury glycerine barometer, by Dr J. Joly This barometer has the full range of the glycerine barometer The total length of the tube is, however, only 250 cms about This result is attained by weighting the glycerine in the tube by a column of mercury 67 cms in length. By means of a float in the mercury which pulls a disk, loosely fitting the tube, against the base of the column, this is kept from breaking, and falling down through the glycerine In a uniform tube this column remains of invariable length and moves up and down with the glycerine The balance of the atmospheric pressure is equilibrated by glycerine drawn from a bath of glycerine Owing to the short length of tubing traversed by the viscous liquid, the instrument is probably more prompt than the full length glycerine barometer On the other hand, there appears to be a very slow ascent of the glycerine past the mercury, which will probably necessitate the resetting of the instrument at intervals —Mr J R Wigham read a paper explanatory of the new "giant" lighthouse lens, the largest ever made, which he exhibited to the meeting It was constructed for him by Messrs Barbier and Co, of Paris Its focal distance is 2 metres, and its axial intensity equal to 800,000 candles The beam which this lens, in triform, in conjunction with Mr Wigham's new "intensity" burner, is capable of transmitting to the mariner, has more than five times the power of that of Tory Island, the largest lighthouse light in the world, and is much more efficacious in penetrating fog than the most powerful electric light —Dr G Johnstone Stoney, F R S, read a paper on the cause of the absence of hydrogen from the earth's atmosphere, and of water and air from the moon In this communication reference is made to the conditions that determine the height of an atmosphere upon any celestial body These had been announced by the author in a paper "On the Physical Constitution of the Sun and Stars," printed in the Proceedings of the Royal Society for 1868, and in the present paper it is pointed out that the same method of investigation shows that under certain circumstances some of the constituents of an atmosphere may, molecule by molecule, wander off into space This event occurs with more readiness—(1) the lower the mass of the molecules of the gas, (2) the feebler the attraction downwards at the boundary of the atmosphere, (3) the higher the temperature at the boundary of the atmosphere By investigating the conditions that prevail on the earth and moon, it is shown that free hydrogen could not remain a constituent of the earth's atmosphere, and that no free oxygen, nitrogen, or the vapour of water, could remain on the moon. Hence, even if there were no oxygen present, the earth's atmosphere could not retain free hydrogen, and on the moon there is now neither atmosphere, such as we know it, nor water, nor ice It follows from the investigation that space must be peopled with vast numbers of wandering gaseous molecules, especially of the lighter gases, and that these tend ultimately to settle down upon such of the more massive bodies of the universe as are sufficiently dense to exercise a powerful attraction at their surface Finally, the investigation indicates conditions which must be fulfilled by any "nebular hypothesis" in order that it may be admissible —A list of Irish Rotifers, with descriptions of twenty five new species, by Miss Glascott, was communicated by Prof A C Haddon

PARIS

Academy of Sciences, May 9 —M d'Abbadie in the chair —Photographs of solar prominences taken by M Deslandres at Paris Observatory, by M Mouchez This is a brief statement of the work that is being done at Paris on the dimensions and velocities of solar prominences By the methods employed the radial velocity can be determined within about a kilometre per second Some of the photographs obtained were presented by M l'Amiral Mouchez to the Academy It is proposed to make a continuous record of the movements of the solar atmosphere as soon as the necessary funds are obtained —On the propagation of Hertz oscillations, by M H Poincaré —On residual life and the products of the action of separate tissues of living beings, by MM A Gautier and L Landi After a healthy animal has been killed, a considerable interval elapses before the death of the tissues This action after the death of the body as a whole is termed "*la vie residuelle*" by the authors They have investigated the changes that go on by analyzing flesh freshly killed and otherwise, and comparing the results.—On entire functions of the form $e^{G(x)}$, by M Hadamard —A theorem on harmonic functions, by M G D d'Arone —On the determination of the moment of the torsion couple of a unifilar suspension, by M C Limb —Action of potassium cyanide on ammoniacal copper chloride, by M E Fleurent By heating together in sealed tubes potassium cyanide, cupric chloride, and ammonium chloride, the author has succeeded in forming the compounds, (1) $2Cu_2Cy_2 . AmCy . 2NH_3 . 3H_2O$, forming long blue needles, very unstable; (2) $2CuCy_2$ Cu_2Cy_2 $2NH_3$ $3H_2O$, green rectangular plates, quite stable in the air —Sodium trimethylcarbinol:

thermal value of the replacement of H by Na in a tertiary alcohol, by M de Forcrand

$$C_4H_{10}O \text{ sol} + Na \text{ sol} = H \text{ gas} + C_4H_9ONa \text{ sol} \quad +27\ 89 \text{ cal}$$

For secondary and primary alcohols the values are respectively +29 75 and +32 00 cal —Establishment of the fundamental formulæ for the calculation of maximum moments of inertia (of molecules), by M G Hinrichs —The constitution of the hydrocarbon derived from perseite, by M L Maquenne —The chemical properties and analysis of acetyl fluoride, by M Maurice Meslans (See Notes)—The acid antimonite of pyrocatechol, by M H Causse —Action of organic acids on acetylenic hydrocarbons, by MM A Behal and A Desgrez —On the stranding of a whale mentioned in the 113th Olympiad, by M G Pouchet —On the physiological constitution of the tubercles of potatoes in relation to the development of shoots, by M A Prunet —On the old glaciers of the Cordilleras of Chili, by M A G Noguès —On the genus *Megapleuron*, by M. Léon Vaillant —On a Dicotyledon found in the Upper Cretaceous on the environs of Sainte-Menehould (Marne), by M P Fliche.

AMSTERDAM.

Royal Academy of Sciences, April 29 —Prof van de Sande Bakhuyzen in the chair —Mr Behrens dealt with the microscopic structure of alloys Crystallization is a common phenomenon in metals The least crystalline are pure Al, Cu, Ni, when cast without overheating Rapid cooling has no other effect than to make the crystals of smaller size Pure Ag does show always crystallization, if properly etched In alloys crystallization is more easy and perfect than in unalloyed metals When 1 gr of Cu, alloyed with 2 mgr Ag, is melted and slowly cooled, it will be found chequered by minute threads of an alloy rich in silver All types of structure found in crystalline rocks can be reproduced in alloys The most common is rectangular wickerwork, less common are isolated clusters of crystals (alloys with few crystals of high melting point, as in Zn + 10 per cent Pt, Cu + 10 per cent Co) Mechanical stress does not destroy the crystalline structure A fibrous or lamellar structure is set up, corresponding with planes of sliding or shearing in intercrystalline matter, and under heavy stresses partly due to flattening and stretching of crystals By annealing, alloys of Cu with Ni can be made to crystallize even as soft iron, thereby becoming even brittle —Mr Schoute treated of movement in space of *n* dimensions —Mr Bakhuis Roozeboom treated of the hydrates of iron perchloride —Mr Kapteyn made a communication on the distribution of the stars in space He has compared the spectral type of stars of different proper motion For this latter element the list given by Mr Stumpe in the *Astr Nachr*, Nos 2999–3000, was used, the spectral types were taken from Mr Pickering's "Draper Catalogue" 476 stars not fainter than 7 om were found common to the two catalogues Together with these, 115 other well-determined stars were used, taken from Bradley's catalogue, whose proper motion according to Auwers's reduction is less than 0 003s in R A, and less than 0″ 03 in Decl This material, arranged according to the amount of the proper motion, leads to the following conclusion —The region of the universe nearest to our planetary system contains nearly exclusively stars of the second type (Pickering's Cl E–L), with growing distances the number of stars of the first type (Pickering's Cl A–D), relatively to the number of those of the second type, increases gradually and approximately in inverse ratio with the proper motion (*i e* very probably in direct ratio with the distance) in such a way that equality of number is reached at a distance corresponding to a proper motion of 0″ 08 or thereabout At distances still greater, the stars of the first type begin to preponderate, and they are more than twice as numerous as those of the second type at the mean distance of those of Bradley's stars, whose proper motion is insensible From the differences between visual and photographic magnitudes Mr Kapteyn shows that analogous results will most probably be found for the southern hemisphere as soon as a catalogue of southern star spectra is published The investigation further indicates, though far less clearly, for the centre of symmetry of the system, a situation at a certain distance from the sun in the direction of 23 hours of R.A Lastly, it is demonstrated that, even for distances corresponding to proper motion of 0″ 16 to 0″ 30, no accumulation of stars towards the plane of the Milky Way is shown, that for distances considerably greater this accumulation cannot be considerable, and that the Milky Way must be attributed therefore to stars at enormous distances —Mr Franchimont communicated an experiment used by him in his College during several years to show that the presence of hydriodic acid is necessary for the formation of iodine starch

GOTTINGEN

Royal Society of Sciences —The following papers of scientific interest have appeared in the *Nachrichten* since November 11, 1891 —

November 11, 1891 —E Riecke and W Voigt, the piezo electric constants of quartz and tourmaline

November 25 —Franz Meyer, on a persistence theorem for algebraic equations Starting from the theorem that, for a cubic equation, the sum of the number of real roots for the cubic and its Hessian together is always three, the author finds for any equation of odd order a series of forms such that the sum of the real roots of the equation and these forms together is always the same —Otto Burger, preliminary communication on the *Nemertina* of the Gulf of Naples —Otto Wallach, on certain new hydrocarbons with a ring of carbon-atoms

December 23 —Alfonso Sella, contribution to our knowledge of the specific heats of minerals —Frobenius, on potential functions whose Hessian is zero —Schonflies, remark on Hilbert's theory of algebraic forms —Alberto Tonelli, remark on the solution of quadratic congruences —P Drude and W Nernst, on fluorescence-effects of stationary light waves

January 27, 1892 —Heinrich Burkhardt, the reduction of the twenty seven lines of a cubic surface to the transformation problem of the hyper-elliptic functions for $p = 2$ —David Hilbert, on the theory of algebraic invariants —Clemens Hartlaub, on the *Anthomedusæ*

March 9 —J Disse, changes in the renal epithelium during secretion —Kroeker, the dependence of the specific heat of boracite upon the temperature

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MATHEMATICS USED IN PHYSICS

Einleitung in die Theoretische Physik Von Victor von Lange Second Edition, Enlarged and Revised (Braunschweig Vieweg, 1891)

THIS work is intended to give an account of the mathematical processes employed in physical investigations It is divided into chapters dealing with the various branches of physics, mechanics, gravitation, magnetism, electricity, solids, fluids, gases, light, and heat It is very difficult in such a book to decide how far to go in mathematical processes, and Herr von Lange has exercised his discretion wisely in this matter At the other limit of how little to assume known he has certainly not erred in the direction of assuming too much, for he introduces proofs of simple differentiations and integrations when he requires them, which had much better be learnt continuously in an elementary treatise on the calculus No English student would use a book of this advanced character without some preliminary mathematical training, and it is very doubtful whether anybody picking up the calculus in this haphazard fashion could ever use it in his own investigations, and if it is no use to him for this, would it not be a great saving of time and energy for him to depend on the investigations of others without going through all their work, just as an investigator of magnetic declination need hardly expect to have time to work through the lunar and planetary theories that help in the calculations of the *Nautical Almanac* he uses? A work of this kind is of great service as a concentrated store of information for those who want to study physics, and who have sufficient mathematical ability and training to be able to use the mathematical processes involved, but it cannot successfully compete with special treatises on the elements of solid geometry, differential calculus, &c, as a means of supplying the mathematical training required in order to use these processes

Some readers may be disposed to doubt whether it is worth while introducing into a work of the scope of this book any elementary dynamics The subject, however, wastes only a few pages, and it may very well be worth while introducing it in order to avoid references and explanations that might be quite as long His discussion of the nature of mass is hardly satisfactory without a description of apparatus and methods of experimenting, but, so far as it goes, is fairly sound He does not point out with sufficient clearness where definition ends and observation comes in These are, however, really physical questions, with which a mathematical work might very well dispense. In discussing the rotation of a solid subject to forces, he bases his investigation on Airy's mathematical tracts, but he does not safeguard himself with all the provisos Airy so carefully introduces, and in consequence there are many pitfalls, carefully hidden The method is based upon supposing the body given a series of blows, and appears on the face of it to be purely kinematical It is on the other hand evident that, in general, dynamical questions, such as the centrifugal acceleration introduced when the axis of rotation is not a principal one, must come into consideration when discussing the forces that must be applied to a real body in order to make it move in a given way A student of this investigation would be puzzled to understand how it happens that a solid sphere, when rotating round an axis and given a blow, begins to rotate round a new axis, new both inside the sphere, and in space, while a gyroscope takes up a wobble It is possible by a series of blows given to a sphere to cause its axis of rotation to move round in space while preserving its position in the sphere, but a series of blows in general would not produce this result The kinematic investigation of rotation of a solid round an axis accompanied by an angular acceleration round a rectangular axis is an interesting geometrical question, but must be carefully distinguished from the dynamical question of what forces must be applied to a real solid in order to produce this motion, and these two different questions not being sufficiently clearly distinguished make the investigation unsatisfactory In connection with the motion of a solid, it is to be regretted that a short account of the theory of screws was not included

Under gravitation at one place, there is a full account of free fall, pendulums, balances, bifilar suspensions, torsion balance, &c Then he proceeds to questions depending on gravitation at different places, the figure of the earth, the constant of gravitation Here he mentions Foucault's pendulum, and notices that the elementary investigation is insufficient, without, however, giving more than the result of the complete investigation, not even explaining why the elementary investigation fails, owing to the precessional motion of the axes of the ellipse in which the bob of the pendulum necessarily moves, and which becomes comparable with the motion looked for unless the amplitude be very small and the suspending thread very long This chapter concludes with an account of the theorems connected with forces varying inversely as the square of the distance. It is doubtful whether it would not have been better to deal with this subject in the first place from the hydrodynamical point of view Such theorems as that the flow is equal across every section of a tube of flow, and its numerous consequences, such as that equal quantities of electricity exist at the ends of a tube of force, that the total normal force over any surface is equal to 4π times the quantity of electricity within, &c, are all intuitively evident in hydrodynamics, and it is well to call a student's attention to the way in which he can safely argue from the familiar to the unfamiliar

The chapter on magnetism is very complete, though the action of two magnets on one another is done in a fearfully long-winded way; and in the account of the determination of magnetic declination the spherical trigonometry required in order to calculate the azimuth of the terrestrial meridian from the astronomical observations is not given It would also appear as if the determination of variations of dip by means of an induction vertical force magnetometer were quite a different thing from determinations of the variation of vertical force by means of a balance magnetometer Magnetic induction is the usual mathematical investigation of simple cases where the permeability is assumed constant. An

edition dated 1891 might have included some of the mathematics of hysteresis

Electrostatics is treated as fully as it should be, though perhaps a single chapter on the law of the inverse square, containing most of the theorems required in magnetism and electricity, would have given a sounder view of the mathematics involved. It was hardly to be expected that a mathematician should avoid the temptation of describing Mossotti's theory of dielectrics without a warning that it can hardly be complete, and in consequence gives the electrical displacement as

$$\frac{K-1}{4\pi}$$

instead of $\frac{K}{4\pi}$ times the electrical force, thus making the displacement zero in a vacuum, and justifying this by saying that the results differ very little, while it would really overturn the whole electro-magnetic theory of light This same overturning is calmly got over when the electro-magnetic theory of light is considered further on by a reference to this place, and this very remarkable statement that $K-1$ differs but little from K There seems to be some confusion, arising from the fact that in electro-magnetic measure K is nearly 10^{21}, but such a muddle is inexcusable He further on gives the theory of penetration of electric force into conductors, without referring back to an investigation he has previously given of the concentration of alternating currents on the surface of a wire, not appearing to appreciate that they are the same He also actually explains wave propagation in dielectrics by induction from layer to layer because the inducing force is *very small* initially at a distance He has not learnt the A B C of action by means of a medium, but is still hampered by the dry bones of theories of action at a distance In consequence of this, his investigation of the magnetic action of electric currents is all bristling with the action of elements upon one another, and little or no attention given to the energy stored in the medium, or how it goes from place to place

The chapter on solids begins with some rather doubtful physical paragraphs that are out of place in a mathematical work Is it sound to call heat a force (*Kraft*) that holds the particles of bodies asunder? Is it sound to say that the difference between solids and liquids is the difficulty of separating the parts of the former, when it is known that it often takes hundreds of pounds per square inch to separate the parts of a liquid from one another, and when it is the resistance of the material to shear that he really uses as the characteristic of solids? That mistake of making the difficulty of separation and not the difficulty of shearing the characteristic of solids seems quite common: it occurs in many books The mathematical theory of elasticity is given in the usual analytical way, and applied to some of the simpler cases of bending, &c. Periodic motion is then introduced, and the more important cases of wave motion and vibrations of solids considered. In the consideration of torsion he omits to give any warning as to difficulties arising in the case of non-cylindrical prisms. The chapter concludes with an investigation of the impacts of solid spheres in a manner that brings it into connection with the kinetic theory of gases.

The chapters on liquids and gases are fairly complete There is an interesting numerical calculation of the height of a statical tide this is an example of how complete and varied are the physical questions of which the mathematics is given by Herr von Lange The elementary kinetic theory of gases is given, but without any discussion of the distribution of velocities amongst the molecules Van der Waals's modification of the simple gaseous laws is discussed, and along with it the theory of cubic equations is given in a rather skimpy form—an example of how difficult it is to teach the higher physical mathematics in a way that applies to the particular case in hand, except by teaching the part of the higher mathematics involved from a wider point of view than the particular solution requires

The chapter on light is hardly so full as such an important subject demands Diffraction is run through, but the absence of bands inside a shadow is not discussed, and the theory of definition in telescopes is separated from the same question in microscopes in a very unscientific way There is a lot of reflection theory, and a paragraph on the direction of the vibration relative to the plane of polarization, but no notice is taken of the theory of the blue sky, nor of the electro-magnetic method of determination, nor of Wiener's proof that it is the electric force which acts on silver salts, and is consequently the one probably effective in most chemical actions, and therefore in irritating the retina It is possible, however that iron salts may be acted on by the magnetic force.

The last chapter is on conduction of heat and on the mechanical theory of heat The first part is an account of the simpler parts of Fourier, as any book on conduction of heat must be, and the latter is a good account of thermodynamics It is to be regretted that he does not give some mechanical illustrations of temperature, though a discussion of the nature of temperature would have been out of place The chapter concludes with a variety of applications of thermodynamics to such questions as the relations of electromotive force, compressibility, and surface tension, to temperature, as well as the usual one, vapour pressure It is much easier to point out defects than adequately to describe excellences It must not therefore be concluded from the fact that much of this review is concerned with the former that the defects preponderate over the excellences of Herr von Lange's work On the contrary, the work is full of excellences The way in which physics and mathematics are tending to grow each purer—one in the direction of mathematical abstractions, complexes, matrices, and such like, the other in the direction of experimental methods, accuracy, phenomena, and such like—makes it daily more important for physical investigators especially to have by them a convenient *résumé* of those parts of mathematics that are most often useful to them in their investigations, and this has been ably supplied by Herr von Lange.

PHASES OF ANIMAL LIFE

Phases of Animal Life, Past and Present. By R. Lydekker, B.A. (Cantab) (London Longmans and Co, 1892.)

THE sixteen essays which make up the volume are reprints, with a few alterations, of articles originally published in *Knowledge* "They are intended," the

author tells us, "to illustrate in a popular manner a few of the various modes in which animals—especially vertebrates—are adapted to similar conditions, and also to demonstrate some of the more remarkable types of structure obtaining among the higher vertebrates."

The subject is one upon which Mr. Lydekker is well qualified to write; this is alone a decided recommendation to the book. As a rule, the writing of "popular" books and magazine articles is done by persons who have no special knowledge of the matters of which they treat, and the result of this is not at all gratifying to instructed readers. Mr. Lydekker recognizes the fact that it is impossible to write upon zoology without using plenty of technical terms. When such terms are used they are introduced without any apologies. There are some authors who have the habit of invariably interpolating an apologetic remark in brackets whenever an unusually lengthy word is used. This practice is not at all humorous; and, besides, it is insulting to the intelligence of the reader. Anyone who is likely to read an article upon zoology is perfectly well able to take care of himself when he meets with a strictly technical explanation of some fact. Mr. Lydekker is therefore, in our opinion, quite right in speaking of "Condyles," "Dinosaurs," "Iguanodons," &c., with perfect freedom. Sometimes, however, he goes out of his way to invent or borrow an English equivalent for a scientific name; thus the Ichthyosaurus is always referred to as a "fish-lizard." It seems to us that if there be any fossil creature whose name is absolutely without need of translation it is the Ichthyosaurus; we cannot remember the time when this name was unfamiliar to us; besides, to speak of these reptiles as "fish-lizards" implies that they are intermediate between fishes and lizards, which is by no means the case. It would have been in every way much more reasonable if Mr. Lydekker had spoken of the Dinosaurs as "bird-lizards."

The chapter dealing with these same Dinosaurs is perhaps the most interesting. The information which is given must be newer to the general reader. There is a figure of one of the splendid skeletons of the Iguanodon recently unearthed in Belgium, and now on view in the Brussels Museum; the reproduction of the plate illustrating M. Dollo's memoir upon these remains is not, however, very good; it is difficult to distinguish the numerous small bones which lie along the vertebral column, and which are an indication of the immense development of the tendons of the muscles used to move the powerful tail of the reptile. M. Dollo thought that the Iguanodon lived principally in marshes swimming with the aid of the tail, and only occasionally coming forth to browse upon shrubs on the dry land.

There is naturally a chapter upon the Monotremes. Quite close to the beginning of the chapter it is stated that "within the last few years" these Mammals have been discovered to be oviparous, like reptiles and birds. Mr. Lydekker's book deals mainly with extinct forms of life, and he must have forgotten that in this chapter he was dealing with historical and not with geological time. It is surely unnecessary to remind the author that the oviparity of the Monotremata is not a discovery of the last few years; the *re*-discovery by Mr. Caldwell of this remarkable fact strikingly shows how an important point of this kind may be utterly forgotten. The history of the whole question has been the subject of an interesting article in this journal by Prof. Baldwin Spencer, which appeared two or three years ago.

F. E. B.

OUR BOOK SHELF

Silk Dyeing, Printing, and Finishing. By George H. Hurst, F.C.S. (London: George Bell and Sons, 1892.)

PUBLISHED information connected with the application of colouring matters to silk is somewhat limited, and for the most part scattered throughout the various pamphlets issued by coal-tar colour manufacturers, the periodicals devoted to dyeing, &c.

The present publication is therefore very acceptable, since it brings together, in a convenient and useful form, much of this diffused information, and constitutes one of the well-known series of technological hand-books edited by Sir H. Trueman Wood, Secretary of the Society of Arts.

The author, Mr. Hurst, has here rewritten and brought up to date his articles on the subject of silk-dyeing which appeared during 1889 in the pages of the *Dyer and Calico Printer*, and has added chapters on silk printing and finishing, and on the testing of dyed silks.

The language and style of the book are clear and explicit, and it has evidently been written with distinctly practical aims, so numerous are the working details given throughout the work.

The opening chapter contains an account of the origin, structure, composition, and properties of the most important varieties of silk, followed by one on the preliminary operations of "boiling-off" and bleaching. Special chapters are devoted to the dyeing of blacks, fancy colours, and mixed fabrics. The concluding chapters deal with silk printing, the machinery used in dyeing and finishing, and the examination and assaying of raw and dyed silk.

Some 170 selected and also original recipes, together with 66 dyed patterns of yarn and cloth, appear as an appendix. Altogether the author has succeeded in compressing into a somewhat limited space of about 230 pages, a considerable amount of useful practical information.

In the body of the work, containing numerous technical details of dyeing, explanations of the principles underlying the different processes involved are here and there interspersed, so that the volume may be recommended as a handy book of reference not only for the practical dyer and his apprentice, but also for the student and teacher in technical schools where silk dyeing is taught.

Phycological Memoirs. Edited by Geo. Murray, F.R.S.E., F.L.S. Part I. (London: Dulau and Co., 1892.)

THE establishment of this new serial is an indication of the increased attention given in this country during recent years to the study of Algæ, whether marine or fresh-water. It is intended to form a medium for the publication of the results of researches on Algæ carried on in the Department of Botany at the British Museum, and for making known the treasures of the Museum; and the present number is full of promise of valuable additions to our phycological literature. The place of honour is given to a paper by Miss Margaret O. Mitchell and Miss Frances G. Whitting on *Splachnidium rugosum*, a well-known seaweed of the Southern Seas, hitherto included under the *Fucaceæ*, but which the authors regard as a new type of Algæ occupying possibly an intermediate position between the *Fucaceæ* and the *Laminariaceæ*. For reasons which certainly seem cogent, they are of opinion that the reproductive organs contained in the conceptacles are not sexual oogones and antherids homologous to those of

the Fucaceæ, but non-sexual sporanges containing zoospores similar to those of the *Laminariaceæ*. Mr. E. A. L. Batters describes an interesting new genus of perforating marine Algæ, *Conchocelis*, belonging to the order *Porphyraceæ*, which forms pink stains on empty shells, especially those of *Mya truncata* and *Solen vagina*. Miss Ethel S. Barton describes malformations produced in two seaweeds, *Ascophyllum nodosum* and *Desmarestia aculeata*, by the attacks respectively of a new species of Nematode, *Tylenchus fucicolus*, somewhat similar to that which produces the well-known "galls" of *Vaucheria*, and of an undetermined Copepod. The editor himself has two papers, one on a fossil Alga belonging to the genus *Caulerpa*, from the Oolite (Kimmeridge clay of Dorsetshire), a new species, which he names *C. Carruthersii*; and one on the genus of marine Algæ, *Dictyosphæria*, the position of which he retains among the *Valoniaceæ*, near to *Valonia* and *Anadyomene*. The present number is illustrated by eight well executed plates, most of them coloured.

A. W. B.

Live Stock. By Prof. Wrightson. (London: Cassell, 1892.)

THIS is the third of Cassell's series of agricultural textbooks, and though hardly equal to other writings of Prof. Wrightson, will be found useful as a reader in elementary classes.

The illustrations are well done, and the text is pretty clear, except perhaps on pp. 52–53, in a paragraph upon the "effect of food on milk." Here it is said that

"The quantity of milk is therefore in some degree dependent on liberal feeding. The quality of the milk is much less easily controlled, and it is doubtful if any special feeding will materially alter the percentage of butter-fats or cream in milk."

Then, at the end of the paragraph we have—

"Watery foods, such as silage, grass, grains, and distillery wash, increase the quantity of milk, but lower the quality, and in town dairies, where a large amount of milk is the principal object, they are much employed."

This paragraph is contradictory and confusing, for Prof. Wrightson himself admits that the quality of milk may be lowered by using watery foods, and we are decidedly of opinion that it may be increased by means of rich, oily foods.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Lord Kelvin's Test Case on the Maxwell-Boltzmann Law.

IN his recent communication to the Royal Society, of a case disproving the Boltzmann law, Lord Kelvin seems to have overlooked an important consideration.

It is well known that in an atmosphere near the earth, under conductive (not convective) equilibrium of temperature, the mean kinetic energy (*i.e.*, the temperature) would be uniform notwithstanding the attraction of the earth, which causes each molecule to move more rapidly at the lower end of its path than at the upper end. This is due to the effect of gravity in sifting out the less rapidly moving particles, preventing them from reaching the upper layers, so that, of the particles in any one layer which reach a higher layer, the great proportion are those which move rapidly in the lower layer. Thus there will be fewer particles in the upper layer, but the mean kinetic energy of a particle will be the same in both.

Applying these considerations to Lord Kelvin's example, it appears that the C particle, when going rapidly, will penetrate a considerable distance into the region of the repulsive force, while, when going slowly, it will only penetrate a short distance. Thus the *duration* of a slow flight might be much shorter than that of a quick one (with a force varying directly as the distance, the durations would be equal). It is quite different with the A particle, which moves uniformly to the end of the tube and back again. The duration of a slow flight will be long and of a quick flight short, being always inversely proportional to the velocity. Again, it appears evident that the chances for C having a great or small initial velocity at B are exactly the same as those for A. Hence, if we compare the velocities of A and C at an instant arbitrarily chosen, the probability of our happening on a time when A is moving slowly may be less than that of our happening on a time when C is moving slowly, and we cannot conclude that the mean kinetic energy of A is greater than that of C; indeed, a comparison of this case with that of the atmosphere, would lead us to expect that the mean kinetic energies of A and C would be equal.

There are cases in which the Boltzmann-Maxwell distribution does not hold. For instance, the case of a large particle confined at the end of a tube, with numerous small particles bombarding it. The mean kinetic energy of the large particle will depend on the range of its motion in the tube. This example would suggest the conclusion that in such cases as gases in contact with solids and liquids, where the molecules of the latter are so confined by molecular forces as to approximate to the condition of the large particle at the end of the tube, the conditions of temperature equilibrium can hardly be determined by the Boltzmann-Maxwell law.

40 Trinity College, Dublin. EDW. P. CULVERWELL.

Poincaré's Thermodynamics.

RENTRANT à Paris après une assez longue absence, je prends seulement connaissance de la dernière lettre de M. Tait. Je ne veux pas continuer une discussion qui ne saurait se prolonger sans dégénérer en une simple logomachie. Il résulte en effet des débats que M. Tait n'attribue pas le même sens que moi à certaines expressions, et en particulier au mot force électromotrice. Il me semble seulement, puisque c'était mon livre qu'il critiquait, que c'était à lui d'adopter mon langage, qui est d'ailleurs celui de tout le monde. Je m'arrêterai donc là, quoiqu'il arrive.

Je suis pourtant obligé d'insister sur un point, parce que je ne veux pas laisser suspecter ma bonne foi. M. Tait a écrit: "Nothing is said, in this connection, about Joule's experiments." En ne tenant pas compte de ces mots "in this connection," j'aurais dénaturé sa pensée. Ces mots ne m'avaient pas échappé. Ils signifient, si je ne me trompe: "dans ses rapports avec la détermination de la température absolue." Et c'est pourquoi, après avoir rappelé que j'avais décrit ces expériences à la page 164, j'ai ajouté que j'avais expliqué à la page 169 comment elles permettent de déterminer la température absolue.

POINCARÉ.

[I need scarcely say that I never dreamt of doubting the good faith of M. Poincaré. What I did (and still do) doubt is my having made my meaning clear to him. For I cannot see how such a discussion could degenerate into a mere war of words. So far as I understand myself, I have been dealing mainly with the validity of certain modes of establishing physical laws, *not* with the mere terms employed in describing the experimental facts on which they are founded.—P. G. T.]

Land and Freshwater Shells Peculiar to the British Isles.

THERE cannot be any reasonable doubt that the inland Mollusca of Britain present some peculiar features, but it is surprising, considering the amount of attention that has been devoted to them, how little exact knowledge we have of this subject. This want of knowledge is doubtless due to two principal causes—first, that so many conchologists consider varieties, and especially slight varieties, to be of little or no importance; and secondly, because those who study our native shells are, as a rule, but ill acquainted with foreign species and varieties. The publication of a list of supposed peculiar forms in the new edition of Dr. Wallace's "Island Life," will, it is hoped, direct attention to this matter. Although this list is more or less provisional, and will doubtless require much alteration as time goes on, I anticipate that the number of forms actually peculiar to our islands, when fully ascertained, will considerably exceed eighty-three, the number at present listed. On the other hand, no doubt, several at present in the list will have to be eventually struck out.

With regard to the peculiar species *Limnaea involuta* is doubtless an isolated derivative of the *peregra* type, to which the curious and distinct var *burnetti* of Scotland may be said to lead. *Assiminea grayana* and *Hydrobia jenkinsi* belong to the brackish-water and salt-marsh fauna, which, as has been well observed, formerly extended far beyond its present limits. To this now restricted fauna belong many of our peculiar Lepidoptera (see the list in "Island Life," pp. 347-350), and the probability is that most of these are destined shortly to become extinct, as the large copper butterfly (*Chrysophanus dispar*) already is. The fourth species, *Geomalacus maculosus*, is not strictly peculiar, being also found in Portugal; but it is a survival of the Lusitanian fauna, to be classed with numerous plants of similar range, recorded in "Island Life," p. 364. Thus, of the four species given as peculiar, one only is strictly endemic, having regard to its whole history; and the three others are apparently best regarded as survivals of faunæ which were formerly more widely spread.

Turning now to the varieties, we meet with a much larger proportion of truly endemic forms, though from our want of knowledge there is much uncertainty. *Limax marginatus* var. *maculatus* is quite common in parts of Ireland, and as it is a very striking form, it could not easily have been overlooked had it occurred on the Continent. The same applies with perhaps greater force to the beautiful var. *albolateralis* of *Arion ater*, which abounds in parts of Wales. The black variety of *Agriolimax agrestis* is frequent in some places in Yorkshire, and has never been detected on the Continent. But Simroth found it recently on mountains in the Azores, above the zone of cultivation; and in Sicily and Crete there is a melanic form (*panormitanus*), still more differentiated. The var. *griseus* of *A. agrestis*, found in England, and lately by Scharff in Ireland, is grey instead of black, but I am not aware that even this degree of melanism exists on the Continent, though, it is true, they have the dark brown var. *tristis*.

This melanism is well illustrated by other British slugs—namely, two forms of *Limax flavus*, and two of *Amalia sowerbyi*, and may be compared with the well known cases of melanism so frequent among our Lepidoptera. That there is a strong tendency to the formation of melanic races in these islands cannot, I think, be doubted; and insular melanism elsewhere has been well established as a fact.

There is another class of varieties, noticed especially in the shells, characterized by a slight and yet real difference from the continental type. This sort of variation is as yet very little worked out, but most conchologists who have received common species in numbers from abroad, must have noticed how frequently they have a different *facies* from those familiar to us in Britain, though the actual difference may be so slight that we should hesitate to separate them as varieties. Quite recently, M. Bourguignat has regarded certain British specimens of *Clausilia* and *Unio* as constituting new species. Probably hardly anyone will be found to follow him in this decision, but we know how thoroughly he and his colleagues have ransacked Europe, and especially France, for novelties, so we may rest assured that in all probability these shells represent variations not existing on the Continent.

Another class consists of forms which might be set down by some as mere monstrosities, but which, nevertheless, are local in their distribution. Such are sinistral forms, which occur rarely in many species, but in many instances frequently in certain places. This form of variation is certainly inherited, and in fact has become the character of species and genera. White shells of coloured species are apt to be scoffed at as mere albinos, but the character is undoubtedly an important one, since in *Hyalinia* we have every gradation of species from those which rarely present white varieties, to those which are normally and indeed invariably white. The colourless variety of *Cochlicopa lubrica* is frequent in one or two British localities, at least, but I never heard of its occurrence on the Continent, nor in North America, where the species is abundant.

The sources of possible error, in estimating the number of peculiar forms, are obviously many, and hence the need for prolonged and careful research in the future. *Helix virgata* var. *subdeleta* is very common in England, and I formerly supposed it endemic; but recently Mr. J. T. Carrington found it at Toulon; and *Helix dautzei*, Kobelt, a supposed species from near Algesiras and Gibraltar, is almost precisely identical with it, so far as I can judge from specimens collected by the Rev. J. W. Horsley. The variety *leucozona* of the same species also seemed characteristic of the British fauna, but a form from Toulon differs but slightly from it. *Arion hortensis* var. *fallax*, with orange slime, is given as peculiar. It may, however, be the same as var. *subfuscus*, C. Pfr., which is of a brownish colour, or var. *rufescens*, which is described as reddish or orange. These would look extremely like *fallax* when the latter was covered with slime; but there is an element of uncertainty, since Dr. Scharff has shown that in *A. subfuscus*, Drap., there are two forms, one coloured reddish only by its slime, as in *fallax*, and the other with a yellow pigment in the skin. Similarly, we remain doubtful about *Helix aspersa* var. *lutescens*, a form not rare in some English localities. I know nothing described from the Continent that would agree with it, but when it loses its epidermis it agrees with the description of a French variety, and if we suppose the type of the latter to have been a weathered specimen, the two must be identical.

T. D. A. COCKERELL

Institute of Jamaica, Kingston, Jamaica, May 3.

The Former Connection of Southern Continents.

I READ Mr. Lydekker's article on "The Discovery of Australian-like Mammals in South America," in NATURE of May 5 (p. 11), with the greatest interest. It is worth while calling attention to a physiographic fact pointing towards a former connection between South America and Southern Africa, such as appears to be required on biological grounds, as pointed out by Mr. Lydekker.

The island of South Georgia in the Antarctic Ocean lat. 54° S., long. 37° W., is composed of clay slate, the mountains, rising precipitately from the ocean, attaining to altitudes of from 2000 to 3000 metres (NATURE, March 27, 1884, p. 509). It is about 1200 miles due east of Cape Horn, and almost exactly one third of the way between that cape and the Cape of Good Hope.

The full significance of these facts seems hardly to have been realized, especially from a geological point of view. The existence of clay slate rock forming mountains of an Alpine character indicates with certainty that the island is a portion of a submerged land of great extent. In "The Origin of Mountain Ranges" I have dwelt upon and developed the law that all great mountain ranges (not volcanoes) are thrown up only in areas of great sedimentation. This is true of every mountain range that has been geologically examined, and I do not know of a single exception. Keeping this law well in view, clay-slate mountains of an Alpine character protruding directly from the ocean become invested with deep meaning. They indicate vast horizontal extensions of thick sedimentary deposits which have been subjected to great lateral pressure, and have become ridged up along lines of least resistance. That such sedimentary rocks exist far and wide, forming the ocean bottom about the island of South Georgia, I have not the least doubt. A continental stepping stone one third of the way is a somewhat important independent support towards the land connections required by biologists between two great continents.

Park Corner, May 9. T. MELLARD READE.

The Lesser Spotted Woodpecker.

THE lesser spotted woodpecker is rather a rare bird, and perhaps the following notes may be worth recording.

This house is in the fields, at the foot of the Cotswolds. Opposite my bedroom window, and only four yards distant, there is a very tall old Lombardy poplar, with a stem two feet thick. One of these birds visited this tree almost every day from the latter part of March till the 12th of this month, coming every morning between 6 and 8, and sometimes also at other hours. He fixed himself always on the same part of the stem, opposite my window, and about 25 feet from the ground; and as there are only a few small branches there, he was very plainly seen. He made a remarkable sound, very loud, like the boring of a large auger, continued for one or two seconds, and repeated again and again at short intervals. While the sound continued his whole body seemed in rapid vibration, and he was tapping the tree with extreme rapidity with the point of his beak. During the intervals his head was generally moving quickly from side to side, and his beak was often turned over to plume himself. At this time the crest on his head became often a splendid object. When the sun shone on it, it was like a flash of flame, or the glitter of polished copper foil. The bird was about six inches long, with a rather thick, fluffy looking body, the tail and back striped black and white, the stripes broadest at the tail. What he was really doing I could not determine. The

stem of the tree at that place seems to be hollow, and the bark is cracked, but no hole has been bored, and no insects are seen there I have had it examined with a long ladder The bird has now disappeared I think his nest has been in the stem of an ash-tree in a field not far off There is a hole in it about the size of a tea-cup, but out of reach I have not seen his mate, or heard any answering cry

ALBERT C MOTT

Detmore, near Cheltenham, May 21.

The God of the Ethiopians

IF we were to classify the various African tribes which speak dialects of the Bantu language-branch (the Ethiopians of Herodotus and Pomponius Mela, of Dos Santos and Merolla) according to the names by which they designate the Deity, the greater number of them would be found to fall into two great groups

Those on the eastern coast worship a god who is known under some form of the word Unkulunkulu

Tribe	Name for God	Root, meaning "great" or "old"	Derivative
ama Mpondo	Ukulukulu		inkulu = great, old
ama Xosa, ama Zulu	Unkulunkulu	Kulu	ubukulu = greatness; ukukulwa = to make great
be Chuana	(Mokholokholo)[1]	Kholo	ekholo = great
Inhambane tribe	Mulungulu		
Tribe at L Moero	Mulungu		
,, ,, L Tanganika	Mulungu		
wa Yao	Mulungu		ukulungwa = greatness.
a Nyika	Mulungu	Kulu	
wa Kamba	Mulungu		
ma Konde	Mlungu		
ma Koa, Moçambique	Moloko (Muluku)		
,, Quillimane	Mulugo		
,, Rovumah	Mlugu		
Sofala tribes	Murungu	guru	
,, ,, of Dos Santos	Molungo		
Sena tribes	Murungu	Kuru	ikuru = great
Tete tribes	Muungu	Kuru	
L Bangweolo tribe	Mungu		
wa Swahili, Zanzibar	Muungu	Ku	Kukuu = old; Kwanza = old; Kuu = morally great; Kubwa = physically great; ukuu, ukubwa greatness
,, C Delgado	Mlungu		
wa Pokomo	Mungo	Ku	
ba Yanzi (Central Africa)	Molongo		
ova Herero (South-West Africa)	Mukuru	Kuru	ou kuru = antiquity; ova kuru = ancestors; ova kurupa = old age

[1] This term means simply a very old person, and is not applied to God

It will be seen that the least corrupted form of the word Unkulunkulu, or Ukulukulu, is found in the Zulu, Xosa, and Pondo dialects of the Kaffir language

The word itself is formed from the Zulu or Xosa adjective nkulu (root kulu) "great," "grown," hence "adult," "old" Unkulunkulu therefore means primarily "the great (or old) one of the great (or old) one"

The cult paid to Unkulunkulu is a typical instance of that form of monotheism which takes its origin from ancestor worship The Kaffirs call him their progenitor Unkulunkulu ukobu wetu

The above table appears to show that, in Molungo, Mulungulu, Mlugu, or Mungu, the term thus variously modified is derived directly from the full form Unkulunkulu (perhaps originally Munkulunkulu), and thereafter corrupted by phonetic decay, instead of being in each case derived independently, like the archaic form, from the adjective signifying "great" in the language to which it belongs.

The inference, therefore, seems to be that the word Munkulunkulu was used (not necessarily in its present sense) by the common ancestors of all the Eastern Bantu tribes from the River Dana to the Great Fish River, whose descendants still retain the name in their vocabularies, and still hold it in veneration

On the western coast this name seems replaced by a word which may be most conveniently referred to under its most common form Nzambi

Tribe.	Name of God
di Wala, i Subu	Nyambi
n Halemoe	Nyama
be Nga, ba Seke	Nyambi
o Rungu	Anyambi
m Pongwe	Njambi
m Bete	Ndshambi
a Shira	Aniembie, Njambe
ba Kele	Nshambi
ba Nyombe	Ndzambi
Loango tribes	Zambi
Kabinda tribes	Nzambi Pongo
Ka Kongo tribes, Angoy tribes	Zumbi
ba Sundi	Ndzambi à pungo
ba Teke	Ndshambe, Nshami, &c
ba Yansi	Nzambi, Nyambi
ba Buma	Ndshambi
eshi Kongo	Nzambi, Nzambi ampungo
ba Lunda	Zambi
ba Bunda	Onzambi
ma Ngala	Nsambi
ba Bihe	Nzambi
ba Rotse	Nyampe
ova Herero	Ndyambi

The worship of Nzambi is inextricably commingled with that of fetishes and idols, and has doubtless been still further corrupted by contact with the Portuguese missionaries who were so active in the work of conversion in the Congo Empire in the seventeenth century But there is reason to believe that in its

primitive conception Nzambi was a celestial being or force a Nature spirit like Zeus or Indra, who ruled the sky or controlled the tempest.

Among the Isubu, *e.g.*, a cognate form signifies "heaven," and such is the case also at Cape Lopez. Winwood Read's Mpongwe raised their hands to heaven when they appealed to Njambi to save them from the hurricane, and his Ashira slave pointed in the same direction when questioned on the subject of the deity. The Manyombe regard Nyambi as heaven, and the Basundi call him the "spirit on high", and according to Kolbe the otyi Herero term Karunga Ondyambi = "heavenly bestower," "who gives and withholds rain."

The word bears little evidence of change, and is perhaps of comparatively modern origin.

It appears, therefore, that while the Eastern Bantus, who worship Unkulunkulu, indulge in *ahnen cult*, the western adherents of Nzambi are more or less Nature worshippers. In this respect they appear to approach the Negroes of the Gold, Slave, and Oil Coasts.

A third and smaller, but very distinct group apply the term Morimo or Molimo to their conception of the deity. I refer to the Barolong, the Basuto, the Batlapin, and other clans, which are generally classed together as the Bechuana tribes. "Morimo" is the singular form of a word the plural of which, barimo, balimo, bedimo, bazimo, is found almost universally among the Bantu tribes to denote the spirits of the dead.

The application of the singular form, Morimo, Molimo, in a specialized and restricted sense to the Supreme Being is confined almost entirely to the Bechuana tribes, and has perhaps been only recently used in this monotheistic sense, although John Pory mentions (in his edition of Leo Africanus, A.D. 1600) Muzimo as the one god of the Monomotápa tribes, and Gravenbroek (A.D. 1695) says of the Kaffirs of Zimboe, "Divinitatem aliquem Messimo dictam in lucis summo cultu venerantur."

One other tribe, the Lomwe, who live east of Lake Kilwa among the Namuli Hills, use the word Murimu for God, in this respect differing from their Makoa foes, who worship Mlugu, but this rather leads one to conclude that this tribe is an outlying Bechuana clan. Mr. O'Neill has pointed out the peculiarities of language and architecture which distinguish the Lomwe from their neighbours. W. HAMMOND TOOKE.

Cape Town.

Aurora Borealis

HAVE any of your readers observed the display of aurora borealis to-night (Wednesday)? I regret that insufficient knowledge of astronomical technicalities does not permit me to describe more exactly the size and position of the display. It appeared between 11 and 11.30 p.m., as white streaks or bands of light, varying in width and intensity, now shooting up a considerable distance, now dying away. It was especially brilliant just to the right of the constellation of Cassiopeia, and this was its furthest eastward limit, it extended more or less across the whole northern sky, and at times was bright enough to dim the stars it covered. The rays appeared to shoot up high into the sky above Cassiopeia. It was a very beautiful phenomenon, and was possibly more distinct in more northern latitudes. WARINGTON STOCK.

S. Paul's Vicarage, Derby, May 18.

THE NEW ELEMENT, MASRIUM

FURTHER details concerning the new element, whose probable existence was announced in a paper communicated to the Chemical Society at their meeting on April 21, are contributed to the number of the *Chemiker Zeitung* dated May 11. The mineral containing the new substance was discovered in 1890 by Johnson Pacha in the bed of an old river in Upper Egypt long since dried up, but of the former existence of which there are records dating back some 6000 years. Indeed, the name by which it is known in the neighbourhood is "Bahr-bela-Mā," or "river without water." Here and there in the track of the old watercourse are small lakes whose water is of considerable repute for its medicinal value. Specimens of the mineral were sent by Johnson Pacha to the Khedivial Laboratory at Cairo, where it was examined by Messrs. H. Droop Richmond and Hussein Off, the authors of the paper laid before the Chemical Society. The mineral is found to be a fibrous variety of a mixed aluminium and iron alum containing ferrous, manganous, and cobaltous oxides. In addition, however, to these ordinary constituents, a small quantity of the oxide of another element would appear to be present, having properties entirely different from those of any yet known. This element the discoverers have termed *masrium*, from the Arabic name for Egypt, and the mineral has accordingly received the name of *masrite*. The symbol adopted for masrium is Ms.

The composition of masrite may be expressed by the formula $(Al,Fe)_2O_3$ (Ms, Mn, Co, Fe)O $4SO_3$, $20H_2O$. The amount of masrium present is very small, averaging only about 0.2 per cent., but by working upon fifteen kilograms of the mineral a considerable quantity of the element in the form of various salts has been accumulated. A typical analysis of masrite published in the Proceedings of the Chemical Society is as follows:—

Water	40.35
Insoluble matter	2.61
Alumina	10.62
Ferric oxide	1.63
Masrium oxide	0.20
Manganous oxide	2.56
Cobaltous oxide	1.02
Ferrous oxide	4.23
Sulphuric oxide	36.78
	100.00

Suspicions that the mineral contained some hitherto unknown constituent were first aroused by the fact that when it was dissolved in water, and sulphuretted hydrogen was passed slowly through the solution in presence of acetic acid, instead of the expected black precipitate of sulphide of cobalt a white insoluble substance was first precipitated. This white precipitate continued to form until the new substance in the solution was all used up, when black sulphide of cobalt began to be thrown down. By decantation before the formation of the latter, and subsequent washing with dilute hydrochloric acid, the white substance was isolated in a state of tolerable purity. It was found to dissolve in boiling nitrohydrochloric acid. The solution in *aqua regia* was evaporated in order to remove the excess of acid, and ammonium hydrate added, when a voluminous white precipitate of the hydrate of the new metal was thrown down. The hydrate was washed by decantation, and subsequently dissolved in the minimum excess of sulphuric acid. The solution of the sulphate of the new metal was next evaporated to syrupy consistency, water was added until complete solution was just effected, and the solution mixed with an equal bulk of alcohol. The effect of this addition of alcohol was to cause immediate precipitation of crystals of the sulphate of the new metal, a further crop of which was also obtained upon evaporation. By repeated recrystallization most of the small quantity of iron present was removed. In order to eliminate the last traces of admixed ferrous sulphate, the crystals were redissolved in water, and excess of sodium hydrate added. As the hydrate of the new metal is soluble in excess of soda, the hydrated oxide of iron was readily removed by filtration. Upon the addition of ammonium chloride the white hydrate was precipitated in a gelatinous form; the hydrate was redissolved in hydrochloric acid, and again precipitated and washed. The almost perfectly pure hydrate so obtained was then finally converted to chloride by solution in hydrochloric acid.

In order to obtain data as to the atomic weight of masrium the following determinations were made. A known quantity of the chloride solution was precipitated by ammonia, and the hydrate thus obtained was ignited, and the remaining oxide weighed. A second portion was precipitated by a solution of microcosmic salt in presence of ammonia, and the phosphate obtained ignited

and weighed. The chlorine contained in a third portion was determined by means of silver nitrate in the ordinary manner. From the numbers so obtained the equivalent of masrium was calculated. A pure preparation of masrium oxalate was also obtained by precipitating the neutral solution of the chloride with ammonium oxalate, masrium oxalate resembling the oxalate of calcium in being insoluble under such conditions. The precipitated oxalate was washed, dried, and ignited in a combustion tube whose forward end was filled with copper oxide, when the salt was decomposed with elimination of its water of crystallization, which was absorbed and weighed in the usual manner. The residual oxide was also weighed, and the oxalic acid, in another quantity of the salt, was determined by means of a standard solution of potassium permanganate. The crystals of the oxalate were thus found to contain 52.70 per cent. of masrium oxide, 15.85 per cent. of oxalic anhydride, and 31.27 per cent. of water.

From the whole of the analytical data yet obtained, assuming, as the reactions of the salts would indicate, that masrium is a divalent element, the atomic weight would appear to be 228. An element of atomic weight about 225 is, indeed, required to occupy a vacant place in the periodic system in the beryllium-calcium group, and masrium appears likely to be the element in question.

Masrium has only yet been observed to combine with oxygen in one proportion, to form the oxide MsO. Masrium oxide is a white substance much resembling the oxides of the lime group. The chloride, $MsCl_2$, is obtained upon evaporation of a solution of the oxide or hydrate in hydrochloric acid. The nitrate, $Ms(NO_3)_2$, crystallizes from 50 per cent. alcohol, and the crystals contain water, the amount of which has not been determined. The sulphate, $MsSO_4 . 8H_2O$, is a white salt which crystallizes badly from water, but which separates in well developed crystals from 50 per cent. alcohol. It combines with sulphate of alumina to form an alum, also with potassium sulphate to form a double sulphate. The oxalate above referred to, $MsC_2O_4 . 8H_2O$, is a white salt, soluble in acetic acid, and also in excess of masrium chloride.

The most important reactions of the salts of masrium, as far as they have yet been studied, are the following: Sulphuretted hydrogen produces no precipitate in presence of hydrochloric acid, but yields a white precipitate in presence of acetic acid. Ammonia precipitates the white hydrate of masrium from solutions of the salts; the hydrate is insoluble in excess of ammonia. Ammonium sulphide and carbonate produce white gelatinous precipitates, likewise insoluble in excess of the reagents. Ammonium phosphate yields a white precipitate of phosphate. Caustic alkalies precipitate the hydrate, but the precipitate is readily soluble in excess of the alkaline hydrate. Potassium ferrocyanide produces a white precipitate which is soluble in excess of masrium chloride, but not in dilute hydrochloric acid. Potassium ferricyanide yields no precipitate. Potassium chromate precipitates yellow chromate of masrium, which is soluble in a further quantity of masrium chloride. Potassium tartrate yields a white tartrate precipitate which dissolves in excess of the reagent, but the solution is not reprecipitated by the addition of ammonia.

Metallic masrium has not yet been obtained. Attempts to isolate it by heating the chloride with sodium under a layer of common salt, and by the electrolysis of a solution of the cyanide proved unsuccessful. The chloride, moreover, is not sufficiently volatile to permit of its vapour density being determined.

From the above interesting reactions, however, it will be evident that masrium possesses a strong individuality, although on the whole behaving somewhat like the metals of the alkaline earths and those of the zinc group. Further work will doubtless afford more definite information concerning its nature and properties.

A. E. TUTTON.

ON A NEW METHOD OF VIEWING NEWTON'S RINGS

If we observe the reflection of a rectangular strip of any opaque substance (A) about ¼ inch wide in a piece of plate glass *of about the same thickness*, it appears thus:—

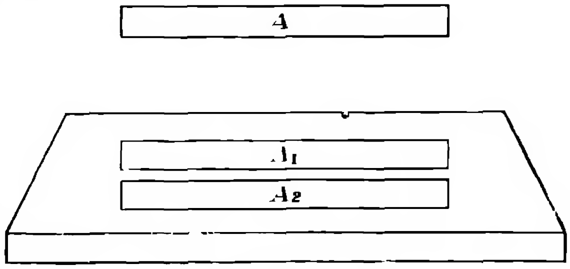


Fig. 1.

A_1 A_2 being the reflections caused by the upper and lower surfaces of the glass respectively.

If a second glass plate, of the same thickness, be added beneath the first, there is a third reflection (A_3) added below A_2 thus, drawing only the reflections for simplicity's sake:—

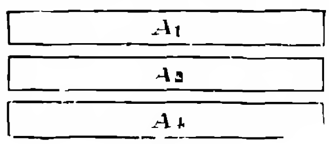


Fig. 2.

Now if the upper slab of glass be *gradually* raised above the lower, the opaque strip remaining in position, the reflection A_2 (Fig. 2), which generally exhibits traces of colour when plate glass is used, splits up into two (A_2 A_3), thus:—

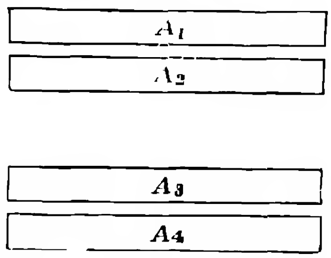


Fig. 3.

Thus it is proved that A_2 (Fig. 2) is the resultant of the reflections of the strip by the lower surface of the upper plate, and the upper surface of the lower plate (A_2 and A_3, Fig. 3, respectively).

In saying that A_1 is the reflection of A caused by the top surface, we mean that light which would fall on that surface and be reflected to the eye is prevented from so doing by the presence of A; and so with respect to the other reflections: thus, if any one of the reflections is not perfectly dark, we can assert that the light seen in it is at any rate not due to reflection (for the first time) at the corresponding surface; *e.g.* A_4 (Fig. 2) appears anything but dark, and we may assert that the light seen in it is not reflected from the bottom surface of the lower plate (at all events for the first time).

Now by means of two similar rectangular strips A and B, placed with their long sides parallel to the surface of the glass, B being further from the observer and from the top plate, it is very easy to arrange them so that B_4—the reflection of B in the lower surface of the lower plate—

apparently coincides with A_1—the reflection of A in the upper surface of the upper plate, and thus, neglecting for the time light which has undergone more than one reflection, we see this A_1B_4 combination of reflections illuminated by light which has undergone reflection at the two inner surfaces only.

It is clear that if we substitute for the two glass plates the apparatus generally sold for exhibiting Newton's rings, we can by this simple method view the rings by the light proceeding from the two inner surfaces only. Thus viewed, the central dark spot appears of a rich velvety black, and the coloured rings very brilliant. The experiment can easily be projected, and the difference in the appearance of the rings on the screen, with and without the opaque screens, is very striking.

The effect of the two screens can be still more simply given by cutting a slit in a piece of blackened cardboard of about the same width as the thickness of one of the glass plates in the rings apparatus; it is almost needless to state that the cardboard in the region of the upper and lower edges of the slit performs the functions of the screens B and A respectively. In this way the backing of the lower glass plate (to get rid of the reflection from its lower surface) may be avoided, an obvious advantage when it is desirable to show the interference in the transmitted as well as in the reflected light.

But the interest of the method does not only lie in its simplicity. Besides affording an easy proof that the rings are caused by light reflected at the inner surfaces of the plates, it also gives a method of seeing and possibly differentiating the interference curves produced by light which has undergone only one reflection, *i.e.* the rings commonly known as Newton's, from the curves produced by the interferences of waves which have undergone two reflections or more (and these last, so far as I know, can only be shown by this method); for if, using the ring apparatus and a single opaque screen say 3 inches × ½ inch, we look into the central reflection (A_2) carefully, two sets of rings, intersecting, can be seen. These cannot be due to light reflected at the points whence the rays which form the primary rings are reflected—by what has gone before.

To indicate, without attempting for the present any further analysis, how some of the other interference systems may be rendered visible:—Take a strip of blackened cardboard, say 8 inches × 2½ inches, and view its reflections in the Newton's rings apparatus. C (see Fig. 4) being the lower portion of this new screen, its

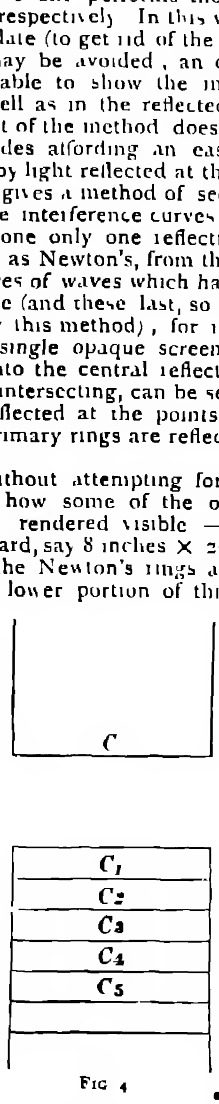


FIG. 4.

reflection will be seen to consist of a number of shaded strips, C_1, C_2, C_3, &c., and in each of these will be evident different interference curves (plainer, of course, when monochromatic light is used); in C_1 the primary rings; in C_2 two series of rings crossed; in C_3 still more complicated forms, and so on; each set fainter than the last, the light to which it is due having undergone more reflections than its predecessor. The method suggested for the experimental analysis of these interference systems can only be sketched roughly here. It is, by the use of a second screen, possibly a third, so to combine the reflections of the screens with observations of the consequent alteration in the interference curves, as to completely verify the results a mathematical analysis of the problem would predict.

I. C. PORTER.

JEAN SERVAIS STAS.

FEW, if any, among the men of science of the present day have at once done such important work and earned so little popular recognition as Jean Servais Stas. The names of Faraday, Liebig, Dumas, Darwin, have become household words beyond the laboratory and the lecture theatre, and are frequently taken in vain by the purveyors of "science for the million." But, whether among the "classes" or the "masses," if we mention Stas we are apt to be asked, Who was he? What has he done? If we mention his determination of the atomic weights, we have to follow this statement up with a popular lecture on stoichiometry, and are then told that there is not much in it.

Stas was born at Louvain, on August 21, 1813. Like many young men of scientific tastes in the earlier part of the century, he entered upon the study of medicine, and graduated as M.D. But, feeling himself strongly drawn to chemical research, he came to the conclusion that the life of a practising physician was not his true sphere. So early as 1835 he undertook, in conjunction with his friend De Koninck, an investigation of the root-bark of the apple-tree, and discovered phloridzine, an interesting crystalline body. However, at the outset he merely succeeded in obtaining this body in its pure state and in ascertaining its behaviour with reagents. He decided to go further, and to study the constitution and transformations of phloridzine. To this end he stood in need of further instruction. But the methods of organic investigation were at that time little advanced. The art of research was taught only by Liebig at Giessen, and by Dumas at Paris. Stas made choice of Dumas, and after overcoming endless difficulties, was admitted as a pupil in the laboratory of that distinguished Academician.

Here, he resumed the study of phloridzine, and soon succeeded in determining its formula, and those of its principal derivatives. He ascertained that in contact with acids, phloridzine was split into glucose and phloretin, thus belonging to the class of glucosides, bodies the prototype of which had been discovered by Liebig and Wöhler in amygdaline. Berzelius, a man by no means lavish of praise, declared that "from an investigator who has carried out such a research much may be expected."

Impressed with the ability of his pupil, Dumas requested him to undertake a series of investigations in concert with himself. The first of these researches was the examination of the action of potassa-lime on alcohols. They determined that, without exception, alcohols were transformed into corresponding acids. By their powers methylic alcohol yielded formic acid, and ethylic alcohol yielded acetic acid. Fusel oil gave a valerianic acid exactly agreeing in its properties with the natural valerianic acid—a discovery of great importance considering the paucity of synthetic organic compounds then known. In conjunction with his master, he ascertained the molecular weight of valerianic acid by a determination of its vapour density and by its conversion into tri- and tetra-chlorvalerianic acid, thus justifying their joint belief

as to the alcoholic nature of fusel-oil This conclusion was experimentally confirmed by the conversion of fusel-oil into valeraldehyde

Immediately after these experiments, Stas, aided by Dumas, entered on the most important work of his life It had been already found that on the combustion of the more highly carbonized hydrocarbons the sum of the carbon and hydrogen was decidedly greater than the weight of the substance taken for analysis Two possible explanations were suggested The excess might be due to a constant error in the method employed, but on careful and frequent repetition of the experiments no such error could be traced, or there remained the possibility that the composition either of carbon dioxide or that of water had not hitherto been accurately determined In deciding this question Dumas and Stas developed precautions which had never been equalled, and which certainly have not been since surpassed

It must be remembered that, like Darwin in another department of science, Stas was his own most acute and formidable critic He seems never to have wearied in devising possible objections to his methods and results, nor of suggesting loop-holes through which errors might possibly have crept In redetermining the atomic weight of carbon, graphite (natural and artificial) and diamonds were submitted to combustion in a current of perfectly dry oxygen After the checking and re-checking of results, the operators were forced to conclude that the true atomic weight of carbon was lower than hitherto had been universally accepted It had been determined by Berzelius and Dulong as 12 24 Dumas and Stas made it simply 12, and confirmed the result by carefully repeated analyses of many substances of known composition Hence Dumas was led to accept for the atomic weight of oxygen 16, and for that of nitrogen 14 Whilst Dumas and Boussingault executed their determinations in Paris, Stas carried out the same experiments by the same method at Brussels

These startling results recalled the attention of chemists to the hypothesis of Prout, *i e* that the atomic weights of all the elements must be multiples of that of hydrogen (H = 1), by a series of whole numbers Into this question Dumas and Stas threw themselves heart and soul The experimenters came to separate conclusions Stas entered the investigation in the full conviction that he should find the principle of Prout exactly confirmed At the conclusion of his arduous labours, he found his expectations to be "pure illusion"

On the other hand, Dumas sought to retain the hypothesis in a modified form

Neither of these eminent researchers seems to have paid sufficient attention to the fact that the atomic weights of a considerable number of the elements differ but very slightly, in excess or in deficiency, from the values which the hypothesis of Prout would require It is quite possible we are here in presence of a residual phenomenon which interferes with the exactitude of the law

In a paper recently read by Prof W Spring before the Belgian Academy of Sciences the speaker gave an abstract of the unpublished researches of Stas In a certain memoir, "On Silver," was discussed a treatise by Dumas on the quantity of gases absorbed by silver, in which Dumas had conceived doubts as to the conclusions of Stas on the hypothesis of Prout For the critical purpose Stas prepared absolutely pure silver, containing not a trace of gases nor of kindred metals At the melting-point of iridium the silver was volatilized without revealing by the spectroscope any trace of sodium, a metal which Dumas had suggested as being possibly present This pure silver gave the same atomic weight as the silver used previously by Stas Hence the atomic weight of silver must retain the value which Stas, in his earliest determinations, had assigned to it, and consequently the objections of Dumas fall to the ground

A second Stas memoir, recently brought to light, fully investigates the question whether the elements sodium, potassium, lithium, calcium, strontium, barium, and thallium can be mutually transformed either by intense heat or by electric action To carry out his experiments, undertaken in consequence of the views lately expressed, that the spectra of the above metals assume a different aspect at very high temperatures, Stas required materials chemically, or rather spectroscopically, pure This difficult task took him eleven years to accomplish As a result he found that even at the melting-point of iridium (from 2200° to 2500°) the spectral lines of the metals remained unaltered, and that consequently the transmutation of elements under the special circumstance is devoid of foundation The error may have arisen, as Stas suggests, from the use of materials not absolutely pure

In this course of experiments he verified the distinction pointed out by Bunsen between the flame spectra and the electric spark spectra of metals The flame spectrum of sodium, even at the most intense temperature, shows the well-known double yellow line But in the complete electric spark spectrum there appear six double lines, lying respectively in the orange red, the yellow, the greenish-yellow, the green, the greenish blue, and the violet In the solar spectrum all these six double lines are represented by black lines In the spectrum of the electric arc may be recognized the six double lines, but in the intense white light of the poles merely the flame spectrum with its double yellow line

The results of his investigation Stas describes in a discourse entitled "De la Nature de la Lumière Solaire," delivered in 1891 From the coincidence of the lines of the metals as recognized in the spark-spectrum with Frauenhofer's dark lines in the solar spectrum, Stas inferred that the heat and light of the chromosphere were produced by disruptive discharges

The daily life of Stas was by no means devoid of troubles Posts of honour, indeed, were showered upon him both in his own country and abroad He was Vice-President of the Belgian Sanitary Council, technical assessor of the National Bank, a perpetual member of the Council of Administrators of the University of Brussels, a member of the Statistical Bureau, President of the Belgian Academy of Sciences, Honorary Fellow of the Royal Society (which conferred on him the Davy Medal), Corresponding Member of the French Academy of Sciences, and of the majority of the more distinguished Academies and scientific Societies So far back as 1873, he was elected an honorary member of the German Chemical Society He was also a Grand Officer of the Belgian Order of Leopold and of the French Legion of Honour, as well as a knight of many orders throughout Europe

His earliest remunerative position was that of Professor of Chemistry at the Military School of Brussels, a post he successfully filled for more than a quarter of a century So paltry was the salary attached to this office that he finally petitioned Government for an increase His request was granted, but in a fashion worse than refusal He was voted an additional salary of 200 francs —a sum he naturally disdained to accept Soon after he suffered from an affection of the larynx, which put an end to the delivery of lectures He was compelled to tender his resignation, but as he had not completed the thirty years of service extorted by law he missed his pension From this plight he was rescued by the offer of a post in connection with the Mint (Commissaire des Monnaies) The respite from trouble was brief A syndicate of speculative capitalists proposed to the Government to coin an enormous sum of francs With the full

concurrence of the Minister of Finance, Stas resolutely resisted a scheme he considered dangerous to the interests of the nation With a change of Ministry the proposed measure was carried Stas forthwith resigned his post in the Mint, preferring to sacrifice emolument rather than countenance a step which he knew to be detrimental

Stas not unfrequently engaged in tasks which appeal more directly to the popular mind than the determination of atomic weights In 1850, Belgium was thrown into excitement by a poisoning case not less sensational than that of Palmer in our own country It has been said of Belgium that it is less permissible to knock down an *ouvrier* than to murder a nobleman A Count Bocarme had poisoned his brother-in-law Had the crime in question been committed by one of the *people*, it might, if not condoned, have been inquired into in a somewhat perfunctory manner But as the only man to whom suspicion pointed was an aristocrat, a searching investigation was demanded by an indignant public The chemical investigation conducted by Stas was performed in a masterly manner The unerring chemist not only detected nicotine poison, but also the exact quantity which had been administered The guilt of Count Bocarme was much more satisfactorily established than that of Palmer in the Rugeley case

With characteristic thoroughness Stas was not satisfied with the mere detection and quantitative determination of nicotine He elaborated a general method for the recognition of organic poisons in chemico-legal investigations His method of detection, revised and perfected by Julius Otto, is still in general use among toxicologists, under the name of the Stas Otto process

At the London International Exhibition of 1862, to Stas was intrusted the report on the industry of oils and fats The question was discussed whether the old method of saponification by means of alkalies or the recently invented acid saponification was to be preferred The experiments of Stas demonstrated not only the superiority of the acid process from an economical point of view, but supplied the industrial world with the working details of a method still followed by the manufacturers of stearine candles

At the initial meeting of the International Committee of Weights and Measures held at Paris in 1875, Stas appeared as the Belgian representative, and took a very active part in its labours From 1877 to 1879 he was associated partly with H Ste Claire Deville, and partly with C J Broch in the selection of the metals to be used as standards or prototypes for weights and measures The alloy selected consisted of 90 per cent of platinum, and 10 per cent of iridium The reports are rich in important observations on the properties of the platinum metals Unfortunately they have been published, so far as the writer is aware, only in the *Procès-Verbaux du Comité International des Poids et Mesures*, documents not readily accessible The results have still to find their way into the text-books and metallurgical manuals

But other labours of the illustrious Belgian chemist have still to be unearthed At the request of his Government he carried out important researches on metallic alloys for the manufacture of heavy artillery His copious reports are said to be buried in the archives of the Belgian War Department

In one quarter only did Stas encounter ill will He was a champion of the freedom of research and of the independence of the Universities Hence he came into frequent collision with the "clerical party," which in Belgium plays a *rôle* similar to that of the ethicists and self-constituted "anti-" Societies in Britain

On January 1, 1891, at the King's New Year reception he courageously reminded the Ministry of the respect which a Government owes to science. We regret we have not met with the text of this discourse, which would be worth reproduction in England The insulting replies to the bold utterance of Stas were drowned in the loud and general approval of the country

It is pleasant to add that the personal character of Stas was in harmony with his scientific pre-eminence He was a man of whom it could be said, "Nihil tetigit quod non ornavit" It was one of his great distinctions that, unlike many illustrious men of science, he was not followed to the grave by the ghosts of dead theories

NOTES

MEN of science were glad to see that the list of those on whom birthday honours were conferred included Dr John Evans, who has become a K C B , Mr W T Thiselton Dyer, who has been made a C I E , and Mr H H Howorth, who has been made a K C I E

THE annual visitation of the Royal Observatory at Greenwich will take place on Saturday, June 4.

THE Secretary of the British Association Committee for arranging for the occupation of a table at the laboratory of the Marine Biological Association, at Plymouth, requests us to announce that applications for the use of the table during the present summer should be addressed to him (Mr S F Harmer, King's College, Cambridge) not later than Friday, June 10.

MR WALTER GARSTANG, M A , Berkeley Fellow of the Owens College, Manchester, and formerly assistant to the Director of the Marine Biological Association, has been appointed to a naturalist's post upon the staff of the Marine Biological Association at Plymouth, and will have charge of the dredging and collecting operations conducted at the station

IN the fifth Annual Report of the Liverpool Marine Biology Committee (December 1891), Prof Herdman suggested that the marine biological station might with advantage be changed from Puffin Island to some more easily accessible part of the district, where a fresh area could be investigated After a careful consideration of several sites, the Committee decided upon Port Erin, at the south end of the Isle of Man, and a suitable building for a marine laboratory, of three rooms, has now been erected, on the beach immediately below the Bellevue Hotel, from plans prepared by Prof Herdman This laboratory being ready for workers, and a number of members of the Liverpool Biological and other scientific societies, and also of the Isle of Man Natural History and Antiquarian Society, having expressed an interest in the progress of the undertaking, the Committee have resolved to inaugurate the station by a formal opening on Saturday, June 4. The Lieutenant-Governor of the Island, Mr Spencer Walpole, has consented to perform the ceremony , and His Excellency, and the Bishop of Sodor and Man, have accepted the invitation of the Committee to be present at a luncheon to be given at the Bellevue Hotel on the occasion

THE Puffin Island Biological Station has been taken over by several members of the staff of the University College of North Wales, Bangor, and will be worked henceforth in connection with that College Dr Philip White, the lecturer on zoology, has been appointed director of the station The island is in full view of, and within easy reach of, the College. The station, as formerly, will be entirely supported by voluntary contributions.

THE Marine Biological Laboratory at Wood's Holl, Massachusetts, will be open for investigators from June 1 to August 30 The demand for tables at the laboratory has been so great

that the trustees decided some time ago to enlarge the building, and a spacious new wing will be ready for use on July 1 Various courses of instruction in zoology, botany, and microscopical technique will be given, as usual, during the season Lectures on special subjects will also be delivered by members of the staff

THE annual *conversazione* of the Society of Arts will take place at the South Kensington Museum on Wednesday evening, June 29

THE German Anthropological Society will hold its general meeting this year at Ulm, beginning work on July 31 Arrangements have been made for some very pleasant excursions in the neighbourhood.

MAJOR-GENERAL NOBLE, R A, died on Tuesday, May 17, in his fifty eighth year He was well known, not only as the author of books on military subjects, but as the inventor of various scientific instruments connected with the manufacture of guns and gunpowder

THE University of Heidelberg has conferred the degree of Doctor of Natural Philosophy, *honoris causâ*, on the well-known entomologist, Baron Osten Sacken

THE beautiful illustrations contained in the *Black and White* Hand-book to the Royal Academy and New Gallery pictures are sure to be welcomed by those who have not already seen them, while to those who have visited these Galleries good reproductions of them will not be amiss The different coloured tints given to the pictures produce a pleasant variety of impression, while the fidelity to the original details, which is the chief feature of photographic processes, is here thoroughly maintained Not only the pictures, but the specimens of sculpture, are reproduced in the same way, the results being equally successful As an introduction to the volume, a brief but interesting account is given of the Royal Academy, together with illustrated biographies of the present Academicians and Associates

PART I of Mr G J Romanes's treatise, "Darwin and after Darwin," was published a day or two ago by Messrs Longmans, Green, and Co It deals in a critical manner with the distinctively Darwinian theory, or the evidences of evolution as a fact, and of natural selection (with sexual selection) as a method. It is copiously illustrated, for the most part with original woodcuts, and runs to 450 pages We gather from the preface that Part II is to treat in a similar spirit of "Post-Darwinian Theories" (heredity, utility, isolation, physiological selection, &c), and understand that it will probably be ready for publication in the autumn season

ON April 29, Mauritius was visited by the most terrible hurricane that is known to have ever devastated the island According to the official telegram from the Acting Governor to the Secretary of State for the Colonies, one-third of Port Louis was destroyed The Royal College, twenty-four churches and chapels, and many sugar-mills in the country were completely wrecked. There were over 600 deaths in Port Louis, over 300 deaths in the country and over 1000 wounded "In Port Louis district," the telegram continued, "returns incomplete, probably same amount No loss among the military Estimated reduction of crop one half Destruction to property enormous. No famine apprehended All relief measures taken. Relief committee appointed Panic allayed. Order and quiet reign, but, in presence of thousands of homeless people, pecuniary assistance urgently needed" A public subscription in aid of the sufferers was at once opened by the Lord Mayor It is to be hoped that the Observatory at Mauritius has been spared It was thence that Dr Meldrum announced that at Mauritius the hurricanes and wrecks varied with the sun spots We have again a maximum of sun-spots and unprecedented devastation

THE National Home Reading Society will hold two summer assemblies this year, one at Weston super-Mare, the other at Bowness. The former will last from June 25 to July 2, the latter from June 27 to July 2 At both meetings science will be well represented among the subjects of study At Weston-super-Mare, Prof Lloyd Morgan will lecture on "The Physical History of the Mendip Hills," Sir Robert Ball on "How came the Great Ice Age?", Dr Dallinger on "Ants a Study of Sociology and Politics among Insects," Dr C W. Kimmins on "Flowers and their Insect Visitors," Mr A. W Clayden on "Geological Structure and the Formation of Scenery." At Bowness, Mr J E Marr and Mr. G Massee will give geological and botanical lectures, but the chief work of the classes in geology and botany will be done in the course of excursions to the places of scientific interest in the Lake District Both assemblies are likely to be of great service to all who attend them

MR GEORGE FORBES arrived on May 6 at the Niagara Falls in company with the executive officers of the Cataract Construction Company He is acting as the Company's adviser in connection with the plans he submitted to them in 1890 for the transmission of electrical power from the Falls to Buffalo When the Company appointed a commission of Sir William Thomson, Mascart, Colonel Turrettini, and others to examine the plans, Mr Forbes gave them as his mature opinion the assurance that they must use alternating currents, and for motors either the ordinary alternator, as first used by Wilde, or the rotating field (Drehstrom), as then used by Tesla, which Mr Forbes had tested at Pittsburg These alternating currents to be used with transformers for lighting, and coupled to motors as described for general power, but for electric tramways and some other purposes the alternating motors were to drive continuous current dynamos These plans were not approved by the commission, and a resolution was nearly passed saying that alternating currents could not be used for the purpose There was only one dissentient voice, but in the end no resolution was passed Turrettini and Mascart are now both converted, and Mr Forbes's plans have been adopted.

MUCH interest has been excited in Philadelphia by a loan collection of objects used in worship, exhibited in the Museum of Archæology of the University of Pennsylvania Most of the leading religions of the world are represented in the collection The objects are arranged in accordance with the plan adopted at the Guimet Museum, Paris, and the managers have tried to make up for gaps by notes in the catalogue, which is a closely printed octavo of 174 pages One result of the exhibition has been that it has brought to light many objects of scientific importance, the significance and value of which were not formerly known by the possessors.

MR JOHN H COOKE has made a valuable addition to the Museum of the Malta University. The *Mediterranean Naturalist* describes the gift as a suite of the Maltese fossil Echinoidea, similar to those that have lately been presented by the same gentleman to the British Museum and to the University of Bologna

A WRITER in the May number of the *Mediterranean Naturalist*, speaking of the colours of the waters of the Medi-

terranean, says they vary considerably at different seasons of the year and in different localities. During storms and boisterous weather the sea assumes a deep green and sometimes a brownish tint, but when calm and undisturbed it is of a bright, deep blue. In the Bosphorus, and among the islands of the Archipelago, the water is of varying tints, in some places being of a liquid blue graduating into a brighter green, and in others assuming a blue so deep in its intensity as to almost approach a purple.

MR. K. SEKIYA AND MR. F. OMORI contribute to the new volume of the Transactions of the Seismological Society of Japan a most careful paper presenting a comparison of earthquake measurements made in a pit and on the surface ground. It is generally thought that the earthquake motion is considerably less in a pit than on the surface. The conclusion of these inquirers is that for small earthquakes there is no practical difference between the surface and underground observations. For the principal undulations of severe earthquakes a difference may exist, but not to any marked degree; but for small quick vibrations the difference is considerable. Though the calculation for the ripples may be only approximate, their maximum velocities and maximum accelerations are found to be very great, and, in fact, many times greater than those for the principal undulations. Thus, if these ripples are really in great part smoothed away in the pit, it is very likely that in the case of very severe earthquakes there might be less destructive action in deep pits than on the free surface.

THE weather during the past week has been less settled generally than for some time past, although for the most part it was fine and dry over the south and east of England. The distribution of atmospheric pressure was favourable to a westerly type of wind, the barometer being highest over the south of our islands, and lowest over Scotland. An anticyclone was situated over France and Spain throughout the period, and the southern portion of England came greatly under its influence. Several depressions reached the northern parts of the kingdom from the Atlantic, and caused strong winds and gales at some places. The rainfall was considerable in the north and west, amounting to one inch at Stornoway on Monday, but slight in other parts. Bright sunshine was less prevalent; the Meteorological Office report for the week ended the 21st shows that it was below the average in all districts except the Channel Islands. A thick fog occurred over the south of England and parts of the Channel on Sunday. Temperatures have been rather high recently, the maxima reaching 70° and upwards, in places, since Sunday.

THE Weather Bureau of Washington, U.S., has issued, under the title of "Meteorological Work for Agricultural Institutions," a pamphlet containing suggestions as to observations and investigations regarding the relations of climate to agriculture which may with advantage be undertaken at stations situated in agricultural districts, as distinct from the work carried on at observatories and stations established in towns. These suggestions are equally useful for observers in any country; we therefore draw attention to some of the points referred to: (1) Problems of temperature; such as the differences that occur in quiescent air, between places that are close together. These differences depend on solar and terrestrial radiation, the covering of the soil, &c. The subject of protection from frosts also deserves further study. (2) Moisture in the air; especially measurements of evaporation, both from a water surface and from different kinds of soil. The transpiration of plants should also be measured, in such a way that the evaporation from a plant can be compared with the precipitation over the surface occupied by the plant. (3) Condensation and precipitation of moisture. An accurate record of the amount of dew is much wanted; at present, no observations are regularly made. A drosometer has, however, been recently constructed by Kappeller, of Vienna; it is described in the *Meteorologische Zeitschrift* of March last, and is said to give good results. Snow presents many features of interest, such as its density, and the relation of the character of the flake to the character of the weather at the time of the fall. The density of fog, also, should be recorded on some uniform plan, such as the distance at which a slender pole can be seen. The average size and usual forms of hail-stones should also be recorded. (4) Local weather predictions, independent of the daily weather charts, should be carefully studied. The special study of thunderstorms and other local disturbances will result in enabling them to be predicted several hours in advance. Systematic observation with the rain-band spectroscope should also be made. These are but a few of the questions raised in Prof. Harrington's interesting memoir.

WE have received from the Director of the Batavia Observatory (1) rainfall observations in the East Indian Archipelago, and (2) observations made at the Magnetical and Meteorological Observatory, Batavia, both for the year 1890. The daily and monthly rainfall values are given for 193 stations, together with the mean values, calculated from five or more years for 171 stations. The summaries show that the rainfall which accompanied the eastern monsoon was copious over the whole area, and that both in the years 1889 and 1890 the amount during the months of May to September was abnormally high in the eastern parts of the archipelago. In addition to the hourly meteorological observations for 1890, results for twenty-five years, 1866–90, are published in this volume. Dr. Van der Stok considers the fact proved beyond doubt that at Batavia the moon has an appreciable influence on the number of thunderstorms. The cloud curve also shows an increase of cloudiness as the moon rises above the horizon. After the moon has set, the cloudiness does not decrease at a continuous rate, but apparently remains constant.

WE have received the January number of the *Revista do Observatorio*, which is a monthly publication of the Observatory of Rio de Janeiro. This pamphlet, which, by the way, is an index number, contains in tabulated form all the meteorological observations made during that month at the several places from which regular observations can be obtained. The tables show the daily as well as the hourly reduced readings.

THE Technological Museum of Sydney was taken over by the Department of Public Instruction on January 1, 1890. In his first annual report, just received, Mr. J. H. Maiden, the Curator, says the public have shown their appreciation of the usefulness of the Museum by presenting it with a large number of objects, many of which are of great value. The authorities of the Museum have done excellent service by supplying lecturers with specimens, diagrams, and apparatus for illustrative purposes, and by answering questions sent to them by public school teachers—chiefly in country districts—on such matters as the naming of minerals and plants. Technological museums have been, or are being, formed in all those towns in New South Wales which already possess technical colleges. Mr. Maiden says that the matter has been taken up warmly in country districts, and that the formation of local collections is felt to fill up an important gap in the arrangements for technical education in the colony. A flourishing scientific society at West Maitland offered its valuable collection of natural history specimens to the Department of Public Instruction on condition that suitable accommodation should be found for them, and facilities given to the members for access to them. The specimens having been accepted by the Minister on these terms, they form a valuable addition to the West Maitland Technological Museum, constituting a natural history "side" to it. As local scientific societies are always likely to be useful in securing

specimens for local museums, and in concentrating the scientific activity of a district to the advantage of the local technical college, and of the district in general, Messrs. Sach and Ross, the resident science masters at Goulburn and Bathurst respectively, have formed scientific societies in their respective cities These societies have already a good number of members, who meet regularly for the discussion of scientific questions, and they seem to Mr. Maiden to give promise of much usefulness

AT the meeting of the Linnean Society of New South Wales on March 30, Mr R Etheridge, Jun , read a paper on, and exhibited, a very peculiar form of "womerah" It is from an unknown locality, but its history is partially known, and a clue is furnished by three very similar weapons in the Macleay Collection from Port Darwin It is lath-like in form, slightly curved in outline, and altogether a remarkable implement, very unlike anything, to the author's knowledge, previously described

DR G T STEVENS publishes in *Science* of May 6 an interesting preliminary note on the relations of the motor muscles of the eyes to certain facial expressions He has for some years closely observed the anomalies of the muscles which govern the movements of the eyes, and has been struck by the fact that remarkable changes often follow the modification of the conditions of these muscles This led him not only to regard such facial changes with greater care, but to bring to the subject the aid of photography, by means of which alone the expressions could be accurately registered Photographic portraits giving a direct front view of more than two thousand persons have thus been made In each case a record, as full as he has been able to obtain of the state of the eye muscles has been made, and in the majority of cases careful observations have been repeated many times during some weeks or months Photographs have been taken at various stages of modification of these muscles, so that a comparative study of the face under varying conditions of the eye muscles has been rendered possible The result of the investigation has been to demonstrate that "certain well defined types of facial expression are not only associated with, but are dependent upon, certain relative tensions of the oculo motor muscles" The object of his paper is to present the general characteristics of some of the most typical forms of expression which have their origin in efforts to adjust the eyes

THE first part of a paper on the development of American armour-plate, by Mr F Lynwood Garrison, appears in the May number of the Journal of the Franklin Institute It was the author's original intention to present in the form of a report the results of the recent armour plate trials at Indian Head As, however, these trials have been described in an excellent report by the Chief of the Bureau of Ordance of the U S Navy, Mr Garrison has preferred to give a sketch of the development of armour-plate, combining with this the more important details of the official report He writes from the standpoint of the metallurgist rather than that of the military engineer At present great interest is centred upon the use of the complex steel alloys and the methods adopted to harden them, and it is to these subjects more particularly that he calls attention The detailed methods of producing such alloys as well as the several methods for quenching and tempering armour-plate are kept secret by steel manufacturers, but the results are made public at the trials, and "the possible deductions to be made therefrom," says Mr. Garrison, "are patent to every observing and thinking engineer." The fact that he has had exceptionally good opportunities of making such observations is a sufficient reason for the publication of his views.

SOME interesting details as to the production of mercury in Russia have been submitted by Prof Emile Muller, of Taschkent, to the Paris Geographical Society. A bed of this rare metal, discovered at Ekaterinoslav, is now worked with great energy, and 20,000 pouds (320,000 kilogrammes) of pure mercury are obtained The entire demand for the metal in Russia is supplied from this source, and a surplus of 14,000 pouds (224,000 kilogrammes) is exported During the past year mercury was discovered in the district of Daghestan, in the Caucasus, and it is expected that the discovery will lead to the growth of a profitable industry in that region

THE vine industry in Bashahr, in the Punjab, was formerly of great importance, but of late years it has declined in consequence of the old trees having been attacked by a disease Mr Coldstream, the Deputy Commissioner of Simla, proposes to revive the industry, if possible, and has secured a large number of cuttings for the State

THE *Pioneer Mail* (Allahabad) of May 5 says that locust swarms are reported from the frontier, and that stragglers have been observed again passing over Lahore It is thought that they have chosen a bad time, as the district is full of the migratory hosts of starlings which come at this season of the year to feed upon wild mulberries, and few of the stragglers are likely to "run the gauntlet" successfully

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mr M McPherson, a Crested Porcupine (*Hystrix cristatus*) from Africa, presented by Mr J Bullock, a Common Pea-fowl (*Pavo cristatus*) from India, presented by Colonel Bagot Chester, two Yellow bellied Toads (*Bombinator bombinus*), European, presented by Mr A M Ansler, two Black Bears (*Ursus americanus*) from North America, deposited, a Japanese Deer (*Cervus sika* ♂), a Bennett's Wallaby (*Halmaturus bennetti* ♀), two Himalayan Monauls (*Lophophorus impeyanus*), two Greater Black backed Gulls (*Larus marinus*), bred in the Gardens

OUR ASTRONOMICAL COLUMN

PARIS OBSERVATORY REPORT —The annual report on the state of the Paris Observatory for the year 1891, presented by Admiral Mouchez, shows that a considerable amount of work, as in former years, has been accomplished during the past year. After mentioning briefly some of the last reports that have been communicated by those who are undertaking the work of photographically charting the heavens, he gives a *résumé* of the resolutions that have been adopted during the session of 1891 In the table showing the zones allotted to the different Observatories, that given to Greenwich lies between declinations $+ 90°$ and $+ 65°$, and that to Oxford between $+ 31°$ and $+ 25°$, the number of plates for each zone being 1149 and 1180 respectively A *résumé* of the meridional observations for the year informs us that no less than 19,458 observations were made, while those of the planets amounted to 570 M Paul Henry, M Wolf, and M Deslandres, have all been busily engaged in their respective sections, their work having been previously mentioned in these columns The second volume of the catalogue and the second volume of the observed positions (6h to 12h.) have been completed and published, while Part III (12h to 18h) is still in preparation The observations for 1884 are now quite finished, and those for 1885 will be ready by the end of this year The verification of the reduction of the observations made in 1884–86 for the formation of a catalogue of twenty-four stars very near the Pole has already been commenced, and should, when completed, form a most important volume The individual works that have been published from time to time are also referred to here The meteorological observations and time service have been continued as usual.

STARS WITH REMARKABLE SPECTRA.—No. 3090 of the *Astronomische Nachrichten* contains a list of stars with remarkable spectra, continued from a former number (3023) of the same periodical, and communicated by T E Espin The num-

ber of spectra described here is no less than 121, and the star places have all been brought up to the year 1900

Comet 1892 Swift (March 6) —The ephemeris of this comet for this week is as follows —

1892	R A h m s	Decl ° ′	log Δ	log r	Br
May 27	23 43 17	+35 36 6			
28	45 36	36 2 2			
29	47 54	36 27 4	0 1727	0 1297	0 42
30	50 10	36 52 1			
31	52 24	37 16 2			
1	54 36	37 39 9			
2	56 46	38 3 2	0 1821	0 1429	0 38

*The brightness at the time of discovery is taken as unity

On the 30th the comet will lie in the prolongation of the line joining v and θ Andromedæ, being about twice the distance from θ as is σ

Light Variations of Y Cygni —In *Astronomische Nachrichten*, No 3091, Prof Dunér discusses the results of his observations, made during the interval April 1891 to April 1892, of Y Cygni, with respect to the cause of the anomalies in the light variations The number of minima observed amounted to twenty-seven, and on their reduction (together with many others), by grouping the differences between observation and calculation in a particular way, the values for the normal deviations were obtained These figures showed that the even and odd epochs deviated on the positive and negative sides respectively, and from subsequent calculation, in which $\pm z$ represented constant deviation of the even from the odd minima, the numerical value of z was found not to be constant, but a slowly-increasing quantity Mr Yendell, who has previously considered this question, explained the possibility of representing such differences by a periodical function, but Prof Dunér, assuming a systematic difference between the even and odd epochs, explains them otherwise—"that the star Y Cygni consists of two equally large and bright components, which revolve around their common centre of gravity in an elliptic orbit with a period of revolution of 2d 23h 54m 44s, the perihelion passages occurring between the even and the odd epochs" If the value of z be found to be real, and not as at present only suspected, we might suppose "a third body, dark or only slightly luminous, which should cause a perturbation in the position of the lines of apsides, such as we recognize in the planets and satellites of our solar system"

To facilitate observation, Prof Dunér gives an ephemeris for the times of minima expressed in Greenwich mean time From the latest observations these times may be probably half an hour too late

Epoch		Minimum	d	h	m
1341	1892	June	9	9	33
1361		July	9	8	40
1381		August	8	7	46
1401		September	7	6	52
1421		October	7	5	58
1441		November	6	5	5
1461		December	6	4	12

Nebulæ —The *Monthly Notices* for April contain some notes on observations of nebulæ made by Mr Burnham with the 36-inch refractor of the Lick Observatory The work was undertaken by him during the months of September and October, 1891, in order to give fuller details concerning the descriptions, places, and actual existence of several of these objects included in the general catalogue. All the places derived from the measures are referred to the epoch 1860 of the general catalogue, while the numbers used in all cases are those of Dreyer's general catalogue

During this survey, several new nebulæ were found, although no attempt was made to search for new objects. The following list includes some of these, together with some of the doubtful nebulæ —

No 707 —R.A. 1h. 44m 31s., Decl. –9° 12′·0. In the immediate vicinity of this a new nebula was found, R.A 1h 43m. 31s., Decl. –9° 13′·4.

No 874.—R A. 2h. 9m. 43s., Decl –23° 50′·5 No nebula found near this place. Probably a faint star had been seen, as many are near this position

No. 942 —R.A 2h. 21m 30s., Decl. –11° 27′ 2 Near this position are three fainter nebulæ, two of which have been observed before, but one quite new The places for these three are Neb (*a*) (new) 2h 22m 0 5s, Decl –11° 27′ 9, Neb (*b*) 2h 22m 23 5s, –11° 28′ 1, and Neb (*c*) 2h 22m 22 7s, –11° 27′ 6

No 988 —R A 2h 28m 34s, Decl 9° 57′ 9 No suggestion of any nebulosity about this star after very careful scrutiny

Barnard —R A 5h 14m 33s, Decl + 3° 20′ 7 In sweeping for this double nebula, another nebula was found in the immediate vicinity, R A 5h 14m 40s, Decl + 3° 10′ 4

No 1988 —R A 5h 29m 4s, Decl + 21° 7′ 7 Not the least trace of nebulosity here Dreyer stated that Tempel pointed out that supposed nebula was only a false image of the star New observation endorses this view

No 7447 —R A 22h 53m 6s, Decl 11 16 7 This object certainly does not exist

No 1086 —Near this nebula are two others—

Neb I 2h 40m 49s, Decl + 40° 28′ 5
Neb II 2h 41m 12s, Decl + 40° 28′ 6

ANNIVERSARY MEETING OF THE ROYAL GEOGRAPHICAL SOCIETY

The anniversary meeting of the Royal Geographical Society was held on Monday afternoon, when the Right Honourable Sir Mountstuart E Grant Duff was re-elected President The following changes have taken place amongst members of the Council —Sir Henry Rawlinson and Mr Clements R Markham have been appointed Vice-Presidents in the room of Sir Frederick Goldsmid and Sir Beauchamp Walker, both of whom remain on the Council, Sir Beauchamp Walker being appointed Foreign Secretary in place of the late Lord Arthur Russell In addition to the Councillors who have been elected Vice-Presidents, the following have retired by rotation —Sir George Bowen, Dr R N Cust, Sir Alfred Dent, the Duke of Fife, and General Maclagan In their place Lieut Colonel J C Dalton, Sir Arthur Hodgson, Mr John Murray (the publisher), Mr E G Ravenstein, Sir Rawson Rawson, and Colonel Tanner have been elected

During the meeting the Royal Medals for the Encouragement of Geographical Science and Discovery were presented, the Founder's Medal being given to Dr Alfred Russel Wallace in recognition of the high geographical value of his great works, "The Geographical Distribution of Animals," "Island Life," and "The Malay Archipelago," and his further claim for distinction as co-discoverer with Darwin of the theory of natural selection The Patron's Medal was presented to Mr Edward Whymper for the results of his journey in 1879-80, recorded in his work, "Travels among the Great Andes of the Equator," London, 1892, 2 vols, besides a volume on the aneroid barometer The Murchison Grant for 1892 went to Mr Robert Swan, surveyor and geologist, who accompanied Mr Bent in his expedition to Mashonaland, making a careful route map of the country traversed down to the East Coast at Beira, the Back Grant to the Rev James Sibree, for his many years' work on the geography and bibliography of Madagascar, the Cuthbert Peek Grant to Mr Charles W Campbell, for his important journeys in Korea, and the Gill Memorial to Mr G H Garrett, for important geographical work done during the past fifteen years in Sierra Leone Mr Mackinder and Mr Buchanan gave a short account of the Geographical Lectureships at Oxford and Cambridge The scholarships and prizes given by the Royal Geographical Society to students in training colleges for 1892 were also presented

The President delivered the annual address on the progress of geography, in the course of which, after referring to the evening meetings and to the Proceedings for the past year, he said —

"With our meetings all Fellows of the Society who live in London, and with our Proceedings all Fellows of the Society, may be taken to be more or less familiar, but our Fellows by their contributions do a great deal more for their science than to make it possible to hold meetings and to publish Proceedings, nor does it seem unadvisable to remind them, from time to time, what they are doing in other ways for science and the body politic They are aware that an annual vote of £500 is taken in the Estimates in aid of the Society's

finances In return for that it is bound to keep open for the public at large, and does keep open, a map collection of great importance During the last year some 2500 persons visited the map room, which is in charge, as you all know, of Mr Coles, a most competent officer, but if we had more room we could be much more useful We could, for example, store, in such a way as to make it quite easy to refer to them, all the 25 inch Ordnance Survey maps That at present is perfectly out of the question We should like also, if we had the space, to have a room where any Member of Parliament or person holding an official position could at once be supplied with all the information he could desire upon any of the innumerable questions where politics and administration cross the frontiers of geography

"Another of our duties is to collect and keep together a large collection of books, maps, diagrams, photographs, and other helps to earth knowledge Of the first of these we have about 40,000, valued at not less than £10,000 Of the second and third, about 50,000 maps and charts and 7000 atlases, and of the fourth about 4000 copies, together valued at about £8000 We keep, too, a stock of instruments, which we lend from time to time to travellers who satisfy us that they can use them, £680 worth of these have been lent to Government officials since 1888 A further department of our activity is map-making We have recently produced a large scale map of East Central Africa, as well as maps of Persia and Tibet, edited respectively by Mr George Curzon and General J T Walker, while we are constantly publishing in our Proceedings original maps which, but for us, would never see the light at all, or, if they did, only after an amount of delay which would greatly impair their usefulness

"The same officer who presides so well over our map collection renders very useful services to the public, by giving instruction in surveying and practical astronomy to persons who are going into countries the geography of which is little known Forty eight servants of the Government, soldiers, sailors, and others, of whom twenty one were employed on special service and boundary commissions, have recently taken advantage of this teaching We receive too as students, at the desire of the Colonial Office, all officials who come to us before going out to West Africa, and pay half their fees, while our advice and help is always at the disposal of any of the Government Offices which desire to consult us on the choice and purchase of Instruments

"Another very important function which our Fellows enable the Council to fulfil, is the granting of direct subventions to intending explorers, and you all know what large sums have been given at various times for such purposes Mr Conway, a most experienced mountaineer, and a man of large scientific knowledge, started in the beginning of this year to explore the glaciers of the Karakorum He received from us £250 towards his expenses, and a conditional promise of more

"To Mr Pratt, who read at one of the Society's meetings a very valuable paper on North Western China more than a year ago, and who is now going through the regions, first clearly revealed to science by Mr Bates in his delightful "Naturalist on the Amazons," to explore the still unknown or little known regions in the extensive valley of that great river, we have given a grant of £100, and have lent him instruments If he adds considerably to geographical knowledge, our contribution may be increased at a later period We have given a small grant in aid of a proposed inquiry into the Houssa language and people To Dr Nansen we have voted £300 The object of his expedition, it should be remembered, is not so much to reach the North Pole, as to explore the unknown Arctic region This he proposes to effect, not by following the coast line of Greenland or Franz Josef Land, which might be the best plan *if* their coast lines extend much beyond the points already known, but to reach the edge of the hitherto untravelled region by the help of the surface currents which he believes cross the Polar region from Siberia towards Greenland

"In the beginning of the year we published a circular prepared by the Orthographical Committee of the Council upon the spelling of geographical names This was done in pursuance of the policy announced in the Proceedings for 1885, p 535—a policy in which we were encouraged by observing that the charts and maps issued during the last six years by the Admiralty and War Office have conformed to our views, that the Foreign and Colonial Offices have done the same, and that the Government of the United States of America has adopted a very similar system.

"The death of Mr Bates rendered vacant the office of Assistant Secretary, and the Council felt sure that it would consult the best interests of the Society by promoting to that position our late librarian, Mr Keltie, who was made at the same time editor of the Society's publications The vacancy caused by this promotion was filled after a very careful consideration by the appointment of Dr H R Mill, who has done much already for scientific geography Our cartographical department has been strengthened by the accession of Mr Darbishire, a highly promising pupil of Mr Mackinder's at Oxford, who has also had an excellent German training

"The Council has requested three gentlemen, well known to the Society, to represent it at one or other of the Congresses to be held at Madrid, in the neighbourhood of Huelva, and at Genoa, in honour of the fourth centenary of the discovery of America by Columbus The attention of many I address was doubtless called to the Congress at Berne, where, by the way, England 'was conspicuous by its absence' in the Educational Section A strong wish was expressed there that the next Congress should meet in London, and the necessary steps have been taken to comply with that wish A committee, of which Major Darwin is the head, is now engaged in initiating arrangements for a Geographical Congress to be held in 1895

"Hardly inferior in importance to the duty of assisting well-considered exploration and supplying true explorers with an audience to applaud their discoveries—a duty laid upon the Society by all its past—is the duty laid upon it by the necessities of the present to assist in the wider diffusion of geographical instruction

"In our attempts to increase the amount and improve the quality of geographical teaching in the country we had to put up with some grievous disappointments We began as far back as 1869 by giving medals to be competed for by the principal English schools Two schools, and two only, distinguished themselves in the competitions—Dulwich College and Liverpool College' As to the fourteen others, the less said the better The Society, however, had no idea of allowing itself to be beaten by the *vis inertiae* or *laches* of individuals Mr Freshfield, one of our honorary secretaries, himself an Etonian, was possessed with a perfect passion for giving to others the advantages in respect of geographical instruction which he had not enjoyed in boyhood Mr Bates, our late excellent assistant secretary, pondered long, as was his wont, as to whether we ought to throw a substantial portion of our strength into improving education, and having come to an affirmative conclusion, took the matter up with characteristic energy The Council was of the same mind, and ere long it was determined—

"1 To send Mr Keltie to report upon geographical teaching at home and abroad

"2 To open, under the auspices of the Society, an Educational Exhibition, in which all the best appliances for the teaching of geography should be brought together

"Mr Keltie accordingly commenced his investigations, travelling very widely while he carried them into effect His Report was published, and excited much attention The Exhibition was open during December 1885 and January 1886, and was visited by several thousands of persons interested in education The collection contained in it has been lent to the Teachers' Guild, and is now exhibited in the museum of that body in Gower Street

"The movement thus inaugurated resulted in various changes in our policy We concluded a treaty with the University of Oxford in 1887, and with Cambridge in 1888, by which it was stipulated that we should go shares with each of these learned bodies in paying the salary of a lecturer to teach geography to such of their members as choose to avail themselves of his services An argument, if it deserves the name, has sometimes been advanced, to the effect that we should not teach geography at our Universities, 'because it is a graphy and not a logy'"

"Throughout Germany the question has been settled In that country, as well as in Austria and elsewhere, professors of geography are lecturing, and lecturing to excellent purpose, without interfering either with the domain of their historical colleagues on the one side or their geological colleagues on the other Whether it is taught or not taught in schools and Universities, geography must in the nature of things rule the territory in which the sciences relating to organic life, from history down to the structure of the humblest animate thing, meet the sciences which have to do with inorganic nature

Call it a 'graphy,' or a 'logy,' or a 'Kunde,' or what you please, it remains the body of knowledge which has to do with the theatre of the activity of man and all things that have life. We may stunt and injure the activity of the next generation by refusing to teach it, but eventually it must obtain the position which the greatest of living systematic botanists claimed for it in 1886. 'It must permeate,' he said, 'the whole of education to the termination of the University career, every subject taught having a geographical aspect.'

"When, in spite of foolish objections, we had sown the seeds of what we may hope, having regard to the slowness with which trees grow in our English climate, to be vigorous saplings about the end of the century and respectable denizens of the forest in the year 2000, we turned to the training schools, and concluded a convention with the Education Department, whereby we engaged to give certain scholarships and prizes to such of their students as were reported by the Inspectors of Schools charged with the conduct of the examinations to be worthy of those distinctions. Then, further, we entered into arrangements in 1888, with the directing Delegates of the Oxford University Extension Lectures, by which we agreed to give, on certain conditions, a yearly grant of £60, in aid of geographical teaching. We have resolved to set on foot regular courses of geographical lectures in London, which will commence probably next November, and be given by Mr. Mackinder and other competent geographers.

"Our very latest measures for the improvement of geographical education have been:—

"1. To agree to some modifications in the distribution of the prizes to the training colleges which the officers of the Education Department advised, and which will better promote the object which the Society has in view.

"2. To co-operate with the Manchester Geographical Society in assisting the governing body of the Victoria University to introduce geographical teaching into the curriculum by making a substantial grant for that purpose.

"3. To award a travelling scholarship of £100—our share being £50—after an examination held at Oxford. This was gained by a young man, Mr. Grundy, who was bound, under the conditions prescribed, to travel for at least three months in one of a number of districts from which he might take his choice, and communicate the results to us. He has selected Bœotia, and will, I make no doubt, furnish the Society ere long with some valuable information.

"We continue the prizes given at the Oxford and Cambridge local examinations, and to the boys of the training ships. These belong to the same period of our history as the Public School medals, but with them we have been more successful. We are in correspondence with the Scotch Education Department as to the best method of further encouraging geographical study on the other side of the Tweed, where it has long been comparatively popular.

"It seems to me quite certain that this part of our activity will fill a larger and larger space in the thoughts of all of us for a long time to come. The day will arrive when it will be of very little importance. Common sense has a way of conquering in the end, and the proposition that it is highly desirable for intelligent creatures inhabiting this planet to have a good general notion of the opportunities which it affords them is so self-evident, that one would think it did not require a very numerous and powerful Society to urge its general acceptance upon the scholastic world.

"Geography and history are relegated to a subordinate place in almost all our schools which consider themselves to belong to the first or second rank, while the utmost prominence is given, not to reading the classics, to getting thoroughly imbued with classical ideas, and to having the mind filled with whatever of good and great the ancient world has bequeathed to us, but largely to accomplishments in the way of turning out pretty pieces of verse or prose, in the ancient tongues, which bear much the same relations to serious intellectual pursuits as do to the proper works and ways of an intelligent dog the art of jumping through a hoop filled with paper, or that of balancing on his nose a piece of biscuit till he is told that it is 'paid for.' Educators who have given the best years of their lives to these accomplishments naturally abhor the idea of diminishing their importance, and when they are asked to find a reasonable place for history and geography in their schools they piteously point to their time-tables and say, 'How are we to manage it?' Manage it by the elimination of rubbish. Put composition in the ancient tongues as a piece of regular 'school business' behind the fire, and greatly diminish the amount of time given to learning by heart in the interest of Latin and Greek composition. Neither geography nor history will ever obtain their proper position in education until we can get rid of the superstition as distinguished from the religion of the classics. No reasonable man who has a competent acquaintance with the subject can tolerate the idea of the classics being neglected. They form a most important part, and must always continue to form a most important part of literature, and literature is for a large class of minds a most excellent training. For a great many minds, however, it is not an excellent training, and to a considerable proportion of those susceptible of being trained by it the ancient languages present no attractions. I maintain that for a great many minds geography and history, well and carefully taught, would be much more educative than the two studies which as late as the time at which I took my degree, not quite forty two years ago, almost absolutely monopolized attention in Oxford and Cambridge. Then, too, we must remember that while for everybody classics are mainly educative, and in a much less degree instructive, and while mathematics are instructive in a high degree only to those who are going into any of the no doubt numerous careers for which they are essential, geography and history are instructive in a very high degree to all, even to those to whom they are not educative.

"What I think we as a Society should keep chiefly in view is to try to have a clear and connected account of the leading facts which are known about the theatre of man's activity, together with an intelligent idea of the leading causes which have brought those facts about very much more widely extended through all ranks than they are now. We must keep our aims moderate in geography. There are undeniably a few persons to whom both geography and history, teach them as you will, are thoroughly abhorrent. Well, teach the very minimum of them to such people. A large number of people can be cultivated, and very highly cultivated, better through geography and history than anything else. All I ask for is, that in the education of such people these two sciences should play a very much larger part than they do now. I think that if we could see some thoroughly good hand book of physical geography and another of political and commercial geography made part of the teaching of all secondary schools, and a subject of the leaving examination which should be borrowed from Germany, if we continue to hold up as we are doing at Oxford, and elsewhere, a very high standard of professorial teaching in our subject, while we at the same time persist in the other lines of educational activity to which I have alluded, we should have done a good deal; but it is far from improbable that we may ere long see our way to giving further stimulus to sound geographical teaching in various parts of the country. The Society, however, may be assured that we will remember the maxim *Festina lente*, and not waste the resources with which its members supply us in any rash experiments. Geography is rooted in the physical sciences, and makes each of them tributary to her, while history which is not rooted in geography, and which does not learn from geography all it has to teach about the existing conditions of man's dwelling-place, is simply bad history."

The President then referred to the year's exploration. Herr Merzbacher's work in the Caucasus, and Mr. Howell's ascent of Oræfa Jokull in Iceland, were noticed as the chief mountaineering feats. In Asia military exploration had gone on steadily on the northern frontiers, and the Society was making efforts to have the results of such work made more accessible to the public. Lord Lamington's journey in the Shan States, Captain Bower's and Dr. Thorold's adventurous crossing of Tibet also opened up new ground. In Africa Mr. E. A. Floyer crossed the Egyptian Desert from Assouan to the Red Sea; and in the region of the Great Lakes Captain Lugard, Emin Pasha, Dr. Stuhlman, and the late Father Schynse have added to our knowledge. The Italians have been energetic in exploring Somali land, and the French, despite the disaster to M. Crampel, have not abandoned their efforts to reach Lake Chad from the west. Captain Gallwey and Mr. Gilbert T. Carter have made important discoveries in Lagos and Benin. Mr. Bent's well-known exploration of Zimbabwe, and Mr. Joseph Thomson's study of Lake Bangweola, which ill-health still prevents him from recording, are the most important pieces of work in South Africa.

The semi-Arctic regions of Labrador and Alaska have received much attention in America, and their topography is being more definitely ascertained.

In Australia the Elder expedition has unfortunately collapsed,

after doing much good work, but Sir William MacGregor has been very active in opening up British New Guinea

Reference was also made to the progress of the hydrographic surveys in different parts of the world

In the evening the anniversary dinner of the Society took place at the Whitehall Rooms, Hôtel Metropole, and was attended by a large gathering of Fellows, with many of the leading scientific men and members of the Diplomatic Service as guests The President occupied the chair A clever speech was delivered by Mr Whymper, in response to the toast of "The Medallists." Mr Bryce, Colonel Maurice, Prof Flower, Mr W T Thiselton Dyer, and Mr Norman Lockyer responded to the toast of "The Allied Sciences and Sister Departments"

TRANSFORMERS[1]

ALTHOUGH transformers are in constant use for changing alternating currents of electricity from high to low or from low to high potential, exact calculations concerning them have hitherto been looked upon by scientific men as impossible because of the complicated law of magnetization which must subsist in iron Calculations on the assumption of constant magnetic permeability were thought to be worthless, therefore, although these were the only ones which could be made Certain graphical methods of representing what occurred were, however, based upon the constant permeability hypothesis, and although such graphical methods could only be useful in illustrative work, they were thought to be accurate enough when great accuracy was impossible The absence of a theory was supplied by vague statements regarding the effects of hysteresis, and the cycle of magnetization being supposed to be exactly the same, however rapidly performed, and Foucault currents being ignored, it was possible for any writer to get his literature on this subject published and read and commented upon

Prof Perry has for a long time preached the doctrine that the only theory of the transformer that can be carefully worked out—namely, that in which hysteresis is ignored—ought to be worked out and compared with experimental results, and he insisted that when the known phenomena of magnetic leakage and slight saturation and Foucault currents are taken into account, the results of this theory explain all observed experimental results

In the present paper he takes up the general case of a transformer with many primary and secondary circuits with magnetic leakage, Foucault currents, choking coils and condensers in series with or in parallel to any or all the circuits He clears away much of the old difficulty by proving that, in all calculations except that of the idle current supplied to an unloaded transformer, in all practical cases, exactly the same answers are obtained, to four significant figures or more, whether we assume the most complicated of hysteresis cycles or whether we assume the very simplest, which is that of constant permeability It is, for example, interesting to observe that a formula never hitherto published as correct, often enough used by manufacturers as sufficiently correct for practical purposes, is really a very correct formula It is also shown that the mathematical difficulties introduced by condensers and magnetic leakage efface themselves completely now that the complete problem has been attacked, and that the numerical working out of the most complicated cases is a very simple matter

The one problem on transformers in which it is necessary to consider the law of magnetization of the iron—namely, the calculation of the idle current when the transformer is unloaded—is solved by the author in general terms, and he gives a simpler solution, which in his opinion agrees with all experimental results, although it assumes that there is no hysteresis in the iron.

SCIENTIFIC SERIALS

THE only important paper in the *Nuovo Giornale Botanico Italiano* for April is an elaborate one by Signor G Paoletti on the movements of the leaves of *Porlieria hygrometrica* The structure of the plant is described in detail, and especially the anatomy of the "motor nodes" of the leaves and of the leaflets He distinguishes in them two kinds of tissue, a motor system and a passive system The cause of the movements appears to reside in the protoplasm and in the osmotic properties of the cell-sap. The author is unable to find in the leaves any hygrometric properties, the supposed presence of which was the reason for the specific name of the plant The paper is illustrated by four plates.

THE greater number of the papers in the 2nd, 3rd, and 4th numbers of the *Bullettino della Società Botanica Italiana* for 1892 are chiefly of local interest to Italian botanists. Among those of a wider scope are the following —Signor L Macchiati describes an appearance presented by *Navicula elliptica*, which he considers strongly to confirm Castracane's view of the occasional reproduction of diatoms by internal germs —Signor P Pichi gives the results of experiments on the power of the vine to absorb sulphate of copper through the roots as a specific against the attacks of *Peronospora* Analysis of the ash showed the presence of copper in leaves taken from both the upper and the lower branches —Signor L. Piccioli gives some details respecting the destruction of plants by different kinds of land and freshwater snails, with the amount which is devoured of different plants This is generally greater in the spring than in the summer

IN the *Botanical Gazette* for April, Mr G E Stone describes and figures a self-registering auxanometer, which can be readily constructed, of much simpler construction than those at present in use in botanical laboratories —Mr Conway Macmillan offers suggestions as to the classification of the Metaphyta, *i e* of the higher forms of vegetable life

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 28 —"On some Phenomena connected with Cloudy Condensation" By John Aitken, F R.S, F R S E

This paper is divided into two parts In Part I are described the different influences which cause the condensation of a jet of steam when mixing with ordinary air to become more dense than it generally is, and in Part II certain colour phenomena are described which have been observed when cloudy condensation is made to take place under certain conditions

PART I

Steam Jets

It had been previously shown that when a jet of steam is electrified the condensation suddenly becomes very dense In addition to electrification, it is found that this change in the appearance of the jet may be produced by other four causes There are thus five influences capable of producing the dense form of condensation These are 1st, electricity, 2nd, a large number of dust particles in the air, 3rd, cold or low temperature of the air, 4th, high pressure of the steam, and, 5th, obstructions in front of the nozzle, and rough or irregular nozzles

1st *Electrification*

It is shown that the mere presence of an electrified body has no influence on the steam jet In order to produce the increased density the water particles in the jet must be electrified, either by direct discharge, or by an inductive discharge, effected by means either of a point or a flame

The increased density produced by electrification is due to an increase in the number of water particles in the jet, by the electrification preventing the small drops coming into contact by their mutual repulsions, in the same manner as the water drops in Lord Rayleigh's experiments with water jets, which scatter more when electrified than when not electrified The coalescence of the drops in water jets takes place only under the disturbance produced by the presence of an electrified body, while such a disturbance produces no effect on steam jets

Other experiments point to the conclusion that the increase in the density is due to an increase in the number, and not to an increase in the size, of the drops For instance, if steam is blown into a receiver full of air in which there are many nuclei, the condensation is dense, and, if there are few nuclei, the clouding is thin The same holds good for the clouding produced by expanding moist air If many dust particles be present, the clouding is dense, if few, it is thin. The action of the electricity does not seem to be positive, as it has no effect on a mixture of hot moist air and cold air It seems rather to

[1] Abstract of a paper read at the Royal Society, May 12, by Prof Perry, D Sc, F R S

prevent something which takes place in the jet under ordinary conditions The particles in a jet being in rapid movement, there are frequent collisions, and consequent coalescence of the drops, but when the particles are electrified they repel each other, and coalescence is prevented

The jet on becoming dense emits a peculiar sound, which is the same whatever be the cause of the increased density But, when electrified, along with this sound there is another, due to the discharge of the electricity, which causes the electrified jet to appear to make a louder noise The jet, instead of changing suddenly in appearance when electrified, may be made to change very gradually, either by electrifying it by means of a very sharp point, or by aiding the discharge by a flame Under these conditions, the jet emits only the sound produced when dense from any of the other causes

2nd *A Large Number of Dust Particles in the Air*

Flame has not been found to have any influence on the steam jet, but on bringing the products of combustion to the jet, it at once becomes dense, and remains dense so long as the supply is kept up, and the jet has exactly the same appearance as if electrified When in this condition electricity does no increase its density any further The increased density is here due to the large number of dust nuclei, causing a great increase in the number of water drops, and these being very small, they will have less independent movement, and therefore fewer collisions, and the reduction in number from this cause will therefore be very slight

3rd *Low Temperature of the Air*

When a steam jet condenses in air at ordinary temperatures it has but little density, but, if the open end of a metal tube cooled to 45° be held near the origin of the jet, the condensation at once becomes dense, and neither electrification nor an increased supply of nuclei makes it any denser In a room at a temperature of 46° the jet is always dense, and neither electricity nor the products of combustion have any effect on it, but when the temperature rises to 47 the jet begins to get a little less dense, and electricity now increases its density slightly At 50° the jet is much thinner, and both electricity and the products of combustion have a marked effect on it The change produced by the cold air cannot be entirely due to the lower temperature causing more vapour to be condensed, as the fall of temperature is slight, while the increase in density is great The increased density is shown to be due to a change which takes place in the films of the small drops with the fall of temperature When the temperature is above a certain point, the films have no repulsive action, and the drops coalesce on collision, whereas when cooled below a certain temperature the well-known repulsion comes into play and prevents coalescence This was proved by repeating Lord Rayleigh's experiments with water jets When the temperature of the water was over 160°, the drops had no tendency to scatter, and the presence of an electrified body had no influence on the jet It was only when the temperature fell that the scattering began, and the electrical disturbance produced coalescence The effect of the low temperature is the same as that of electrification both of them prevent the water drops coming into contact, one by electrical repulsion, and the other by the repulsive action of the water films, and the result is the same—namely, an increase, or rather a prevention of the decrease, in the number of the particles, and a consequent increase in the density of the clouding

4th *High Pressure of the Steam*

Below a temperature of 46 the jet is dense at all pressures, and as the temperature rises the density decreases, but the density may be made to return by increasing the pressure The increased density of the high-pressure steam jet is due to an increase in the number of drops produced, (1) by the jet being more cooled by the greater amount of air taken into it, (2) by a larger supply of dust nuclei, and (3) owing to the rate at which the condensation is made to take place, a larger number of dust particles are forced to become centres of condensation.

5th *Rough Nozzles and Obstruction in Front of the Nozzle*

Rough nozzles and obstruction in front of the nozzle are found to act in the same way as increase of pressure they aid pressure in producing its effects with a less velocity of steam They act by producing eddies, which mix more air with the steam, so lowering the temperature of the jet, increasing the number of dust nuclei, and quickening the rate of condensation

The seat of sensitiveness to all these influences causing the condensation in the jet to become dense is near the nozzle Both low temperature and obstructions have an effect only when they act very close to the nozzle, while electricity and increase in number of nuclei have a slight, but rapidly diminishing, influence to a distance of 3 or 4 cm from the nozzle

PART II

Colour Phenomena connected with Cloudy Condensation

The manner in which cloudy condensation changes after it is formed is pointed out, and it is also shown that the number of dust particles which become centres of condensation depends on the rate at which the condensation is made to take place, slow condensation producing few water particles and thin clouding, while quick condensation produces a large number of water particles and dense clouding It is only when the dust particles are few that all of them become active centres of condensation

Colour Phenomena in Steam Jets

Colour has been seen by Principal Forbes and others in the steam escaping from engine boilers, but these colour phenomena have as yet been but little studied For observing the colour in steam jets, the author has found it to be a great advantage to inclose the jet in a tube, and examine the effect through some length of condensing steam Steam by itself has no colour in moderate lengths, but when mixed with a certain amount of cold air, and a certain quantity of dust, very beautiful colours are produced A jet of steam is allowed to blow into the open end of a tube, and the amount of dusty air entering with it is regulated to the necessary amount When the jet is condensing under ordinary conditions, the colour of the transmitted light varies from greens to blues of various depths, according to the conditions The colour may be made very pale or extremely deep by varying the conditions If the condensation in the jet be made to change and become dense by any of the influences already mentioned, the colour changes, and generally becomes of a yellowish-brown

This yellow colour, seen through steam when the jet is electrified, has been previously observed It was thought that the colour was due to the electricity, and that the experiment explained the lurid colour of thunder-clouds There does not, however, seem to be any connection between the electrification and the colour, as the transmitted light becomes of the same lurid hue when the jet is made dense by any of the other influences

The yellow colours seen through steam are not generally so fine as the greens and blues, but when the density is due to high pressure steam the yellow is very fine

Colours in Cloudy Condensation produced by Expansion

No colours had been previously seen in the light transmitted directly through the clouded air produced by expanding saturated air in a receiver It was thought this was due to the slowness with which this process is generally made to take place in the expansion experiments On arranging an experiment to make the rate of condensation quick, beautiful colours were seen on looking through the clouded air An air pump was connected with a metal tube provided with glass ends The capacity of the tube was small compared with the capacity of the receivers usually used in these experiments When the air in the tube was suddenly expanded, the light passing through it became beautifully coloured, and the colour, and the depth of the colour, varied with the conditions With few dust particles in the air, a slight expansion made the transmitted light blue, a greater expansion changed it to green, and then to yellow, and when the expansion was still further increased the colour changed, and a second blue made its appearance, followed by a second green and yellow But, if very many particles were present, the same amount of expansion which produced the second yellow only gave a very deep blue When it is desired to produce these colour phenomena on a large scale a vacuum receiver is used This receiver is connected with the experimental tube or flask by means of a pipe fitted with a stop cock After a partial vacuum has been made in the receiver, the connection between it and the flask or tube in which the colours are to be shown is suddenly opened, when the colour producing condensation is produced These colour phenomena fade

rapidly, owing to the differentiation which takes place in the water drops

The spectroscope shows that when the light is blue there is a general darkening of the whole spectrum, but the absorption is greatest in the red end, and the red end is also much shortened When the transmitted light was yellow, the blue end was cut out, and the yellow part was much the brightest

The Cause of the Colour

In the steam jet when the condensation is dense some of the yellow colour in the transmitted light is due to some of the particles being so small that they reflect and scatter the blue rays This blue reflected light is polarized The colours, however, seem in most cases to be produced in the same manner as the colours in thin plates, only a few of the colours of the first order or spectrum are visible, whilst those of the second and third orders are very distinct.

A "Green" or "Blue" Sun

It is thought that these phenomena give the explanation of the "green" or "blue" sun seen in India and elsewhere in September, 1883, and also on other occasions The eruption of Krakatão had taken place a few days before the green sun was observed in India The volcano threw into our atmosphere a great quantity of water vapour, and a vast amount of dust, the very materials necessary for producing a green sun by small drops of water Prof C. Michie Smith's observations made in India show that there was a great amount of vapour present in our atmosphere at the time, and most observers frequently refer to a fine form of haze which covered the sky on the days the green sun was seen It is therefore in the highest degree probable that, under the conditions existing at the time, this haze was greatly composed of water.

A New Instrument for Detecting Dust polluted Air

The colour phenomena produced when air is suddenly expanded has led to the construction of a new instrument for indicating roughly the amount of dusty pollution in the air This instrument has been called a "koniscope," and it is hoped it will be found useful for studying sanitary questions The instrument consists simply of an air pump and a tube provided with glass ends The air to be tested is drawn into the tube, where it is moistened and expanded The depth of colour seen on looking through the tube indicates the amount of impurity in the air With about 80,000 particles of dust per cubic centimetre the colour is very faint, 1,500,000 gives a fine blue, while 4,000,000 gives an extremely dark blue These colours are for an instrument having a tube half a metre long By means of this instrument it is easy to trace the pollution taking place in our rooms by open flames and other causes We can trace by means of it the pure and impure currents in the room, and note the rate at which the impurity varies

May 5 —"The Potential of an Anchor Ring" By F W Dyson, Fellow of Trinity College, Cambridge Communicated by Prof J J Thomson, F R S

In this paper the author develops a method of dealing with physical questions connected with anchor rings He applies it

(1) To find the potential of a solid anchor ring at all external points The result is obtained in a very convergent series of integrals, each of which may be reduced to elliptic functions The equipotential surfaces are drawn, when the ratio of the radius of the generating circle to the mean circle of the ring is $\frac{1}{8}$, $\frac{2}{8}$, $\frac{4}{8}$, $\frac{6}{8}$, 1

(2) The density, at any point, of a ring charged with electricity is found, and the charge is calculated

(3) The velocity potential of a ring moving in an infinite fluid is found, the kinetic energy calculated, and a few cases of motion discussed

(4) The annular form of rotating fluid is considered, and the form of the cross-section determined The cross-section even for large rings is, roughly, of an elliptic shape, the minor axis being parallel to the axis of revolution of the annulus.

May 12 —"On the Embryology of *Angiopteris evecta*, Hoffm" By J Bretland Farmer, M.A, Fellow of Magdalen College, Oxford Communicated by S H. Vines, M A, F R S

The germination of the spore and the development of the prothallium have been described by Jonkman,[1] who also observed the formation of the sexual organs The antheridium is formed from a superficial cell of the prothallium, which divides by a wall, parallel to the surface, into an outer shallow cell and an inner cubical cell The former, by walls at right angles to the free surface, gives rise to the cover-cells, while the inner one, by successive bipartitions, originates the antherozoid mother-cells

The antheridia are distributed both on the upper and lower surfaces of the prothallium, and apparently without any approach to regularity, though they are somewhat more frequent on the lower surface I may observe, however, that an antheridium may often occur on the upper surface immediately above an archegonium which has been fertilized

The archegonia occur exclusively on the lower surface Their development has been described by Jonkman, who also noticed the division of the neck canal cell, by a transverse wall, into two cells The division is not, however, invariable, and in one preparation in which the protoplasm had shrunk slightly from the wall, I observed that the cell plate had not extended so as to completely partition the neck passage into two cells

The oospore, after fertilization, speedily forms an ovoid cellular body, and although I was not so fortunate, owing to scarcity of material, as to see the formation of the earliest cell walls, their succession could be determined with tolerable certainty in the youngest embryo that I met with, consisting as it did of about ten cells

The basal wall is formed, as in *Isoëtes*, at right angles to the axis of the archegonium The next one in order of occurrence I believe to be the median wall, which can easily be distinguished, even in advanced embryos, as a well-defined vertical line

The tranverse wall is much more indefinite, and early loses its individuality owing to the unequal growth of the various parts of the young embryo The further cell-division is irregular, and to a far greater extent than is the case with the leptosporangiate ferns as described by Hofmeister and Leitgeb

The anterior epibasal octants together give rise to the cotyledon, the stem apex is formed, not as in the leptosporangiate ferns, from *one* octant only, but from *both* of the posterior epibasal octants, though one of them contributes the greater portion The truth of this statement is seen on examining vertical sections through the embryo cut at right angles to the median wall, when a few cells on each side are seen to be clearly marked out, by their dense protoplasmic contents and large nuclei, as meristem cells There is no single apical cell in *Angiopteris* from which all the later stem tissue is derived, and this fact is, without doubt, to be connected with the character of the apical meristem just described The root is formed from one of the octants beneath the cotyledon, *i e* from an anterior hypobasal one, and is at first indicated by a triangular apical cell, which, in one fortunate preparation, showed the first cap cell The other octant, together with the two posterior hypobasal octants (which together form the rudimentary foot), round off the base of the embryo The root presents considerable difficulty in tracing the course of its development, as the apical cell, at no time very clear, is early replaced by two cells Moreover, the root grows in a somewhat sinuous manner in the embryo, and the cells of its apex may easily be confounded with other triangular cells which occur irregularly scattered in the lower portion of the embryo It finally emerges, not immediately beneath, nor yet exactly opposite, the cotyledon, but at a distance from it of between one third and one-half of the circumference of the embryo The difficulties attending the exact following of its growth, added to the scarcity of the material, have prevented my elucidating completely the details of development, but the important point, that, even before its emergence from the embryo, its apex contains a *group* of initial cells, occupying the place of the single one characteristic of other orders of ferns, can be regarded as established with certainty

When the embryo has reached a certain size, it bursts through the prothallium, the root boring through below, whilst the cotyledon and stem grow through the upper surface This manner of issuing from the prothallium at once serves to distinguish *Angiopteris* from those other ferns whose embryogeny is known, and probably the peculiarity of its growth may be reasonably connected with the direction and position of the basal wall which separates the root and short portions of the embryo

Fresh leaves and roots speedily arise on the young plantlet the second leaf appearing just above the place of exit of the first root—that is, not quite opposite the first leaf. The third leaf rises between the first and second ones, and nearer the first than the second Their roots observe the same rule of divergence as

[1] "De geslachtsgeneratie der Marattiaceeën," door H F Jonkman.

that which obtains in the case of the first root The stipular structures, so characteristic of the Marattiaceæ, are entirely absent from the first two leaves, but appear in a well developed condition on the third and all succeeding leaves

"On the Shoulder girdle in Ichthyosauria and Sauropterygia" By J. W Hulke, F R S

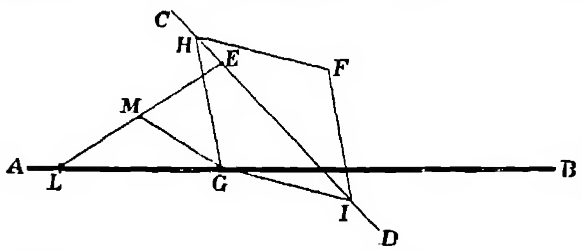
The author discusses the structure of the shoulder girdle and the homologies of its several parts in these families He shows that the alleged existence of a precoracoid in the Ichthyosauria rests on an insufficient foundation, offers proofs that in Plesiosauria the anterior ventral ray is not only theoretically but *actually* precoracoid, and also that the dorsal ray in the girdle is homologous with the shoulder-blade in Testudinata and other Reptilia.

"On the Development of the Stigmata in Ascidians" By Walter Garstang, M A

The author shows that the transverse rows of stigmata, which are present in all the fixed Ascidians, may arise in one or the other of two ways either as independent perforations, distinct from the first (oozooid of *Clavelina*, buds of *Botryllus*), or as secondary formations, due to the subdivision of a series of primary transverse stigmata on each side (oozooid of *Botryllus*, *Styelinæ*) The former method of development is shown to be a modification of the latter

The primary transverse stigmata (or "protostigmata") of *Botryllus* and the *Styelinæ* agree precisely with the definitive stigmata of *Pyrosoma* in structure, position, and order of formation They are accordingly regarded as homologous formations, and the conclusion is drawn that *Pyrosoma* has not been derived from the fixed Ascidians, but represents an ancestral type of Caducichordate Tunicata, antecedent to the whole of the phylum Ascidiacea

Physical Society, May 13 —Dr E Atkinson, Treasurer, in the chair —Mr R Inwards read a paper on an instrument for drawing parabolas It was designed for drawing curves of short focus such as are required for reflectors and for diagrams of the paths of comets and projectiles Its construction is based on the fundamental property that every point on the curve is equidistant from the focus and the directrix In the diagram below, AB is a slot representing the directrix, and FGHI



a rhombus jointed at the corners and pivoted at F, whilst CD indicates a bar capable of sliding through guides at H and I A rod, LE, is coupled to G by a bar, GM, such that the lengths LM, ME, and MG are equal As L and G slide along AB, the point E describes a parabola whose latus rectum depends on the distance of F from AB In the instrument F is carried by a slotted arm so that its position is adjustable GE is always perpendicular to AB and equal to FF Prof Boys inquired whether the instrument could be modified to draw any conic section by arranging that the ratio of EF to EG instead of being unity, might be greater or less than unity Prof Perry said an instrument for drawing curves represented by the equation $y = x^n$ was greatly needed for engineering work —Mr F H Nalder exhibited and described some electrical instruments The first shown was a ballistic galvanometer with one pair of coils, the distinguishing features of which were accessibility, small damping, great sensitiveness, and the arrangement of the control The control is effected by a "tail magnet" carried on a horizontal tube supported by a pillar outside the case, as suggested by Prof R M Walmsley. A small magnet on the cover serves for zero adjustment The suspended system consists of four bell magnets, two being in the middle of the coil and one at top and bottom respectively, arranged so as to be astatic The sensitiveness of the instrument shown was such that ½ of a microcoulomb gave 300 divisions (fortieths of an inch) when the periodic time was 10 seconds and scale distance about 3 feet Resistance of galvanometer about 10,000 ohms To bring the needle to rest quickly, a damping coil mounted on an adjustable stand, and a special reversing key with resistances in its base, are provided The key has successive contacts arranged so that when pressed lightly only a weak current passes round the damping coil, whilst when pressed further a much stronger current passes The strong currents are used to check the large elongations, and the weak ones for finally bringing to zero A lamp stand with semi-transparent scale arranged for use with a glow lamp was next shown Instead of reading by the image of the filament, as is ordinarily done, the lantern is arranged to give a bright disk of light with a black line across the middle Mr Blakesley asked if the galvanometer was astatic For damping non astatic ones he had found it useful to wind several turns of wire round the bobbin, and put them in series with a few thermo electric junctions warmed by the hand and a key In reply, Mr Nalder said the galvanometer was astatic, but the damping coil could be placed so as to act on one pair of magnets more than on the other A paper on a portable instrument for measuring magnetic fields, with some observations on the strength of the stray fields of dynamos, by Mr E Edgar and Mr H Stansfield, was then read The instrument was described as an inversion of a d'Arsonval galvanometer, for the torque necessary to maintain a suspended coil conveying a constant current parallel to the field gives a measure of the strength of the field The constant current is furnished by a Hellensen's dry cell which the authors found remarkably constant The instrument consists of a coil of about fifty ohms, wound on mica and suspended by two German silver strips within a tube A pointer is fixed to the mica, and a divided head, to which the outer end of one strip is attached, serves to measure the torsion Within the head chamber is a commutator which automatically reverses the current in the coil when the head is turned in opposite directions from zero Two readings may thus be taken to eliminate gravity errors due to want of perfect balance in the coil Means are provided for adjusting and measuring the tension of the suspensions The constant of the instrument was determined by placing the coil in the field of a Helmholtz galvanometer, and found to be 0 293 per 1° Any other field is therefore given by 0 293 $(n + 1)\theta$, where θ is the angle of torsion in degrees, and n the multiple of 50 ohms in series with the coil Fields from 2 or 3 C G S lines upwards can be measured to about 2 per cent by the instrument, and even the earth's field is appreciable The authors have tested the fields of dynamos at the Crystal Palace Exhibition and elsewhere, and the results obtained are given in the paper It is noted that the stray fields of multipolar machines fall off much more rapidly than those of two pole dynamos as the distances are increased, and that near edges and corners of the magnets the fields are much stronger than near flat surfaces The disturbing effect of armature reactions on the strength of the stray fields were measured, and the shapes of the fields observed in some cases Experiments on magnetized watches are described in the paper Mr Whipple said the Kew Committee were to some extent responsible for the experiments described, for it was on their account that the investigations were commenced In connection with the rating of so called non-magnetic watches, it was necessary to know what strength of fields they were likely to be subjected to The instrument devised for making the tests was a very interesting one, and the results obtained by it of great value Mr. A P Trotter hoped the authors would supplement their work by tracing out the directions of the fields of dynamos, and he described a simple method of doing this by a test needle used as an india-rubber stamp The question of watches, he thought, must be considered soon, even non-magnetic watches were stopped by being placed in strong fields, owing to Foucault currents generated in the moving parts Mr Blakesley inquired whether the instrument could be used in any position He thought three observations would be necessary to completely determine any field Mr Stansfield, in reply, said they used a pilot needle for showing the directions of the fields, and then placed the coil accordingly The instrument could be used in any position, for the weight of the coil was only about 2 grammes, and did not greatly alter the tension of the suspensions, which was usually about 300 grammes A watch with a brass balance was not influenced by a field of 10 C G S lines but seriously affected by one of 40 —Mr Joseph W Lovibond read a paper on a unit of measurement of light and colour The paper was illustrated by many coloured charts, diagrams, and models, and several pieces of apparatus by which colour measurements could

be made were shown The principle of the measurements depends on the selective absorption of the constituents of normal white light by coloured glasses (red, yellow, and blue) The depths of tint of the glasses are carefully graduated to give absorptions in numerical proportions For example, two equal glasses, each called one unit red, give the same absorption as a two-unit red, and so on The units of red, yellow, and blue are so chosen that a combination of one of each absorb white light without colouring the transmitted light Such a combination is called a "neutral tint unit" By the use of successive neutral tint units, white light can be gradually absorbed without showing traces of colour, and the number of such units required to produce complete absorption is taken as a measure of the intensity or luminosity of the white light Methods of representing colours by circles and charts were fully dealt with, and the influence of time of observation on the penetrability of different colours was illustrated by diagrams The results of 151 experiments on colour mixture were explained, and represented diagrammatically After the reading of the paper the methods used for colour matching and measurement were shown by Mr and Miss Lovibond —Mr R W Paul exhibited his improved form of Wheatstone bridge, arranged to occupy the same space, and fulfil the same conditions, as the well-known Post Office pattern

Chemical Society, April 21 —Prof A Crum Brown, F R S, President, in the chair —The following paper was read —Masrite, a new Egyptian mineral, and the possible occurrence of a new element therein, by H D Richmond and Hussein Off Masrite is the name assigned by the authors to a variety of fibrous alum obtained in Egypt by S E Johnson Pasha. It contains from 1 to nearly 4 per cent of cobalt This being the first occasion on which cobalt has been met with in Egypt, the authors were led to inquire whether the blue colour used in the paintings on Egyptian monuments contained that element The samples obtained, however, owed their colour to compounds of copper and iron The mineral is principally interesting on account of the presence in it of a minute quantity of a substance, the properties of which appear to be unlike those of any known element, which the authors provisionally term masrium, from the Arabic name for Egypt From an analysis of the oxalate, on the assumption that it is a bivalent element, the atomic weight of masrium is calculated to be 228 The authors point out that there is a vacant place in the glucinum-calcium group of the periodic system for an element having the atomic weight 225 In many of its properties masrium resembles glucinum, and the oxalate is analogous to that of calcium Masrite has the composition

$$(Al,Fe)_2O_3, (Ms,Mn,Co,Fe)O, 4SO_3, 20OH_2$$

May 5 —Prof A Crum Brown, F R S, President, in the chair —An extract was read from a letter to Sir H E Roscoe, written by Prof Kuhne, of Heidelberg, at the request of Prof Bunsen, expressing his thanks for the address presented to him by the Chemical Society —The following papers were read — The existence of two acetaldoximes, by W R Dunstan and T S Dymond. Acetaldoxime, CH_3 CH NOH, has hitherto been regarded as a liquid capable of existing in only one form, attempts to obtain evidence of the existence of an isomeride having failed, the authors, however, find that it can be crystallized by cooling The crystals so obtained are often several inches in length, and melt at 46° 5 On heating them to 100°-150° no decomposition occurs, and the substance boils constantly at 114°·5 If this heated liquid be now cooled, it does not crystallize until nearly 35° below the melting-point of the original substance, and the crystals so obtained become liquid at ordinary temperatures. Many similar observations have been made, and it has been invariably found that on heating the aldoxime the freezing-point is lowered to a greater or less extent. Evidence has in this way been accumulated, showing that a change in the constitution of acetaldoxime occurs when it is heated, the original substance, melting at 46° 5, being gradually converted into a new modification, which melts at 12° It is noteworthy that the acetaldoxime melting at 12° is slowly reconverted into that melting at 46°·5 on standing at ordinary temperatures The authors term the substance melting at 46° 5 α acetaldoxime, that melting at 12° being named β-acetaldoxime —Sulphonic acids derived from anisoils (No 1.), by G T Moody The author finds that contrary to the statement of Kekulé, and of Opl and Lippmann, anisoil and phenetoil afford only parasulphonic acids on sulphonation. Carefully purified anisoil was dissolved in concentrated sulphuric acid, and the product poured into water, when part of the anisoil was liberated, showing that as in the case of phenol an intermediate compound is formed before the sulphonic acid The anisoil thus set free was treated with strong sulphuric acid at 80°, when complete sulphonation occurred The solution yields a well-defined calcium salt, no indications of the presence of an isomeride were found The calcium, potassium, and sodium salts of the anisoil parasulphonic acid obtained in this way are described, together with the sulphochloride and sulphonamide Pure phenetoil similarly is shown to yield only the parasulphonic acid The products of sulphonation, either with sulphuric acid or with chlorosulphonic acid, are in both cases the same, only one sulphonic acid resulting —The formation of trithionate by the action of iodine on a mixture of sulphite and thiosulphate, by W Spring In his paper on the investigation of the change proceeding in an acidified solution of sodium thiosulphate, Colefax credits the author with having stated that trithionate of sodium is produced when iodine acts on a mixture of sodium sulphite and thiosulphate, and further denies that this is the case The author used potassium salts, and not sodium salts, but, owing to an error in the abstract of Spring's original paper, Colefax was led to believe that sodium salts were used The difference in the behaviour of the potassium and sodium salts is very striking, and arises from the greater instability of the sodium polythionates already pointed out by the author Another difference between the two sets of experiments is found in the employment by Colefax of a larger proportion of iodine than that used by the author The equation

$$K_2SO_3 + K_2S_2O_3 + I_2 = K_2S_3O_6 + 2KI$$

requires less iodine than would be necessary to oxidize the sulphite to sulphate, and the hyposulphite to tetrathionate of sodium The author does not, however, contend that the formation of trithionate takes place in accordance with the equation

$$Na_2S_2O_3 + Na_2SO_3 + I_2 = Na_2S_3O_6 + 2NaI.$$

He is convinced that sulphites have the property of desulphurising the tetrathionates, so as to convert them into trithionates It would hence be more consistent to admit that the sodium sulphite which owes its existence to the employment of a reduced quantity of iodine decomposes the small quantity of sodium tetrathionate produced in the first instance, thus,

$$Na_2S_4O_6 + Na_2SO_3 = Na_2S_3O_6 + Na_2S_2O_3$$

The statement erroneously ascribed by Colefax to the author seems, in consequence, to be really correct It is, however, indispensable that the experiments should be performed under exactly the same conditions as those employed in the work on the potassium salts.—The determination of the temperature of steam arising from boiling salt solutions, by J Sakurai The evidence now on record as to the temperature of the steam arising from boiling salt solutions is exceedingly unsatisfactory and inconsistent. Such being the case, the author has devised a method for accurately measuring this temperature, and finds that the temperature of the steam escaping from a boiling salt solution is the same as that of the solution The conditions for success are —(1) The thermometer used must be kept from contact even with the smallest drops of the solution thrown up by ebullition. (2) The effect of cooling of the thermometer by radiation must be rendered insignificant in proportion to the heating up by the steam This condition is readily fulfilled by the expedient of combining the introduction of steam from without with the ebullition by the lamp (3) The walls of the chamber surrounding the thermometer must be sufficiently protected from external cooling, and yet, at the same time, must not be heated to the temperature of the steam This is effected by jacketing the steam chamber with the vapour evolved from dilute acetic acid boiling at about 2° lower than the salt solution The agreement between the numbers representing the temperature of the steam and that of the boiling salt solution is good —Note on an observation by Gerlach of the boiling-point of a solution of Glauber's salt, by J Sakurai. Some years ago Gerlach stated that the steam escaping from a boiling solution of Glauber's salt containing a crystalline magma of the anhydrous salt indicates a temperature of 100°, whilst the liquid is boiling at 82° or even 72° The author finds that this is hardly true, for it is only a wet mass of sodium sulphate crystals that is heated The steam, consequently, does not arise uniformly from the heated mass, but

escapes from channels produced in those portions of it which are in contact with the sides of the vessel The central portion of the magma therefore may be at a low temperature, whilst steam at 100° is issuing from the sides —Chemistry of the thioureas, Part II., by E A Werner It is pointed out that the paper recently published by Bertram on the monophenylthioureas was evidently written in ignorance of the fact that the bulk of the work detailed therein has been already published by the author A number of new derivatives of thiourea are now described

Geological Society, May 11 —W H Hudleston, F R S, President, in the chair —The President announced that a bust of the late Sir Charles Lyell had been kindly presented to the Society by Mrs Katherine Lyell, through the intermediary of Prof J W Judd, F R S —The following communications were read —On the so called gneiss of Carboniferous age at Guttannen (Canton Berne, Switzerland), by Prof T G Bonney, F.R.S It is stated by Dr Heim (*Quarterly Journal*, vol xlvi p 237) that the stems of *Calamites* have been found at Guttannen in a variety of gneiss, *i e* in one of a group of rocks which exactly "resemble true crystalline schists in mode of occurrence Petrographically they are related to them by passage rocks, at least the line of separation is not easily distinguished

The Palæozoic formations mostly show an intimate tectonic relation to the crystalline schists, and have been converted petrographically into crystalline schists" The Author describes the result of a visit to the section at Guttannen in company with Mr J Eccles (to whom he is greatly indebted for kind assistance), and of his subsequent study of the specimens then collected The belt of sericitic "phyllites and gneisses," presumably of Carboniferous age, represented on the Swiss geological map (Blatt xiii) as infolded, at and above Guttannen, in true crystalline gneissoid rocks, is found on examination to consist partly of true gneisses, partly of detrital rocks The boulder from which the stems in the Berne Museum were obtained belongs to the latter These rocks sometimes present macroscopically, and occasionally even microscopically, considerable resemblance to true gneisses, but this proves on careful examination to be illusory They are, like the Torridon Sandstone of Scotland, or the *Grès feldspathique* of Normandy, composed of the detritus of granitoid or gneissoid rock, which sometimes forms a mosaic resembling the original rock, and which has been generally more or less affected by subsequent pressure and the usual secondary mineral changes Thus, if the term be employed in the ordinary sense, they are no more gneisses than the rocks of Carboniferous age at Vernayaz (Canton Valais) are mica-schists, but in some cases the imitation is unusually good, and, so far as the author saw, there are at Guttannen neither conglomerates nor slates to betray the imposition, as happens at the other locality The reading of this paper was followed by a discussion, in which the President, Prof Judd, Mr Eccles, General McMahon, Mr Rutley, Prof Blake, Prof Bonney, and Prof Seeley took part —On the lithophyses in the obsidian of the Rocche Rosse, Lipari, by Prof Grenville A J Cole, and Gerard W Butler The rock described in this paper differs in no essential particular from that at Forgia Vecchia, or from the obsidian on the north flank of Vulcano, but the specimens show in a specially striking manner the passage through various stages of lithophysal structure, from indisputable steam vesicles with glassy walls to typical solid spherulites A full description is given of the formation of spherulites by a double process—firstly, divergent growth from the margins of vesicles outwards, and secondly, convergent growth inwards from the margins towards the centres of the hollows, until in the smallest cases the fibres from the opposite sides of the vesicle may meet in the centre, producing a spherulite, which, but for the occurrence of intermediate stages, might be supposed to have originated entirely by divergent growth. The authors give details of the appearances presented by intermediate stages of growth The prevailing type of spherulite, both in Lipari and Vulcano, shows in section a dusky fibrous central area, which may possess concentric as well as radial structure, surrounded by an irregular brown cloudy zone of various width. The authors' studies lead them to the conclusion that this type owes its characters to the dual mode of growth, and therefore to the original presence of vesicles in the rock. Commonly the process of infilling does not go so far as this, on the ends of the felspar fibres plates of tridymite are deposited, and this seems to close the growth It is clear that the lithophysal structure of the Lipari obsidians was formed during the cooling of the mass, and not by subsequent amygdaloidal infilling of vesicles. The authors discuss the effect of confined vapours on such rocks as those forming the subject of the paper, noting that these vapours may be kept at a high temperature for a considerable time, each vesicle thus becoming a sphere of hydrothermal action, so that if the surrounding glass remains at a temperature little below its fusion-point, crystallization will be promoted in it, and at the same time the action of the vapour in the vesicle will produce reactions on its walls An appendix, by Prof Cole, treats of the lithophyses and hollow spherulites of altered rocks While admitting the presence of true lithophyses in many of the Welsh lavas, he is not prepared to abandon a former suggestion that the interspaces between successive coats of the Conway lithophyses result from alteration of a formerly solid mass In the lavas of Esgair-felen and near the Wrekin he has no doubt as to the production of "hollow spherulites" by ordinary processes of decay The typical Continental pyromerides are truly spherulitic, as is much of the Wrekin lava In the latter case and that of the rocks of Bouley Bay it will be difficult to distinguish between infilled primary and secondary cavities In the discussion which followed the reading of this paper Prof Bonney, Prof Judd, General McMahon, Mr J W Gregory, Mr Rutley, Prof Cole, and Mr G W Butler took part

Royal Meteorological Society, May 18 —Dr C Theodore Williams, President, in the chair —The following papers were read —Raindrops, by Mr E J Lowe, F R S The author has made over 300 sketches of raindrops, and has gathered some interesting facts respecting their variation in size, form, and distribution Sheets of slate in a book form, which could be instantly closed, were employed, these were ruled in inch squares, and after exposure the drops were copied on sheets of paper ruled like the slates Some drops produce a wet circular spot, whilst others, falling with greater force, have splashes around the drops The same sized drop varies considerably in the amount of water it contains The size of the drop ranges from an almost invisible point to that of at least 2 inches in diameter Occasionally large drops fall that must be more or less hollow, as they fail to wet the whole surface inclosed within the drop Besides the ordinary raindrops, the author exhibited diagrams, showing the drops produced by a mist floating along the ground, and also the manner in which snow-flakes, on melting, wet the slates —Results of a comparison of Richard's anémo cinemographe with the standard Beckley anemograph at the Kew Observatory, by Mr G M Whipple This instrument is a windmill vane anemometer, and is formed by six small wings or vanes of aluminium, 4 inches in diameter, inclined at 45°, rivetted on very light steel arms, the diameter of which is so calculated that the vane should make exactly one turn for a metre of wind Its running is always verified by means of a whirling frame fitted up in an experimental room, where the air is absolutely calm, and, if necessary, a table of corrections is supplied The recording part of the apparatus differs entirely from any other anemometer, and is called the anemo-cinémographe, and in principle is as follows —The pen, recording on a movable paper, is wound up at a constant rate by means of a conical pendulum acting as a train of wheel links, whilst a second train, driven by the fan, is always tending to force it down to the lower edge of the paper, its position, therefore, is governed by the relative difference in the velocity of the two trains of wheel-work, being at zero when the air is calm, but at other times it records the rate of the fan in metres per second The author has made a comparison of this instrument with the standard anemometer at the Kew Observatory, and finds that it gives exceedingly good results —Levels of the River Vaal at Kimberley, South Africa, with remarks on the rainfall of the watershed, by Mr W B Tripp Measurements of the height of the River Vaal have for several years past been made at the Kimberley Waterworks These gaugings having been placed at the disposal of the Society, the author has compared them with the rainfall of the watershed. There is a marked period of floods and fluctuations at a comparatively high level from about the end of October to the latter part of April, and a period of quiescence during which the river steadily falls, with very slight fluctuations from about April 19 to October 31 The highest flood (52·5 feet) occurred in 1880, the next highest being 50 3 feet on January 24, 1891

OXFORD

University Junior Scientific Club, May 4.—The meeting was held in the University Museum In private, business regulations about the "Robert Boyle Lecture" were passed

by the Club —Papers were read on the action of light on metallic iodides, by Mr Douglas Berridge, on the colours of birds, by Mr F Finn, and on Caliche by Mr P Elford

May 13 —At an open meeting Mr E F im Thurn (Exeter) delivered a lecture on "Primitive Games of the Red Men of Guiana" Prof Tylor afterwards addressed the Club —The inaugural "Robert Boyle Lecture" will be given at a *conversazione* on May 27 All old members of the Club are cordially invited

PARIS

Academy of Sciences, May 16 —M d'Abbadie in the chair —Contribution to the history of silico carbon compounds, by M P Schutzenberger The compound, SiC, has been produced by long heating of silicium diluted with silica in carbon crucibles The friable mass is broken up, heated with potash solution, which dissolves out the silicium, and some silica, and then boiled with moderately concentrated hydrofluoric acid, by which all the silica is taken up and silicium nitride is converted into silicium fluoride and ammonium fluoride The clear green pulverulent residue of SiC is not attacked by potash or by boiling HF, it is infusible, and at a white heat forms SiCO —On the determination of the density of liquefied gases and their saturated vapours, elements of the critical point of carbonic acid, by M E H Amagat The critical constants for carbonic acid are given as—temp = 31° 35 C, pressure = 72 9 atmos, density = 0 464—Observation of the partial eclipse of the moon on May 11-12, 1892, by MM Codde, Guerin, Nègre, Zielke, Valette, and Léotard —On the theory of *fonctions fuchsiennes*, by M L Schlesinger —On the relations existing between the infinitesimal elements of two reciprocal polar surfaces, by M Alphonse Demoulin —On transformations in mechanics, by M Paul Painlevé —The physiological scale of distinct vision, applications to photometry and *photo esthésiométrie*, by M W Nicati —On a method of separation of xylenes, by M J M Crafts —Calculation of boiling-points of compounds with simple terminal substitution, by M G Hinrichs —Method for the proximate analysis of chlorophyll extracts, nature of chlorophyllane, by M A Etard —Influence of the nature of the soil on vegetation, by M J Raulin —Presence of fumarine in one of the Papaveraceæ, by M J A. Battandier —On some muscular anomalies in man, by M Fernand Delisle —On the apparently teratological origin of two species of *Triclades*, by M P Hallez —On the theory of gills and the parablast, by M F Houssay —The origins of the wing nerve among the Coleoptera, by M Alfred Binet —The nervous system of *Nerita polita*, by M L Boutan —On the origin and formation of the chitinous coat of the larvæ of *Libellules*, by M Joannes Chatin —On the microscopic structure of ooliths from the *bathonien* and *bajocien* of Lorraine, by M Bleicher —The odoriferous properties of alcohols of the fatty series, by M Jacques Passy The odoriferous power, as measured by the inverse of the millionths of a gram present in one litre of air when the odour can be just distinguished, increases regularly with the molecular weight —On the lack of movement of the deep oceanic waters, by M J Thoulet

BERLIN

Physiological Society, April 27 —Prof du Bois Reymond, President, in the chair —Dr Boruttau gave an account of experiments made to determine the cause of the difference in latent period observed during the direct and indirect stimulation of muscles, being, as is well known, greater (with maximal and supra-maximal stimuli) in the latter mode of stimulation According to some observers the difference is due to the resistance offered by the end-plates, whereas some regard it as due rather to a summation of stimuli during direct stimulation The speaker had satisfied himself by a careful repetition of the experiments under many varying conditions that the difference is due solely to the resistance of the end-plates In connection with the above, Prof Gad pointed out the possible important bearing of the results obtained on the processes which go on in other organs Thus recent anatomical research has shown that in the central nervous system there is no complete continuity between the axis-cylinders and ganglia, hence the existence of some intermediate structure must be assumed, and a portion at least of the slowing which impulses experience in the central nervous system may be due to the resistance offered by this structure —Prof Wolff exhibited a patient in whom the larynx had been completely extirpated some seven months previously, and who was now able, by means of an artificial larynx, to speak quite loud and clearly Prof Gad gave an historical account of the construction of artificial larynxes, of the requirements which these instruments must satisfy, and of recent improvements in the cannulæ employed by patients

Physical Society, May 6 —Prof Kundt, President, in the chair —Dr Gross spoke on the principle of entropy, and criticised several formulæ of Clausius and Zeuner

[In the reports of the Berlin Scientific Societies, NATURE, vol xlv p 599, *for* Schumbert *read* Schubert, and *for* Lammer and Brodhan *read* Lummer and Brodhun]

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS —Genesis I and Modern Science Dr C B Warring (New York, Hunt and Eaton) —Analyse des Vins Dr L Magnier de la Source (Paris, Gauthier Villars) —Tiroirs et Distributeurs de Vapeur A Madamet (Gauthier Villars) —Studies in South American Native Languages Dr D G Brinton (Philadelphia) —Die Eibe in Westpreussen H Conwentz (Danzig, Berling) —Wood Notes Wild Notations of Bird Music S P Cheney (Boston, Lee and Shepard) —Lehrbuch der Botanik Erster Band Dr A B Frank (Leipzig Engelmann) —The Theory of Substitutions and its Applications to Algebra Dr F Netto, translated by Dr F N Cole (Ann Arbor Michigan, *Register* Publishing Company) —Results of the Meteorological Observations made at the Government Observatory Madras, during the Years 1851–90, edited by C M Smith (Madras) —Watts's Dictionary of Chemistry, vol iii, revised, &c, by H F Morley and M M P Muir (Longmans).—Practical Enlarging J A Hodges (Iliffe) —The First Principles of Photography C I Leaper (Iliffe) —Smithsonian Report, U S National Museum, 1889 Washington) —Key to J B Lock's Elementary Dynamics G H Lock (Macmillan) —The Anatomy, &c, of the Blow Fly, Part 3 B T Lowne (Porter)

PAMPHLETS —On the Organization of Science A Free Lance (Williams and Norgate) —The Nitrate Fields of Chile C M Aikman.—Sadducee *versus* Pharisee G M McCrie (Bickers)

SERIALS —Quarterly Journal of the Geological Society, vol xlviii Part 2, No 190 (Longmans).—Engineering Magazine May (New York) —Himmel und Erde, May (Berlin, Paetel) —Transactions of the Royal Irish Academy, vol xxix Part 19 (Williams and Norgate) Verhandlungen des Naturhistorischen Vereines der Preussischen Rheinlande &c —Achtundvierzigster Jahrgang Fünfte Folge, 8 Jahrg Zweite Hälfte (Bonn Cohen).—Bulletins de la Société d'Anthropologie de Paris, tome 2 (1891) 3e Fasc (Paris Masson) —Journal of the Chemical Society, May (Gurney and Jackson) —Institute of Jamaica, Bulletin No 1, A Provisional List of the Fishes of Jamaica T D A Cockerell (Kingston) —Rapport Annuel sur l'État de l'Observatoire de Paris, 1891, le Contre Amiral Mouchez (Paris Gauthier Villars) —Indian Museum Notes, vol ii No 5 (Calcutta) —Journal of the Institution of Electrical Engineers No 98 vol xxi (Spon) —Mémoires de la Société de Physique et d'Histoire Naturelle de Genève, Vol Supplémentaire, Centenaire de la Fondation de la Société (Genève)

CONTENTS.

THURSDAY, JUNE 2, 1892.

THE GRAMMAR OF SCIENCE.

The Grammar of Science By Karl Pearson, M A, Sir Thomas Gresham's Professor of Geometry "The Contemporary Science Series" (London Walter Scott, 1892)

ONE chief merit of this book is its exposition of the meaning of scientific law There still exists, unfortunately, a type of mind which delights in such phrases as "the reign of law," the "immutable laws of Nature," and so on The truly scientific mind has, however, been long familiar with the truth that a so-called law of Nature is simply a convenient formula for the co ordination of a certain range of phenomena It is this which Prof Pearson so emphatically, if somewhat redundantly, expounds in the earlier chapters of the "Grammar" As he delights in putting it, a scientific law is a description in mental shorthand of certain sequences of sense-impressions Through these sense-impressions alone can we gain any knowledge of what we are accustomed to call the external world Thus the Universe as pictured by the scientific mind is a purely mental product We can assert, scientifically, nothing regarding its constitution other than what we may validly infer from our perceptions and the conceptions based on these, and even then we must never forget that the reality to us is conditioned wholly by our powers of perception This is the grand argument of the grammarian of science

In developing his theme he introduces not a few interesting questions and analogies Take, for example, his comparison of the brain to a telephone exchange Here Reason, presiding as clerk, finds by experience that a certain subscriber always desires to correspond with a certain other subscriber As soon as the call-bell from the former sounds, the clerk mechanically links him to the latter "This corresponds to an habitual exertion following unconsciously on a sense-impression" Other analogies are obvious Now, just as the clerk would obtain a very scrappy knowledge of the outside world if he had to trust simply to the messages which stream past him through the exchange, so (it is suggested) the picture our mind forms of the external world acting upon us through our sense-impressions may be very wide of the reality Of course analogies must not be pressed too far Yet it does seem that this analogy of the telephone exchange could be worked out most consistently by the despised teleologist To Sir Thomas Gresham's Professor of Geometry, however, a telephone exchange evolving its own clerk is as simple a matter as an uninterrupted stream of sense-impressions creating Spencerianly a consciousness

But Prof Pearson is no mere preacher of familiar doctrines He is a second Hercules, self-appointed to clear the scientific stables of all materialistic and metaphysical rubbish He labours at the task of proving how illogical is the mind that passes to "the beyond" of the sense-impressions and the conceptions directly based on these. Thus he argues that, because the Universe is known only as our own mental product, we have no right to infer a mind in or above Nature as an explanation of the universality of the scientific law Nevertheless, it behoves him to find a rational substitute for the law of continuity on which the authors of the Unseen Universe build their edifice Consequently on p 121 we read —

"It is therefore not surprising that normal human beings perceive the same world of phenomena, and reflect upon it in much the same manner"

Why not surprising? Because, as we learn from the preceding sentence, human beings "in the normal civilized condition have perceptions and reflective faculties nearly akin" But why nearly akin? Well, it has to be so because "the world of phenomena must be practically the same for all normal human beings," or the universality of scientific law will fail Putting in the definitions of the terms in the first quoted sentence we read It is therefore not surprising that beings, who have perceptive and reflective faculties capable only of producing practically the same world of phenomena, perceive the same world of phenomena and reflect upon it in much the same manner In this exquisite cycle of reasoning what, we ask, is the logical work done?

Our grammarian poses as a logician of the straitest sect Bad logic he cannot abide, and since apparently he cannot read a book without seeing the cloven hoof he must have rather a sorry time of it His own logic must, of course, be flawless So, when we are told with reiterated emphasis that time and space are but modes of perception, and are then asked to imagine our Universe in time and space without a consciousness to perceive it, we feel a sinking at the heart Things, we find, can exist under certain modes of a non-existent perception The laws of Nature are a mental product, yet a certain evolution theory logically based upon them quite eliminates the mental We are reminded of the sagacious carpenter who sat high and lifted up on the end of the bracket beam he was sawing through, or of the small boy who spent his wealth in buying a purse to hold it in

A large section of Prof Pearson's book is destructive criticism "Cause," "Force," and "Matter" are as red rags to him Cursed be he who uses these words without clearly defining, in footnote or otherwise, their significance according to the definitions given in the "Grammar of Science" Sir Isaac Newton is severely visited for his sins, Thomson and Tait get a thorough drubbing, Maxwell is censured for his bad logic, and Prof Tait especially, if we are to judge of him through the medium of this book, must have done more to retard the progress of science than any other single man of the century Sound criticism is always welcome, but "smart" controversy of the hustings type is rarely sound in print As a fair example of our grammarian's method, take his critique of Maxwell's descriptions (not definitions be it noted) of the intimate relation between matter and energy Maxwell says, "We are acquainted with matter only as that which may have energy communicated to it from other matter, &c.," and "Energy, on the other hand, we know only as that which is continually passing from one portion of matter to another" These are represented as meaning that "the only way in which we can understand matter is through the energy which it transfers," and "the only way to understand energy is through matter Matter has been defined in terms of energy, and energy again

in terms of matter" By what logic or grammar can *understand* be substituted for *are acquainted with* or *know*, and by what right is a description twisted into a definition? Words in their usual meanings may, however, be of little consequence to a writer who persists in using the English word *resume* in the French sense It seems to us that Prof Pearson has altogether missed the significance of the word "objective" as used by Prof Tait, to whom, as everyone knows or should know, we owe the first clear presentation of the dogma that force has no objective existence At any rate, we are surprised to find in the "Grammar of Science" no distinct reference to the two grand principles of all science—to wit, the conservation of matter and the conservation of energy This omission by an avowed writer on the principles of science is certainly matter of surprise As regards the views of force expounded in the book, the author is simply a disciple of Prof Tait If not, he must regard Tait as "that worst of plagiarists"—the man who made the discovery before he did Prof Pearson has, indeed, a certain fatality for having dealings with that most unsatisfactory kind of plagiarism In Tait's "Properties of Matter," first edition (1885), paragraph 162, are written these words —

"Sir W Thomson has shown that if space be filled with an incompressible fluid, which comes into existence in fresh quantities at the surface of every particle of matter, at a rate proportional to its mass, and is swallowed up at an infinite distance, or, if each particle of matter constantly swallows up an amount proportional to its mass, a constant supply being kept up from an infinite distance,—in either case gravitation would be accounted for"

If this is not *essentially* the theory of "ether-squirts" which "the author has ventured to put forward," what then is the ether-squirt? The quotation just given occurs in Tait's seventh chapter, which, being empty of "red rags," probably failed to come within Prof Pearson's sphere of perception

Be it noted that we do not criticize our author's views as to the significance of such words as force and cause, but we cannot say we fancy his critical tone towards others. He himself uses the phrase "acceleration of A due to B," but warns the reader in a footnote against taking the phrase in its literal sense, yet anybody else from Newton down the centuries who has dared to use similar phrases is sneered at as a searcher after the unknowable "why"

For example, in his criticism of Newton's first law of motion, what right has he to say that Newton "was thinking of force in the sense of mediæval metaphysics as a cause of change in motion"? What is the perceptual or conceptual basis of this assumed certitude? Newton was probably thinking of *vis impressa*, the very grammatical form of which shows that there was nothing ultimate implied in the *vis* After discussing the various kinds of *vires* that have to be dealt with, and pointing out clearly by definitions and descriptions their precise meanings, Newton concludes one paragraph in these words —

"*Mathematicus duntaxat est hic conceptus. Nam virium causas et sedes physicas jam non expendo*"

Then a little further on we read —

"*Has vires non physice sed mathematice tantum considerando Unde caveat lector, ne per hujusmodi voces cogitet me speciem vel modum actionis causamve aut rationem physicam alicubi definire vel centris (quæ sunt puncta mathematica) vires vere et physice tribuere, si forte aut centra trahere, aut vires centrorum esse dixero*"

Can it be that Prof Pearson has never read Newton's "Principia," and has he forgotten that the complete title is "Philosophiæ Naturalis Principia Mathematica"? To insinuate that Newton's laws of motion (which, it should never be forgot, are intimately associated with the *Definitiones*) are incomplete because they may not possibly apply to corpuscles other than those of "gross" matter, to corpuscles of all imaginable types in short, implies a complete misapprehension of the whole purpose and scope of the "Principia" Again, our grammarian pounces upon the word "body," or *corpus*, as used by Newton, who should at least have used particle or corpuscle In Definition I will be found the meaning intended by Newton to be attached to the word *corpus*, but in any case the whole phraseology of the first law is quite intelligible to the candid mind Newton had a fine faith in his reader He gave the *Definitiones* and *Axiomata* in a form that appealed at once to the common experiences of thoughtful minds, and what more do we need?

Prof Pearson characterizes the second law as a "veritable metaphysical somersault How the imperceptible cause of change in motion can be applied in a straight line surpasses comprehension, &c" This may be smart, but is it relevant? Where does Newton define *Vis Motrix* as the "imperceptible cause of change in motion"?

We have not space to enter upon a discussion of the five laws of motion suggested by Sir Thomas Gresham's Professor of Geometry as a true non-metaphysical basis for all science They are good enough in their way, but they seem to lack that direct reference to ordinary facts of experience which is a desideratum of all physical axioms They begin with a dance of molecules and end with a measure of force Their ostensible merits are their logical form and their comprehensiveness—ether corpuscles as well as matter corpuscles being nominally included Yet we have to confess our inability to see that these laws of motion can effect more than Newton's Dynamics, in all its branches, still is Newtonian.

In its discussion of the meaning of scientific law, in its presentation of kinematic principles, and in its treatment of certain present-day speculations as to the constitution of matter and of ether, Prof Pearson's book is at once interesting and instructive There is much in it fitted to arrest the materialistic tendency of many who are devotees of science to the exclusion of all other intellectual activities. Yet its own conclusions are as materialistic as they well can be The automaton theory of the human will, and the spontaneous generation of life, are articles of its creed In the second last chapter we are treated to a choice collection of charming dogmatisms Perhaps the most charming of all is the author's "unwavering belief" that the hitherto undiscovered formulæ which are to make history a science

"can hardly be other than those which so effectually describe the relations of organic to organic and of organic to inorganic phenomena in the earlier phases of their development" A curious assertion, surely, for one to make who objects to Newton's laws of motion because they don't include imaginable but still unknown types of corpuscular motion The particular value, however, of this confession of faith is that it enables the confessor to convict of scientific heresy Prof Robertson Smith and all others who cannot regard it as other than an assumption To believe as Prof Pearson believes is to believe scientifically, all other belief is rotten As the "auld licht" dame said when telling over the number of the elect, "Ay, there's just me and John, and whiles I'm no that sure o' John" C G K

THE TEACHING OF THE PRINCIPLES OF CHEMISTRY

Laboratory Practice A Series of Experiments on the Fundamental Principles of Chemistry A Companion Volume to "The New Chemistry" By Josiah Parsons Cooke, LL D, Erving Professor, and Director of the Chemical Laboratory, Harvard University Pp 192 (London Kegan Paul, Trench, Trubner, and Co, 1892)

THIS little book represents another attempt to teach the theory of chemistry upon the basis of a narrowly restricted experience of facts and phenomena Whether this is possible is a question debatable, and still, in fact, debated among teachers That it is possible to make the study of chemistry by young people, as a form of intellectual exercise, more useful than has usually been the case there can be no doubt, and that much instruction could be got out of a course such as this which is indicated in Prof Cooke's little work is certain The book appears to be intended as a guide for the teacher as much as for the pupil, and much would depend upon the qualifications of the former for the work of demonstration and exposition It contains directions for the performance of a system of experiments, and to do justice to the system the teacher ought carefully to study the instructions given in the introduction, and to act upon them And to those who know anything of the manner in which chemistry is too often taught in the schools of this country, either by the visiting "science teacher," who knows little, or by the mathematical master, who usually knows nothing at all about the subject, such remarks as the following, taken from the introduction, will seem particularly welcome and appropriate

The author says

"Experiments are only of value as parts of a course of instruction logically followed out from beginning to end In such a course there must be necessarily a great deal to be filled out by the teacher, and this can vastly better be taught from his lips, with such illustrations as he can command, than from any books"

And again,

"The best apparatus will be of no use unless the teacher stands before it and speaks to his pupils out of the fulness of his own knowledge This is an essential condition of success, and without it the experimental method should never be attempted"

But after these things have all been duly noted and acted upon, a glance at the table of contents is apt to raise a doubt whether after all the erection of so large a superstructure is justifiable or practicable upon foundations so slender The book begins at p 13, and thence to p 52, with the exception of three or four pages about water, the whole is devoted to the physical properties of liquids and solids represented by water and air Then we come to oxygen, hydrogen, sulphur and its oxides, chlorine, carbon and the oxides of carbon, ethylene, nitrogen, nitric acid, ammonia, magnesium, zinc, sodium, copper, and iron, all of which are included in the fifty pages following Then comes a chapter on general principles, a third on molecules and atoms, followed by chapters on symbols and nomenclature, molecular structure, and thermal relations

This is not the first book which has appeared with similar objects In this country there have been Prof Ramsay's little book on "Chemical Theory," Muir and Carnegie's "Practical Chemistry," Shenstone's "Practical Introduction to Chemistry," and probably others, which seem to aim at dealing with chemistry in the same kind of way, which is intended to be a way of pleasantness and a short cut to rather exalted territory The road, however, is bordered by precipices unseen by the young traveller

The advocates of this kind of system, which consists in passing from one or two rough experiments, or observations, direct to great generalizations, anticipate great things from its general adoption All the rising generation who come under its influence are to possess greatly developed powers of observation and reasoning Some of those who have been accustomed to old-fashioned ways of getting a good grip of facts, and some stock of experience before proceeding to difficult investigation, are not convinced, and are inclined to doubt whether school boys and girls can be made to reason out for themselves problems which have cost for their elucidation the work of generations of men And the logic of the process is often more than questionable Here is an example (p 110) The law of the conservation of mass is supposed to be established by a single experiment, which consists in burning a bit of phosphorus in a jar, and showing that there is no loss of weight

"Hence it must be that, *The sum of the weights of the products of a chemical change is exactly equal to the sum of the weights of the factors* We may conceive of any chemical process as taking place in an hermetically sealed space—indeed the earth is essentially such a space —and hence this law must be universally true"

Here the process of induction is reduced to collecting a single instance, which is itself imperfect Surely this is not to stand as an example of the methods of physical science

One would not wish to be hard upon Prof Cooke's little book, but with many meritorious features it does not seem to represent a great improvement upon the books referred to above The naive statement at the end of the introduction, that the directions can in many cases be improved, cannot be held to excuse the rough and

slipshod character of some of the forms of experiment recommended The book will supply suggestions which will be found useful by some teachers, but the reference to apparatus unfamiliar on this side the Atlantic may be a slight bar to its adoption here W A T

OUR BOOK SHELF

Elementary Geography of the British Colonies By George M Dawson, LL D, F R S, and Alexander Sutherland, M A With Illustrations. (London Macmillan and Co, 1892)

THIS volume forms one of the well-known geographical series edited by Sir Archibald Geikie The part of it for which Dr Dawson is responsible is that which deals with the British possessions in North America, the West Indies, and the southern part of the South Atlantic Ocean Mr Sutherland describes the British colonies, dependencies, and protectorates in the northern part of the South Atlantic, Mediterranean Sea, Africa, Asia (exclusive of India and Ceylon, which are described in a separate volume of the series, by Mr H F Blanford), Australasia, and Oceania Both writers have enlightened ideas as to the needs of those for whom such books are prepared They have carefully avoided the bringing together of masses of uninteresting detail, their chief object being to convey a good general idea of the physical features and resources of the British colonies, and of the various ways in which these have affected the distribution of the population and the growth of industry and commerce The facts are presented simply and clearly, and every page contains statements which an intelligent teacher would have no difficulty in using as texts for pleasant and profitable instruction Most of the illustrations are from photographs, but there are also several very effective engravings from original drawings by Mr Pritchett

Farmyard Manure By C M Aikman, M A, B Sc (Edinburgh and London Blackwood, 1892)

WE are told in the preface that this little work is in substance a chapter from a larger work on "Soils and Manures," on which the author is at present engaged Perhaps we may be excused if we fail to see the necessity of publishing this chapter separately in advance It certainly contains much information from German works, such as Heiden's "Dungerlehre," but the book is written mainly from the chemist's point of view and not from the farmer's The pamphlet gives one the impression of having been hurriedly prepared, but no doubt its deficiencies will be remedied in the larger book

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications*]

Peripatus from St Vincent

SOME of the readers of NATURE will doubtless be interested to learn that, while collecting in St Vincent on behalf of the Committee appointed for the investigation of the fauna and flora of the Lesser Antilles, Mr H H Smith obtained five examples of the genus *Peripatus*.

The importance of the discovery, or rather rediscovery, of this Arthropod in St Vincent rests upon the fact that the Rev L Guilding procured the first recorded examples of the genus in this same island. A description of these, under the name *juliformis*, was published by this naturalist in 1826, in vol ii of the *Zoological Journal* But from that time until now, a period of 66 years, no additional specimens have been brought to light in this locality, and since Guilding's types have been lost sight of, and his description of them is wanting in detail, the identity of *juliformis* has been involved in considerable obscurity There can, however, be little if any doubt that the examples collected by Mr H H Smith are specifically identical with those that Guilding described Nevertheless this assumption receives more support from identity of locality than from the agreement that obtains between the description of *juliformis* and the specimens before me The largest of these measures 43 mm in length and 6 5 in width, the smallest, on the contrary, is only 13 mm long One example has 34 pairs of legs, two of them 33, one 30, and one 29 The colour of the lower surface may be described as fawn, that of the dorsal side varies from fawn to blackish grey

Those who are familiar with Mr Smith's qualifications as a collector need hardly be told that the specimens are on the whole in a satisfactory state of preservation I consequently hope to be able to prepare a detailed description of the species, to be incorporated in the report upon the Myriopoda of the Lesser Antilles, the identification of the species of this group, together with that of the Scorpions, Pedipalpi, and fresh-water Decapoda, having been kindly intrusted to my care by the members of the Exploration Committee R. I POCOCK

Natural History Museum, May 27

The Line Spectra of the Elements

I QUITE agree with Prof Stoney that Fourier's theorem can be applied to motions which approximate to non periodic motions in any assigned degree, and for any assigned time. And so the co ordinates of any arbitrary motion may approximately in any assigned degree and for any assigned time be represented by formulas of this kind —

$$a_0 + a_1 \sin\left(\frac{m_1 t}{j} + a_1\right) + a_2 \sin\left(\frac{m_2 t}{j} + a_2\right) + \dots + a_n \sin\left(\frac{m_n t}{j} + a_n\right),$$

where $m_1, m_2, \dots m_n$ are positive integers, and j must be chosen sufficiently large to suit the length of the assigned time This is not the point in Prof Stoney's reasoning to which I object

What I want to say is this If the motion is not periodical, the periods of the circular functions, as well as the amplitudes and phases, are not necessarily definite That is to say, if we choose a larger value of j, to get a closer approximation for a longer time, the values of $a, \frac{m}{j}, a$ do not necessarily approach definite values, but may become totally different

Take, for instance, the equation—

$$t = 2j\left[\sin\frac{t}{j} - \tfrac{1}{2}\sin\frac{2t}{j} + \tfrac{1}{3}\sin\frac{3t}{j} - \dots\right],$$

which holds good for all values of t between $-j$ and $+j$ Prof Stoney may say that Fourier's theorem can be applied to the function t So it can, certainly, if an interval is assigned But the amplitudes and periods of the single terms are not independent of the length of the interval, and do not approach definite values when the interval increases indefinitely

The time during which the approximation is to hold good need not be indefinitely long But the time must be long in comparison with the longest of the periods Motions of the ether that are represented by such functions will be resolved by a diffraction grating into different rays, but others will not. Prof Stoney has not noticed that a distinct property of the function is wanted in order to get a proper resolution into a sum of circular functions His reasonings in chapter iv of his memoir on the cause of double lines, &c (Transactions of the Royal Dublin Society, 1891), refer to all functions with or without this property, and therefore do not seem to me to be correct. But I admit that my expression in the passage quoted by Prof. Stoney might have been clearer C RUNGE

Techn Hochschule, Hannover, May 19

Maxwell's Law of Distribution of Energy.

IN the current number of the *Philosophical Magazine*, Lord Kelvin describes a dynamical system in which when in stationary

motion Maxwell's law of distribution of energy would fail, assuming that law to consist in the ultimate equality of the energy of different parts of the system. He has thus shown the necessity for more accurate language than is commonly employed in the enunciation of that law, and a consideration of his problem may help to determine the limits to which it is subject.

The following statement, whether co-extensive with Maxwell's law or not, will probably be accepted as true as far as it goes:—

If there exist a very great number of material systems, the state of each being defined by certain co ordinates and momenta, and if at a given instant all combinations of the co ordinates and momenta are represented among them with frequency proportional to $\epsilon^{-h(\chi+T)}$, then that distribution will be permanent—that is, will not be disturbed by the mutual action of the systems, or by any forces in the field of which they are placed, provided all the forces concerned be conservative.

The further question as to how far the solution thus found for the permanent state is unique, has been treated by Boltzmann. He shows that a certain function, which in stationary motion must be positive and constant, necessarily diminishes with the time, so long as any small deviations exist from the above described state. It is obvious that this proposition of Boltzmann's cannot be applicable to all cases of stationary motion. Periodic motions are exceptions, and so is the system described by Lord Kelvin. The question is what assumptions underlie Boltzmann's demonstration. It will be of great advantage if one speaking with Lord Kelvin's authority will assist in defining the limits to which the proposition is subject.

Maxwell, although he may at times have expressed himself incautiously, was aware that the theory was subject to limitations. The statistical, as distinguished from the historical, method was from his point of view of the essence of the theory. A distinction may be drawn between systems, such as Lord Kelvin's, to which the statistical method is inapplicable, and those in which the stationary motion, when attained, is what is called thermal motion—that is, the relative motions are in all directions indifferently, and of that irregular character in which heat is supposed to consist.

It may be that we shall be driven to the conclusion that Maxwell's law has no application except to this class of systems; that it is, in fact, only the limiting state to which a material system approaches as we increase indefinitely the number of its degrees of freedom.

It does, at all events, appear that in cases where the law fails, its failure is due to the introduction of some restrictions on freedom of motion, especially as regards direction. Maxwell pointed out that dæmons—or, shall we say, beings endowed with free will—might by directing the courses of individual molecules cause a system to violate, not only the law of distribution of energy, but even the second law of thermodynamics. What these beings might be supposed to do, that Lord Kelvin in fact does once for all for his system, by prescribing *a priori* the directions of motion and other conditions of the problem to suit his purpose.

H. W. WATSON.
S. H. BURBURY.

The Former Connection of Southern Continents

WITH reference to the very interesting question treated in Mr. Mellard Reade's letter of your issue of May 26 (p. 77), as to the former connection of southern continents, it may be worth while calling attention to the fact that a great circle, which I may call the Kaffraria Great Circle, connects that coast line with the Falkland Island and the South Georgia Island. It may be presumed that these two islands are the remaining summits of what was once a chain of mountains in connection with the continent of South America. Some of the points through which or near which this great circle passes are as follow:—the abovementioned islands, Port de Sta. Cruz, Patagonia; it traverses the Pacific, runs parallel to the southern branch of the Aleutian Islands, and cuts Kamtchatka somewhat south of Klienchewskaia Volcano, and traversing Asia emerges by the Island of Cutch, so interesting on account of the earthquakes which occurred there. It is of interest to note that South Georgia Island is antipodal to the northern extremity of Saghalian Island.

J. P. O'REILLY.

Royal College of Science for Ireland,
Stephen's Green, Dublin, May 30.

ON THE RELATIVE DENSITIES OF HYDROGEN AND OXYGEN.[1]

IN a preliminary notice upon this subject (Roy. Soc. Proc., vol. xliii. p. 356, February 1888), I explained the procedure by which I found as the ratio of densities 15·884. The hydrogen was prepared from zinc and sulphuric, or from zinc and hydrochloric, acid, and was liberated upon a platinum plate, the generator being in fact a Smee cell, inclosed in a vessel capable of sustaining a vacuum, and set in action by closing the electric circuit at an external contact. The hydrogen thus prepared was purified by corrosive sublimate and potash, and desiccated by passage through a long tube packed with phosphoric anhydride. The oxygen was from chlorate of potash, or from mixed chlorates of potash and soda.

In a subsequent paper "On the Composition of Water" (Roy. Soc. Proc., vol. xlv. p. 425, February 1889), I attacked the problem by a direct synthesis of water from weighed quantities of the two component gases. The ratio of atomic weights thus obtained was 15.89.

At the time when these researches were commenced, the latest work bearing upon the subject dated from 1845, and the number then accepted was 15.96. There was, however, nothing to show that the true ratio really deviated from the 16 : 1 of Prout's law, and the main object of my work was to ascertain whether or not such deviation existed. About the year 1888, however, a revival of interest in this question manifested itself, especially in the United States, and several results of importance have been published. Thus, Prof. Cooke and Mr. T. W. Richards found a number which, when corrected for an error of weighing that had at first been overlooked, became 15.869.

The substantial agreement of this number with those obtained by myself, seemed at first to settle the question, but almost immediately afterwards there appeared an account of a research by Mr. Keiser, who used a method presenting some excellent features, and whose result was as high as 15.949. The discrepancy has not been fully explained, but subsequent numbers agree more nearly with the lower value. Thus, Noyes obtains 15·896, and Dittmar and Henderson give 15.866.

I had intended further to elaborate and extend my observations on the synthesis of water from weighed quantities of oxygen and hydrogen, but the publication of Prof. E. W. Morley's masterly researches upon the "Volumetric Composition of Water" (*Amer. Journ. Sci.*, March 1891) led me to the conclusion that the best contribution that I could now make to the subject would be by the further determination of the relative densities of the two gases. The combination of this with the number 2.0002,[2] obtained by Morley as the mean of astonishingly concordant individual experiments, would give a better result for the atomic weights than any I could hope to obtain directly.

In the present work two objects have been especially kept in view. The first is simplicity upon the chemical side, and the second the use of materials in such a form that the elimination of impurities goes forward in the normal working of the process. When, as in the former determinations, the hydrogen is made from zinc, any impurity which that material may contain and communicate to the gas cannot be eliminated from the generator; for each experiment brings into play a fresh quantity of zinc,

[1] "On the Relative Densities of Hydrogen and Oxygen. II." Abstract of a paper by Lord Rayleigh, Sec. R.S., read at the Royal Society on February 18, 1892.

[2] It should not be overlooked that this number is difficult to reconcile with views generally held as to the applicability of Avogadro's law to very rare gases. From what we know of the behaviour of oxygen and hydrogen gases under compression, it seems improbable that volumes which are as 2.0002 : 1 under atmospheric conditions would remain as 2 : 1 upon indefinite expansion. According to the formula of Van der Waals a greater change than this in the ratio of volumes is to be expected.

with its accompanying contamination. Moreover, the supply of acid that can be included in one charge of the generator is inadequate, and good results are only obtained as the charge is becoming exhausted These difficulties are avoided when zinc is discarded The only material consumed during the experiments is then the water, of which a large quantity can be included from the first On the other hand, the hydrogen liberated is necessarily contaminated with oxygen, and this must be removed by copper contained in a red-hot tube In the experiments to be described the generator was charged with potash,[1] and the gases were liberated at platinum electrodes In the case of a hydrogen filling, the oxygen blew off on one side from a mercury seal, and on the other the hydrogen was conveyed through hot tubes containing copper The bulk of the aqueous vapour was deposited in a small flask containing strong solution of potash, and the gas then passed over solid potash to a long tube packed with phosphoric anhydride Of this only a very short length showed signs of being affected at the close of all operations

With respect to impurities, other than oxygen and oxides of hydrogen, which may contaminate the gas, we have the following alternative Either the impurity is evolved much more rapidly than in proportion to the consumption of water in the generator, or it is not If the rate of evolution of the impurity, reckoned as a fraction of the quantity originally present, is not much more rapid than the correspondingly reckoned consumption of water, the presence of the impurity will be of little importance If, on the other hand, as is probable, the rate of evolution is much more rapid than the consumption of water, the impurity is soon eliminated from the residue, and the gas subsequently generated becomes practically pure A similar argument holds good if the source of the impurity be in the copper, or even in the phosphoric anhydride, and it applies with increased force when at the close of one set of operations the generator is replenished by the mere addition of water It is, however, here assumed that the apparatus itself is perfectly tight

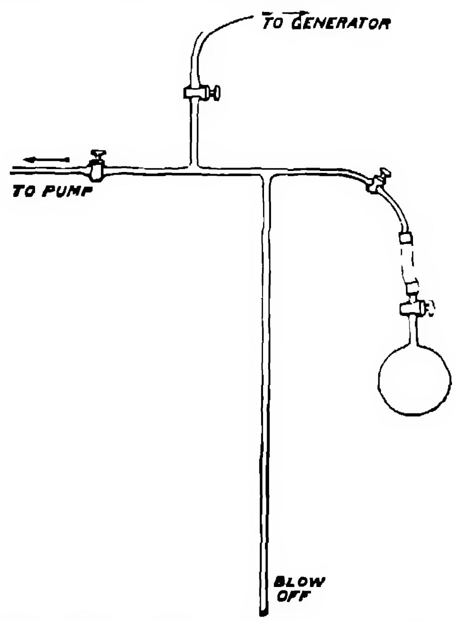
Except for the reversal of the electric current, the action of the apparatus is almost the same whether oxygen or hydrogen is to be collected In the latter case the copper in the hot tubes is in the reduced, and in the former case in the oxidized, state For the sake of distinctness we will suppose that the globe is to be filled with hydrogen

The generator itself is of the U-form, with unusually long branches, and it is supplied from Grove cells with about 3 amperes of electric current Since on one side the oxygen blows off into the air, the pressure in the generator is always nearly atmospheric Some trouble has been caused by leakage between the platinum electrodes and the glass In the later experiments to be here recorded these joints were drowned with mercury On leaving the generator the hydrogen traverses a red-hot tube of hard glass charged with copper,[2] then a flask containing a strong solution of potash, and afterwards a second similar hot tube. The additional tube was introduced with the idea that the action of the hot copper in promoting the union of the hydrogen with its oxygen contamination might be more complete after removal of the greater part of the oxygen, whether in the combined or in the uncombined state From this point onward the gas was nearly dry In the earlier experiments the junctions of the hard furnace tubes with the soft glass of the remainder of the apparatus were effected by fusion. One of these joints remained in use, but the others were replaced by india-rubber connexions *drowned in mercury* It is believed that no leakage occurred at these joints, but as an additional security a tap was provided between the generator and the furnace, and was kept closed whenever there was no forward current of hydrogen In this way the liquid in the generator would be protected from any possible infiltration of nitrogen Any that might find its way into the furnace tubes could easily be removed before the commencement of a filling

Almost immediately upon leaving the furnace tubes the gas arrives at a tap which for distinctness may be called the regulator In the generator and in the furnace tubes the pressure must be nearly atmospheric, but in the globe there is (at the commencement) a vacuum The transition from the one pressure to the other takes place at the regulator, which must be so adjusted that the flow through it is approximately equal to the production of gas At first the manipulation of the regulator was a source of trouble, and required almost constant attention, but a very simple addition gave the desired control This was merely a long wooden arm, attached to the plug, which served both as a lever and as an indicator Underneath the pointed extremity was a small table to which its motions could be referred During the first two-thirds of a filling very little readjustment was needed, and the apparatus could be left for half an hour with but little fear of displacing too much the liquid in the generator Towards the close, as the motive force fell off, the tap required to be opened more widely Sometimes the recovery of level could be more conveniently effected by insertion of resistance into the electric circuit, or by interrupting it altogether for a few minutes Into details of this kind it is hardly necessary to go further

From the regulator the gas passed to the desiccating tubes The first of these was charged with fragments of solid potash, and the second with a long length of phosphoric anhydride Finally, a tube stuffed with glass wool intercepted any suspended matter that might have been carried forward

The connection of the globe with the generator, with the Toppler, and with the blow off, is shown in the accompanying figure On the morning of a projected



filling the vacuous globe would be connected with the free end of the stout-walled india-rubber tube, and secured by winding wire The generator being cut off, a high vacuum would be made up to the tap of the globe

[1] At the suggestion of Prof Morley, the solution was freed from carbonate or nearly so, by the use of baryta, of which it contained a slight excess.

[2] The copper must be free from sulphur, otherwise the contamination with sulphuretted hydrogen is somewhat persistent

After a couple of hours' standing the leakage through the india-rubber and at the joints could be measured. The amount of the leakage found in the first two hours was usually negligible, considered as an addition to a globe-ful of hydrogen, and the leakage that would occur in the hours following would (in the absence of accidents) be still smaller. If the test were satisfactory, the filling would proceed as follows:—

The electric current through the generator being established, and the furnace being heated, any oxygen that might have percolated into the drying tubes had first to be washed out. In order to do this more effectively, a moderate vacuum (of pressure equal to about 1 inch of mercury) was maintained in the tubes and up to the regulator by the action of the pump. In this way the current of gas is made very rapid, and the half-hour allowed must have been more than sufficient for the purpose. The generator was then temporarily cut off, and a high vacuum produced in the globe connection and in the blow-off tube, which, being out of the main current of gas, might be supposed to harbour impurities. After this the pump would be cut off, the connection with the generator re-established, and, finally, the tap of the globe cautiously opened.

The operation of filling usually occupied from two to three hours. When the gas began to blow off under an excess of pressure represented by about half an inch of mercury, the blow-off cistern was lowered so as to leave the extremity of the tube free. For two minutes the current of gas from the generator was allowed to flow through, after which the generator was cut off, and the globe left in simple communication with the atmosphere, until it was supposed that equilibrium of pressure had been sufficiently established. Doubts have at various times been felt as to the interval required for this purpose. If too little time is allowed, there will remain an excess of pressure in the globe, and the calculated weight of the filling will come out too high. On the other hand, an undue prolongation of the time might lead to a diffusion of air back into the globe. In a special experiment no abnormal weight was detected after half an hour's communication, so that the danger on this side appeared to be small. When the passages through the taps were free from grease, one or two minutes sufficed for the establishment of equilibrium, but there was always a possibility of a partial obstruction. In the results to be presently given, four minutes were allowed after the separation from the generator. It may be remarked that a part of any minute error that may arise from this source will be eliminated in the comparison with oxygen, which was collected under like conditions.

The reading of the barometers and thermometers at the moment when the tap of the globe was turned off took place as described in the former paper. The arrangements for the weighings were also the same.

In the evacuations the process was always continued until, as tested by the gauge of the Toppler after at least a quarter of an hour's standing, the residue could be neglected. Here, again, any minute error would be eliminated in the comparison of the two gases.

In the case of oxygen, the errors due to contamination (even with hydrogen) are very much diminished, and similar errors of weighing tell very much less upon the proportional agreement of the final numbers. A comparison of the actual results with the two kinds of gas does not, however, show so great an advantage on the side of the oxygen as might have been expected. The inference appears to be that the individual results are somewhat largely affected by temperature errors. Two thermometers were, indeed, used (on opposite sides) within the wooden box by which the globe is surrounded, and they could easily be read to within $\frac{1}{20}$° C. But in other respects, the circumstances were unfavourable, in consequence of the presence in the same room of the furnace necessary to heat the copper. An error of ± 0·1 C. in the temperature leads to a discrepancy of 1 part in 1500 in the final numbers. Some further elaboration of the screening arrangements actually employed would have been an improvement, but inasmuch as the circumstances were precisely the same for the two gases, no systematic error can here arise. The thermometers were, of course, the same in the two cases.

The experiments are grouped in five sets, two for oxygen and three for hydrogen. In each set the work was usually continued until the tap of the globe required re-greasing, or until, owing to a breakage or to some other accident, operations had to be suspended.

The means are as follow:—

HYDROGEN

1891	Weight	Bar. temp., F.	Globe temp., C.	Corrected to 12°
	grams	°	°	grams
July	0·15808	65	18	0·158056
September	0·15797	61	17	0·157950
October	0·15804	53	12	0·158040
Mean		60	16	0·158015

OXYGEN

1891	Weight	Bar. temp., F.	Globe temp., C.	Corrected to 12°
	grams	°	°	grams
June	2·51785	68	20	2·51735
November	2·51720	55	13	2·51713
Mean		61½	16½	2·51724

The means here exhibited give the weights of the two gases as they would be found with the globe at 12° C., and the barometers at 60° F. and at 30 inches. The close agreement of the mean temperatures for the two gases shows how little room there is for systematic error dependent upon imperfections in the barometers and thermometers. But the results still require modification before they can be compared with the view of deducing the relative densities of the gases.

In the first place, there is a systematic, though minute, difference in the pressures hitherto considered as corresponding. The terminal of the blow-off tube is 33 inches below the centre of the globe at the time of filling. In the one case this is occupied by hydrogen, and in the other by oxygen. If we treat the latter as the standard, we must regard the hydrogen fillings as taking place under an excess of pressure equal to $\frac{15}{16}$ of the weight of a column of oxygen 33 inches high, and this must be compared with 30 inches of mercury. Hence, if we take the sp. gr. of oxygen under atmospheric conditions at 0·0014, and that of mercury at 13·6, the excess of pressure under which the hydrogen was collected is as a fraction of the whole pressure

$$\frac{33}{30} \cdot \frac{15}{16} \cdot \frac{0 \cdot 0014}{13 \cdot 6} = 0 \cdot 000106,$$

and 0·000106 × 0·158 = 0·000017. This, then, is what we must subtract from the weight of the hydrogen on account of the difference of pressures due to the gas in the blow-off tube. Thus

$$H = 0 \cdot 157998, \qquad O = 2 \cdot 51724.$$

But there is still another and a more important correction to be introduced. In my former paper it was shown that when the weighings are conducted in air the true weight of the gas contained in the globe is not given

by merely subtracting the weight of the globe when empty from the weight when full. When the globe is empty, its external volume is less than when full, and thus, in order to obtain the true weight, the apparent weight of the gas must be increased by the weight of air whose volume is equal to the change of volume of the globe.

In order to determine the amount of this change of volume, the globe is filled to the neck with recently boiled distilled water, and the effect is observed upon the level in the stem due to a suction of, say, 20 inches of mercury. It is not advisable to carry the exhaustion much further, for fear of approaching too nearly the point at which bubbles of vapour may be formed internally. In the earlier experiments, described in the preliminary note, the upper surface of the liquid was in the stem of the globe itself (below the tap), and the only difficulty lay in the accurate estimation of a change of volume occurring in a wide and somewhat irregular tube. The method employed was to produce, by introduction of a weighed quantity of mercury, a rise of level equal to that caused by the suction.

The advantage of this procedure lay in the avoidance of joints and of the tap itself, but, for the reasons given, the readings were not quite so accurate as might be desired. I wished, therefore, to supplement, if possible, the former determination by one in which the change of volume occurred in a tube narrower and of better shape. With this object in view, the stem of the globe was prolonged by a graduated tubular pipette attached with the aid of india-rubber. The tubes themselves were treated with gutta-percha cement, and brought almost into contact. It had hardly been expected that the joint would prove unyielding under the applied suction, but it was considered that the amount of the yielding could be estimated and allowed for by operations conducted *with tap closed*. The event, however, proved that the yielding at the joint was scarcely, if at all, perceptible.

The pipette, of bore such that 16 cm. corresponded to 1 c.c., was graduated to 0·01, and was read by estimation to 0·001 c.c. In order the better to eliminate the changes due to temperature, readings under atmospheric pressure, and under a suction of 20 inches of mercury, were alternated. On January 28, 1892, a first set gave 0·648 − 0·300 = 0·348, a second gave 0·6645 − 0·316 = 0·3485, and a third gave 0·675 − 0·326 = 0·349. Similar operations with tap closed[1] gave no visible movement.

The result of the day's experiments was thus 0·3485 for 20 inches, or 0·523 for 30 inches, suction. Similar experiments on January 28, at a different part of the graduation, gave 0·526. On this day the yielding with tap closed was just visible, and was estimated at 0·001. As a mean result, we may adopt 0·524 c.c. The graduation of the pipette was subsequently verified by weighing a thread of mercury that occupied a measured length.

A part of the above-measured volume is due to the expansion of the water when the pressure is relieved. We may take this at 0·000047 of the volume per atmosphere. The volume itself may be derived with sufficient accuracy for the present purpose from the weight of its oxygen contents. It is 2·517/0·00137, or 1837 c.c. The expansion of the water per atmosphere is thus 0·000047 × 1837, or 0·087 c.c. This is to be subtracted from 0·524, and leaves 0·437 c.c. This number applies strictly to the volume inclosed within the glass, but the change in the external volume of the globe will be almost the same.

The correction now under consideration is thus the weight of 0·437 c.c. of air at the average temperature of the balance room. The density of this air may be estimated at 0·00122; so that the weight of 0·437 c.c. is 0·000533 gram. This is the quantity which must be added to the apparent weights of the gases. The former estimate was 0·00056 gram. The finally corrected weights are thus—

$$H = 0{\cdot}158531, \qquad O = 2{\cdot}51777,$$

and for the ratio of densities we have

15·882.

This corresponds to a mean atmospheric condition of pressure and temperature.

If we combine the above ratio of densities with Prof. Morley's ratio of volumes, viz. 2·0002 : 1, we get, as the ratio of atomic weights, 15·880.

If we refer to the table, we see that the agreement of the first and third series of hydrogen weighings is very good, but that the mean from the second series is decidedly lighter. This may have been in part fortuitous, but it is scarcely probable that it was so altogether. Under the circumstances we can hardly reckon the accuracy of the final results as closer than $\frac{1}{1000}$.

The accompanying table of results, found by various experimenters, may be useful for comparison:—

Name	Date	Atomic weights	Densities
Dumas	1842	15·96	—
Regnault	1845	—	15·96
Rayleigh	1888	—	15·884
Cooke and Richards	1888	15·869	—
Keiser	1888	15·949	—
Rayleigh	1889	15·89	—
Noyes	1890	15·896	—
Dittmar	1890	15·866	—
Morley	1891	15·879	—
Leduc	1891	—	15·905
Rayleigh	1892	—	15·882

[1] For greater security the tap was turned while the interior was under suction.

THE ORIGIN OF THE YEAR.[1]

II.

Difficulties.

THERE no doubt was a time when the Egyptian astronomer-priests imagined that, by the introduction of the 365-days year, beginning at the solstice or the nearly contemporaneous Nile flood (there is an interval of three days between them in the present Coptic calendar[2]), and by marking the commencement, in addition, by the heliacal rising of one of the host of heaven, they had achieved finality. But alas! the dream must soon have vanished.

Even with this period of 365 days, the true length of the year had not been reached; and soon, whether by observations of the beginning of the inundation, or by observations of the solstice in some of the solar temples which, beyond all doubt, were then in existence, it was found that there was a difference of a day every four years between the beginning of the natural and of the newly-established year, arising, of course, from the fact that the true year is 365 days *and a quarter of a day* (roughly) in length.

The true year and this established year of 365 days, then, behaved to each other as follows. Let us take a year when the solstice, representing the beginning of the

[1] Continued from vol. xlv. p. 490.

[2] The calendar in question (given both by Brugsch and De Rougé) is, doubtless, a survival from old Egyptian times. It is good for the neighbourhood of Cairo, and the relation of the important days of the inundation to the solstice, in that part of the river, is as follows:—

Night of the drop	11 Payni	
	15 ,,	Summer solstice.
Beginning of the inundation	18 ,,	3 days after
Assembly at the Nilometer	25 ,,	10 ,,
Proclamation of the inundation	26 ,,	11 ,,
Marriage of the Nile	18 Mesori	63 ,,
The Nile ceases to rise	16 Thoth	96 ,,
Opening of the dams	17 ,,	97 ,,
End of the greater inundation	7 Phaophi	117 ,,

true year, occurred on the 1st Thoth of the established year We should have, in the subsequent years, the state of things described in the diagram The solstice

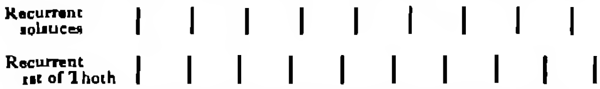


FIG. 2 —Showing the relation between the recurrences of the solstices and the 1st of Thoth

would year by year occur *later* in relation to the 1st of Thoth The 1st of Thoth would occur *earlier*, in relation to the solstice, so that in relation to the established year the solstice would sweep forwards among the days, in relation to the true year the 1st of Thoth would sweep backwards

Let us call the true natural year a *fixed* year it is obvious that, the months of the 365-day year would be perpetually varying their place in relation to those of the fixed year Let us, therefore, call the 365-day year a *vague* year

Now if the fixed year were exactly 365¼ days long, it is quite clear that, still to consider the above diagram, the 1st of Thoth would again coincide with the solstice in 1460 years, since in 4 years the solstice would fall on the 2nd of Thoth, in 8 years on the 3rd of Thoth, and so on $(365 \times 4 = 1460)$

But the fixed year is not 365¼ days long *exactly* In the time of Hipparchus 365 25 did not really represent the true length of the solar year, instead of 365 25 we must write 365 242392—that is to say, the real length of the year is a little *less* than 365¼ days

Now the length of the year being a little *less*, of course we should only get a second coincidence of the 1st of Thoth vague with the solstice in a *longer* period than the 1460-years cycle, and, as a matter of fact, 1506 years are required to fit the months into the years with this slightly shortened length of the year In the case of the solstice and the vague year, then, we have a cycle of 1506 years

The variations between the fixed and vague years were known perhaps for many centuries to the priests alone They would not allow the established year of 365 days, since called the *vague* year, to be altered, and so strongly did they feel on this point that, as already stated, every king had to swear when he was crowned that he would not alter the year We can surmise why this was It gave great power to the priests, they alone could tell on what particular day of what particular month the Nile would rise in each year, because they alone knew in what part of the cycle they were, and in order to get that knowledge they had simply to continue going every year into their Holy of Holies one day in the year as the priests did afterwards in Jerusalem, and watch the little patch of bright sunlight coming into the sanctuary That would tell them exactly the relation of the true solar solstice to their year, and the exact date of the inundation of the Nile could be predicted by those who could determine observationally the solstice, but by no others

But now suppose that instead of the solstice we take the heliacal rising of Sirius, and compare the successive risings at the solstice with the 1st of Thoth

But why, it will be asked, should there be any difference in the length of the cycles depending upon successive coincidences of the 1st of Thoth with the solstice and the heliacal rising of Sirius? The reason is that stars change their places, and the star to which they trusted to warn them of the beginning of a new year was, like all stars, subject to the effects brought about by the precession of the equinoxes Not for long could it continue to rise heliacally either at the solstice or the Nile flood

Among the most important contributors to the astronomical side of this subject are M. Biot and Prof Oppolzer It is of the highest importance to bring together the fundamental points which have been made out by their calculations We have determinate references to the heliacal rising of Sirius, to the 1st of Thoth, to the solstice, and to the rising of the Nile in connection with the Egyptian year, but, so far as I have been able to make out, we find nowhere at present any sharp reference to the importance of their correlation with the times of the *tropical* year at which these various phenomena took place The question has been complicated by the use by chronologists of the Julian year in such calculations, so the Julian year and the use made of it by chronologists have to be borne in mind. Unfortunately, many side issues have in this way been raised

The heliacal rising of Sirius, of course—if in those days a true *tropical* year was being dealt with—would have given us a more or less constant variation in the time of the rising over a long period, *on account of its precessional movement*, but M Biot and others before him have pointed out that the variation in the time of the year at which the heliacal rising took place, produced by that movement, was almost exactly equal to the error of the *Julian* year as compared with the true tropical or Gregorian one Biot showed by his calculations, using the solar tables extant before those of Leverrier, that from 3200 B C to 200 B C in the Julian year of the chronologists, Sirius had constantly, in each year, risen heliacally on July 20 Julian = June 20 Gregorian Oppolzer, more recently, using Leverrier's tables, has made a very slight correction to this, which, however, is practically immaterial for the purposes of a general statement He shows that in the latitude of Memphis, in 1600 B C, the heliacal rising took place on July 18 6, while in the year 0 it took place on July 19 7, both Julian dates

The variation from the true tropical year brought about by the precessional movement of Sirius or any other star, however, can be watched by noting its heliacal rising in relation to any physical phenomenon which marks the true length of the tropical year Such a phenomenon we have in the rising of the Nile, which, during the whole course of historical time, has been found to rise and fall with absolute constancy in each year, the initial rise of the waters, some little way above Memphis, taking place very nearly at the summer solstice

Again, M Biot has made a series of calculations from which we learn that the heliacal rising of Sirius AT THE SOLSTICE occurred on July 20 (Julian) in the year 3285 B C, and that in the year 275 B C the *solstice* occurred on June 27 (Julian), while the heliacal *rising of Sirius* took place, as before, on July 20 (Julian), so that in Ptolemaic times, at Memphis, there was a difference of time of about 24 days between the heliacal rising of Sirius and the solstice, and therefore the beginning of the Nile flood in that part of the river This, among other things, is shown in Fig 3

We learn from the work of Biot and Oppolzer then that the precessional movement of the star caused successive heliacal risings of Sirius at the solstice to be separated by almost exactly 365¼ days—that is, by a greater period than the length of the true year. So that, in relation to this star, two successive heliacal risings at the 1st of Thoth vague are represented by a period of $(365\frac{1}{4} \times 4 =)$ 1461 years, while in the case of the solstices we want 1506

Now in books on Egyptology the period of 1461 years is termed the Sothic period, and truly so, as it very nearly correctly measures the period elapsing between two heliacal risings at the solstice (or the beginning of the Nile flood) on the 1st of Thoth in the *vague* year

But it is merely the result of *chance* that 365¼ × 4 represents it It has been stated that this period had not any ancient existence, but was calculated back in later times. This seems to me very improbable I look upon it rather as a true result of observation, the more so as the period was shortened *in later times*, as Oppolzer has shown

It will be seen that our investigations land us in several astronomical questions of the greatest interest, and that the study is one in which modern computations, with the great accuracy which the work of Leverrier and others give to them, can come to the rescue, and eke out the scantiness of the ancient records. tremendously involved state of the problem may be gathered from the fact that the authorities are not yet decided whether many of the dates really belong to a fixed or a vague year!

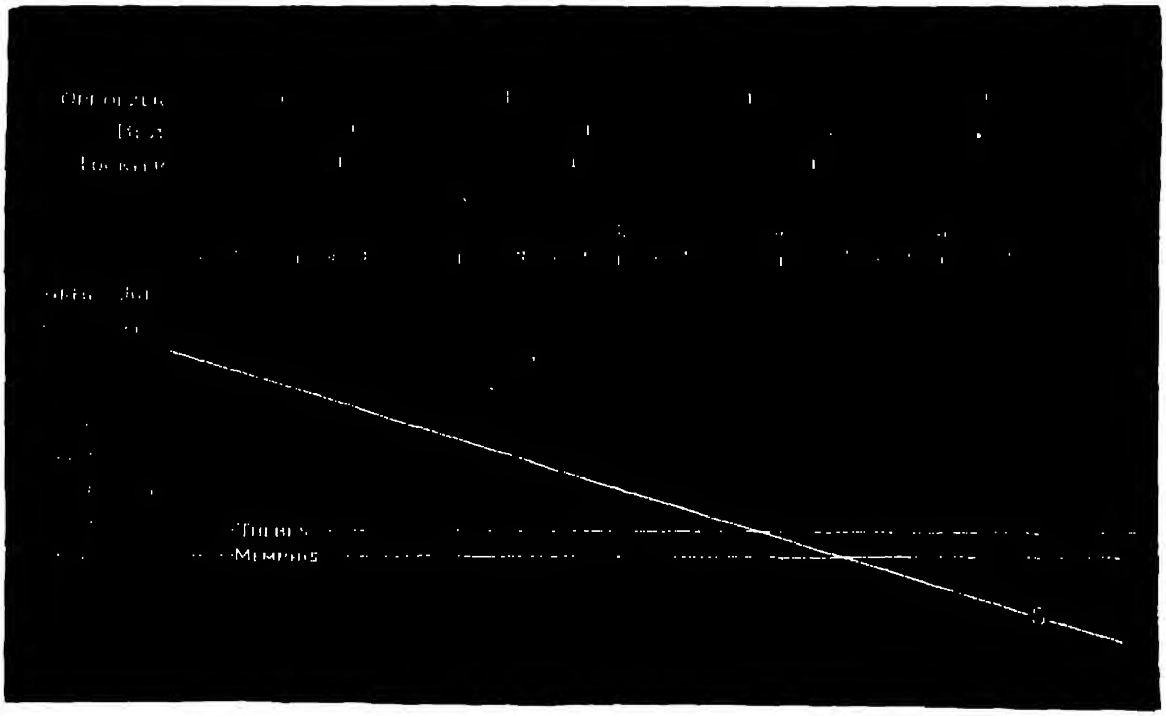


FIG. 3.—The conditions of the heliacal rising of Sirius from 4000 B.C. to 600 A.D. The diagram shows (1) by white horizontal lines, the Gregorian and Julian dates for the rising at Thebes and at Memphis. (2) By the full diagonal line the *Julian* date of the solstice or beginning of the inundation in each century, at a point of the river near Memphis. The fainter lines show the Julian dates for other places where the time of the beginning of the flood differs by three days from the Memphis dates. The interval between each line represents a difference of three days in the arrival of the flood. (3) The interval in days between the heliacal rising and the inundation at different periods and at different points on the river. This can be determined for each century by noticing the interval between the proper diagonal line and that indicating the heliacal rising. (4) By dots at the top of the diagram the commencement of the Sothic period as determined by Oppolzer, Biot, and the author.

others give to them, can come to the rescue, and eke out the scantiness of the ancient records.

To consider the subject further, we must pass from the mere question of the year to that of chronology generally,

Let us, rather, put ourselves in the place of the old Egyptians, and inquire how, out of the materials they had at hand, a calendar could be constructed in the simplest way.

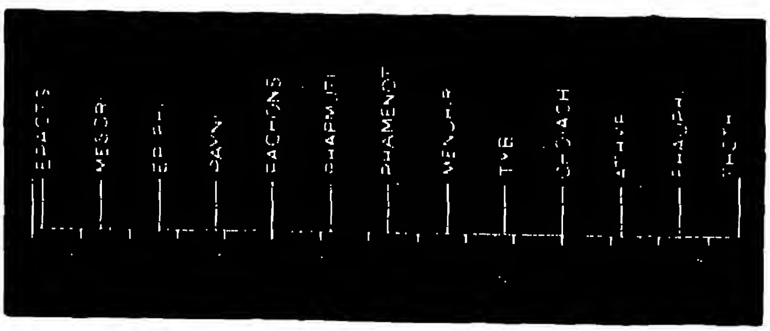


FIG. 4.—The distribution of the 1st of Thoth (representing the rising of Sirius) among the Egyptian months in the 1460 year Sothic cycle.

but in doing so I shall limit myself to the more purely astronomical part. To go over the already vast literature is far from my intention, nor is it necessary to attempt to settle all the differences of opinion which exist, and which are so ably referred to by Krall in his masterly analysis, to which I own myself deeply indebted. The

To make what follows clearer, it will be well to construct another diagram somewhat like the former one.

Let us map out the 1460 years which elapsed between two successive coincidences between the 1st of Thoth in the vague year and the heliacal rising of Sirius at the solstice, so that we can see at a glance the actual num-

ber of years from any start point (= 0) at which the 1st of Thoth in the vague year occurred successively further and further from the heliacal rising, until at length, after a period of 1460 years, it coincided again

As the Sirius-year is longer than the vague one, the first vague year will be completed before the first Sirius-year, hence the second vague year will commence just before the end of the fixed year, and that is the reason that I have reversed the order of months in the diagram (Fig 4)

Now it is clear that, if the Egyptians really worked in this fashion, any special day in the vague year given as the date of the heliacal rising of Sirius would enable us to determine the number of years which had elapsed from the beginning of the cycle This will help us to determine whether or not they acted on this principle, or used one widely different In such an investigation as this, however, we are terribly hampered by the uncertainty of Egyptian dates, while, as I have said before, there is great divergence of opinion among Egyptologists as to whether, from very early times, there was not a true fixed year

But let us suppose that the vague year was in use, and that the rising of Sirius started the year, then, if we can get any accepted date to work with, and use the diagram to see how many years had elapsed between that date and the start-point of the cycle, we shall see if there be any cyclical relation, and if we find it, it will be evidence, so far as it goes, of the existence of a vague year

Now it so happens that there are three references, with dates given, to the rising of Sirius in widely different times, and, curiously enough, the month references are nearly the same I begin with the most recent, as in this case the date can be fixed with the greater certainty It is an inscription at Philæ, described by Brugsch (p 87), who states that, when it was written, the 1st of Thoth = 28th of Epiphi That is, according to the view we are considering, the heliacal rising of Sirius occurred on the 28th of Epiphi in the vague year He fixes the date of the inscription between 127 and 117 B C Let us take it as 122 Next, referring to our diagram to find how many years had elapsed since the beginning of the cycle, we have—

Days
5 Epacts
30 Mesori
2 Epiphi
—
37 × 4 = 148 years elapsed

The cycle, then, began in (148 + 122 =) 270 B C

We next find a much more ancient inscription recording the rising of Sirius on the 28th of Epiphi Obviously, if the Sothic cycle had anything to do with the matter, this must have happened 1458 years earlier, *i e* about (1458 + 122 =) 1580 B C Under which king? Thotmes III, who reigned, according to Lepsius, 1603-1565 B C, according to Brugsch, 1625-1577 Now, the inscription in question is stated to have been inscribed by Thotmes III, and, it may be added, on the temple (now destroyed) at Elephantiné

There is yet another inscription, also known to be of a still earlier period, referring to the rising of Sirius on the 27th of Epiphi We may neglect the difference of one day, and again, if the use of the Sothic cycle were the origin of the identity of dates, we have this time, according to Oppolzer, a period of 1460 years to add this gives us (1584 + 1460 =) 3044 B C Again under which king? Here we are face to face with one of the difficulties of these inquiries It may be stated, however, that the inscription is ascribed to Pepi, and that, according to various authorities, he reigned some time between 3000 and 3700 B C

We come, then, to this that one of the oldest dated inscriptions known seems to belong to a system which continued in use at Philæ up to about 100 B.C, and it was essentially a system of a vague year

Now, assuming that the approximate date of the earliest inscription is 3044 B C, and that it represented the heliacal rising of Sirius on the 27th of Epiphi, the year 3044 must have been the [(5 + 30 + 3) × 4 =] 152nd after the beginning of the cycle The cycle, then, must have commenced (3044 + 152 =) 3196 B C

According to Biot's calculation, the first heliacal rising of Sirius at the solstice took place in the year 3285 B C,

If we assume that the real date of Pepi, who, it is stated, reigned 100 years, included the year 3044 B C, it may be that the inscriptions to which I have directed attention give us three Sothic cycles beginning—

122 + 148 = 270 B C
1580 + 148 = 1728 B C
3044 + 148 = 3192 B C

J NORMAN LOCKYER

(To be continued)

NOTES

THE list of those on whom honorary degrees are to be conferred at Cambridge on the occasion of the installation of the Duke of Devonshire as Chancellor shows that culture, and especially scientific culture, goes for very little among the classes of distinction recognized by the University Eminence in the political world and in society seems to be the claim chiefly recognized

SCIENCE was well represented at the annual dinner of the Incorporated Society of Authors on Tuesday The chair was occupied by Prof Michael Foster, and Sir Archibald Geikie was one of those who responded to the toast of "Literature"

DR A F BATALIN has been appointed Director of the Imperial Botanic Garden at St Petersburg, in succession to the late Dr E Regel

THE ninety seventh meeting of the Yorkshire Naturalists' Union will be held on Whit Monday, June 6 Some interesting notes on the physical geography and geology, botany, entomology, conchology, and vertebrate zoology of the district have been issued for the benefit of those who intend to be present We are glad to see that members are expected to "do all in their power to discourage the uprooting of ferns and rare plants, or the too free collection of rarities of any kind"

THE Botanical Society of France has held its annual meeting at Algiers, commencing April 16, under the presidency of the Algerian botanist, M Battandier In addition to the reading of papers, excursions were made to Biskra, and other spots on the border of the Sahara

WE have received the programme of the ninth International Congress of Orientalists It is to be held in London from September 5 to 12, Prof Max Muller acting as President. The Duke of Connaught has accepted the office of Honorary President The following are the Vice Presidents the Marquis of Ripon, Lord Northbrook, Lord Reay, Major-Gen Sir Henry Rawlinson, the Rt Hon Sir M E Grant Duff, Sir John Lubbock, Sir William Muir, Sir William W Hunter, Sir George Birdwood, Sir William Markby, Sir Edwin Arnold, the Provost of Oriel College, Oxford, the Master of Balliol College, Oxford, the Master of Christ's College, Cambridge, H S King, and M M. Bhownuggree The Treasurer is Mr E Delmar Morgan The Honorary Secretaries are the Rev C D Ginsburg, D D, Prof T W Rhys Davids, the Rev E. W Bullinger, D D, Prof A A Macdonell, M M. Bhownuggree, the Raja Peari Mohan Mukharji (for Bengal), Prof. Peterson (for Bombay) Many eminent foreign scholars and members of former Congresses have signified their adhesion, and several important Societies have undertaken to send delegates. The sections into which the work of the Con-

gress has been provisionally divided, are the following (the name of the President being in each case given first, that of the Secretary second) —I Aryan, Prof Cowell, Prof A A Macdonell, II Semitic (*a*) Assyrian and Babylonian, Prof A H Sayce, T G Pinches, (*b*) General, Prof Robertson Smith, A A Bevan, III China and the Far East, Sir Thomas Wade, (for China) Prof Douglas, (for Japan) Prof B H Chamberlain, IV Egypt and Africa, Prof Le Page Renouf, E Budge, V Australasia and Oceania, Sir Arthur Gordon, Rev R H Codrington, D D, VI Anthropological and Mythological, Dr E B Tylor, VII Indian, Lord Reay, Prof T W Rhys Davids, VIII Geographical, Sir M. E. Grant Duff, Halford J Mackinder, IX Archaic Greece and the East, the Rt Hon. W E Gladstone

THE Committee of the two International Congresses of Prehistoric Archæology and Zoology, which will be held at Moscow this summer in connection with the Geographical and Anthropological Exhibition, has announced, in accordance with a decision of the Russian Railway Department, that all members of the Congresses and exhibitors at the Exhibition may obtain tickets with a 50 per cent reduction for travelling to Moscow and back Exhibits may be sent and will be returned on the same terms As there are at Moscou two different Societies, the Société des Naturalistes de Moscou and the Society of Friends of Natural Science (*Obschestvo Lubitelei Estestvoznaniya*), it may be worth while to note that it is the latter which is organizing the Exhibition and the two Congresses, and to which all applications for the Exhibition must be made

IT is stated that the Secretary of State for the Colonies has appointed Miss Doberck, formerly Government Meteorological Observer in Sligo, to be Assistant Meteorologist in Hong Kong Miss Doberck's father has for some years past been the head of the Meteorological Observatory in Hong Kong

LIEUTENANT-COLONEL HOLDICH, of the Survey of India, will, it is said, personally superintend the mapping out of Captain Bower's journey across Tibet The work will be done in the Survey drawing offices at Simla, where Captain Bower is at present engaged in preparing the report of his journey

IT is bad news for farmers that the diamond back moth has made its appearance in Yorkshire and Northumberland Specimens from both counties have been identified by Miss Ormerod

THE weather during the past week has been noteworthy for the occurrence of thunderstorms, copious rainfall at nearly all places, and excessive temperatures at most of the English stations In London a severe thunderstorm was experienced on Thursday morning, May 26 (succeeding one that occurred the previous evening), with a heavy downpour of rain varying from 0 7 inch to 1 0 inch in different parts of the metropolis. At 8h. a.m on Saturday the thermometer registered 76° in London, being the highest recorded at that hour this year. The type of wind has been cyclonic, with light or moderate south westerly breezes generally The Meteorological Office report for the week ending May 28, shows that the rainfall was equal to the normal value in the south and east of England, and exceeded it in all other districts, while in the northern parts, in Ireland and in Scotland, the fall was about three times as much as the mean. On Sunday the temperature was considerably lower, but since then it has again become abnormally high, the maxima in the shade registering 75° and upwards in places over the southern parts of the kingdom, 83° being registered in London on Tuesday, and thunder-showers occurred in various places on that day

THE detailed despatches brought to Marseilles from Port Louis by the mail steamer *Australien* confirm all that was stated in the telegrams relating to the hurricane which devastated Mauritius on April 29 A Reuter's telegram from Marseilles, giving a summary of the despatches, says that the total number of lives lost amounted to 1200, while the list of persons injured exceeded 4000 Strong magnetic disturbances were noticed on April 25, and continued with increasing intensity on the three following days. Several well-defined groups of sun-spots were also noticed at the same time On the afternoon of the 28th, the eve of the hurricane, there was a vivid display of lightning and a good deal of thunder, while the air grew peculiarly heavy On the following morning the tempest broke over the island in all its fury, the velocity of the wind at times reaching 112 miles an hour The sea rose 9 feet above its usual level, a thing unknown since the terrible cyclone of 1818, when the water rose nearly four metres. In Port Louis itself houses fell to the ground in nearly every street In the Tringlar quarter not a single house was left standing In fact, there is scarcely a house in the entire colony which does not show some signs of the fury of the storm Half the sugar crop has been destroyed An immense number of persons were overwhelmed and killed by the ruins of the falling houses, or were stricken down in the streets, as they fled, by the falling stones and wreckage

A VERY destructive cyclone passed over various towns in Kansas, on May 27. The storm gave no signs of its approach Travelling in a north easterly direction, it struck Wellington (a town containing a population of 10,000) at nine o'clock in the evening, when most people were indoors Within a few seconds the central parts of the town coming within its track were devastated from end to end Wellington Avenue, the principal business street, is lined on both sides with ruins, whole blocks of buildings having been shaken and overthrown as violently as if the place had been rocked by an earthquake Numbers of victims were buried in the ruins, and of those who momentarily survived many were found struggling for their lives in order to escape from the flames which broke out in all directions in consequence of the sudden escape of gas The towns of Harper and Argona were also visited by the cyclone. In the former town seven people were killed in the wreck of the buildings, and five at the latter It is estimated that between twenty and thirty people lost their lives in the cyclone, while seventy others have been more or less injured

ON Tuesday, May 3, a fall of hail mixed with foreign particles was observed in Stockholm, and appears to have extended as far as Christiania The fall of dust lasted from 1 to 8 p m, and was abundant enough to allow of considerable quantities being collected At a meeting of the Geologiska Forening in Stockholm, remarks were made by Baron Nordenskiold, and Messrs N Holst, E Svedmark, and Tornebohm, from which it appears that the dust contained glassy, isotropic, and various anisotropic particles, hornblende, magnetite, minute scales of mica, metallic iron, and some diatoms.

THE Tiflis *Kavkas* gives the following description of a meteor of great brilliancy which was observed at Tiflis, on May 10. It appeared at 11 p m in the west part of the sky, was of a round shape, and very brilliant Three seconds after its appearance a part of it separated, moving towards the Mtatsminda Mountain, and disappeared below the horizon, after lighting the slopes of the mountain, the central meteor continuing to move, but having lost for a few seconds its great brilliancy, which, however, soon reappeared. In about 30 seconds after the first appearance of the meteor, a second small part separated from it, increasing in size as it approached the earth This also disappeared in the west, behind the same mountain, after having brilliantly lighted for two or three seconds its slopes and gorges. After that, the meteor took first a milky colora-

tion, but soon became bright again, and of phosphoric aspect A third part separated from it, but it was much smaller and not so brilliant as the two former F[illegible] the meteor disappeared behind the clouds—a white, lighted blot being seen through them—and gradually faded away The phenomenon lasted altogether about three minutes

WE learn from the *Pioneer Mail* that a smart shock of earthquake was felt at Madras on May 6, about ten minutes to ten o'clock The sound heard was at first like distant thunder, and afterwards like a railway train, running close by The shock was distinctly felt The weather was cloudy and the atmosphere still at the time

THE *Annuaire Géologique universel*, founded by Dr Dagincourt in 1885, and continued under the editorship of Dr L Carez for geology, and of M H Douvillé for palæontology, has now reached its seventh volume Each year the work has increased in value, and it now affords an admirable *résumé* of geological literature Hitherto each volume has been issued in a complete form, but the latest has appeared in four parts By the arrangement adopted there is some repetition, but this enables information required to be readily obtained There is first a fairly complete list of papers and other publications, then a systematic account of the various main chronological divisions of formations, this is followed by a description of separate districts, and finally we have a summary of palæontological work The stratigraphical notes are not always complete in each volume, sometimes two years are grouped in one yearly issue, for instance, this volume contains no account of the Triassic and Tertiary rocks, whilst the Cretaceous works of 1890-91 are here included The volume contains lists of geologists in France, Belgium, and the British Isles, next year we are promised lists for other European countries The editors are assisted by a large staff of workers in various countries

M E RIGAUX, of Boulogne sur-Mer, who has devoted many years to the study of the geology of the Bas Boulonnais, has published an excellent account of this region in the *Mémoires de la Soc Académ de Boulogne* (vol xiv, 108 pp) The district is of especial interest to English geologists because of the fine development there of the Devonian and Carboniferous rocks, and of the Jurassic series from the Great Oolite upwards The coal, formerly supposed to lie within the Carboniferous Limestone series, is now known to be true coal measures, over which the older rocks have been thrust The paper gives an account of several important deep borings, in some of which Silurian rocks have been reached beneath the Jurassic series Thirteen new species of fossils are described

DURING the past season, Dr Sheldon Jackson, the Government Agent of Education in Alaska, introduced into Alaska from Siberia sixteen reindeer Next year he proposes to establish a herd of reindeer in the neighbourhood of Fort Clarence, and he expects to begin with 100 animals The *Scientific American*, which records these facts, is of opinion that from an economical point of view the experiment is of the highest interest, because the reindeer is useful as a draught animal for sledges, as well as for its milk, its meat, and its skin As it flourishes in Siberia, there seems to be no reason why it should not also flourish in Alaska, where the conditions of climate and vegetation are very similar to those of Siberia.

THE editors of the *Entomological Monthly Magazine* note that at the sale of the late Mr Arthur Naish, of Bristol, at Stevens's Rooms on May 16, some of the extinct (or nearly extinct) species of British Lepidoptera fetched high prices Seven examples of *Lycæna dispar* (the long extinct British form of *L. Hippothoe*) realized £16 8*s*, or an average of nearly £2 7*s*. each A lot containing four *Polyommatus Acis* (perhaps extinct) was sold for 18*s* Eight *Lælia cænosa* (apparently recently extinct) were sold for £3 17*s* 6*d* Two *Cleora viduaria* (not found very recently) were knocked down for a guinea Seven *Noctua subrosea* (long extinct as British, and the continental form of which, *subcærulea*, is very different in appearance) obtained £6 12*s*, one very fine example realizing £2 10*s*

MR C W DALE, writing from Glanvilles Wootton, records, in the June number of the *Entomologist's Monthly Magazine*, that the effect of the weather upon insect life in Dorsetshire during April was remarkable Butterflies were unusually plentiful, moths unusually scarce The conclusion he draws is that easterly winds, with frosts at night, are injurious to moth life, but do not affect butterfly life, so long as there is plenty of blue sky and sunshine These were the general meteorological conditions in Dorsetshire during April

MESSRS LONGMANS, GREEN, AND CO have issued a new and revised edition (the third) of Mr W A Shenstone's "Practical Introduction to Chemistry" It contains the practical introductory course of work in use at Clifton College In this edition the author has made several changes which have been suggested by his own experience and that of various friends

THE forty fourth part of Cassell's "New Popular Educator" has been published It includes two coloured maps, one of Asia Minor, the other of Palestine

CYANIDE of arsenic, $As(CN)_3$, has been prepared by M Guenez, and is described by him in the current number of the *Comptes Rendus* It has been obtained by the action of finely divided elementary arsenic upon iodide of cyanogen, CNI, a substance which is usually obtained crystallized in delicate, transparent needles, frequently attaining the length of several inches About thirty grams of perfectly dry cyanogen iodide were placed in a strong Wurtz flask, together with seven grams of powdered arsenic and sixty to seventy cubic centimetres of carbon bisulphide previously dried over phosphoric anhydride The air contained in the flask was then displaced by dry carbon dioxide and the flask sealed The reaction was found to commence in the cold, crystals of tri iodide of arsenic soon making their appearance But, in order to complete the conversion of the iodide of cyanogen into arsenic cyanide, it was found necessary to heat the flask for about twenty four hours over a water-bath The heating is best carried out in successive periods of seven or eight hours, allowing the flask to cool after each period and subjecting the contents to brisk agitation Under these circumstances a quantitative yield of arsenic cyanide was obtained, in accordance with the following equation —

$$2As + 3CNI = AsI_3 + As(CN)_3$$

In order to isolate the cyanide, advantage was taken of its insolubility in carbon bisulphide, arsenic iodide being readily soluble The product of the reaction was therefore placed in a continuous extracting apparatus, in which it was thoroughly exhausted with pure carbon bisulphide The residual cyanide was subsequently dried in a current of carbon dioxide, and preserved in sealed tubes previously filled with the same indifferent gas

CYANIDE of arsenic obtained in the manner above indicated is a slightly yellow substance consisting of small crystals, which under the microscope are observed to be well formed, and to possess a deep yellow colour by transmitted light The crystals are extremely deliquescent, being instantly decomposed by water with production of arsenious oxide and prussic acid ·

$$2As(CN)_3 + 3H_2O = As_2O_3 + 6HCN.$$

When heated, arsenic cyanide evolves about a third of its cyanogen in the form of gaseous di-cyanogen, the residue con-

sisting of a mixture of free arsenic and paracyanogen When brought in contact with concentrated sulphuric acid and slightly warmed, mutual decomposition occurs, with liberation of sulphur dioxide and carbon monoxide, the nitrogen remaining in the form of ammonium sulphate Iodine reacts with arsenic cyanide in an energetic manner, even in the cold, forming iodides of arsenic and cyanogen without the volatilization of any iodine With potassium chlorate, arsenic cyanide forms a mixture which detonates with considerable violence when struck

THE additions to the Zoological Society's Gardens during the past week include two Black-backed Jackals (*Canis mesomelas*) from South Africa, presented by Master Logan, two North African Jackals (*Canis anthus*), four —— Gerbilles (*Gerbillus* sp inc), an Egyptian Jerboa (*Dipus ægyptius*), six Leith's Tortoises (*Testudo leithii*), five Common Skinks (*Scincus officinalis*), an Egyptian Eryx (*Eryx jaculus*), a Schneider's Skink (*Eumeces schneideri*), two Crowned Snakes (*Zamenis diadema*), a Hissing Sand-Snake (*Psammophis sibilans*) from Egypt, presented by Dr J Anderson, F R S, F Z S, a Cinerous Vulture (*Vultur monachus*) from Aden, presented by Mr W H Still, a Common Peafowl (*Pavo cristatus* ♂) from India, presented by Colonel Bagot-Chester, two African Love-Birds (*Agapornis pullaria*) from West Africa, presented by Lady McKenna, a Chinese Goose (*Anser cygnoides* ♂) from China, presented by Miss Hill, two Common Vipers (*Vipera berus*), four Common Snakes (*Tropidonotus natrix*), a Slowworm (*Anguis fragilis*), British, presented by Mr C Browne, a Mocassin Snake (*Tropidonotus fasciatus*) from North America, presented by Master Denny Stradling, two Purple-capped Lories (*Lorius domicella*) from Moluccas, two Scaly breasted Lorikeets (*Trichoglossus chlorolepidotus*) from Timor, deposited, four Common Sheldrakes (*Tadorna vulpanser*, 2 ♂, 2 ♀), four Ringed Doves (*Columba palumbarius*, 2 ♂, 2 ♀), European, purchased, two Black eared Marmosets (*Hapale penicillata*), born in the Gardens

OUR ASTRONOMICAL COLUMN

WINNECKE'S PERIODIC COMET, 1892 —The following ephemeris for this comet has been extracted from *Astronomische Nachrichten*, No 3083 The comet itself is becoming decidedly brighter, and will be found just between the Great Bear and Leo Minor

Berlin Midnight

1892	App. R A. h. m s	App. Decl ° ′ ″	log Δ	log r	Br
June 2	10 50 23.4	+43 11 46.0	9.9949	9.5376	8.61
3	48 52.4	4 31.4			
4	47 16.4	42 56 59.7			
5	45 34.6	49 10.6			
6	43 46.4	41 2.7	9.9837	9.5012	10.72
7	41 50.7	32 34.0			
8	39 47.0	23 42.0			
9	37 34.4	14 23.5			

SATURN'S RINGS —At the present time the earth may be said to be very nearly in the plane of Saturn's Rings, thus affording observers an opportunity of examining the ring from the sectional point of view M. Bigourdan communicates to the *Comptes rendus* (No. 21) the results of a study he has just made, with reference to some peculiarities he has found to exist. The preceding arm of the ring, he says, presented nothing very abnormal, but it appeared to thin rather than thicken whilst approaching the planet The amount of thinning in the case of the following arm was much more striking At a distance of two-thirds of the length of the arm it commenced to leave the outside edge, continuing gradually, and producing "the appearance of a luminous angle, regular and very pointed, the apex of which joined to the disk of the planet" Observed again on May 21, the following arm showed a protuberance situated near Cassini's division In M Bigourdan's own words, the above appearances could be produced by an "elevation of the level edging the separation of Cassini, and producing on the opposite face a luminous pad which would nearly double the apparent thickness of the ring"

GEOGRAPHICAL NOTES

Petermann's Mitteilungen for June contains the long expected account of Emin Pasha's return expedition to the equatorial lakes, written by his companion, Dr Stuhlmann Leaving Kahura in March 1891, they traversed an unknown region to the southern shore of Lake Albert Edward, which they followed round its western side, and marched as far north as the Ituri in 2° 13′ N Here the party had to turn Emin met a number of his old followers living near Kavalli, on Lake Albert, and many of them joined his expedition The return journey was disastrous An outbreak of small-pox made it necessary to divide the expedition, Emin was left behind, while Stuhlmann went on with those able to travel and reached the German station of Bukoba on Lake Victoria in February 1892 The scientific observations made necessitate certain corrections on the map of this part of Africa Mount Mfumbiro is further west than originally supposed, and may even lie within the boundaries of the Congo State It is a volcanic chain, one of the peaks of which, Mount Virungo, is apparently still active Stuhlmann gives the level of Lake Albert Edward as 2750 feet instead of 3307 as determined by Stanley

SIR WILLIAM MACGREGOR continues to give proofs of remarkable energy as an explorer, and of tact and skill as Administrator of British New Guinea In the early part of this year he has been engaged in a series of journeys through the south-eastern districts of the possession, and everywhere he has found the natives peaceful and friendly In a recent coasting trip he passed several islands, which at first sight appeared uninhabited, but on landing he discovered that this appearance was due to their singular configuration A narrow belt of gently sloping land led from the sea to a steep wall of coral rock, from 300 to 400 feet high, from the summit of which an undulating plateau was seen dipping inland Here the villages were built, from 50 to 100 feet below the level of the encircling rim, and sheltered from the trade winds Sir William considers these islands to be upraised atolls, modified in most cases by subsequent wave action on the shore strips

LIEUTENANT T H BARNES, on behalf of the Bolivian Government and the Argentine Geographical Society, is investigating the navigability of the Rio Otuquis, a tributary of the Upper Paraguay, in the hope of opening a new route for Bolivian trade

LIEUTENANT MIZON, compelled by the passive resistance of the Royal Niger Company to relinquish his projected journey by the Benué to Lake Chad, has (according to *La Politique Coloniale*) crossed the watershed to the Congo Basin, and on his way from the Benué to the Sangha, traversed the hinterland of the German Cameroon colony, one of the rapidly-shrinking blank spots on the map of Africa Reports from Tripoli state that Captain Monteil is pushing on from Kano, in Sokoto, to Bornu and Lake Chad

THE collection of educational appliances, books, atlases, &c, made by Mr J Scott Keltie on behalf of the Royal Geographical Society in 1885, has been lent to the Teachers' Guild of Great Britain and Ireland, in whose rooms at 74 Gower Street it has been admirably arranged by Miss Busk. This collection, which after its original appearance in London was shown in most of the large towns in the country, has never been more effectively displayed When first brought together, the inferiority of the British school atlases and text books to the German and French productions was very marked, but during the last seven years English publishers have made great advances, and several of the newer and better publications have been added It would be most desirable if the department of English books, maps, and geographical appliances could be made thoroughly representative, so that teachers would have a real opportunity of comparing the best work of 1892 with that which was current in 1885.

MR. H J MACKINDER, Reader in Geography at Oxford, has recently returned from a brief visit to the United States, where he has been devoting special attention to the state of the

higher geographical teaching In many respects the American Colleges are in advance of the corresponding institutions in this country, and geography is attracting increased attention on the part of some of the most energetic and progressive educationists

COUNT PFEIL, who recently passed through London, *en route* for the Cape of Good Hope, is about to conduct a party of emigrants to Walfisch Bay, in the hope of colonising the adjacent parts of German South West Africa

Two pillars, erected by Diogo Cão, the first Portuguese explorer on the west coast of Africa, have recently been brought back to Lisbon An interesting circumstance is the discovery on the pillar brought from Benguela of an inscription showing that the coast had been traced so far in 1482, two years earlier than the date usually assigned

THE IRON AND STEEL INSTITUTE

THE annual meeting of this institution was held on Thursday and Friday of last week, at the Institution of Civil Engineers, Sir Frederick Abel, the President, occupying the chair After the reading of the Council's annual report Sir Frederick Abel delivered his Presidential address He began with a reference to the losses which the Institute had sustained during the year by the death of some of its eminent members He spoke especially of the solid services rendered to science by the late Duke of Devonshire The Duke's wise munificence in the establishment of the Cavendish Laboratory in Cambridge University, and the important part he took in the labours of the Royal Commission on scientific instruction and the advancement of science, were described as "illustrations of his active participation in a movement of most vital importance to the maintenance of our position and influence among nations" Sir Frederick also referred to the Duke's ready consent to fill the post of first president of the Iron and Steel Institute as a proof of his appreciation of the high importance to be attached to the successful foundation of an organization of which he predicted that it would prove "a powerful instrument for the advancement and progress of the iron and steel trade of Great Britain, by promoting intercourse and interchange of knowledge between its members"—a prediction which was speedily and amply fulfilled In his introductory address the Duke had discussed the development of iron-manufacture in most interesting and comprehensive fashion In referring to the most extraordinary mineral wealth of the United States, he pointed out that although in 1867 the production of pig iron in America had risen to nearly 1,350,000 tons (of 2240 lbs.), the price of labour did not warrant the belief that there was any immediate prospect of the United States competing with the iron-producing countries of Europe in the open markets of the world

Sir Frederick continued —

A very interesting report upon the state of iron manufacture was presented by Sir Lowthian Bell to the British Association at its meeting in Dundee in 1867 A critical examination was made therein of the relative position of ourselves and Continental nations as Iron manufacturers, *à propos* of the Paris International Exhibition of that year, but in the encouraging view which that eminent authority presented of our position at the period named he was not led to make any reference to the prominence which the United States were beginning to assume among iron-producing countries After the lapse of twelve years, however, the production of pig iron in the States had been doubled, while in another ten years it had reached a figure approximating to the average production in Great Britain during the past ten years [1]

Viewed from our present standpoint, the observations made by our first President in his opening address of 1867, regarding the development of the manufacture of steel, are very interesting The Duke pointed out that, "owing to recent inventions and improvements, steel had acquired an importance greatly exceeding that which it previously possessed" After referring to the then prevalent views regarding the nature of steel, and to its production by the cementation process, the puddling and the mixing processes, and the partial decarbonisation of cast iron by blowing air into pig iron melted in a charcoal hearth, he dwelt upon the interest with which the development of the Bessemer process had been watched by the iron-making world, upon the *promise* "which that process afforded of furnishing a supply of steel suitable for many most important purposes upon a scale and at a price hitherto unknown," and upon the association of the names of Joseph Heath with the first employment of manganese in steel manufacture, and of Robert Mushet with the important part played by manganese alloys in the development of the Bessemer process While the approaching expiration of the first Bessemer patent was referred to as likely to tend to an increase in the demand for its products, the limits which the then existing knowledge placed upon the application of the process were pointed out, and the advantages of the puddling process dwelt upon It is interesting to note that, at any rate in Germany, these advantages have not yet been dispelled, in spite of the great revolution which the Bessemer and open hearth processes have effected in the applications of wrought iron and steel On the other hand, the importance which steel had acquired through the practical development of the Bessemer process, at the date of our first President's address, was but an indication of the new era upon which the iron and steel industries were about to enter In that year the produce of Bessemer-steel in the United Kingdom was only 160,000 tons, while open-hearth steel was not yet a staple product, in 1890 the British production of Bessemer steel exceeded two millions of tons, while that of open-hearth steel exceeded 1 5 millions of tons [1]

A statement made in the Duke's address of 1869, that, so far as existing knowledge went, the Bessemer process was of limited application, as only certain kinds of iron were susceptible of successful treatment by it, affords, by a comparison with the present condition of things, an interesting illustration of the continuous progress made in the successful application of advances in scientific knowledge to practical purposes The success which crowned the efforts of Thomas, Gilchrist, Snelus, and others to render the Bessemer- and open-hearth processes efficient in their application to ores, the successful treatment of which by them appeared well nigh hopeless in the earlier days of the Iron and Steel Institute's existence, has recently been very prominently before the public, and the members will certainly receive with special interest the communication which the Director of Naval Construction has promised us on experiments with basic steel

In the discussion which took place at the meeting of the Institute of Naval Architects last year, *à propos* to a paper by M J Barba on recent improvements in armour plates, it became evident that the public were far better instructed as to progress made in such directions as this by other nations than as to advances made by ourselves, such information as Mr White feels warranted in affording us with respect to our progress in practical experience on the merits of basic steel as applied to shipbuilding and other naval purposes will therefore be very welcome

From the United States interesting accounts have reached us of a continuation of the experiments with armour plates 10½ inches thick, which were commenced at Annapolis in September 1890, when an all-steel and a nickel-steel plate, from the Creusot works, were contested in comparison with a compound plate of Cammel's make Of these, the nickel-steel plate was considered to have shown itself somewhat superior to the all-steel plate, and very decidedly superior to the compound plate, and it is stated that Congress showed its appreciation of the importance of this result by appropriating a million dollars to the purchase of nickel ore The second and third series of trials have been carried out at the Naval Ordnance Proof Ground at Indian Island, near Washington The plates fired at in October last, constituting the second series of three, are described as a high carbon nickel steel plate from the Bethlehem Iron Company, one of low carbon nickel steel from Carnegie, Phipps, and Co's works at Pittsburg, and a so-called "Harveyised" plate of low carbon steel from the Bethlehem works The description given of the Harveyising process

[1] Mr Robert S M Cormick, Resident Commissioner for Great Britain for the Chicago Exhibition of 1893, in a paper recently communicated to the Society of Arts upon the future trade relations between Great Britain and the United States, gives the following figures as demonstrating that the British iron and steel industry has been outstripped in magnitude by that of the United States In 1890 the produce of pig iron in America was 9 202,703 tons against 7,875,130 tons in the United Kingdom, of manufactured iron, including rails 2 820,377 tons were produced in America against 1,923,221 tons in Great Britain, and, of Bessemer steel 3 688,871 tons were American produce, while the production in the United Kingdom amounted to 2,014,843 tons.

[1] 1891 appears to have witnessed a very remarkable falling off in the production of Bessemer steel, to the extent indeed of about 35 per cent., while the production of open-hearth steel exhibits a reduction in the past year of only 3 per cent

identifies it as being a case-hardening or partial cementation treatment, the surfaces of the steel plate being hardened by carbonization (and by a supplementary chilling process), and the increase in carbon dying away towards the interior of the mass. In the trials of these plates, that of high carbon nickel steel appears to have stood the best, but the effect of the Harveyising process upon the powers of resistance of the low carbon steel plate seems to have afforded indications of beneficial effect such as to warrant the application of the process to nickel steel plates included in the third series, fired at last November, and which comprised a high carbon nickel steel plate from Carnegie, Phipps, and Co., a low carbon Harveyised nickel steel plate from the same makers, and a high cabon Harveyised nickel steel plate from the Bethlehem Company. In all the nickel steel plates, including that from Creusot tried in 1890, the amount of nickel in the metal appears to have been a little above 3 per cent.

Care seems to have been taken to render all conditions attending the trials as uniform as practicable, with this not unimportant difference, that very much less time was allowed to elapse, in the second and third trials, between the firing of the successive rounds than in the first experiments.

A careful consideration of the results led the Board, of which Admiral Kimberley was President, to the unanimous conclusion that the high carbon Harveyised nickel steel plate was the best, but that one part of the plate was much superior in resisting powers to the other, which was ascribable apparently to a want of uniformity in the Harveyising or carbonising treatment. The official report is also said to have recorded the unanimous opinion of the Board that both the high carbon nickel-steel Harveyised plate and the high carbon nickel-steel untreated plate were superior to the Creusot nickel steel plate tried in 1890.

Further trials will shortly be made of high and low carbon nickel-steel Harveyised plates, to be supplied by Carnegie, Phipps, and Co. From published analyses it appears that the high carbon nickel steel plate manufactured by that Company contained 0.45 per cent. of carbon and 0.65 per cent. of manganese, and the low carbon plates of nickel-steel, 0.26 per cent. of carbon and 0.75 per cent. of manganese.

The *New York Sun*, with what appears, from the reported results, to be very justifiable sentiments of pride, winds up an account of the results arrived at with the remark that they show that America now stands at the top in the excellence of her ship-armour, and certainly our friends of the Bethlehem and Pittsburg Steel-works are to be warmly congratulated upon their achievements in this new direction.

Although the trials in the United States seemed to establish a marked superiority of nickel steel plates over the compound plates of J. Brown and Co.'s manufacture, it is interesting to notice that this eminent firm is gallantly striving to maintain the high position which exhaustive trials had secured to that form of plate, as efficient armouring for ships of war, and that recent trials at Shoeburyness and at Portsmouth of experimental compound plates which have been submitted to a supplemental process devised by Captain Tressider, late Royal Engineers, seem, so far as I can learn, to have demonstrated that powers of resistance and endurance, much exceeding those of the compound plates tried in the United States and in the Ochta experiments of last year, can be secured to these structures. I have reason to hope that we shall receive a communication ere long on the interesting results which are being obtained in this direction.

My reference to the rapid advance which has been made in the United States in the manufacture of armour plates will recall to the minds of many here present the memorable visit of the Institute to America in 1890. The valuable record of that visit presented to us a few months ago by the American Institute of Mining Engineers, in the form of a portly volume, embracing full accounts of the proceedings and the papers read and discussed at the international meetings at New York and Pittsburgh, constitutes an important work of reference, as well as an interesting memento of one of the most notable events in the history of our Institute. And now, thanks mainly to the self sacrificing exertions of our much esteemed past President, Sir Lowthian Bell, we have been able to match this American volume with a companion work, the interest and value of which it would, I venture to say, be difficult to over estimate. The series of monographs by Sir Lowthian Bell and other highly competent authorities which are embraced in this special volume (aptly named "The Iron and Steel Institute in America"), will certainly receive careful study—productive both of profit and of pleasure, at the hands not only of members of the Institute, but also of our transatlantic friends who so cordially received us, and our warmest thanks are due to the joint authors of this work, and especially to Sir Lowthian Bell, who, besides contributing some of the most valuable of its contents, undertook the arduous task of editing the volume, and I beg leave heartily to congratulate him upon the realization of his wish, that the completed work should make its first appearance in public at this meeting.

An interesting illustration afforded by the inaugural address of the Duke of Devonshire in 1869 of the advance made in the knowledge at the disposal of the iron and steel maker, is found in his observations on the relations of carbon to iron and steel, a subject which I had occasion to discuss in some detail in my opening address last year, in reference to the then recent interesting investigations in that direction, a subject on which we may still hope to have further light thrown by the continued researches of Osmond and others. The very complete and systematic manner in which existing knowledge on this subject is treated in the first part, recently published, of Dr. Hermann Wedding's new edition of his *Handbuch der Eisenhuttenkunde*, calls for the highest commendation.

The importance of pursuing the investigation of problems such as the conditions most favourable to economy in the use of fuel in the blast furnace, and conditions to be fulfilled in the form and dimensions of the furnace for ensuring efficiency and economy of working, were dwelt upon by the Duke of Devonshire in his comprehensive address, and reference was made to the elaborate inquiry into the chemical operations occurring in the blast furnace upon which Sir Lowthian Bell had then for some time been engaged. The interesting results arrived at by him, and the instructive discussions to which they and the conclusions based upon them gave rise, are memorable illustrations of the progress in the application of scientific research and reasoning to the study of metallurgic operations, in the promotion of which the Iron and Steel Institute has of late years played an important part, and the most recent outcome of which, in connection with the production of pig iron, is to be found in the remarkable achievements recounted by Mr. Gayley in his paper on the development of American blast furnaces, which was one of the most noteworthy communications dealt with at the New York meeting in 1890.

In directing attention to that paper in my address a year ago, I spoke of the reference made by Mr. Gayley to the importance of the elaborate series of investigations carried out, nearly a quarter of a century ago, by Sir Lowthian Bell on the chemistry of the blast furnace. I have had occasion since then to refresh my memory with regard to the ground covered by the work which our ex President then carried out, and I must freely confess that I had no recollection of its extent nor of the mass of interesting and important experimental data accumulated by him, until I lately referred to the comprehensive and systematic investigations on the chemical phenomena of iron smelting, which he communicated in detail to the meeting of the Institute at Merthyr in 1870. His paper on the chemistry of the blast furnace, to which I had the pleasure of listening at the Chemical Society in 1869, deals with the circumstances and conditions attending the union of iron with carbon in the blast furnace, and gives interesting results bearing upon the question of the temperature at which carbon is deposited in a finely divided state in ironstone when it is exposed to the waste gases, rich in carbonic oxide, of the blast furnace, and the subject is discussed more definitely, by the light of additional experimental information, in Sir Lowthian Bell's admirable work on the "Principles of the Manufacture of Iron and Steel," published in 1884. He there demonstrates the readiness with which carbon is deposited in iron sponge from carbonic oxide at temperatures up to a dull red heat, examines into the question whether the presence of iron in the metallic state in iron ore is indispensable for determining the dissociation of carbonic oxide, and, after concluding in the negative, and demonstrating that metallic iron is not more active in this respect than its oxide, he refers to trials made by him of the power of several other metals and metallic oxides to effect the dissociation of carbonic oxide.

In the researches communicated in 1870 to the Merthyr meeting, the whole of these experiments are given and discussed, and it is to be regretted that the interesting results arrived at did not receive greater publicity than they met with in the Transactions of a young technical Institute, then comparatively

unknown in the scientific world, and in which the results of original scientific research would scarcely be sought for

Without venturing to enter into the details of these researches, I may mention that experimental evidence favoured the conclusion that the carbon impregnation of an iron ore by dissociation of carbonic oxide takes place at as low a temperature as de oxidation, which, in the case of Cleveland ore, occurs at 200° to 210° C (392° to 410° F), and that freshly reduced spongy iron, at about that temperature, reduces carbon from carbonic oxide to an extent corresponding to 20-24 per cent of its weight, but that, as the temperature approaches a red heat, the deposition of carbon diminishes considerably in amount

The results of many experiments with other metals and their oxides showed that zinc, tin, chromium, and silicon, and their oxides are neither reduced by carbonic oxide at a temperature of about 420° (that of melted zinc), nor give rise to deposition of carbon, that copper and lead are reduced at temperatures up to a red heat, without deposition of carbon, that the higher manganese oxides are reduced to protoxide below a red heat without impregnation by carbon, but that nickel, and in a smaller degree cobalt, suffer reduction from their oxides, with deposition of carbon

Sir Lowthian Bell, while conducting his experiments at temperatures considerably below those prevailing at the particular positions in the blast furnace where the production of pig iron was believed to be effected, did not have recourse to so low a temperature as that at which Messrs Mond, Langer, and Quincke, after having demonstrated (what appeared, in the absence of an acquaintance with Bell's results, a novel observation) that carbon was separated from carbonic oxide by passing the gas over nickel at a high temperature, found that this metal actually entered into the composition of the gas Thus they started from the point, in this particular direction, up to which Sir Lowthian Bell had carried his observations twenty years previously, and obtained the remarkable nickel carbon-oxide compound referred to by me in my address last year, which they have since succeeded in producing upon so considerable a scale as to afford prospect of its acquiring industrial importance

In the description of their earliest results, they stated that attempts to produce similar combinations of carbon oxide with other metals, including iron, had failed By persevering with research in many very varied directions, and especially with iron, they at length succeeded in volatilizing notable, although small, quantities of the latter metal in a current of carbonic oxide, by using the finely-divided pure iron obtained by reducing the oxalate in a current of hydrogen at the lowest possible temperature (about 400° C), by allowing the product to cool in hydrogen to 80°, and then by passing a current of carbonic oxide over the spongy metal The gas, after this treatment, was found to impart a yellow colour to a colourless flame, and if conducted through glass tubes heated to between 200° and 350° C, it deposited a metallic mirror, at a higher temperature it furnished black flakes, which analysis showed to contain 79 30 per cent of carbon The quantity of iron- and carbon oxide compound produced in this way was very small, by passing 2½ litres of carbonic oxide per hour over the metal (the latter being from time to time reheated in a current of hydrogen), the issuing gas contained not more than 0 01 grm of iron, equal to less than 2 c c. of the gaseous iron compound in a litre of the carbonic oxide

The gas mixture, when passed through benzine or heavy mineral- or tar oils, was partially deprived of the iron compound, and the result of examination of solutions of this kind led to the conclusion that the gaseous iron combination, analogous in composition to the nickel-carbon oxide compound (or nickel-tetra-carbonyl), had been found, and that its formula was $Fe(CO)_4$.

In continuing their researches, Mr Mond and Dr Langer have succeeded in obtaining the iron compound in the form of a liquid of spec. grav 1 4664 (at 18° C), which distils without decomposition at 102° 8 C, and solidifies below 21° into yellow needle-shaped crystals It is slowly decomposed by exposure to air, and when its vapour is heated to 180°, it is completely decomposed into iron and carbonic oxide Analysis and the determination of its vapour density show the composition of the liquid to be represented by the formula $Fe(CO)_5$, and Messrs Mond and Langer have therefore called the compound *ferro-penta-carbonyl*

If exposed to light in a sealed vessel for several hours, it deposits gold-coloured tabular crystals having a metallic lustre like gold when dry, but becoming brown by gradual decomposition when exposed to air These crystals appear to contain a slightly smaller amount of carbonic oxide than the liquid compound from which they are deposited Mr Mond and his co-laborateurs are still actively engaged in pursuing the researches which have brought to light the formation of these remarkable metallic compounds, whose discovery and properties suggest possibilities in several directions of technical chemistry which will doubtless lead to interesting investigations

The first report made by Prof Roberts Austen to the Alloys Research Committee of the Institution of Mechanical Engineers, bearing upon the particular investigation undertaken by him at their request, although little more than introductory in its character, is full of interest, and of importance not only on account of the valuable information it furnishes regarding the method of investigation adopted by him and of the preliminary results attained by its agency, but also because of the interesting discussion elicited by its presentation to the Institution of Mechanical Engineers at their meeting last autumn

At our annual gathering a year ago we had the advantage of receiving from Prof Roberts Austen a description of the autographic method adopted by him for recording the results indicated by the Le Chatelier pyrometer, the efficient operation of which I had an opportunity of witnessing as a member of the Alloys Research Committee We also heard from Sir Lowthian Bell that he had already successfully and very usefully applied this pyrometer to determine the temperature of the blast entering a furnace at a considerable distance from the point of observation We shall, I trust, have the advantage of learning the results of further experience by Sir Lowthian and others in the practical application of this much needed instrument in conjunction with the automatic recording system used by Prof Roberts-Austen, the observations made by the present President of the Institution of Mechanical Engineers, by Mr Henry M Howe, of Boston, and by others at the discussion of the Professor's report, demonstrated that several valuable applications were already being made of the Le Chatelier pyrometer and the system of continuous record of its indications While it is satisfactory to me, as one of the earliest to use the ingenious pyrometer designed by my distinguished friend the late Sir William Siemens, to note that its trustworthiness as an indicator of temperatures up to 500° C has been vindicated by the work of Messrs Callendar and Smith, the accuracy and sharpness of the indications of Le Chatelier's pyrometer, the simplicity of its character, and the well established trustworthiness of its results at temperatures of over 1000° C, render it decidedly more valuable to the practical metallurgist, as well as to the scientific investigator, than any instrument of the class hitherto available We shall none the less be glad to hear what Mr. Callendar has to tell us on the present occasion with regard to the results of his persevering and, I believe, successful labours in discovering and eliminating the defects of construction which served to destroy the confidence placed, in the first instance, on the indications afforded by platinum pyrometers

The tendency of the discussion following the reading of Prof Roberts Austen's report, which was shared in by Mr Robert Hadfield, Mr Henry M Howe, and by some others whose right to criticism was beyond dispute, was to emphasise the necessity for caution in the application of theoretical views, regarding the laws which regulate the mechanical or physical properties of metals, to predictions as to the influence upon the properties of metals, such as iron, of particular impurities. I believe no one will be disposed to differ from the view expressed on that occasion by Prof Arnold, that, for a thoroughly comprehensive examination into "the effects of small admixtures of certain elements on the mechanical and physical properties of iron, copper, lead, and other metals," it is indispensable to combine different lines of investigation with the particular one which Prof Roberts Austen has so far prosecuted with very promising results

The fame which Mr Gruson has acquired in connection with the production of chilled iron structures, for land defence, presenting marvellous powers of resistance, must cause members of the Institute to look forward with much interest to the communication which has been promised us by the director of the Gruson Works, Mr E Reimers, on the manufacture and application of chilled cast iron, a subject with which, especially in regard to the selection of varieties and mixtures of iron suitable for securing a structure of metal essential to the attainment of combined toughness and hardness in armour piercing projectiles,

I was much concerned in the days of my much-lamented friend, the late Sir William Pallisser

Another subject to which I devoted considerable attention twenty three years ago, in co operation with the late Dr Matthiessen, bears directly upon some very interesting results which will be brought to your notice by my old and valued friend Colonel Dyer, of the Elswick Ordnance Works In 1863 Dr Matthiessen communicated to the British Association the results of some interesting researches into the chemical nature of alloys, which he followed up in 1866 with a preliminary report on the chemical nature of cast iron In this memoir, after drawing a comparison between the physical deportment of what he terms the alloys of carbon and iron, and those of such alloys as are produced by copper with zinc and with tin, he discusses in some detail the question whether carbon exists in combination with iron, in cast iron, and expresses himself in favour of the view that white iron is not actually a chemical combination of carbon with the metal, but rather a solidified solution in it of carbon, while grey iron is a solidified solution of the same kind, with carbon mechanically intermixed But while he supports this hypothesis by certain analogies between the specific electric conducting power of different varieties of iron and of alloys of other metals, he proposes to test the validity of his views by preparing pure iron, alloying it with various proportions of carbon, examining the physical and chemical properties of these alloys, and afterwards investigating the properties of alloys of the pure metal with various other metals and non metals Matthiessen's persevering endeavours to elaborate a process for the preparation of pure iron, which extended over three years, were at length crowned with success, and in 1869 I was engaged with him upon experiments with metal, obtained in the form of sponge, containing as its only impurity a minute trace of sulphur This iron was prepared by fusing together perfectly pure and dried ferrous sulphate and sodium sulphate, completely washing the crystalline oxide thus obtained, and then reducing it to metallic sponge by heating it in thoroughly purified hydrogen The sponge metal was welded together in the cold by powerful compression, for certain experiments, for others it was fused in very carefully prepared lime-crucibles The experiments which it was hoped to undertake with this pure material, in the directions I have indicated, were arrested almost at their commencement by Dr Matthiessen's death, and by the all-engrossing nature of my official labours The process, which was elaborated with such trouble, may perhaps prove useful in connection with the investigation which Prof Roberts-Austen has undertaken for the Alloys Research Committee of the Institution of Mechanical Engineers; but it appears to me that there is good prospect of procuring iron sufficiently pure, at any rate for certain of the experiments (when carried out upon a practical scale) which will form part of these investigations, by the very simple mode of procedure which Colonel Dyer has adopted in the production of iron containing only traces of carbon and silicon, no phosphorus, and less than two-hundredths of one per cent. of sulphur, and which affords a very interesting instance of the application of the basic furnace

In concluding these few observations, I cannot forbear once more referring to the interesting address delivered to the members by our first President twenty-three years ago, in order to point out how strikingly its peroration illustrates the progress which has been made in the development of the steel industry during the past twenty two years While forcibly dwelling upon "the extraordinary influence which the manufacture of iron had come to exercise on the condition of society throughout the civilized world," the writer gives no indication of the part then played, or destined to be played, by *steel* in that civilizing influence Even seven years later, when steel manufacture had advanced with rapid strides, there was still great hesitation in adopting it for some of the most important purposes to which iron was applied, thus Sir Nathanial Barnaby wrote at that time, "Our distrust of steel is so great that the material may be said to be altogether unused by private shipbuilders" Yet, a few years afterwards, it had come to pass that the examples of the marvellous development in the applications of iron, to which the Duke referred in illustration of his statements, constituted the very directions in which the steel manufacturer has accomplished his most prominent achievements, and in which the use of iron is becoming a memory of the past

The following was the list of papers to be read —On experiments with basic steel, by W. H. White, C B., F R S., Director of Naval Construction, on the production of pure iron in the basic furnace, by Colonel H S Dyer, of Elswick, on experiments on the elimination of sulphur from iron, by E J Ball, Ph D, and A Wingham, F I C, on platinum pyrometers, by H L Callendar, on the manufacture and application of chilled cast iron (Gruson's system), by E Reimers, of Magdeburg, on valves for open hearth furnaces, by J W Wailes, on the calorific efficiency of the puddling furnace, by Major Cubillo, of Trubia Arsenal, Spain, on a practical slide rule for use in the calculation of blast furnace charges, by A Wingham, F I C, notes on fuel, and its efficiency in metallurgic operations, by B H Thwaite

The whole of these papers were read except that by Major Cubillo

Mr White's was the first contribution taken His paper was founded on a number of experiments made at Pembroke Dockyard, with a view to determine the suitability of steel made by the basic process for ship building purposes It would be useless to attempt to summarise the results of the large amount of information contained in the paper, and in the tables, which formed an appendix to it As a general fact, it may be said that basic steel no longer labours under the disadvantages that attended its early days, when it was undoubtedly unfit to be used as a ship building material The importance of the basic process to this country can hardly be overrated The manufacture of steel on the original acid process demands a pig low in phosphorus, and this can only be prepared from a special ore, such as the hematites of Cumberland and other parts Unfortunately, the deposits of such ore in the British Isles are very limited in extent, and it is for this reason that we have been, for years past, importing vast quantities of steel-making ore from the neighbourhood of Bilboa in Spain This means a heavy item for freight, and it is a question whether we could, in England, stand the competition of Spain, if that country once organized her steel making resources on a sound footing But in any case it is desirable we should depend, as little as possible, on foreign countries for raw material, when we have such vast stocks within our own borders In the ores of the Cleveland district and other parts, we have such deposits, but the ore contains a comparatively large percentage of phosphorus, which entirely unfits it for the old acid process of steel making The basic process, however, is designed to enable phosphoric pig to be used, and to judge by Mr White's paper a fair measure of success has been attained in this direction It would have been interesting if the paper had given details as to the pig from which the steel was made. Mr Martell has said that no steel to meet Lloyd's requirements has been made from pig containing 3 per cent of phosphorus, and that the basic steel which has been successful has been made from an ore low in phosphorus It is, however, not the bulk of the phosphorus which is difficult to eliminate, but the last part, and Sir Lowthian Bell stated that he would be glad if the pig of his district did contain 3 per cent of phosphorus instead of about half that quantity, as it would then produce a slag more valuable for fertilizing purposes. However this may be, it would have been satisfactory to have had full analyses of pig to attach to particulars of physical tests so well authenticated as those now given to the engineering world by Mr White's paper Another point upon which it is desirable to get information is, which process gives the best results in working on the basic principle? We have always considered it a settled matter that the open hearth furnace was superior to the converter in this respect, so far as the quality of the product is concerned, and the discussion of last Thursday, on the whole, tended to confirm this opinion The opposite view, however, was advanced by more than one speaker whose words should carry weight, and there is also the question of cost and quickness of production to consider On the whole, it would seem, therefore, that the problem as to whether the converter or the open hearth furnace should be used is still an open one, doubtless it will be settled in this case, as before, by the special requirements of the metal to be produced As we have said, we cannot reproduce even a brief abstract of Mr White's paper, but we can give one or two figures One sample of basic Bessemer had a tensile strength of 30 6 tons per square inch, and an extension in 8 inches of 26 per cent Of some pieces tested after annealing the tensile strength was about 28 tons, with an elongation of 25 per cent One sample of basic open hearth showed 31 3 tons per square inch tensile strength and 26 2 per cent extension in 8 inches We quote these

figures as showing the best results, and to serve as a guide, it is doubtless unnecessary to say that they are not conclusive standing alone The riveting tests given are valuable, but these are of a nature which cannot be epitomized

Colonel Dyer's paper might well have been longer, as the subject of it is one of considerable importance Pure iron is a substance at any rate difficult to get Sir Lowthian Bell has said he has never met with absolutely pure iron Commercially pure iron, or what might be called practically pure iron, is not uncommon Colonel Dyer's object was to obtain a pure iron in order to determine the value of alloys By working on the lines which he had followed, the author hoped that pure iron and steel may be produced at reasonable cost In the first experiments the furnace was charged in the ordinary manner with pig and scrap of fairly good quality, and the charge was worked slowly, care being taken to keep the slag well saturated with lime by liberal additions of limestone The phosphorus was reduced during the process, but the result left much to be desired in other respects Charges composed of from one half to four fifths of good scrap, and one half to one-fifth of good Swedish pig were then worked very quickly, and a remarkably pure iron was obtained, of which the following was the result of analysis —

Combined carbon	trace
Silicon	005
Manganese	trace
Phosphorus	trace
Sulphur	015

This iron could only be forged in small pieces, even with the greatest care, and therefore no results could be given as to its mechanical properties Dr Hopkinson had determined the magnetic properties of the metal, but the results are to be reserved for the Royal Society Speaking generally, it has been found that the metal is more easily magnetized for small magnetizing forces than any other metal hitherto tested, its coercive force is less, its magnetization is greater, than any other sample experimented with The next stage of Colonel Dyer's experiments had for their object the utilization of ordinary scrap steel, and the production, in the basic furnace, of steel high in carbon and low in phosphorus, and at the same time to decrease the wear and tear of the furnace The principle of the process consists in melting scrap with carbonaceous material, and the results of the experiments have shown that when a pure carbonaceous material and ferro-manganese free from phosphorus can be obtained there will be no difficulty in producing a pure carbide of iron containing only sufficient manganese for forging The author next described the method by which the process was carried out Nine consecutive charges were worked, with the object of producing steel containing varying percentages of carbon, to test the value of the process The following table gives the chemical analyses and the mechanical properties of the steel of these charges —

	Tensile Tests				Chemical Analysis				
No	Yield.	Break	Elongation	Fracture	C C	Si	Mn	P	S
			Per cent						
1	14 0	22 7	44 0	F	11	trace	21	trace	070
2	14 0	23 0	41 5	F	10	,,	21	,,	040
3	18 0	27 5	32 0	F	16	020	40	018	[illegible]
4	21 0	30 0	33 0	F	21	trace	39	014	020
5	20 0	31 2	32 5	F	25	014	43	trace	019
6	23 0	34 0	26 0	F	24	018	50	019	024
7	25 0	35 4	20 0	F	30	trace	38	019	017
8	25 0	43 2	18 5	F	53	012	54	016	02
9	24 0	45 3	14 5	F G	50	031	60	009	026

The paper by Messrs Ball and Wingham, on the elimination of sulphur, contained the results of experiments thoughtful and suggestive in themselves, even if they do not show the iron and steel maker any immediate results which he may apply The authors found that potassium cyanide placed on the surface of molten cast iron almost completely removed the sulphur Owing to the extreme volatility of the cyanide, it was not found possible to reduce the quantity required to within practical limits, and efforts were therefore made to find some flux which would retain, when molten, a quantity of cyanide sufficient to effect the desulphurisation Sodium carbonate, lime, and blast-furnace slag were in turn tried It was found that the desulphurising action was greater when the flux consisted mainly of sodium carbonate than when a less basic lime slag was used, and that in the latter case the diminution in the percentage of sulphur varied directly with the amount of added cyanide A table is given of the results of the experiments, the best condition being obtained when 200 grains of sodium carbonate and 100 grains of potassium cyanide were used to 2000 grains of metal, when the sulphur was reduced from 0 46 per cent to 0 06 per cent A further experiment with sodium carbonate alone—400 grains being added to 4000 grains of metal—the sulphur was reduced from 1 11 to 0 15 per cent With caustic soda the sulphur was reduced from 0 15 per cent to 0 02 per cent, which is a satisfactory result The experiments also showed the facility with which sulphur is reduced when present in large quantities, and that it is the last part which gives difficulty in removing Metallic sodium was introduced into the bath in the form of an alloy with lead, and this had the effect of entirely removing 0 18 per cent of sulphur

The paper by Mr Reimers, which was the first read on Friday, the second day of the meeting, does not call for notice, excepting, perhaps, to remark that the Council of the Institute were to blame for not taking care that the author was informed beforehand that his contribution was not of a nature which should have been submitted in the form in which it was read Mr Callendar's paper on "Platinum Pyrometers" is a great contrast to the last mentioned The prominence given to the Le Chatelier pyrometer in this country, by Prof Roberts Austen chiefly, has led to renewed hope on the part of those who desire to measure higher temperatures Mr Callendar has been amongst those who have been giving attention to the subject, and the results of his labours, which are distinctly valuable, are given in his paper, to which we would refer all practically interested in the matter His introductory remarks on air pyrometers are interesting, and may be read with advantage by those not already acquainted with this branch of the subject, but it is of the Siemens electrical resistance thermometer, known generally as the "platinum pyrometer," that he has most to say It has been hitherto accepted that the platinum pyrometer was subject to the serious defect of changing its zero with use. The British Association Committee of 1874 discovered this, and it has since been amply confirmed as a fact The Committee experimented chiefly with a pyrometer in an ordinary fire at moderate temperatures of about 800° C, and they found that the resistance increased continuously with heating, and that the wire underwent rapid deterioration They also made some experiments and suggestions with a view to remedy this defect, but they did not succeed in overcoming it This continuous change of zero is certainly the most serious practical defect that a pyrometer can have, and there can be no doubt that the report of the British Association did a great deal to destroy confidence in this method of measuring temperature

We cannot do better than continue Mr Callendar's communication on this part of the subject in his own words —

"About seven years ago, when I began making experiments on this subject at the Cavendish Laboratory, Cambridge, I was at first very much surprised to find that the platinum wires which I used did *not* undergo continuous change, even when subjected to much more severe tests than those applied to the Siemens pyrometer by the Committee of the British Association. By making further experiments, however, with a sort of imitation Siemens pyrometer, I succeeded in reproducing at pleasure the effects they had observed, and in proving to my own satisfaction that these defects were not inherent to the method, but merely incidental to the particular form of instrument on which they experimented I found that if the wire were properly protected from strain and from contamination, the pyrometers could be made practically free from change of zero, even at very high temperatures

"The construction of the Siemens pyrometer has not, so far as I am aware, undergone any material change since 1874 The coil of platinum wire, which forms the sensitive part of the instrument, is wound on a clay cylinder, and packed in an iron tube from 5 to 8 feet long, and about an inch or so in diameter I have here the fine wire and the clay cylinder from a pyrometer which was recently in use at the Royal Arsenal, Woolwich. I was informed that it had never been heated above 900° C, or 1600° F, but its resistance had increased some 15 per cent, corresponding to an error of about 100° F in the temperature measurements. When the instrument was taken to pieces it was found that the wire was quite rotten and brittle

in some places, and sticking to the clay cylinder. This, I think, is sufficient evidence that the clay, or some impurity contained in it, attacks the wire, otherwise the local nature of the action could not be explained, unless the quality of the wire used was very inferior

"I have tried several materials on which to wind the wire, but have found nothing that answers so well as mica The plan I generally adopt is to double the wire on itself, and wind it round a very thin plate of mica, in such a way that it only touches the mica at the edges This method gives very good insulation, even at high temperatures, and, so far as I can discover, the mica has no action on the wire even at temperatures of 1200° C

"Another defect of the Siemens pyrometer is the iron containing tube Metallic vapours of any kind will attack the wire readily, and will ruin the pyrometer It is not probable that the iron itself will be appreciably volatile at temperatures below 1000° C, but it is very likely to contain several more volatile impurities Vapours of copper, tin, zinc, &c, rapidly render the wire brittle and useless A comparatively small trace suffices"

Mr Callendar's wires were inclosed in glass, a material which naturally cannot be used for high temperatures He finds that a hard glazed porcelain tube does very well to protect the wire, at least up to temperatures of 1200° C A silica tube would be better, but that the author has not succeeded in obtaining He pointed out, however, that good porcelain is not so fragile as it is generally thought to be He has only broken one tube, and that with a hammer He hopes, however, ultimately to be able to produce a satisfactory silica tube The remainder of the paper was taken up with a description of the indicating apparatus, but here, again, we must refer our readers to the original paper

Mr Thwaites's paper is of far too formidable proportions for us to deal with in anything like detail in this notice He describes calorimeters, pyrometers, &c, and their uses A good deal of the matter put forward is not altogether new

Mr Wingham's paper on the slide rule is of value to those interested in the practical working of blast furnaces

Mr Wailes's gas furnace valve has been designed to give an absolutely air tight closing, an effect which is obtained by a water seal. Illustrations were given by means of wall diagrams

The meeting was brought to a close with the usual votes of thanks

The autumn meeting will be held in Liverpool, but the date is not yet fixed

THE YEARLY ADMISSIONS TO THE ROYAL SOCIETY[1]

THE discussions that arose in connection with the revision of the Statutes of the Royal Society during the years 1890 and 1891, led me to endeavour to obtain definite data on which to found a trustworthy opinion as to the effect of the existing limitation of the number of yearly admissions on the eventual total strength of the Society, and the probable result of increasing the number beyond fifteen, the present limit

The facts bearing on this subject, so far as I have been able to collect them from the records of the Society, are embodied in the tables annexed to this communication, for the proper appreciation of the significance of the figures in which a few preliminary explanations are necessary

The anniversary of the Society being fixed for November 30 in each year, the customary record of the number of Fellows for any year refers to the number on that date I have throughout regarded the date to which this number applies as being January 1 of the following year

The annual election of Ordinary Fellows usually takes place in the first or second week of June in each year I have considered the date to be January 1 of the same year.

The lapses, whether from death or other causes, have been treated as having occurred at the end of the calendar year in which they take place

These assumptions have been made to simplify the various computations that the investigation required (which have been sufficiently troublesome as it is), and owing to the considerable period dealt with, forty three years, the results will not, I believe, be sensibly affected thereby

Unless it is otherwise specifically stated, the numbers refer exclusively to the *Ordinary Fellows*, elected at the regular annual meetings fixed for the purpose

So far as I have been able to ascertain (for the earlier records in many particulars are defective), the number of Ordinary Fellows elected since 1848 has been 15 in each year, except on four occasions, in two years the number having been 14, and in two years 16 the average, therefore, is 15 yearly

During the period since 1848, the number of *Royal* and *Honorary* Fellows has been about 5, and the *Foreign* Members about 50, these are included in the total number of Fellows shown in the annual reports of the Council, but will not be further considered in what follows

The rules under which certain privileged classes have been admitted as Fellows, in addition to the *Ordinary* Fellows, have varied somewhat since 1848, but at present, apart from the persons eligible for the classes of Fellows above excluded, the only persons so privileged are Privy Councillors The total number of *Privileged* Fellows elected since 1848 seems to have been 75, which for 43 years gives an average of 1 75 per annum

Table I contains a summary of the available data relating to the total number of Fellows since 1848

The total number, excluding Royal, Honorary, and Foreign Fellows, at the commencement of 1848 was 768 I am not able to say how many of these were Fellows elected in the ordinary way, and how many were privileged, but this has no importance for my present object From 1860 onwards the distinction between the three classes, those elected before 1848, Privileged Fellows, and Ordinary Fellows, is exhibited.

At the end of 1890, the total number of Fellows, excluding the Royal, Honorary, and Foreign Classes, was 463, of whom 26 were Fellows elected before 1848, 36 were Privileged Fellows elected since 1848, and 401 Ordinary Fellows elected since 1848

Hence it appears that the reduction of number of Fellows, of the three classes last referred to, has been 305, and as the number of admissions of the Privileged class has not been very materially affected by the changes in the rules relating to them, it follows that virtually the whole of this large reduction is a consequence of the restriction, to 15, of the number of Ordinary Fellows elected yearly

As the ages of the 768 Fellows who constituted the bulk of the Society in 1848 are not known, and as the conditions of election before that year differed materially from what they have been since, no very useful conclusions can be drawn from the rate of their diminution since 1848

Assuming, however, that the number of Privileged Fellows in 1848 was, as is probable, about 50, there would remain 718 Ordinary Fellows, of whom in 43 years 692 lapsed, or at an average yearly rate of 2 24 per cent, that is rather more than 16 a year This rate, as I shall show subsequently, does not differ greatly from that which has prevailed among the Ordinary Fellows elected since 1848, and it may therefore be presumed that the average age of the Fellows in that year did not differ greatly from the average age since

Table II gives, as far as available data admit, the ages at the time of election of all Fellows elected since 1848, and shows the number of years they severally survived, the average age at election, the number and average age of those who were alive in 1891, and the greatest and least ages of Fellows elected in each year

From this table it will be seen that there has been a gradual small increase in the age at election, the average for the first 10 years having been 42 2, for the second 10 years, 43 0; for the third 10 years, 44 8, and for the last 13 years, 45 2

The accuracy of these conclusions may be somewhat affected by the greater number of unknown ages in the earlier years, the age when unknown having been taken at the average of the group of years in which the election took place

The least age at which any Fellow has been elected is 24, one such case being recorded The average minimum at any election is slightly under 30, and the average maximum is rather over 63, one election at an age of 87 is recorded, and, several above 70.

The oldest survivor of the Fellows elected since 1848, who alone are dealt with in this table, was 86 years of age in 1891.

[1] "On the Probable Effect of the Limitation of the Number of Ordinary Fellows elected into the Royal Society to Fifteen in each Year on the eventual Total Number of Fellows." By Lieut General R Strachey, R E, F R S Read at the Royal Society on May 12, 1892 This paper was accompanied by four tables, presenting summaries of the author's results

J, The average age at election was 43 9, and the average age of all the Fellows in 1891 was 58 4

Table III records the numbers of Ordinary Fellows elected in each year, and remaining alive in each year after election, until 1891

From this it will be seen that during the last ten years the numbers have increased by 46, in the previous ten years the increase was 68, or 22 more, and in the ten years still earlier the increase was 111, or 43 more than the last If the decrease of growth for the ten years after 1890 takes place in a similar ratio to that which took place between 1870 80 and 1880–90, we might anticipate an increase of only 11 up to 1900, or probably a smaller number

In order to obtain a satisfactory comparison between the lives of the Fellows, and those of the general population as shown in the accepted life tables, I have calculated, from the known ages of the Fellows at election, and the known dates of the deaths that have occurred among them, the average age of the Fellows remaining alive in each year From these ages I have computed, from Dr Farr's tables, the probable number of Fellows that would survive from year to year, assuming the initial number to be 15

From Table III, above referred to, has been ascertained the number of Fellows surviving in each successive year after election, and thence has been obtained the average number surviving from an initial number 15

The results of these computations will be found in Table IV

The second column in this table shows the number of lives dealt with for each year after election The first entry, 645, is the total number of Fellows elected in the whole 43 years The next column to the right gives their aggregate ages, and the next their average age, 44 0, in their first year Following the same line to the right, we find the average number of Fellows elected, and in their first year

Passing to the second line of the table, 619, immediately below 645, is the total number of Fellows remaining in their second year from the elections of 42 years, this is succeeded, in the columns to the right, by their aggregate ages in their second year and their average age, and the average number in their second year, out of 15, the average number elected

The third line gives the same data for the third year of Fellowship, and so on throughout, the last line but one showing that in their 42nd year there remained 6 Fellows from the elections of 2 years, with an aggregate age of 444 years, and an average age of 74 0, the average number surviving in their 42nd year, out of the 15 elected, being 3

The sixth column of the table gives the successive sums of the numbers in the fifth column, and therefore indicates the aggregate number of Fellows that will, on the average, be surviving in each successive year of Fellowship, the number elected in each year being always supposed to be 15

It will be seen that the total for the 43rd year is 397 0, whereas the actual number surviving, shown in column XI, is 431 This difference is of course due to the number 397 representing what the result would be if the average rates of election and decrease prevailed, instead of the actual rates for the separate years, and it is probably sufficiently accounted for by the fact, already pointed out, of the gradually increasing age at election in the later years, which will lead to the lives in the earlier years of the series being somewhat better than the average Column XI shows the *actual* results for successive years corresponding to the average results given in column VI The differences will be seen to be somewhat irregular, but nowhere to be of importance

Column VII gives the aggregate ages of the numbers surviving in successive years, as shown in column V, and from it is deduced the average age of the whole number of Fellows shown in column VI, 397, which is seen to be 57 7 years, a result differing slightly from that obtained from the actual ages of the Fellows surviving in 1891, which was shown to be 58 4. The cause of this difference has already been indicated

Columns VIII and IX supply the results that would be obtained by applying to an initial number of 15, the rates of mortality in Dr Farr's tables, for the ages in successive years given in column IV. Column X contains the ratio of column VI to column IX, and indicates that throughout the whole period of 43 years the actual results are somewhat better than the tabular results, or that the lives of the Fellows are better than the ordinary lives, and that this advantage leads in the 43rd year to the actual number of survivors being rather more than 5 per cent in excess of that which would be given by the life tables, or of about 20 on a total of 400

An examination of this table will show that, with the exception of the last six or eight years, in which the number of lives dealt with at last becomes very small, the figures indicate a very regular and consistent progression, and it will practically be quite safe to assume that the series in column VI may be extended on the basis of the ordinary life tables, subject to the addition of 5 per cent on the total amounts obtained from these last

Hence it will be found that in 10 years after 1891 the aggregate number of Fellows is not at all likely to be increased by more than 15 that the final result may be as little as 410, but is not likely to be more than 420, or at the outside 425

In an earlier part of this paper, I mentioned that the rate of decrease of the Ordinary Fellows elected before 1848 did not appear to differ materially from that which has prevailed subsequently

Taking the number of Ordinary Fellows elected before 1848, and then alive, at 718, it will be found that in 12 years (1860) the number was reduced to 422, which is about 60 per cent of the original number, after 24 years (1872) the number fell to 206, which is about 30 per cent of the original, and in 36 years (1884) there remained only 65, which is about 9 per cent of the first number

Assuming that the average age of the 718 Fellows elected before 1848, and then alive, was not materially different from (58) the average age of the Fellows elected after 1848 and alive in 1891, when it has probably become nearly stationary, it may be inferred that the lapses among a body of Fellows of that age will correspond to the lapses among the Fellows alive in 1848 Now, from Table IV it will be seen that of the Fellows elected after 1848, the average age in their 17th year was 58 3 years, which is almost exactly the average age of the whole body Further, it is shown that of the supposed original 15 there remained 10 9 in the 17th year of the age above mentioned, 58 3 This number was reduced in 12 years to 6 7, which is nearly 60 per cent of the number in the 17th year, and again falls after 12 years more to 3 7, which is not very different from 30 per cent of the starting number, and after 12 years more the number will be seen to be likely to be less than 1 0, which again will not differ materially from 9 per cent of the original 10 9 These proportions, it will have been observed, are those above shown to hold in the case of the Fellows elected before 1848

On the whole, it seems to be established that the present restriction to 15 of the number of Ordinary Fellows elected in any year will lead to an eventual maximum number not exceeding 420, and that the ultimate increase of the total strength of the Society, for each additional Fellow elected in excess of 15 may be taken at 28, so that an increase to 18 of the annual number of Ordinary Fellows elected would lead to an ultimate total of 500 such Fellows

THE ERUPTIONS OF VULCANO (AUGUST 3, 1888, TO MARCH 22, 1890)[1]

THERE are some 180 (nominally 212) pages and 11 plates Of these latter 4 are reproductions of Silvestri's beautiful whole plate photographs [one of Vulcano at rest (with Vulcanello), and the other three instantaneous views of the volcano in eruption] A fifth reproduces, half-size, two of Dr Johnston-Lavis's instantaneous views of eruptions taken from the crater's edge[2] Two other plates give 14 excellent photographs of the "bombs," and of the rest two are sketches of Stromboli crater, one petrographical, and the last the map of Vulcano (1/50,000)

1 "Le Eruzione dell' Isola di Vulcano, incominciate il 3 agosto, 1888, e terminate il 22 Marzo, 1890 Relazione scientifica della Commissione incaricata degli studi dal R Governo," *Annali dell' Ufficio Centrale di Meteorologica e Geodinamica*, Parte 4, vol x, 1888 (Rome, 1891).

The Commission was originally as follows —President, Prof O Silvestri (Catania) Prof G Mercalli (Milan), Prof Grablovitz (Seismological Observatory, Ischia), and as engineer, V Clerici (Messina), with A Cerau, Prof Ponte and A Silvestri, as assistants.

As is known, Prof Silvestri died before the publication of the Report, but not till some months after the end of the eruptions, on which he had elsewhere published various papers The Commission must thus have had full time to profit by his experience both in the field and afterwards, and his name appears as author or joint author of a number of sections. After Silvestri's death Prof Mercalli, the largest contributor to this Report, took his place, and brought the work to its completion.

2 For others by Dr Lavis and Silvestri, see "South Italian Volcanoes."

A table of contents may be found at the end

Appended to the various sections are the names of the authors responsible The 180 pages of text necessarily vary in character Thus, 50 pages are devoted to an almost daily record of the state of the volcano during the twenty months of the eruption For not a few days we have a record of the times and degree of violence of all the explosions which (February 12 and 14, 1889) might number more than 100 between 10 a m and 6 p m On the other hand, we find between pp 207 and 210, a *résumé* of the chief facts observed, and the conclusions to which they point.

There are 20 pages (9-29) on the topography and geology of the island of Vulcano Details are given as to the rocks collected at various localities, and the conclusion (expressed with some reserve) as to the history of the island, is very similar to the view stated (Proc Geol Assoc, vol xi pp 395-96, 1890) by Dr Johnston-Lavis

The author (Mercalli) only recognizes one crater (with lavas of andesitic and basaltic type) in the "Piano" district, which forms the southern half of the island The Serro di Capo and Monte Lentia represent the western part of a second old (north-west) crater of more "acid" type, which may have had its centre almost coincident with that of the present active cone, and which, judging by the weathering of the rocks, may be older than the Piano crater The author notices that the straight north and south line, drawn from *Vulcanello* through the *hot springs* by the "Faraglioni" and the two overlapping "*Forgia Vecchia*" s (on the north flank of Vulcano) to the present crater (or "*Fossa di Vulcano*"), if continued, strikes *Monte Saraceno* (a lateral cone on the north-west edge of the Piano crater) It is then pointed out that, assuming Monte Saraceno to be situated over a continuation of the crack which most probably runs from Vulcano to Vulcanello, and assuming the present eruptive centre to coincide with that of the old north west crater, that then the present "Fossa di Vulcano" is situated on the point of meeting of two cracks, viz. a north to south one from Vulcanello to Monte Saraceno, and a north-west to south east one joining the more ancient craters The present crater would then be situated over a weak point Whether or no Monte Saraceno be situated over a crack extending south from Vulcano rather than over some other, there is nothing at any rate in the above against the view expressed in Prof Judd's "Volcanoes" (see Fig 81), according to which there is one main crack beneath the island of Vulcano, the crack from Vulcano to Vulcanello being but a continuation of that on which the more ancient craters lie As to the number of craters more ancient than the main modern cone, it will be seen that the Report takes a view intermediate between that of Scrope ["Volcanos," 2nd edit, p 192, Fig 47] and that of Judd ["Volcanoes,' p 196, and Figs 77 and 85]

The twenty pages (30-50) devoted to the records of previous eruptions are naturally full of interest A number of quotations from older writers are given The conclusion is that the eruptions of Vulcano in the historic period have been on the whole very similar

As interesting dates may be noticed —475 B C, Vulcano in activity (Thucydides), 183 B C, Vulcanello formed, about 1550 A D, strait between Vulcanello and Vulcano filled up by eruption of the latter, 1727, Forgia Vecchia (on north slope of Vulcano) in eruption (D'Orville), 1771, "Pietre Cotte" obsidian stream (on north flank of Vulcano) poured out, 1878, Fumaroles still visible on Vulcanello [1]

From p 53 to p 174 is devoted to (1) detailed record of the eruptions, as to which a valuable *résumé* is given, pp 112-14, (2) seismological and various other physical observations, and (3) the description of the erupted products

The following epitome is based on that given by Silvestri, pp 207-208 —

(*a*) The recent activity of Vulcano lasted 20 months, viz. August 3, 1888, to March 22, 1890 (with final explosions, May 17), the most violent explosions (p 113) occurring on August 4, 1888, December 26, 1889, and March 15, 1890 There had previously been a period of repose (1832-72), followed by minor premonitory eruptions in 1873-7-8-9 and 1886

(*b*) Just as we have the "*Plinian*" or "*Vesuvian*" eruptions of Vesuvius accompanied by violent outbursts of "ashes" and welling out of lava, and the incessant, milder "*Strombolian*" type of eruption, so we may distinguish a "*Vulcanian*" type (pp 58-59) Characteristic of this are—

(i) Intermittent explosions with discharge of bombs, ash, dust, and vapours Each of these explosions resembles the first outburst of "Plinian" ("Vesuvian") eruptions (p 112)

(ii) The absence of lava streams

(iii) The absence of noteworthy earthquake shocks

(*c*) The more violent of the explosions burst out suddenly, discharging clouds of vapour, with dust lapilli, and more or fewer bombs and fragments of compact lava, and such an explosion was then followed at short intervals by feebler ones, which merely discharged the smaller materials, or vapours only

(*d*) The more violent explosions were generally separated by longish intervals, either of absolute repose, or with insignificant explosions, and, on the other hand, when eruptions took place every few minutes, they were generally feeble

(*e*) (p 113, 70) Observations of atmospheric pressure extending over a day, or short period of time, show no relation to the frequency or degree of violence of the explosions But viewing the 20 months of the eruption as a whole, it is found that Vulcano enjoyed comparative repose during periods of high atmospheric pressure, or of small change, and was most active during periods of change from fair to stormy weather, with marked fall of barometer

(*f*) Though during the 20 months of the eruption there were altogether a good many earthquakes recorded either by the seismoscope, or by some of the inhabitants (pp 134-37), still these were but slight, and, as stated, formed no feature of the eruption, being very rare compared with the explosions

It was found (pp 125-28) that for making observations of the shocks or tremors accompanying the explosive eruptions, even close to the foot of Vulcano, seismoscopes were as a rule not sensitive enough. On the other hand, owing to the frequency of the explosions, a tromometer was never quiet The simplest method is often the best, and recourse was had to pools of mercury (at once sensitive and stable) With the aid of a reflector it was then easy to keep an eye at once on the reflection of some object in the mercury, and on the lip of the crater, and so observe the time relation between the tremors and the explosive outbursts.

Observations made near the base of Vulcano showed that each eruption was preceded by a short tremor (apparently the result of a deep seated explosion), followed after a short interval of calm, of from a few seconds to three-quarters of a minute, by another, the result, apparently, of the superficial explosion that made a vent for the vaporous and solid ejecta The interval was shorter in the case of the more violent explosions

(*g*) In the first three days of the eruption (pp. 54 and 152-58), August 3-5, 1888, the ejecta consisted mainly of a variety of old materials blocking the neck of the volcano These, much of which was more or less altered by solfataric action, were discharged in pieces of all sizes from fine dust to large masses [1]

(*h*) After an interval of thirteen days, the second main period of the eruption set in The older materials soon became almost entirely replaced by newly elaborated matter in the form of dust, lapilli, lighter or heavier "bread crust" bombs,[2] and masses of compacter lava. These, as opposed to the matter discharged during the first three days, were all, except for inclusions of older rocks, of essentially similar mineralogical and chemical constitution (of andesitic type (p 165), with 62-67 per cent of silica, the percentage of which might be greater in the centre than in the crust of the same bomb) The larger masses on leaving the crater had a high initial temperature, and were plastic, taking rounded, elongated, or flattened forms, and on reaching the ground melted various metallic wires—silver (1000° C), and copper (perhaps 1200°, but, as we are cautioned, the copper might oxidize and then fuse lower)

From the preceding, Silvestri draws the following conclusions —

(Excluding the ejecta of the first three days) The high temperature and plasticity, with the presence of inclusions of older rocks, and the uniform composition of the ejecta, point to their being derived from a molten magma of recent elabo-

[1] Dr Lavis found these practically extinct in 1887 (see NATURE, vol xxxviii p. 13).

[1] The Report describes these as not so hot as the later ejecta However, from Mr Narlian's graphic account (*Times*, September 13, 1888, and Brit Assoc Report, 1888, p 665) it would seem that, at the first outburst, some of the ejecta fell red-hot, so as to set hedges &c, on fire.

[2] Dr Lavis, in NATURE, vol. xxxix. p 110.

ration. Of this, all things considered, there was probably a vast reservoir at a depth probably far below the bottom of the adjacent sea (which is 670 metres on the east, and 500 metres on the west) At intervals the steam included in this molten lava would acquire sufficient force to burst forth, producing the premonitory tremor (see (*f*) above, and pp 125-28), and though it is not very clearly stated, I gather that the interval of calm between the first and second tremors is considered to have been occupied by the escape of such steam into the space between the surface of the deep seated lava and the crater floor, till it acquired sufficient pressure to force an exit through the mouth of the crater (which became plugged by the fall of ejecta after each eruption) Then the visible explosion would take place, accompanied by the second tremor

The "bread crust" bombs (with pumiceous interior and cracked subvitreous crust) are said to commonly contain inclusions of older rock, and it is suggested (pp 163 and 209) that the frothing up of the interior is *in part* due to these, for, says he, fragments of rock falling into a superhydrated molten lava may not improbably act as centres of ebullition, just as solids (in proportion to their extent of surface) cause rapid disengagement of gas when dropped into "soda"—or other aerated—waters

The compact fragments and masses sometimes ejected (pp 120, 160, and 209), notably in the last eruption, might be explained as pieces of the shells of domelike bubbles which had partly consolidated below the volcano, or as derived from less hydrated parts of the magma.

If there was this huge lake of lava and so much steam, why did not the lava appear at the surface? Silvestri points out that the rise of the lava will depend on the proportion of the compressed steam to the mass of the lava that contains it, and on the resistance offered to its escape If the exit of the steam is blocked by lava, we may have all the phenomena of a "Plinian" ("Vesuvian") eruption On the other hand, in 1888 Etna had eruptions of vapours only, and we get all stages between these two In the case of a large space partly filled with lava at a great depth below the surface, the conditions might well be such that the steam would escape long before the lava overflowed

Among other points dealt with in the Report may be noticed —Pp 143-45, the breaking three times during this eruptive period of the submarine cable between Lipari and Milazzo in Sicily The first and third breaks were near the same spot, and near a place where the sea was seen to "boil," with pumice rising to the surface

On p 147 observations are recorded which support the view that the electric discharges accompanying eruptions depend principally on the friction of much dust and fine ejecta Violent explosions discharging large masses, if unaccompanied by such finer matter, might be without the electric phenomena (p 146)

There are ten pages on the state of Stromboli during the eruption of Vulcano, from which there appears to have been no relation between the two Nor do the "secondary phenomena" (the hot springs and fumaroles) in these islands appear to have been markedly affected Some of the fumaroles increased and some decreased in vigour, and some showed no change

From what has been said as to the slight seismic effects, we are prepared to hear that no change in the level of the land was produced In this connection there is a chapter on the tides, which have an amplitude at Lipari of about 30 cm

On p 120 are given four sections, in three, of the crater of Vulcano before, during, and after the eruption, from which it is seen that the crater has been much filled up

On November 18, 1891, the writer found the crater still in the quiet solfatara condition, so that one could descend into it The higher slopes were covered with white, and the lower, where the fumaroles were more marked, with yellow and red crystalline deposits A little water lay at the bottom The deepest part was a funnel-like depression, a little to the north of the middle, somewhat as shown in Mercalli's figure for April 1890 This marked the last eruptive vent

In conclusion, then, the Report contains a great mass of facts, and in addition generalization and theory, which, as often based on long experience, are also welcome, and the Commission is to be congratulated

G W. BUTLER

SOCIETIES AND ACADEMIES

LONDON

Anthropological Institute, May 10 —Dr Edward B Tylor, F R S, President, in the chair —The election of the Duke of Devonshire and Dr H Colley March was announced.—Mrs Bishop (Miss Isabella Bird) read a paper on the Ainos of Japan, amongst whom she had spent some time in a village near Volcano Bay It is doubtful whether the Ainos were the aboriginal inhabitants of Japan, they say themselves that they conquered and exterminated an earlier race who dwelt in caves The men are strongly built and muscular, and their stature varies from about 5 feet 4 inches to 5 feet 6 inches The extreme hairiness ascribed to the Ainos applies only to the mountain tribes, and to the men only amongst them the women, and the men of the coast tribes, not being more hairy than many people of other races The houses are rectangular and built of wood, they are all constructed on the same plan, and have a large window at the east end opposite the door, and two smaller ones in the south side, below which is the shelf on which the boys of the family sleep, the girls occupy a similar shelf on the north side of the room, and during the night the sleeping places are screened off by mats The women are remarkable for their modesty, and the men are exceedingly gentle, obliging, and hospitable They are a religious people, and offer copious libations of "saki" on the slightest provocation The race is dying out, and will no doubt be quite extinct in the course of a few generations

PARIS

Academy of Sciences, May 24 —M d'Abbadie in the chair —Heats of combustion and formation of alcohol and of formic and acetic acids, by MM Berthelot and Matignon

$$C_2(\text{diamond}) + H_6 + O = C_2H_6O \begin{cases} \text{liquid} & +69\ 9 \\ \text{gas} & +59\ 8 \\ \text{solution} & +72\ 4 \end{cases} \quad \text{Cal}$$

Heat of combustion of liquid alcohol at constant pressure = 324 5 cal

$$C\ (\text{diamond}) + H_2 + O_2 = CH_2O_2 \begin{cases} \text{solid} & +101\ 3 \\ \text{liquid} & +100\ 8 \\ \text{gas at } 200^\circ & +90\ 0 \end{cases} \quad \text{Cal}$$

Heat of combustion of liquid formic acid at constant pressure = 62 5 cal

$$C_2(\text{diamond}) + H_4 + O_2 = C_2H_4O_2 \begin{cases} \text{solid} & +119\ 7 \\ \text{liquid} & +117\ 2 \\ \text{gas at } 250^\circ & +107\ 1 \end{cases} \quad \text{Cal}$$

Heat of combustion of liquid acetic acid at constant pressure = 209 4 cal —Some facts in the chemical history of nickel, by M P Schutzenberger —Degradation products of the tissues, particularly of the muscles, separated from the living being analytical methods, by MM Armand Gautier and L Landi —On the *Bramus*, a new type of fossil rodent from the Quaternary phosphorites of Berberah, by M A Pomel —On the flexure of Gambey's mural circle, by M Perigaud —On the appearance of Saturn's ring at the present time, by M G Bigourdan On May 21 M Bigourdan made some observations of Saturn's ring, with special reference to its thickness He noted several uneven portions at different points, thus confirming the observations of previous workers.—On integrals in dynamics, by M P Painleve —On equations in dynamics, by M R Liouville —Approximate equation to the trajectory of a projectile in air when the resistance is supposed to be proportional to the fourth power of the velocity, by M de Sparre —Experimental researches on the *matériel de la batellerie*, by M F. B de Mas —On the characteristic equation of various vapours, by M Ch Antoine —The two phases of the persistence of luminous impressions, by M Aug Charpentier —Plastic sulphur formed from sulphur vapour, by M Jules Gal —Some basic nitrates, by MM G Rousseau and G Tite —On the preparation and properties of arsenic cyanide, by M E Guenez.—Occurrence of fluorine in modern and fossil bones by M Ad Carnot.—Apocinchonine and diapocinchonine, by MM E Jungfleisch and E Léger —Monosodium pyrocatechol, by M de Forcrand —Substitution reactions in carbon or nitrogen nuclei application to explosive compounds, by M C Matignon —On dibromomalonic acid, by M G Massol The heats of neutralization by each successive KOH are about 10 cal. superior to those of malonic acid. The general conclusion is drawn that the sub-

stitution of H by a haloid increases the thermal value of the acid function.—Alcohols superior to vinyl alcohol, by M. C. Bardy.—Action of esters of unsaturated acids on ethyl sodium cyanacetate, by M. P. Th. Muller.—On a tetramethyl meta-diamidobenzidine, by M. Charles Lauth.—On the embryology of a Proneomenia, by M. G. Pruvot.—Researches on the general cavity and excretory apparatus of Cirrhipedes, by M. Kœhler.—Anatomical study of the secondary wood of certain apetalons, by M. C. Houlbert.—On the relations of the Trias in the south-east Paris basin, by M. A. de Grossouvre.—Variations in the mean temperature of the air in the region of Paris, by M. E. Renou.—On a natural ice cave at Creux Percé (Gold Coast), by M. E. A. Martel.

BERLIN

Meteorological Society, May 3.—Prof. von Bezold, President, in the chair.—Dr. Schwalbe gave an account of observations on the extent and spread of anomalies of temperature in Germany based on synoptic weather charts. He showed that the weather types introduced by Teisserenc de Bort hold good for Germany, especially in winter, and that, as a result of the varying distribution of barometric pressure, they are the cause of very marked differences of temperature between the north and south, the east and west. These types are less frequently observed in summer, although both then and in the spring certain very marked distributions of pressure exist.—Prof. Sporer spoke on the recent magnetic storm of April 25, for which, as also for the great storms of February 13 and 14, he had been unable to discover any corresponding phenomena in the sun spots at the same dates.

DIARY OF SOCIETIES

LONDON

THURSDAY, JUNE 2.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—On the Method of Examination of Photographic Objectives at the Kew Observatory: Major Darwin.—Supplementary Report on Explorations of Erect Trees containing Animal Remains in the Coal Formation of Nova Scotia: Sir J. W. Dawson, F.R.S.—The Hippocampus: Dr. A. Hill.—On a New Form of Air Leyden, with Application to the Measurement of Small Electrostatic Capacities: Lord Kelvin, P.R.S.—On Certain Ternary Alloys. Part VI. Alloys containing Aluminium, together with Lead (or Bismuth) and Tin (or Silver): Dr. Wright, F.R.S.—The Conditions of the Formation and Decomposition of Nitrous Acid: V. H. Veley.—On the Theory of Electrodynamics as affected by the Nature of the Mechanical Stresses in Excited Dielectrics: Dr. J. Larmor.—On Current Curves: Major Hippisley.

LINNEAN SOCIETY, at 8.—On the Disappearance of Desert Plants in Egypt: E. A. Floyer.—On Insect Colours: F. H. Perry Coste.—Lantern Demonstration.

CHEMICAL SOCIETY, at 8.—Ethylene Derivatives of Diazo Amido Compounds: R. Meldola, F.R.S., and F. W. Streatfield.

ROYAL INSTITUTION, at 3.—Faust: R. G. Moulton.

FRIDAY, JUNE 3.

GEOLOGISTS' ASSOCIATION, at 8.

ROYAL INSTITUTION, at 9.—Metallic Carbonyls: Ludwig Mond, F.R.S.

SATURDAY, JUNE 4.

ROYAL INSTITUTION, at 3.—Some Modern Discoveries in Agricultural and Forest Botany: Prof. H. Marshall Ward, F.R.S.

TUESDAY, JUNE 7.

ROYAL INSTITUTION, at 3.—Some Aspects of Greek Poetry: Prof. R. C. Jebb, M.P.

WEDNESDAY, JUNE 8.

GEOLOGICAL SOCIETY, at 8.—The Tertiary Microzoic Formations of Trinidad: R. J. Lechmere Guppy. (Communicated by Dr. H. Woodward, F.R.S.)—The Bagshot Beds of Bagshot Heath (a Rejoinder): Rev. A. Irving.—Notes on the Geology of the Nile Valley: Johnson Pasha and H. D. Richmond. (Communicated by A. Norman Tate.)

THURSDAY, JUNE 9.

MATHEMATICAL SOCIETY, at 8.—On the Reflection and Refraction of Light from a Magnetized Transparent Medium: A. B. Basset, F.R.S.

ROYAL INSTITUTION, at 3.—Faust: R. G. Moulton.

FRIDAY, JUNE 10.

PHYSICAL SOCIETY, at 5.—Some Points connected with the Electromotive Force of Secondary Batteries: Dr. J. H. Gladstone and Mr. Hibbert.—Workshop Ballistic and other Shielded Galvanometers: Prof. W. E. Ayrton and Mr. Mather.

ROYAL ASTRONOMICAL SOCIETY, at 8.

ROYAL INSTITUTION, at 9.—Magnetic Properties of Liquid Oxygen: Prof. Dewar, F.R.S.

SATURDAY, JUNE 11.

ROYAL BOTANIC SOCIETY, at 3.45.

ROYAL INSTITUTION, at 3.—Some Modern Discoveries in Agricultural and Forest Botany: Prof. H. Marshall Ward, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—Theoretical Mechanics: J. Spencer (Percival).—The First Part of Goethe's Faust, carefully revised, with Introduction by C. A. Buchheim (Bell).—Influenza, 2nd edition: Dr. J. Althaus (Longmans).—The Physiology of the Invertebrata: Dr. A. B. Griffiths (L. Reeve).—Annual Report of the Smithsonian Institution to July 1890 (Washington).—Lessons in Elementary Mechanics, new edition: Sir P. Magnus (Longmans).—Elements of Physics: C. E. Fessenden (Macmillan and Co.).—An Elementary Course in Theory of Equations: C. H. Chapman (Gay and Bird).—A Text-book on Retaining Walls and Masonry Dams: M. Merriman (Gay and Bird).—A Treatise on the Mathematical Theory of Elasticity, vol. 1: A. E. H. Love (Cambridge University Press).—Der Peloponnes, Abteilung ii.: Dr. A. Philippson (Berlin, Friedländer).—Topographische und Hypsometrische Karte des Peloponnes: Dr. A. Philippson (Berlin, Friedländer).—The System of Mineralogy of J. D. Dana, 1837–68: Descriptive Mineralogy, 6th edition: E. S. Dana (Kegan Paul).—Die Tägliche Gang der Temperatur und des Sonnenscheins auf dem Sonnblickgipfel: Dr. W. Trabert (Wien, Tempsky).—Bacteriologisches Practicum: Dr. W. Migula (Karlsruhe, O. Nemnich).—In Starry Realms: Sir R. S. Ball (Isbister).—A Hand-book of the Management of Animals in Captivity in Lower Bengal: Ram Bramha Sanyál (Calcutta).—Mineralogy: Dr. F. H. Hatch (Whittaker).—Darwin and after Darwin, I. The Darwinian Theory: Dr. G. J. Romanes (Longmans).—Animal Coloration: F. E. Beddard (Sonnenschein).—The Discovery of America, 2 vols.: J. Fiske (Macmillan and Co.).—A Text-book of Geometrical Deductions: J. Blaikie and W. Thomson (Longmans).—Distinction and the Criticism of Beliefs: A. Sidgwick (Longmans).—Solutions of the Examples in a Treatise on Elementary Dynamics: S. L. Loney (Cambridge University Press).—Theoretical Mechanics, Division I.: J. C. Horobin (Bell).—A Hand-book of Practical Astronomy: W. W. Campbell (Ann Arbor, Michigan, *Register* Publishing Company).—Logarithmic and other Mathematical Tables, 2nd edition: W. J. Hussey (Ann Arbor, Michigan, *Register* Publishing Company).—The Universal Atlas, Part 15 (Cassell).—Life in Motion: Prof. J. G. McKendrick (Black).—An Elementary Text-book of Magnetism and Electricity: R. W. Stewart (Clive).—The Two Spheres of Truth: T. F. S. T. (Unwin).—The Essentials of Histology, 3rd edition: Prof. E. A. Schäfer (Longmans).—Planisphere for Latitudes 60° to 48° and Key to Planets until 1901: M. W. Harrington (Ann Arbor, Michigan, *Register* Publishing Company).—The Optical Indicatrix and the Transmission of Light in Crystals: L. Fletcher (Frowde).—Tasmanian Official Record, 1892 (Hobart).

PAMPHLET.—The Rutherfurd Photographic Measures of the Group of the Pleiades: H. Jacoby (New York).

SERIALS.—Bulletin of the New York Mathematical Society, vol. 1, No. 8 (New York).—Bulletin de la Société Impériale des Naturalistes de Moscou, No. 4 (Moscou).—Zeitschrift für Wissenschaftliche Zoologie, liv. Band, Supplement (Williams and Norgate).—Natural Science, June (Macmillan and Co.).—Annalen des k.k. Naturhistorischen Hofmuseums, Band vii. Nr. 1 u. 2 (Wien, Hölder).—Proceedings of the Royal Physical Society, Session 1890–91 (Edinburgh).—Internationales Archiv für Ethnographie, Band v. Heft 2 (Leiden, Trap).

CONTENTS.

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THURSDAY, JUNE 9, 1892

A PROFESSORIAL UNIVERSITY OF LONDON

THE recent history of the London University question affords decisive proof that the new University, which is to be the outcome of the labours of the Royal Commission now sitting, must be much more than a merely exclusive or merely local institution Of the two main objects of a University in any English sense of the expression—the promotion of the higher education, and the advancement of learning—both must be equally subserved, and neither will be attained if the new University be established on other than the broadest possible basis, or if its development be controlled and hindered by rivalries that could not but become of an ignoble character In the course of discussion it has been made abundantly clear that a duplication of Universities in London would be a misfortune of the first magnitude, dividing resources and diverting energies into channels that would lead to many undesirable results It is equally clear that a University, consisting of a federation of local educational institutions existing within the same narrow area, would be wanting both in unity and force its government would tend to become a succession of compromises effected between the interests, almost wholly of a financial nature, of its constituent Colleges It may, then, be taken as a conclusion accepted by the great majority of those who have given special attention to the subject that there should be one University, and one only, in London, and that it should not be of a federal character To this position it is a simple corollary that the government of the proposed University should be vested mainly in a professorial body Much the most important work of the University would be the enactment of curricula and syllabuses and the control of teaching and examination—work that can only be efficiently performed by those specially familiar with the subjects taught. With the Professors a proper number of Crown nominees should be associated to act as moderators and as representatives of general educational policy, as well as to guard the interests and assure the continued confidence of the public. With the mode of creation and with the functions of the usual Faculties, and with the details of examinational systems, we need not at present concern ourselves. In fact, the less the new University is fettered by any Charter or Act the better, and it would be a misfortune were the precedent followed of the complicated and minutely detailed Charter recently rejected by the Convocation of the London University On that occasion, it must be admitted, Convocation made good use of its veto, but its continued possession of such a power would, we think, be a source of disquiet and danger, without any corresponding advantage to Convocation itself, or the University—especially a professorial University—or indeed to the public A much more useful provision would be the grant of a power of appeal to some such Committee of the Privy Council as that by whose aid the Scotch Universities are enabled to settle their differences

The possibility of any such University as we have indicated above ever coming into existence—and for a University of any other kind it is scarcely worth while to exert oneself—depends largely on the good will of the existing Colleges. They must follow the capital example set by Bedford College, and signify their willingness to be merged in and become part of a true London University with such reservations in respect of particular portions of their collegiate work as may be necessary As far as the professorial staffs of these Colleges are concerned, there can be little doubt but that they would hail such an event, but it is possible that the governing bodies may take a different view And with regard to the Medical Schools, the reservations touching their purely professional work, must, from the nature of the case, be extensive.

Though, for the moment, the question of a new University is chiefly interesting from the point of view of science and medicine, what for the sake of brevity may be termed the arts aspect of the question must not be neglected There are very few science students who do not follow—and follow of necessity—special courses of instruction in fairly equipped laboratories, but the arts student is less constrained in his mode and course of study—he has, indeed, in London less opportunity of benefiting by adequate instruction in the subjects of his studies The stimulus to every form of education that the new University may be expected to give will supply this deficiency, but meanwhile, and probably to a greater or less extent always, the case of the "private student" in arts will have to be considered We shall not enter upon it here Our object in mentioning the case of the arts student is rather to show that the interests of the two great divisions of human knowledge are at one in the matter of the proposed University. It may be added that the "private student" difficulty, so far as it exists, should be left to be dealt with by the new University It is limited in character, though extensive in scope, and is very far indeed from being insurmountable

To resume. We are entirely in favour of a single non-exclusive London University, mainly, or at least adequately, of a professorial character—which by no means necessarily involves the extreme teacher-examiner system—controlling both teaching and examination, and being or becoming, by absorption or otherwise, homogeneous in interest, and in the highest degree authoritative in function All these features are entirely novel, they are not, we believe, possessed by any British University And herein lies the practical difficulty now to be confronted The present opportunity for creating such a University is not likely to recur, at all events for some generations to come What is to be done to make the best of it? The Royal Commission is fully aware of the greatness of the task committed to it, and has entered upon its labours in no niggard, narrow, or unappreciative spirit. But the Commission must be aided by educational opinion clearly thought out and firmly expressed. It must have the support of the London University, of the great Colleges, of the Medical Schools, and of the professorial body in London, who should be aided by the sympathy of their brethren in the provinces—a sympathy, there is good

reason to believe, that will not be wanting Such professorial opinion will include that of the staffs of the Colleges and Schools, and of those members at least of the Senate and Convocation of the University of London who are or have been engaged in professorial work So powerful a body of opinion cannot but exert a great—indeed, a decisive—influence upon what may be termed the lay elements of the governing bodies, whom we can only reach through their professorial colleagues

It is difficult to see how the arguments of eminent specialists in support of the general arguments called forth by the occasion can be rejected, when once the novelty of their proposals has been got over Convocation, with an appeal to the Privy Council, will have a far more usable and useful power than is inherent in the bare obstructiveness or quasi-terrorism of the veto The Senate in Burlington Gardens will scarcely refuse to complete the University character of the great institution it governs, and perfect its educational machinery, by placing the responsible direction of the higher education of all its students, without exception or distinction, in the hands of the most eminent representatives of those who have made such education the business of their lives The Medical Schools will only give up the teaching they are least adapted to furnish, and in lieu of being scattered entities, will become integral portions of a great whole The private arts student will retain every advantage and privilege he possesses, and cannot but gain by working under syllabuses prepared by past masters in the art of teaching

Perhaps the best procedure to be adopted by the Professoriate, with whom the initiation of any active propaganda must lie, will be to lay their views before the governing bodies by deputation, and before the Commission by the individual testimony of such among them as may be invited to give evidence on the question Here a word of caution may not be out of place Details of a ministerial nature should be avoided as much as possible, for until the main lines of any scheme are settled, it is difficult to say what details are possible or necessary It is still more important to shun any approach to doctrinairism, the besetting vice of professordom, and treat every principle as modifiable by the circumstances of history, national habit, and environment

On the financial aspect of the question we can say little The establishment of a new University will cost money, but no great sum will be needed to start with The University will, of course, be independent, and the necessary expenses will be defrayed in part by an annual Government grant Among other sources of income, the funds at the disposal of the County Council may perhaps be counted, and with a view to such assistance it might be found advisable that the University should have a commercial and technical, as well as a purely academical side

But for the moment, what is of most importance is, we repeat, that the London Professoriate should organize itself, formulate its principles of action in the sense above indicated, and use its influence, publicly and privately, to procure their acceptance as far as circumstances may show to be possible

INDIAN BOTANY

Annals of the Royal Botanic Garden, Calcutta Vol III (1) The Species of Pedicularis of the Indian Empire and its Frontiers, by D Prain, M B, F R S E, Curator of the Herbarium (2) The Magnoliaceæ of British India, by G King, M B, LL D, F R S, C I E, Superintendent of the Garden (3) The Genus Gomphostemma, by D Prain (4) The Species of Myristica of British India, by G King 4to, pp 350, tt 174 (Calcutta Printed at the Bengal Secretariat Press, 1891)

THE two previous volumes of this publication are devoted entirely to the illustration and description of the arboreous element in the Indian Flora, and the letter press is solely the work of Dr King Volume I deals with the difficult genus *Ficus*, illustrated by 232 plates, and the second volume treats of the almost equally difficult genus *Quercus* and the allied *Castanopsis*, as well as the genus *Artocarpus*, of which seventeen species are described and figured As may be seen from the list of papers given above, the work in the present volume is partly by Dr King, and partly by his Curator, Dr Prain, the former continuing his valuable labours on the trees of India, whilst Dr Prain has taken up two herbaceous genera A critical review of this ponderous volume would require more space than could be given to it in the pages of NATURE, and a much deeper knowledge of the subjects than the writer possesses, but it is not a difficult task to give an idea of the nature and quality of the series of monographs it contains At the outset one is disposed to find fault with the bulk and fourteen pounds weight of this book, because it is really fatiguing to handle, and smaller volumes are in every way more desirable Fortunately the present volume may be conveniently bound in three nearly equal parts, as each monograph has its separate title-page and index Indeed, it might be preferable to bind each of the four monographs separately

The present volume, it will be perceived, is partly devoted to utilitarian botany, which will be welcome to the forestry department, as well as to botanists generally, and partly to botany of a kind that appeals more especially to the biologist Dr Prain's elaborate and painstaking monograph of the genus *Pedicularis* belongs to the latter category, and may be recommended for study to the young aspirant for honours in the same direction as a model of thoroughness, so far as external morphology goes To persons acquainted only with our two native species of *Pedicularis*, the wide range of modification exhibited in the forms of the corolla is surprising, and reminds one of Prof Huxley's remark that the genus *Gentiana*, as generally circumscribed, presents nearly as much variation in the shape of the corolla as all the genera of the Gentianaceæ combined This polymorphism is sufficiently illustrated in the comparatively recent monograph of the whole genus *Pedicularis* by the late Mr Maximowicz He figures the flowers of all the species known to him, whilst Dr Prain figures the plants, or portions of the plants, of all the Indian species, as well as their flowers Great as is the variety, however, in the size and shape of the corolla in *Pedicularis*, it would be wrong to

say that it is nearly as great as in the whole order of the Scrophularineæ The two principal kinds of variation are the length and the relative diameter of the tubular portion, and the shape of the lips, especially of the upper one, of which there are many curious and even fantastic modifications Maximowicz's monograph of the whole genus (which is dispersed all round the northern hemisphere, and perhaps extends just over the equator in the Andes) includes about 250 species, and a few have been discovered in India and China since Prain's monograph of the Indian species contains nearly double the number described in the "Flora of British India" in 1884 The systematic part is preceded by an elaborate and masterly essay on the distribution and descent of the species, illustrated by diagrams and a map The latter might certainly, with a little extra work, have been made clearer Dr Prain divides the genus primarily into three groups—namely, *Longirostres*, *Aduncæ*, and *Erostres*—based on the modifications of the upper lip of the corolla, and the names are sufficiently descriptive to indicate their application Each of these groups contains both opposite (or verticillate) and alternate leaved species, and is subdivided into a number of sections. So far as we have tried the keys to the sections and species we have found them work admirably, and the descriptions are evidently very carefully written, but twelve to eighteen lines of description in the ablative absolute without a stop or any variation in type is bewildering, and an innovation that is to be deprecated Dr Prain himself appears to have realized this, for in his account of *Gomphostemma* his descriptions are shorter and punctuated, with the names of the various organs in italics

Dr King's monographs of the Magnoliaceæ and the genus *Myristica* are written entirely in English, perhaps with advantage, because Latin descriptions are not so easily understood as English by many persons interested in trees Including the suborder Schizandreæ, the number of Indian Magnoliaceæ described and figured is forty-five, referred to eight genera.

Passing on to his monograph of the species of *Myristica* of British India, we find that he distinguishes sixty-eight, illustrated by sixty-nine plates By British India, Dr. King understands political British India, including the Nicobar and Andaman Islands, and the territories of the Straits Settlements Dr King follows Bentham and Hooker, and others, in referring all the nutmegs to the one genus *Myristica*, and, as thus limited, it is represented in nearly all tropical countries Ten years ago, less than a hundred species were described, but Dr Warburg, who is at present at Kew engaged on a monograph of the order, estimates the number now in herbaria at about 200 This great augmentation is almost wholly from discoveries in the Malayan Peninsula and Archipelago, New Guinea, and Eastern Polynesia. Dr King abstains from any attempt to trace the geographical distribution of the species, on the ground that he believes many yet remained to be discovered But on running through his work we find that about fifty-four of his sixty-eight species are from the Malayan region, eight from the Deccan and Ceylon, and about six from the Assam and Chittagong region, only two apparently being found as far westward as Sikkim, in North India. Most of the new species are from Perak, a country exceedingly rich in endemic trees Beyond the distribution indicated, there is one species in North Australia, and four each in Madagascar and Tropical Africa, and perhaps about forty or fifty in America, extending from South Brazil through the West Indies and Venezuela to Central America and South Mexico The author is careful to explain that he does not regard the present effort as anything approaching finality, and anyone acquainted with the genus will understand the difficulties encountered in working from herbarium specimens alone With one interesting exception (*Myristica canarioides*, King) the species are diœcious, and female flowers are much rarer than males, and the fruit, which affords good characters in a fresh condition, is often wanting, or not in a good state for description But if Dr King's work is necessarily incomplete, it supplies the very best materials for the foundation of a more exact knowledge The figures, although possessing no great artistic merit, are faithful portraits of authentic specimens of the several species, and, combined with the very full descriptions, are sufficient to enable botanists to determine most of the species On the other hand, the fine work in the analyses of the flowers is indistinctly reproduced in some of the plates, apparently in consequence of their having been drawn on too small a scale The flowers, it may be added, of many species, are exceedingly small, of some not more than a twentieth of an inch in diameter But I must draw this notice to a close with the remark that this volume is a monument to the skill and industry of Dr King and his colleague, and a credit to the native lithographers and printers One only marvels how the authors, with their multifarious duties, accomplish so much in a tropical climate

W BOTTING HEMSLEY

MATHEMATICAL RECREATIONS AND PROBLEMS

Mathematical Recreations and Problems of Past and Present Times By W W Rouse Ball (London Macmillan and Co, 1892)

THE idea of writing some such account as that before us must have been present to Mr Ball's mind when he was collecting the material which he has so skilfully worked up into his "History of Mathematics." We think this because the extent of ground covered by these "Recreations" is commensurate with that of the "History," and many bits of ore which would not suit the earlier work find a fitting niche in this Howsoever the case may be, we are sure that non-mathematical, as well as mathematical, readers will derive amusement, and, we venture to think, profit withal, from a perusal of it. The author forewarns possible readers that "the conclusions are of no practical use, and most of the results are not new" This is plain language, but, lest the warning should be too effectual, he adds, "At the same time I think I may assert that many of the questions—particularly those in the latter half of the book—are interesting, not a few are associated with the names of distinguished mathematicians, while hitherto several of the memoirs quoted have not been easily accessible to English readers." We have thus stated the author's *pros* and *cons*, and remark that he has gone very exhaustively over the ground, and

has left us little opportunity of adding to or correcting what he has thus reproduced from his note-books

There are two sources to which every writer on the subject of the earlier part must apply, viz the "Problèmes plaisans et délectables," by C G Bachet, Sieur de Meziriac, and Ozanam's "Récréations mathématiques et physiques" These Mr Ball carefully discusses as to editions and their respective merits

The work before us is divided into two parts mathematical recreations and mathematical problems and speculations. The former consists of seven chapters. In the first chapter are collected together numerous problems with numbers, watches, and cards Some of these last are interesting to the mathematician, and have been discussed in the *Messenger of Mathematics* and the "Reprint from the *Educational Times*" The Middle Ages furnish some curious questions, and an antique problem in *decimation* is associated with the name of Josephus, but these are well-known instances Bachet's weights problem calls for mention. It finds a place in the author's algebra, the omissions in Bachet's argument, Mr Ball notes, have been supplied by Major MacMahon (see NATURE, vol. xlii. pp 113, 114) Mersenne's numbers have been treated recently at some length by Mr Ball in the *Messenger of Mathematics* (vol xxi pp 34-40); in this account it is stated that $2^{61} - 1 = 2\ 305\ 843\ 009\ 213\ 693\ 951$ is the biggest known prime. Fermat claims some space (cf NATURE, vol. xviii pp 104, 344) Of his so-called *last theorem* (no integral values of x, y, z, can be found to satisfy the equation $x^n + y^n = z^n$, if n is an integer greater than 2) we read —

"This proposition has acquired extraordinary celebrity from the fact that no general demonstration of it has been given, but there is no reason to doubt that it is true"

It is fitting that we should give Mr Ball's grounds for this belief

"Fermat was a mathematician of quite the first rank who had made a special study of the theory of numbers That subject is in itself one of peculiar interest and elegance, but its conclusions have little practical importance, and since his time it has been discussed by only a few mathematicians, while even of them not many have made it their chief study. This is the explanation of the fact that it took more than a century before some of the simpler results which Fermat had enunciated were proved, and thus it is not surprising that a proof of the theorem which he succeeded in establishing only towards the close of his life should involve great difficulties"

Proofs have been given in the cases of $n = 3, 4, 5, 7, 14$ (cf pp 28, 29) Many subjects of interest take up the second chapter, as "Geometrical Fallacies" (every triangle is equilateral, and the whole is equal to a part this latter we think we have seen in an article by De Morgan), curious "Proofs by Dissection" (cf. *Messenger of Mathematics*, vol vi p 87), there is a printer's error (p 35, l. 9 up) of $\tan^{-1} \frac{1}{40}$ in place of $\tan^{-1} \frac{1}{46}$, "Colouring Maps" (only four colours necessary to colour a map of a country, divided into districts, in such a way that no two contiguous districts shall be of the same colour), the literature of this problem is brought fully up to date, an account is given of the results of Cayley's "Contour and Slope Lines," and of Clerk Maxwell's "Hills and Dales" Then follow "Statical Games of Position" ("Three in a Row" and "Tesselation," both problems connected with the name of Sylvester), "Dynamical Games of Position" ("Shunting," "Ferry-boat Problems," and numerous counter, pawn, and solitaire problems), and a glance at "Paradromic Rings"

Chapter iii treats of "Some Mechanical Questions," as "Perpetual Motion," the "Underhand Cut on a Tennis Ball" (*Messenger of Mathematics*, vol vii), the "Boomerang," and the "Flight of Birds" (NATURE, 1890-91) In chapter iv we have a miscellaneous lot, the fifteen puzzle, Chinese rings, the fifteen school-girls problem, and such card problems as Gergonne's pile problem, the mouse-trap, and many others Chapter v discusses "Magic Squares," and chapters vi and vii are devoted to "Unicursal Problems" These are Euler's problem (more fully discussed by Listing, "Topologie," and Tait), mazes, geometrical trees, the Hamiltonian game, and the knight's path on a chess-board All these matters are treated lucidly, and with sufficient detail for the ordinary reader, and for others there is ample store of references. There is no chance of catching Mr Ball tripping in his use of books, and his ready access to mathematical journals can hardly be surpassed, so that we have not come upon any new facts We may mention, however, in connection with the knight's path, that there is a short article, accompanied by diagrams, on the subject in the *Leisure Hour* (December 20, 1873), by H Meyer, of the *Hannoverische Anzeiger*

The second part, in its opening chapter, gives at some length an account of the three classical proplems, viz the duplication of the cube, the trisection of an angle, and the quadrature of the circle Chapter ix, on astrology, has many curious details relating to that science, and gives a facsimile of Cardan's drawing of the horoscope of Edward VI, with an abstract of Cardan's account On the whole matter of the chapter Mr Ball writes —

"Though the practice of astrology was connected so often with impudent quackery, yet one ought not to forget that nearly every physician and man of science in mediæval Europe was an astrologer These observers did not consider that its rules were definitely established, and they laboriously collected much of the astronomical evidence that was to crush their art Thus, though there never was a time when astrology was not practised by knaves, there was a period of intellectual development when it was accepted honestly as a difficult but real science."

De Morgan, it may be remembered, in the "Budget" (p 278) says:—

"If anything ever had a fair trial, it was astrology. The idea itself is natural enough A human being, set down on this earth, without any tradition, would probably suspect that the heavenly bodies had something to do with the guidance of affairs."

"Hyperspace," which occupies chapter x., has a full bibliography (compiled by G. B Halsted, *American Journal of Mathematics*, vols. i and ii), forms the subject of one of Mr Hinton's interesting "Scientific Romances" (cf. NATURE, vol. xxxi. p 431), and is connected with Dr. Abbott's "Flatland" (NATURE, vol. xxxi p 76). Mr

Ball has made all these the text for a clear account of our present knowledge of higher space. The two last chapters rapidly survey "Time and its Measurement" and "The Constitution of Matter."

Our analysis shows how great an extent of ground is covered by the "Mathematical Recreations," and when we add that the account is fully pervaded by the attractive charm Mr. Ball knows so well how to infuse into what many persons would look upon as a dry subject, we have said all we can to commend it to our readers. The book is most carefully printed (only three or four typographical errors have met our eye, and the figures on pp. 32 and 33 the student will recognize must be drawn incorrectly).

SOILS AND MANURES

Soils and Manures. By John M. H. Munro, D.Sc. (Lond.) (London: Cassell, 1892.)

THE preface to this book informs us that "it is written for the use of young people in schools and colleges, and those numerous other readers who take an intelligent interest in the how and why of familiar facts and operations, yet have no special training in the language and methods of science."

We must admit that Dr. Munro has succeeded in his endeavour to write a book so simple that it may be put into the hands of a beginner with confidence that he will find few difficulties unexplained, and so trustworthy that the more advanced student may find it helpful and suggestive.

We are having a flood of small agricultural books just now, consequent upon the great movement for technical education in England, but we believe that this book will reach two classes of readers which the majority of other text-books do not seem to have affected. These two classes of readers are farmers and teachers in elementary schools. Too many of these books are written with the idea of preparing students for examination, and they may serve their purpose, but are not very likely to help forward the cause of technical education in agriculture to any considerable extent.

Such education has lately been much talked about, and written about also, and men of authority and experience have even gone so far as to say that the recent attempts to promote it have mostly been failures. But if the means employed have proved inadequate or unsuitable, it does not follow that technical education in agriculture is unnecessary, or that suitable means and methods of promoting it cannot be found.

To attempt to teach the principles of agriculture to men who have no knowledge of either elementary chemistry or botany can scarcely be expected to be generally successful, nor do we hear good accounts of lectures given to farmers by men whose agricultural experience has been mainly limited to the class-room and the laboratory, and who are apt to confound agricultural chemistry with agriculture itself. Yet there are very many earnest workers on the County Councils, who have the cause of agricultural education too much at heart to let a few failures and disappointments dishearten them, and, before very long, we feel sure that they will have more reason for congratulation than at present.

Meanwhile, we can welcome this book of Dr. Munro's and wish it the success it deserves, for not only does the author avoid errors himself but he corrects a few which some other writers of elementary text-books on agriculture have fallen into. Thus, on pp. 20 and 132, he removes the impression which many beginners get (from some "cram-books" we have seen) that silica in a soluble form is very essential as a plant-food, especially to cereals. Only those who are familiar with answers to examination papers in agriculture have any idea how frequently this mistake is made.

The first part of the book, comprising five chapters, will give the reader a very good account of soils, their formation and properties; also of plant-food in the soil, how it is increased, and how rendered available for the use of plants. Included in this first part are two chapters on "Improving the Land" and "Tillage Operations," from the pen of Prof. Wrightson. These fit in well with the rest of the work.

The second part deals with the subject of manures pretty exhaustively, the author giving many illustrations from the Rothamsted experiments. The last chapter, on "Special Manures," gives instructions for valuing artificial manures from the chemical analysis, and we feel sure that the matter dealt with in this chapter will be specially useful, and do at least a little to help the farmer from being defrauded by some few unscrupulous manufacturers, still, unhappily, existent amongst us.

OUR BOOK SHELF.

Catalogue of the Specimens illustrating the Osteology of Vertebrated Animals, Recent and Extinct, contained in the Museum of the Royal College of Surgeons of England. Part III., Class Aves. By R. Bowdler Sharpe, LL.D. (London: Printed for the College and sold by Taylor and Francis, Red Lion Court, Fleet Street, 1891.)

THE first point of interest in looking into this Catalogue was to ascertain which of the innumerable schemes of bird classification had been adopted by the author; we have so many of them nowadays. Sometimes they come upon us two at a time; and to make confusion worse, aged schemes of classification, which one hoped had long ago sunk into a dishonoured grave, are sprung upon us in a fresh edition. The plan followed by Dr. Sharpe is that of Mr. Seebohm, "elaborated in his 'Birds of the Japanese Empire,'" with a few modifications. Under each order is the diagnosis; and there are a few references to the anatomical literature of the subject, which is an addition to the value of the work. These are not very full, but perhaps it is hardly necessary that they should be. A feature of this catalogue is the introduction of illustrations; there are a good many of these—48 in all. They are for the most part figures of the skull, but the syringes of a few birds and the deep plantar tendons of more are also illustrated; two figures illustrate pterylosis, and two more the under surface of the foot. The illustrations in every case are good. The Catalogue is not encumbered with huge lists of synonyms: there is only the most recently accepted name given, together with a few of the most important synonyms. The collection of bones consists of 2380 specimens, representing altogether a little over one thousand species. Some of the fossil forms are of course represented by casts only; but a number of important extinct species, notably among the Dinornithidæ, are well represented by the actual remains, in many instances the types of the species in question. We may

point out to the charitably disposed that there are a number of desiderata there are, for example, no specimens of either the African or the American "Fin-foots"

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Line Spectra of the Elements

THE proper replies to Prof Runge's letter in last week's issue of NATURE are three in number viz (1) that, as I pointed out in my former letter (NATURE of May 12, p 29), the reasoning in my paper is valid if, as I there proved and as Prof Runge now admits in the first sentence of his letter, Fourier's theorem can be applied to motions which approximate to non-periodic motions in any assigned degree and for any assigned time, (2) that I am not aware of anything I have written which countenances Prof Runge's supposition that "Prof Stoney has not noticed that a distinct property of the function is wanted in order to get a proper" [rather, a mathematically accurate] "resolution into a sum of circular functions", and (3) that Prof Runge is mistaken when he supposes that "the amplitudes and periods" [or frequencies] "of the single terms do not approach definite values when the interval" [*i e* the periodic time of the recurrence required by Fourier's theorem] "increases indefinitely"

What the true state of the case is, is most easily shown as regards the frequencies of the lines, and as the proof is, I believe, new, and leads to a result of importance in the interpretation of spectra, I subjoin it

Take a motion of the electron—

$$x = \text{The sum of partials such as } \left(a \sin \frac{2\pi k t}{j} + b \cos \frac{2\pi k t}{j}\right), \quad (1)$$

with similar expressions for the other two co ordinates, in which the oscillation-frequencies, the k's, may be commensurable with one another, or incommensurable If incommensurable, the motion is non recurrent Let this motion be arrested at intervals of T, and immediately started afresh as at the beginning We thus obtain a recurrent motion consisting of a certain section of the motion (1) repeated over and over again This new motion can be analyzed by Fourier's theorem, and we have to inquire what we thus obtain Without losing anything in generality, we may confine our attention to the motion parallel to the axis of x, and to the single partial of that motion which is written out above, as all the partials lead to similar results

Let us then examine by Fourier's method the motion which is represented by the equation—

$$x_k = a \sin \frac{2\pi k t}{j} + b \cos \frac{2\pi k t}{j} \qquad (2, a)$$

from $t = 0$ till $t = T$, and which is repeated from that on at intervals of T If T is a multiple of j/k, Fourier's theorem simply furnishes equation (2, a) as the complete expression for all time of the motion; so that in this case it indicates the same definite line in the spectrum as is furnished by the original partial of equation (1)

If T is not a multiple of j/k,

$$\text{T will} = (m + \alpha)\frac{j}{k},$$

where m is a whole number and α a proper fraction Equation (2, a) then becomes

$$x_k = a \sin \frac{2\pi(m+\alpha)t}{T} + b \cos \frac{2\pi(m+\alpha)t}{T} \qquad (2, b)$$

which is true from $t = 0$ till $t = T$, after which the motion is to be repeated. Then, by Fourier's theorem—

$$\left.\begin{aligned} x_k = A_0 + A_1 \sin \frac{2\pi t}{T} + A_2 \sin \frac{4\pi t}{T} + \ldots \\ + B_1 \sin \frac{2\pi t}{T} + B_2 \sin \frac{4\pi t}{T} + \ldots \end{aligned}\right\} (3)$$

is true of this motion for all time, in which

$$A_n \int_0^T \sin^2 \frac{2\pi n t}{T}\, dt = a \int_0^T \sin \frac{2\pi(m+\alpha)t}{T} \sin \frac{2\pi n t}{T}\, dt + b \int_0^T \cos \frac{2\pi(m+\alpha)t}{T} \sin \frac{2\pi n t}{T}\, dt,$$

$$B_n \int_0^T \cos^2 \frac{2\pi n t}{T}\, dt = a \int_0^T \sin \frac{2\pi(m+\alpha)t}{T} \cos \frac{2\pi n t}{T}\, dt + b \int_0^T \cos \frac{2\pi(m+\alpha)t}{T} \cos \frac{2\pi n t}{T}\, dt,$$

which, when integrated, give the following values for A_n and B_n—

$$\left.\begin{aligned} A_n &= \frac{a \sin 2\pi\alpha - b(1 - \cos 2\pi\alpha)}{2\pi}\left(\frac{1}{d} - \frac{1}{s}\right) \\ B_n &= \frac{a(1 - \cos 2\pi\alpha) + b \sin 2\pi\alpha}{2\pi}\left(\frac{1}{d} + \frac{1}{s}\right), \end{aligned}\right\} \quad (4)$$

where d stands for $(m - n + \alpha)$, and s for $(m + n + \alpha)$

This furnishes a very remarkable spectrum, a spectrum of lines that are equidistant on a map of oscillation-frequencies, and that extend over the whole spectrum But they are of very unequal intensities If T is a long period, m is a high number The lines are then ruled close to one another, and their intensities are insensible except when n is nearly equal to m, the two brightest lines being the next to the position of the original line of equation (1), one on either side of it, and the others falling off rapidly in brightness in both directions

If we take a longer period for T, m becomes a still higher number, the lines are more closely ruled and are more suddenly bright up to those on either side of the position of the original line of equation (1), to which also they are now closer, so that, at the limit, when T increases indefinitely, equation (3) becomes a mathematical representation of the original line of equation (1)

This interesting investigation is all the more important as it gives a clue to how rulings of lines which are equidistant and brighter up to the middle may arise, and I feel sure that Prof Runge will join me in not regretting that he expressed the doubts which led to its solution

G JOHNSTONE STONEY

9 Palmerston Park, Dublin, June 3

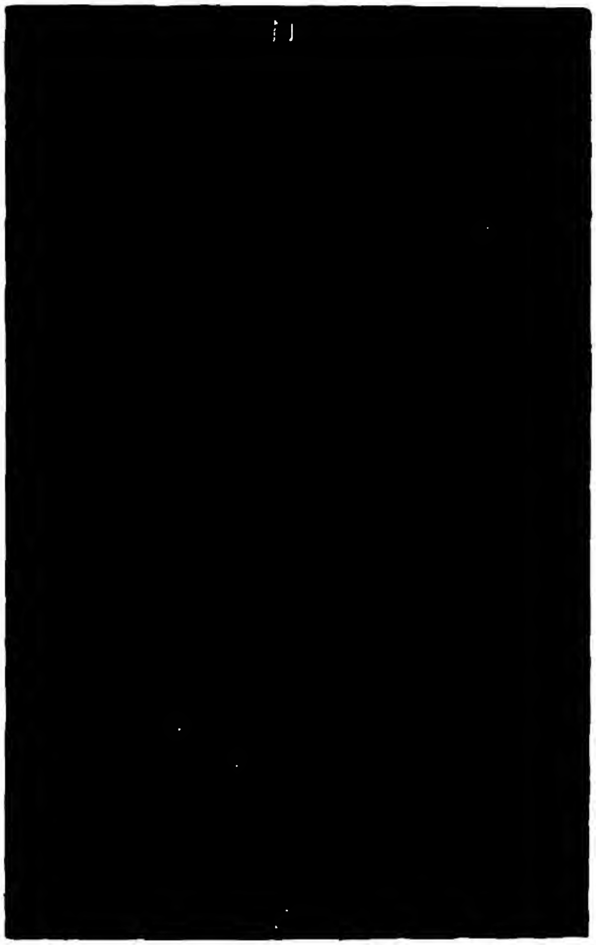
Stone Circles, the Sun, and the Stars

ARTICLES by Mr Norman Lockyer and Mr Penrose, recently published in NATURE, have dealt with the positions of ancient Egyptian and Greek temples with relation to the rising sun, and to the pole star, or some star or stars in its vicinity For some years past I have endeavoured to show in papers read before the British Association and other Societies, that our stone circles had a relation to the rising sun, indicated usually by an outlying stone or by a notable hill top in the direction in which the sunrise would be seen from the circle, and I have in some cases found similar indications towards the north, which may have referred to the pole or other northern star or stars A paper containing many details as to these cases will shortly appear in the Journal of the Royal Archæological Institute

There are six circles on Bodmin Moors, which at first sight appear to have no relation to each other, but which, if the 6-inch Ordnance map is to be relied upon, would seem to have been arranged on a definite plan (see accompanying plan)

The Stannon and Fernacre Circles are in line 1 (true) north of east with the highest point of Brown Willy, the highest hill in Cornwall; and the Stripple Stones and Fernacre Circles are in line with the summits of Garrow and Rough Tor, at right angles with the other line—namely, 1° west of (true) north A line from the Trippet Stones Circle to the summit of Rough Tor would also pass through the centre of one of the Leaze Circles (about 12° east from true north) Other hills are in the direction of the rising sun The Trippet Stones are 11½° south of west from the Stripple Stones, 10° east of south from the Stannon Circle, and about 13° west of south from the Fernacre Circle. The respective bearings of the other circles have already been given, and all are true (not magnetic) according to the 6 inch Ordnance map

More remarkable, perhaps, than the position of these circles are their distances from each other, which, on the level map, are almost exactly as 3, 7½, 2, and 8, for the sides of the irregular four sided figure, of which four of the circles form the corners, while the diagonals are of the same length within a hundred feet, the differences being much less than the 1 per cent which Mr Flinders Petrie has found to be the average error of ancient British and even Assyrian workmanship The builders of these



circles may be supposed to have aimed in their measurements at even numbers of some unit, and the unit which gives the best results appears to be a Royal Persian or Egyptian cubit of 25·1 inches (not at all the unit one would expect) The actual measurements, as nearly as I can get them from the 6 inch Ordnance map, are —

	Feet	Cubits of 25·1 inches.
Stannon Circle to Fernacre Circle	6275	= 3000
Fernacre Circle to Stripple Stones (Practically 7500 cubits)	15730	= 7520
Stripple Stones to Trippet Stones (Practically 2000 cubits)	4180	= 1998 4
Trippet Stones to Stannon Circle (Probably meant for 8000 cubits)	16575	= 7924
Diagonals.		
Fernacre Circle to Trippet Stones	16950	= 8103
Stannon Circle to Stripple Stones (Perhaps meant for 8125 cubits)	16350	= 8055

It must not be forgotten that these measurements are taken from the level map, while the ground between the circles is very irregular, but it seems more probable that the builders of these circles made allowance for the irregularities of the ground than that the distances, as shown by the map, are merely the result of accident

If, however, the 25 1 inch cubit were the unit of measurement for the distances between the circles, it ought to appear in the measurements of the circles themselves—and it does, for the diameter of the Trippet Stones Circle is exactly fifty of such cubits, and the diameters of the Fernacre and Stripple Stones Circles are (as nearly as I can judge in their ruinous condition) seventy of such cubits

The Egyptians appear to have constructed separate buildings for the observation of the sun and of the stars, but if the circle builders used the same circles for both purposes, placing them so that when standing in them they could see the sunrise over a fixed point on one hill, and a certain star rise over a fixed point on another hill in another direction, their system was much more economical, though perhaps less exact than that of the more civilized Egyptians A L LEWIS

The Height of the Nacreous Cloud of January 30

THE cloud referred to by Mr T W Backhouse, in your issue of February 18 (p 365), attracted universal attention over Eastern Yorkshire and even in Lincolnshire, so that numerous letters were sent to the *Leeds Mercury*, *Yorkshire Post*, &c.

Its general appearance in these parts is being dealt with by Mr H Bendelack Hewetson, of Leeds I will therefore merely state that the intensity of the fringes surpassed anything in my previous experience Even those observed in 1884–85, in connection with the Krakatão glows, did not approach it in this respect

Here, as it happened, Venus lay just upon its lower edge As this was fairly horizontal, save for a break not far from the middle, I was very pleased to get from Mr C J Evans, Ackworth, near Pontefract, a second observation In response to further appeals, observations, of varying accuracy, from the places in the subjoined table, were available for calculating the height

Leeds (Prof A Lupton saw the cloud "nearly overhead," "if not, a little S S W," "within 20° of the vertical"), *Ackworth*, and *York* enable us to determine the direction and position of the central part of the lower edge of the cloud as seen from the north and east They give a point just above Mirfield Junction, 9 miles S S W from Leeds, 32 miles S W. from York and 13½ miles W of Ackworth The Driffield direction passes the same spot The only other record, Market Rasen, is very divergent, the observer there putting the centre point south of west, whereas Mirfield is north of west

The altitude of this point was capable of closer determination, thanks to references to Venus and Jupiter The results of careful reductions are given in degrees in the following table, accompanied by the corresponding heights in miles, and distances and directions from Mirfield

Place.	Miles from Mirfield	Direction from Mirfield	Altitude in degrees.	Resulting height above Mirfield	Observer
[1] Ackworth	13½	E	40 (?45)	11 (?13½)	C J Evans, &c
Tadcaster	22	N E	35–40°	15	C Rawson
[1] York	32	N E	22½	13½	J E Clark
Wetwang	50	E N E	16½	19½	E M Cole
Driffield	56	E N E	10–15	16	J Lovell
Hull	44½	E by N	12	13	S Bowen.
[1] Market Rasen	58	E S E	16	15	W Whiteman
[1] Sunderland	88	N by E	7½	14	T W Backhouse

The adopted height from the above eight records is 14 miles, or 75,000 feet

The Leeds record gives 25 miles, but Prof Lupton wrote only from memory, in response to inquiry after some interval It may, however, indicate that the south-west edge of the cloud was more nearly above Leeds By shifting it 4 miles in that direction the Leeds height becomes 16 miles, and that for Ackworth 11½ miles, Tadcaster 12½, York 12, and the rest, except Market Rasen (unchanged), become half a mile less The mean result, taken as before, but now including Leeds, is 13 6 miles, or substantially the same

[1] As the records at these stations appeared to be much the more trustworthy, *double weight* is given them in the reduced value In the Ackworth value, four times the weight is assigned to the 40° as to the 45°, the latter, on inquiry, being stated to be less probable.

The more distant localities did not, of course, view the same *edge* as those nearer, but one which must have been rather nearer them and lower down. Thus they are subject to a positive and a negative source of error, which cannot be well estimated, but which fortunately tend to neutralize each other.

The resulting height is unexpected, but the records agree so nearly as to leave little doubt of its substantial accuracy. Mr. Backhouse's measurements were made merely for altitude and an hour later, but the cloud shift was so slight that it has been included.

J. Edmund Clark.

A Dust Storm at Sea

A few days ago, while returning to Tokio from the southern part of Japan, I joined the s.s. *Yokohama Maru*, which, whilst crossing from Shanghai to Nagasaki had passed through a curious dust storm. Small quantities of the dust were yet to be seen in sheltered corners of the vessel. The commander, Captain R. Swain, who gave me a specimen of the material, told me that on April 2, when about 95 miles west by south of Nagasaki (long. 128° E., lat. 32° 20′ N.), at about 6 p.m. the sun appeared quite yellow. The atmosphere was moist, and rendered everything upon the deck of the ship quite damp. The precipitated moisture was yellowish, and as it dried it left an extremely fine powder. For two days previously the wind had been blowing west-south-west, or from China. Nothing was felt in the eyes, and if the ship had not been covered with yellow powder, the phenomenon would have been regarded as an ordinary but peculiarly coloured fog.

The yellow atmosphere was noticed during the afternoon of the 2nd. At midnight the wind changed to north west—that is, from Corea. The probability, however, is that the material came from the loess plains of China. In Nagasaki, which is 390 miles from the coast of China, a yellow sun was noticed on the morning of the 2nd, and during the day, whilst dust was being precipitated, the appearance of the atmosphere was compared to that of a London fog.

On April 1 there was a fall of dust in the neighbourhood of Nawa in Okinawa-ken, and on the 2nd dust fell in Gifu—the district where the recent great earthquake took place. The P. and O. s.s. *Verona*, which left Hong Kong on April 1, experienced the same phenomenon as the *Yokohama Maru*, the vessel being covered with a fine dust, which, when suspended in the atmosphere, gave rise to so much haze that land was not seen until reaching Nagasaki. On April 3 a yellow sun was seen in Yokohama, but I am not aware that any dust was observed. Roughly speaking, it therefore seems that on April 2, at a distance of from 200 to 400 miles from the coast of China, there was a cloud of dust which may have been over 1000 miles and possibly 2000 miles in length. Dr. B. Koto, who examined a specimen, tells me that the particles are chiefly felspar, but there is a little quartz and shreds of plants.

John Milne.

Tokio, April 23.

Submerged Forest

During a recent visit to an East Lincolnshire seaside place, Mabelthorpe, the remains of a submerged forest were pointed out to me plainly visible at low water. On closer inspection, the stumps of fallen trees, firmly embedded in the clay from one to twenty inches above the surface could be traced along the low-water level. I should be much obliged if any reader could fix a date at which the forest was growing. Does it not prove a subsidence of land in the neighbourhood?

M. H. M.

Carnivorous Caterpillars.

I should like to know if it is a known fact that some caterpillars are carnivorous, eating their own kind, and small ones of another kind? I have found on a lime-tree on our lawn, six caterpillars, two of which have done so.

One of them has (though there was plenty of food, as I had only taken it from the tree a few minutes) eaten one of its own kind about three-quarters its own size, and later on in the day a small green looper (off the lime-tree), which was in the same box. A second has eaten two small loopers. The other three I only found to-day, and they are not as large as those which had eaten their fellows.

I cannot find a description of this caterpillar in "Das Buch der Schmetterlinge" (Lutz), which I use.

They are of a bright green, the colour of the young lime leaves, with a narrow white line down the back and along each side half-way down, and a broader one lower down. Between this and the narrow side stripe are three very small black spots; between the back line and the narrow side-line, are two black spots, to each segment. Each spot has a white edge. On the first two segments the upper two spots are one under the other, but on the rest are side by side. The three spots form an L, with the two lower ones very near, or on the broad side-line.

They have eight prolegs, as well as the two suckers at the back. They appear very irritable, and swing their heads from side to side when touched, and apparently nip other caterpillars which dare to touch them in any way.

I may also mention that there are three very fine specimens of the Red Admiral (*Vanessa Atalanta*) in our garden to-day and yesterday.

Juliet N. Williams.

Blackbrook, Bickley, Kent, May 29.

THE HURRICANE IN MAURITIUS

The devastation caused by the hurricane in Mauritius was so terrible that it was hardly to be expected the Observatory would be spared. We are glad to say, however, that it suffered no damage, and all meteorologists will congratulate themselves that the well-known Director, Mr. Meldrum, was able without delay to prepare an account of the storm. The account is printed in the special overland edition of *The Merchants and Planters Gazette*, May 11. We here reproduce it:—

"*Saturday, April* 30.

"The hurricane which raged for a few hours yesterday, April 29, has in many respects been unprecedented in Mauritius.

"Never till now has the island been visited by a hurricane at any time between April 12 and December 1. Hitherto the hurricane season of Mauritius has been supposed to begin on the latter and to end on the former day, and till yesterday there has been no exception to the rule.

"Nor was there any sign of danger till yesterday, when the barometer began to fall rapidly and the wind to increase to a heavy gale. The suddenness, rapidity, and extent of the changes which took place in a few hours are unparalleled in the annals of the colony.

"The following table will for the present suffice to convey some idea of the changes which took place in the barometric pressure and the direction and velocity of the wind from 9 a.m. on the 24th to 9 p.m. on the 29th:—

Day and Hour	Barometer: Cor. and reduced to sea level	Barometer: Fall or Rise per hour cor. for var.	Wind: Mean Direction	Wind: Velocity in miles per hour
	Inches.			
April 24				
9 a.m.	30 059	—	E S E ½ S	3
April 27				
9 a.m.	29 903	—	E by S.	15
April 28				
9 a.m.	905	—	N E by E.	12
4 p.m.	·816	−0 003	N E by E	14
9 p.m.	850	−0 006	N.E	12
April 29				
6 a.m.	·660	−0 018	N E by E	22 4
8 ,,	630	−0 029	N E ½ E	34 7
9 ,,	576	−0 063	N E by E	35 0
10 ,,	·480	−0 094	E N.E ½ N	40 0
11 ,,	·338	−0 131	N E by E	52 0
Noon	066	−0 251	N E ½ E	68 0
1 p.m.	28 517	−0 532	N E ½ E	96 5
2 ,,	27 990	−0 513	N	56 0
3 ,,	28 034	+0 048	W N W	68·0
4 ,,	520	+0 483	W S W.	112 0
5 ,,	29 059	+0 529	S W	82 0
9 ,,	719	+0·151	S. Wrd.	26 0

"In the above table the fall or rise in the barometric pressure is corrected for the daily variation, and from 9 a.m on the 24th to 9 a.m on the 29th the mean hourly velocities of the wind are given, whereas from 10 a.m to 5 p.m. on the 29th the rates of the velocity per hour are given as obtained from observations taken during intervals of two to five minutes

"It will be seen that at 2 p m on the 29th the barometer was at 27 990 inches; that from noon to 2 p m it fell 1 045 inch, that from 3 to 5 p m it rose 1 012 inch, and that from 5 to 9 p m it rose 660 inch The absolutely lowest pressure was 27 961 inches at 2 30 p m, which is the lowest on record in Mauritius

"From 9 a m on the 28th to 1 p m on the 29th the mean direction of the wind did not vary much, but it occasionally showed a tendency to veer towards north, being at times from north-east by north to north-north-east Between 1 and 2 p m it on the whole veered to north, and between 2 and 3 p m to west-north-west, oscillating considerably, and soon after settling down at west-south-west

"After 11 a m the velocity of the wind increased much, being at 1 p m at the rate of 96 5 miles an hour, and at 1 20 at the rate of 104 miles But from 1 25 to 2 30 p m there was a lull, the velocity decreasing to the rate of 43 miles an hour at 2 33 p m It then began to increase again, and at 3 47 p m was at the rate of 121 2 miles per hour, but it soon began to abate, being at the rate of 72 miles at 5 20 p m, 60 miles at 6 p m, 47 miles at 7 p m and 26 miles at 9 p m By this time the weather was fine, the sky partially clear, and here and there stars shining brightly

"Seeing that from 9 a m on the 24th to 9 a m on the 27th the barometer had fallen from 30 059 to 29 903 inches, and that the wind, though light, had veered from east-south-east half south to east by south, a note was sent to the newspapers on the latter day, stating that there was heavy weather to the northward, and that it had existed since the 24th, which, as usual in such circumstances, meant that there were indications of a cyclone away to the northward and that it was travelling from north-eastward to south-westward

"But the wind having by 9 a m on the 28th reached north-east by east, and the barometer being higher on the 27th at the same hour, there was no apprehension, and in the afternoon of the 28th, the wind being still moderate from north-eastward, and the barometer falling at the rate of only 0 003 inch per hour, it was announced that there was no fear

"As already stated, it was only on the 29th that the conditions became unfavourable, and at 9 40 a.m a telegram was despatched announcing that the barometer was falling at an accelerating rate

"Other telegrams, despatched at 11 a.m, announced that the velocity of the wind was at the rate of 52 miles an hour in the squalls, and that probably it would not exceed 56 miles an hour Soon afterwards the telegraph wires were broken, and all communication ceased

"The barometer continuing to fall at an accelerating rate, and the mean direction of the wind being nearly constant, it was inferred that the centre of the depression would, contrary to long experience (the wind being from north-east) pass over the island, and that the wind would then come from nearly the opposite direction

"The centre, however did not pass over the Observatory, but over a point about six miles to the westward of it, and apparently from that point it travelled across the island on an east-south-easterly course

"As a rule, when the wind is from north-eastward, there is scarcely any danger of a hurricane in Mauritius All our great hurricanes have commenced, not with a north-easterly, but with a south-easterly wind, and this is why, when the wind was from north-east by east at 11 a.m. yesterday, and the barometer at 29 338, it was considered probable that the velocity of the wind would not exceed 56 miles an hour On February 12 last, the barometer fell to 29 325, and the greatest velocity of the wind was 47 5 miles per hour from north-east, the barometer soon afterwards rising and the wind decreasing

"There are, apparently, only two ways of, in a measure, accounting for the passage of the centre of a hurricane over the island yesterday from west-north-westward to east south-eastward Firstly, the cyclone which had been travelling to the northward and north-westward of the island on a south-westerly course, from the 24th to the 27th, recurved to the southward and south-eastward, or secondly, a small secondary cyclone, which was generated in the south-east quadrant of the larger cyclone, travelled to the east-south-eastward, and bore down on Mauritius The latter is perhaps the more probable hypothesis; for the small but violent hurricane of yesterday, with respect to its extent, duration, &c, exhibited the characteristics of a local atmospheric disturbance

"On the night of the 27th and morning of the 28th there was a great deal of thunder and lightning, and also frequent lightning during the night of the 28th But the hurricanes of Mauritius are seldom, if ever, immediately preceded by thunder and lightning

"It may be stated, also, that from the 25th to the 29th there were from five to six groups of sun-spots, indicating a considerable increase of solar activity, and that from the 25th to the 28th there were large magnetic disturbances, the portion of the sun's disk on which there was a very large group of spots on February 12 being again on or near the sun's central meridian

"C MELDRUM"

PROFESSOR JAMES THOMSON

PROF JAMES THOMSON, who died on May 8, after a few days' illness, the result of a chill, was born in Belfast in 1822 He was the son of James Thomson, who was then Lecturer on, and afterwards Professor of, Mathematics in Belfast, and subsequently became Professor of Mathematics in Glasgow University. The father was a highly successful teacher and original investigator in mathematics, and was the author of many important school books. One of these books was, thirty years ago, still the recognized text-book on arithmetic in Ireland, and in all probability still retains its position It was referred to by its very well-known title the "Thomson," by Prof Tyndall in his British Association Address in 1874 We do not need the assurances of contemporaries, which are plentiful, that the two boys, James and William Thomson (now Lord Kelvin), made brilliant progress in their father's subject, and exhibited, even in early days, that combination of inventive genius and painstaking effort for accuracy, which have been their great characteristics since. James took his M A degree at Glasgow, served an apprenticeship under Sir William Fairbairn, and practised in Belfast as an engineer. He held the appointments of engineer to the Belfast Water Commissioners and to the Lagan Canal Navigation Works. In 1857 he became Professor of Civil Engineering in Queen's College, Belfast, and his Belfast pupils are to be found occupying high positions in every part of the world He succeeded Rankine in Glasgow in 1872, and resigned the Professorship at Glasgow in 1889 because his eyesight was failing. He became a Fellow of the Royal Society in 1877 He received the honorary degrees of D Sc from the Queen's University of Ireland, and of LL D from Glasgow and from Dublin In 1853 he married the only daughter of the late Mr William John Hancock, J P, of Lurgan, Co Armagh, and it is a pathetic circumstance connected with his death, that she and one of his daughters survived him only a few days. He leaves a son and another daughter

In his private engineering practice at Belfast, he carried out important work in hydraulic machinery for use at home and in foreign countries. He invented the inward flow vortex turbine, and even now there are men in Ulster who are willing to talk at great length about his troubles and successes with this turbine. There was no practical man, however clever, who did not at first ridicule the scientific young gentleman who proposed to replace an eighty foot wheel by a tiny turbine, whose wheel was less than a foot in diameter. He never in his life could have had a happier moment than that in which, surrounded by crowds of astonished rustics and practical engineers, he saw this tiny wheel in its very first trial, driving the machinery of a large mill. And now, wherever turbines are to be found all over the world, they are mostly "Thomson" turbines, made on the principles so clearly thought out and described by him, albeit they are known under many very different names. His notions on such subjects as strength of materials and the effect of initial strains in materials, although published forty-four years ago, have only lately become the notions of practical engineers. At that early date, his ideas on many of the applications of science in engineering were very clear and correct, and far in advance of his contemporaries. He is especially to be recognized for his services in practical hydrodynamics, a subject in which there has been a more misleading appearance of mathematical theory than in any other branch of engineering. To one of Thomson's pupils it is positively painful to take up any authoritative treatise on hydraulic machinery, for he knows that nearly every page of troublesome mathematical reasoning is based on some absurd assumption, and that James Thomson's few propositions are almost the only ones on which the engineer can rely. James Thomson seemed to fear the misuse by young engineers of the recognized mathematical methods of attacking physical problems. He, himself, when he used mathematical expressions, used them merely to put before others the results of his own method of reasoning. It expresses only a part of the truth to say that he thought about things geometrically rather than algebraically. He refrained from publication until his proof was perfect, and some of his pupils may feel sorry that they have not more faithfully followed their master's example. A study of his successive manuscript proofs of his law of flow of fluids from similar orifices would probably enable us to conceive of the habits of thought of the Greek geometers: every word and phrase is carefully selected, and considered time after time with a view to perfect accuracy. Such invention and such regard for perfection of detail were surely never combined before.

When any of his speculations has been once published in an authoritative text-book, it will be noticed that it appears in all text-books published subsequently; the melting point of ice, the triple point in water-stuff, the continuity in the steam water isothermal, the tears of strong wine, are a few examples. No doubt, as time goes on, text book writers will find that he discovered other important things. He was such a very observant man that he often put forward his most important propositions when explaining phenomena that seemed utterly insignificant. Let the reader only think that what occurs in a wash-basin, or in a little rivulet near the sea, may be of great importance scientifically, and let him read again some of Thomson's insignificant-looking scattered papers, and he will find important propositions published which will not, perhaps, for some years yet, find their proper positions in the text-books.

Of the history of thermodynamics during the eventful years 1849–50, who dares now to say anything? Nor can anyone now say anything about the great glacier dispute. One thing is certain, however, that James Thomson's discovery of the necessary lowering of the melting-point of ice with pressure, published on January 2, 1849, settled for ever the theory of the flow of glaciers. Joule's work was beginning to be known, but Thomson, in his proof, like Lord Kelvin in the well-known paper published on the same day, adopts Carnot's idea of the conservation of heat. A change in one expression, not essential to the proof itself, was all that was needed after the first and second laws of thermodynamics had been recognized. Of his various papers on hydrodynamics, capillarity, heat, light, and the states of matter, published since that time, we have not space to say more than that each of them made a substantial addition to our knowledge. His latest work, the Bakerian Lecture this year of the Royal Society, on "The Grand Currents of Atmospheric Circulation," is such a paper as we might expect from a man who had given more than thirty-five years of study to the subject, that subject being one which was peculiarly his own. It is possible that the practical engineer, judging from the title merely, may neglect to read a paper which is one of phenomenal importance to the engineer as well as to the physiographer.

He was a man of singular purity of mind and simplicity of character, very clear-sighted in all that pertained to moral right and wrong, and conscientious to a degree. In his presence one felt in a purer atmosphere, where mean things seemed impossible. No Professor was ever so willing to take trouble (not mere momentary trouble, but trouble of days and nights) in the interests of a student, but no Professor was ever so rigidly exact in giving certificates and testimonials. The present writer has talked often with his old pupils about him, but never met one of them, who, besides a great respect, had not also a genuine and kindly and pleasurable love for his old Professor, whose kindness and patience had been unfailing, and whose sympathy had many a time been extended to him. How useless it is to speak of the good done to the world by a man of his character. Every one of his pupils, in however small or great a degree, is extending the range of his influence.

JEAN SERVAIS STAS

THE regret expressed in the obituary notice of Jean Servais Stas, that we had not the exact words of his famous discourse delivered before the King of the Belgians, has attracted the attention of a correspondent, who has very courteously sent us the text of the speech.

It was delivered by J. S. Stas in his capacity of President of the Royal Academy of Sciences, and was addressed to the King at the New Year's reception, January 1, 1891. We have much pleasure in laying a translation of it before our readers:—

"Sire,

"The Royal Academy of Science, Literature, and the Fine Arts expresses its sincere wishes for the happiness of your Majesty, and the prosperity of your reign.

"As the central organ of the intellectual movement of the country, the Academy seeks to comprise within its arms the most varied talents, and to remain always an adequate and living expression of the entire activity of the human mind.

"This is both its duty and the reason for its existence.

"In the sphere of Literature and Art its voice is almost always safely guided by public opinion—a competent judge of works accessible to all.

"It is otherwise in the sphere of Science.

"The physical, mathematical, and natural sciences, and even the moral and political sciences, do not appeal in the same degree to public opinion. If their conquests radiate afar, if they incessantly modify the conditions of social existence, they themselves develop in restricted circles, and work out of sight and of knowledge of the multitude.

"The Universities, Sire, in our country especially, are the principal foci of scientific life There not only the men of science of the future are trained, but the present representatives of higher research work, create, and distinguish themselves There also the Royal Academy by preference seeks its fellows to associate them in its task and to render it fruitful.

"Its mission cannot be divorced from that of the institutions for higher education, and their lustre and their decline are simultaneous

"In the name of this great and twofold interest the President of the Royal Academy feels bound to call the attention of your Majesty to the mode of appointment to the professorial chairs in the State Universities

"The method adopted is absolutely faulty, and it affords to Science none of those guarantees which she has a right to demand

"The intensity of party strife has the effect of absorbing into its vortex even those acts of the public authorities which ought to be least open to its influence In place of conferring the University chairs upon the most capable men as their rightful prerogative, with the sole thought of raising the level of studies and of enlarging the intellectual patrimony of mankind, we too often see the spirit of faction disposing of such positions arbitrarily, to the injury of the scientific spirit

"An incompetent professor paralyzes for a quarter of a century, even if he does not kill, instruction in the department committed to him An improper nominee is a denial of justice

"The courts of law have been invested with the right of presentation to vacant judgeships, an analogous prerogative ought to be conferred on the faculties of the Universities Their choice would then be dictated by considerations essentially scientific, and to this end the Royal Academy relies on the great influence of the King"

"The King," adds the *Indépendance Belge*, "did not accept this appeal to his influence, and the Ministers present bestowed black looks upon the President of the Academy"

This impressive discourse has its lessons for us also, as it emphasizes the necessity of conferring scientific appointments purely in accordance *rebus gestis*, and in consideration of the actual work done by the candidate

W C

NOTES

THE annual *conversazione* of the Royal Society will be held on Wednesday, June 15

AT the annual meeting for the election of Fellows, held on Thursday last, the Royal Society elected the fifteen candidates whose names, with the statement of their qualifications, we have already printed

THE British Medical Association will hold its sixtieth annual meeting at Nottingham on July 26, and the three following days. Mr Joseph White, consulting surgeon of the Nottingham General Hospital, will preside Addresses will be given, in medicine, by Prof James Cumming, of Queen's College, Belfast, in surgery, by Prof W H Hingston, of Montreal, and in bacteriology, by Dr G Sims Woodhead, of the Research Laboratory of the Colleges of Physicians and Surgeons, England. The scientific work of the meeting will be done in ten sections

AT a meeting of the American Philosophical Society, Philadelphia, on May 20, it was decided that the one hundred and fiftieth anniversary of the foundation of the Society should be worthily celebrated in 1893, and a committee was appointed to make the necessary arrangements.

THE Federated Institution of Mining Engineers held their general meeting in London on Thursday and Friday last At the meeting on Thursday papers were read on "Gold Mining in New Zealand," by G J Binns, and on "Petroleum in Eastern Europe and the Method of Drilling for it," by A W Eastlake Prof T E Thorpe gave some practical demonstrations of the action of coal dust when exploded with gas. The members visited the Electrical Exhibition at the Crystal Palace in the afternoon, and dined together at the Garden Hall in the evening Among the papers read at the meeting on Friday were papers on "The Causes of Spontaneous Combustion of Coal and Prevention of Explosion on Ships," by M V Jones, "A Safety cage for Mines and Hoists," by J Whitelaw, "Winding by Water balance at Nixon's Merthyr Colliery," by M W Davies, and "Gold Milling," by W F Wilkinson

THE Aldini Medal for Animal Electricity has been awarded to Dr A Waller, Lecturer on Physiology, St Mary's Hospital Medical School, by the Bologna Academy of Sciences

THE Council of the Institution of Electrical Engineers decided that the Salomons Scholarship of £35 should be given to a second year's student training to become an electrical engineer at either King's College, University College, the City and Guilds Central Institution, or the Finsbury Technical College The first award has just been made to C H C Woodhouse, Matriculated Student of the Central Institution, Associate of the Royal College of Science, and B Sc of the London University

AT the annual meeting of the Institution of Civil Engineers Mr Harrison Hayter was elected to act as President for the ensuing year The Vice Presidents are Alfred Giles, Sir Robert Rawlinson, Sir Benjamin Baker, F R S, and Sir Jas N Douglass, F R S The following are the other members of Council —W Anderson, F R S, J Wolfe Barry, Alex R Binnie, I A Cowper, Sir Douglas Fox, J C. Hawkshaw, Charles Hawksley, Sir Bradford Leslie, George Fosbery Lyster, James Mansergh, Sir Guildford L Molesworth, W. H Preece, F R S, Sir Edward J Reed, F R S, William Shelford, and Francis W Webb

IN the official abstract of the report of the Council of the Institution of Civil Engineers for the session 1891–92, it is stated that 59 associate members had been transferred to the class of member, and that there had been elected 3 honorary members, 28 members, 324 associate members, and 7 associates, while 4 associate members had been restored to the register These additions together amounted to 366. After deducting 145 names from deaths, resignations, and erasures, there was an increase of 221, bringing up the total number on the register to 5371, as against 5150 at the corresponding date last year This enumeration was irrespective of the students, of whom 200 had been admitted during the year, as against 166 for the previous twelve months, but during this period, 106 students had become associate members, and 140 had disappeared from the list, so that the number now on the books was only 868, whereas last year the number was 914 Thus, including students, the total number on the books was now 6239, as against 6064 twelve months ago The following awards have been made to the authors of papers which have been discussed:—A George Stephenson Medal and a Telford Premium to Mr Alex R. Binnie, Telford Medals and Telford Premiums to Mr A P. Trotter and Mr W T Douglass; and Telford Premiums to Messrs. H Alfred Roechling, A H Curtis, W Airy, H. Gill, and Prof W. C Roberts-Austen. In respect of communications which have been deemed suitable for printing without being discussed, Telford Medals and Telford Premiums had been adjudged to

Messrs F. Fox and Alfred W Szlumper, and Telford Premiums to Messrs Sheibner, T H Beare, W C Unwin, E Penny, A D Stewart, R H B Downes, and W Matthews The Howard Quinquennial Prize had been awarded to Sir Isaac Lowthian Bell, Bart, F R S, for his treatise on "The Principles involved in the Manufacture of Iron and Steel" The papers read at supplemental meetings of students had shown in nearly every case evidence of having been prepared with care Three, at least, were of high merit, and, with four others above the average, had been deemed worthy of publication, either in whole or in part, in the Minutes of Proceedings For these seven papers the Council have awarded the Miller Scholarship to Mr. H B. Ransom for his paper on "Fly-Wheels and Governors," and Miller Prizes to Messrs C H Wordingham, E L. Hill, D. Carnegie, G H Sheffield, J B Ball, and R J Durley

AT the second annual dinner of the Institute of Marine Engineers, held last Thursday, Lord Kelvin, the President, said in the course of his inaugural address that the institution was one which he thought could not fail to be of the greatest service to the cause of marine engineering He had only to go back to the days of his youth to recall the immense strides which had been made in this great industry His father was an Irishman, as he himself was, and he used to cross the Channel from his home in county Down as best he could to land at some point on the coast of Scotland and find his way to the University of Glasgow, there to pursue his studies He used to make the passage in whatever sailing vessel he could find taking the cattle across, and the time of the passage was not part of the bargain On one occasion he sailed from Belfast to Greenock in twelve hours, on another he was four days on the passage, and sailed three times round Ailsa Craig It was only necessary to state such facts to show how vast had been the progress since those days. No branch of engineering, no branch of science which aimed at supplying the wants of mankind, had made greater progress in the last sixty years than that He was not forgetting railways or telegraphs, but he said advisedly that no branch of engineering had made greater or more splendid strides than marine engineering

MISS DOBERCK, who has been appointed assistant meteorologist in Hong Kong, is the sister, not the daughter, of the present Director of the Hong Kong Meteorological Observatory

ACCORDING to a telegram from Naples, dated June 7, the eruption of Mount Vesuvius, which had been noticeable for some little time, had considerably increased in volume, and large masses of lava were flowing into the Atrio di Cavallo ravine

ON June 7, at 12 30 a.m, an earthquake shock was felt at San Severo, in the province of Foggia, and an adjoining hamlet The oscillations, which were of an undulatory character, created a temporary panic.

THE weather during the first part of the past week has been fine over the eastern and southern portions of England, but unsettled in Ireland and Scotland, with a considerable amount of rainfall, while the temperature was much lower, generally, than in the previous week, the daily maxima not exceeding 70°. On the morning of the 4th a disturbance appeared off the Irish coast and crossed our islands on Sunday, causing heavy rain in places, and thunderstorms in the eastern parts of England. The *Weekly Weather Report* for the week ending the 4th instant shows that during that period the rainfall exceeded the mean in all districts, excepting the east of England, where bright sunshine was very prevalent. Over Ireland and in the north of Scotland the excess above the normal rainfall was large, being 1·2 inch and 0·8 inch respectively, yet, reckoning from the beginning of the year, there was still a deficiency in all districts. On Monday, the 6th, a great increase of temperature occurred in most parts of this country, and the weather became much more settled, under the influence of an anticyclone which approached our islands from the southward, while the shade temperature in London reached 73° and 74° at Loughborough During the early part of this week, the anticyclone became well established, and had caused the temperature to rise considerably in Scotland and Ireland, with prospects of settled, fine weather, generally

MR R H SCOTT has contributed an article, entitled "Notes on the Climate of the British Isles,' to *Longman's Magazine* The author gives some amusing instances of the distortion of facts at seaside stations, where the observers are anxious to prove the advantages of their own towns over those of their rivals Taking the whole year round, the warmest spot is the Scilly Isles, which are a degree warmer than either the west of Cornwall or the Channel Islands, while the coldest region on the coast is the extreme north east of Aberdeenshire In winter very little difference of temperature is met with all along the east coast, but the coldest part of England lies round the Wash With regard to the variability of temperature, or the difference of the mean temperature of an entire day, the equability of the temperature of these islands is very great The only locality for which a more uniform temperature has yet been published is Georgetown (Demerara), the figure for this place is 1° 1, while for London it is 2° 7 All the great changes of temperature occur in winter, and accompany sudden thaws As regards bright sunshine, the Channel Islands are by far the most favoured On the mean of the whole year, Jersey secures 39 per cent, but from the Bristol Channel to the coast of Norfolk there is but little difference in the amounts recorded. In cities like London the deficiency is due to smoke. The statistics relating to fog are not yet completely discussed, but so far as they go they show that in winter the foggiest district is the east coast of England Next come London and Oxford, which are about equal With regard to rainfall the east coast stations receive on an average of the whole year about half as much as those on the west coast, the amount being about 25 inches on the east coast, 30 to 40 inches between Sussex and Devonshire, and 50 inches to the south of Cornwall In the west of Ireland the amount rises to 70 or 80 inches, owing to high land near the coast The driest hour almost everywhere is noon

MR. C MICHIE SMITH has edited a work embodying "Results of the Meteorological Observations made at the Government Observatory, Madras, during the years 1861–90, under the direction of the late Mr Norman Robert Pogson" The volume is published by order of the Government of Madras It was Mr Pogson's intention to issue the work as soon as he could after the completion of thirty years of observation, and at the time of his death a considerable part of the manuscript was nearly ready for press In editing the work, Mr Smith, so far as possible, has retained the original plan He expresses much admiration for the skill and thoroughness with which the observations were organized and carried out

THE Essex Field Club will probably hold its first dredging meeting of the season at Brightlingsea on Friday and Saturday, June 24 and 25. Other field meetings in course of arrangement are: Visit to Dagenham district (June or July), the Writtle Woods (July 30), Rochford and Rayleigh (August), on the Stour from Bures to Manningtree, visit to the Dene holes, &c

THE Clarendon Press will publish immediately a second volume of Prof. Weismann's work on "Heredity and Kindred Biological Problems" It contains four essays, of which only the shortest has previously appeared in an English form (in the

columns of NATURE) The first essay deals with degeneration, and clearly shows, by abundant illustrations, that it has resulted from *panmixia*, or the cessation of natural selection The second is an attempt to explain the development of the art of music, and to show that the hereditary transmission of the results of practice is quite unnecessary in order to account for its rise The third contains a reply to certain objections urged by Prof Vines It will be useful in giving clearer expression to the ideas on the death of multicellular beings and the immortality of the unicellular. The fourth and last essay is by far the longest and most important It deals with the essential significance of sexual reproduction and conjugation, &c, as inferred from the results of the most recent researches Prof Weismann's older views on these subjects (especially concerning the polar bodies) have been modified and in part abandoned The immortality of unicellular beings and the question of the transmission of acquired characters by them are also discussed in detail with reference to recent observations

WE have received the first volume of the *Jahrbuch der Chemie*, a new periodical issued by the Frankfort publisher H Bechhold The editor is Prof Richard Meyer, of Brunswick Chemistry is now divided into so many departments that it is difficult for specialists to obtain an accurate idea of the recent progress of the science as a whole The object of the *Jahrbuch* is to supply this need, and, if we may judge from the first issue, the work is likely to fulfil its purpose admirably The editor has secured the co-operation of many well-known chemists, each of whom presents a general view of what was done last year in the department of research to which he himself is more particularly devoted Thus there are, among other papers, reports on physical chemistry, by W Nernst, on inorganic chemistry, by G Kruss, on organic chemistry, by C A Bischoff, on physiological chemistry, by F Rohmann, on pharmaceutical chemistry, by H Beckurts, on agricultural chemistry, by E F Durre, on explosives, by C Haussermann, and on photography, by J M Eder and F Valenta In future issues the editor hopes to include the bibliography of each branch of the subject

THE new number of Wundt's *Philosophische Studien* opens with a comprehensive paper by the editor on "Hypnotism and Suggestion" The subject is treated from the double standpoint of physiology and psychology, and the article should go far towards bringing about a saner tone of thought than that which is just now current, even in "educated circles" Mr Titchener's chronometrical determinations reduce the recognition time of colours to 30, of letters and short words to 50 thousandths of a second Dr Merkel's article on the psychophysical error methods is concluded, and Drs Külpe and Kirschmann publish the results of a careful testing of the Hipp chronoscope (old pattern) by means of a new control-hammer

ON Sunday last a terrible disaster overtook the petroleum district in Pennsylvania, especially the places called Oil City and Titusville A thunderstorm, accompanied by torrents of rain, broke over the district, and the two cities were so quickly inundated by the swollen waters of Oil Creek that it was difficult for the inhabitants to escape to the hills, and many were drowned Several refineries were struck by lightning, so that the unfortunate towns were devastated equally by fire and by water It is supposed that about 200 persons lost their lives, while the destruction of property was enormous.

THE gallery in the South Kensington Museum assigned to the large collection of wrought iron work which has for some time been closed for rearrangement, was re-opened to the public on Whit Monday The larger grilles and screens, including the gates from Hampton Court, are now placed in the arched spaces on either side, while the lanterns, cressets, signs, &c, are suspended along the gallery, smaller objects being shown in sloping glass cases Among these last is a curious series of rush candle holders, tobacco tongs, and other domestic implements used in England, chiefly in the eighteenth century, collected and lent by Lady Dorothy Nevill. Examples of the locksmith's art, English, French, and German, are numerous, including some chiselled steel locks and keys from old French buildings, but produced by "Johannes Wilkes de Birmingham" in the seventeenth century Some of the more famous specimens of mediæval work in English cathedrals have been reproduced in facsimile A hand book on "Decorative Iron Work," prepared by Mr Starkie Gardner, will shortly be published.

THE Board of Directors of the Zoological Society of Philadelphia have issued their twentieth report, and are able to give a good account of their work during the past year Among the changes of the year was the establishment of "a cheap day," the price of admission on Saturdays and holidays (except the Fourth of July), having been fixed at ten cents for adults and five for children The result has been satisfactory, the attendance having increased considerably, while there has been no material financial loss Another fact noted in the report is that an offer of free admission to the Garden was made to the Board of Education for such classes of pupils of the public schools as seemed to the Board likely to profit by the privilege Under the arrangement entered into, nearly ten thousand scholars of the public schools were admitted between September 23, when tickets were issued, and March 1, the end of the Society's fiscal year

THE botanical section of the Imperial Museum of Natural History at Vienna is about to issue, under the name "Cryptogamæ, Exsiccatæ," a collection of named Cryptogams to its contributors, and in exchange for other similar collections

THE Indian papers report that, under the auspices of the Government and Secretary of State for India, an important work, illustrative of the famous Ajanta Cave mural paintings, will be published shortly The bulk of the work will consist of 173 imperial folio plates, mostly produced in chromo collotype, by Mr Griggs, of Peckham, the accompanying text being from the pen of Mr John Griffiths and Dr James Burgess, C I E

FROM an official return just published it appears that during 1891 the total number of persons killed in the Punjab by wild beasts and snakes was 861, or one less than during the previous year The great majority died of snake bite, only 65 deaths being attributed to wild beasts On the other hand, of the 966 cattle reported to have been destroyed, only 38 were killed by snakes

MR W S KEY calls attention, in the American journal *Electricity*, to the difficulty which manufacturers of electrical devices in the United States experience in obtaining iron adapted for electrical purposes They complain of the inferior quality of the iron, the trouble in obtaining such brands as are in every way suitable, magnetically considered, for use in electrical devices such as dynamo and motor armatures, transformers, &c They also complain of the irregular and unsatisfactory manner in which it is too generally annealed and finished by rolling, scaling, &c. Some of these manufacturers have for years used imported English, Welsh, and Swedish iron, which is necessarily of high price They have also used Pennsylvania iron of high quality, but as yet have failed to discover just the quality they need Mr. Key's experience in connection with a well known firm in England has convinced him that iron such as is wanted in electrical manufactures might be produced if proper methods were adopted "To secure such iron," he says, "of course

a full and accurate knowledge of the qualities of the various brands of pig-iron now on the market would be a prime requisite, none the less would a correct knowledge of mixing be essential, while the rolling, scaling, and annealing would all have to be very carefully attended to if satisfactory results were to be attained"

An important series of bibliographies relating to the more prominent groups of the languages of the North American Indians, by J C Pilling, is being issued by the Smithsonian Institution The numbers concerning the Eskimauan, Siouan, Iroquoian, and Muskogean families are already known to students of these languages, and now a fifth number, giving the bibliography of the Algonquian languages, has been published The sixth will include the languages belonging to the Athapascan stock The volume on the Algonquian languages contains 2245 titular entries, of which 1926 relate to printed books and articles, and 319 to manuscripts It consists of 614 closely-printed pages, and represents an amount of well directed labour for which Mr Pilling deserves the cordial recognition of all who will in any way profit by his researches

The atomic weight of copper has been redetermined by Dr Richards, and an account of his work will be found in two papers contributed to the new *Zeitschrift für Inorganische Chemie* (pp 150 and 187) From the results of experiments concerning the replacement of silver in silver nitrate by metallic copper, Dr Richards was led to believe that the number usually accepted for copper, 63 3, was considerably too low He has, therefore, thoroughly investigated the methods by which the old number was obtained, and made a new series of determinations, in which corrections have been applied for the errors due to the mode of analysis adopted In the year 1874 Hampe made two series of determinations of the atomic weight of this element One of these, in which the amount of metallic copper contained in copper oxide was estimated, gave the value 63 34, the second, which depended upon the copper content of anhydrous copper sulphate, yielded the number 63 32 The lower of these values has since been generally accepted as representing most probably the true atomic weight of copper, on account of the extreme manipulative care taken by Hampe, and the remarkable agreement of the individual experiments Dr Richards, however, has discovered a flaw in the method Hampe dried his sulphate of copper at 250°, but Dr Richards has experimentally proved that the so called anhydrous sulphate obtained at this temperature loses about 0 17 per cent of its weight when heated to the temperature of the vapour of boiling mercury This loss, moreover, when taken into account in calculating the atomic weight, brings up the figure almost exactly to that indicated by the replacement of silver experiments An exhaustive investigation has eventually shown that copper sulphate retains 0 12 per cent of its water of crystallization, even after it has been subjected to a temperature of 400° Indeed, this last trace of water is only eliminated at a temperature at which the sulphate itself commences to decompose Dr Richards has therefore made a series of redeterminations of the atomic weight by Hampe's method, drying the salt at 250°–270°. On calculating directly from the figures obtained, the experiments gave the mean value 63 35, a result almost identical with that of Hampe. But upon applying the correction for the slight amount of water still retained at this temperature the mean value is raised to 63 60

In the second communication Dr Richards discusses the mode of determining the atomic weight by ascertaining the amount of copper contained in copper oxide. He shows that copper oxide which is prepared by the method employed by Hampe, ignition of the oxynitrate, contains four or five times its volume of occluded gases, and that even at a bright red heat only a portion of this occluded gas can be expelled. Dr Richards has therefore made a series of redeterminations by this method, applying the necessary correction for occluded gas, the correction having been very accurately ascertained from a large number of observations The final mean value of the atomic weight of copper afforded by the whole of Dr Richards's experiments is 63 604 (oxygen = 16), the maximum and minimum values being 63 609 and 63 600 respectively If the value of oxygen is taken as 15 96, that of copper becomes 63 44.

The additions to the Zoological Society's Gardens during the past week include two Four-horned Antelopes (*Tetraceros quadricornis* ♂ ♀) from India, presented by Mr H M Phipson, C M Z S, a Huanaco (*Lama huanacos* ♂) from Bolivia, presented by Mr Frank Parish, F Z S, a Black-necked Hare (*Lepus nigricollis*) from Ceylon, presented by Mr T C Kellock, a Common Squirrel (*Sciurus vulgaris*), British, presented by Miss Ruxton, a Masked Parrakeet (*Pyrrhulopsis personata*) from the Fiji Islands, presented by Mr A B Holdsworth, a Booted Eagle (*Nisaëtus pennatus*), European, presented by Lieutenant J E Rhodes, a Kestrel (*Tinnunculus alaudarius*), British, presented by Mr Frank Allen, a European Pond Tortoise (*Emys europaea*), European, presented by Miss Lilian Powell, two Alligators (*Alligator mississippiensis*, jv) from Florida, presented by Mr R White, a Moloch Lizard (*Moloch horridus*) from Australia, presented by Mr John McLey, a Llama (*Lama peruana* ♂) from Peru, an Ostrich (*Struthio camelus* ♂) from Africa, a One-wattled Cassowary (*Casuarius uniappendiculatus*), a Common Crowned Pigeon (*Goura coronata* ♂) from New Guinea, two Victoria Crowned Pigeons (*Goura victoriae* ♂ ♀), from the Island of Jobie, two Narrow barred Pigeons (*Macropygia leptogrammica*) from Java, two Pale-headed Parrakeets (*Platycercus pallidiceps*) from North-East Australia, two Roseate Spoonbills (*Platalea ajaja*) from South America, two Vociferous Sea Eagles (*Haliaëtus vocifer*) from West Africa, purchased, a Japanese Deer (*Cervus sika*), born in the Gardens

OUR ASTRONOMICAL COLUMN

Light-Variations of Y Cygni —The *British Astronomical Journal*, No 266, contains two contributions from Mr S Yendell and Prof Dunér, the former "On some observed minima of Y Cygni," and the latter "On the chief cause of the anomalies in the light-variations of Y Cygni" Mr Yendell in his paper thoroughly agrees with the explanation put forward by Prof Dunér to account for the anomalies in the light variations, and says that, when the two series of observations are taken simultaneously, "the substantial correctness of his (Dunér's) fundamental assumption appears to me to be proved beyond the possibility of a cavil" It may be remembered that, in Prof Dunér's former paper on this subject, he was struck with the discordance of some of Mr Yendell's observations, which did not seem to harmonize with his own suggested explanation These observations are now published in detail in this paper, and will be read with interest by those who are following up this curious variable

Prof Dunér, in a few words, discusses the results obtained when his own observations are compared with those of Mr Yendell The differences between the observed and calculated times of minima showed a decided rate of change, the mean rate being −0 023d, but lacked regularity In one case the jump from one epoch to another amounted to a rate of − 0 056d, but he thinks that this may be accounted for by a variation in Mr Yendell's method of observing, for other observations show altogether nearly constant deviations, indeed, "it will be more correct to attribute the discordance simply to errors of observation, than to anomalies in the light variations of the star"

Active Lunar Volcanoes?—Prof Pickering, in the *Observatory* for this month, raises the question of active lunar volcanoes, from some recent observations made with the 13-inch Clark, using powers varying from 800–1200 Examining first the Mare Serenitatis, of 67 craters 32 were found common to

both charts, 24 on Neison's and not on Prof Pickering's, while 11 were found on Prof Pickering's and not recorded by Neison With higher powers, all Neison's, except two, were discovered, and, in addition, several other small ones Just about the region of Bessel a change seems to have taken place since Neison made his map, for there are one or two cases in which the crater pits picked out by him for reference are now not the most conspicuous objects, there being several others far more prominent in the immediate vicinity. The floor of Plato also has been carefully scrutinized, and several of what were then more or less distinct luminous points are now either invisible or barely so, while one large crater was seen where previously none was recorded Whether a real change has taken place in these parts of the moon's surface, or whether the antecedent observations were sufficiently accurate, is a matter of doubt, and it is for future observers to determine this But now, as Prof Pickering says, "that we are able to study the smaller lunar craters to advantage, and so many changes are noted, it does not seem as if the same cause (the mere action of sunlight) can have affected so many of them in the same way, nor does it seem as if all the changes noted can be due to erroneous delineation"

CATALOGUE OF NEBULÆ.—In *Astronomische Nachrichten*, No 3094, the Catalogue No 10 of nebulæ discovered at the Warner Observatory by Swift is inserted The number included, which generally consists of one hundred, amounts here to sixty, the reason being that owing to the increasing number of electric street lights these faint objects are rendered invisible by the illumination of the atmosphere

GEOGRAPHICAL NOTES

DR HENRY SCHLICHTER contributes a valuable epitome of our knowledge of the pygmies of Africa to the June number of the *Scottish Geographical Magazine* He divides the dwarf tribes hitherto reported into four great groups, according to the regions they inhabit, recognizing, however, the probability of further exploration revealing connecting links between them The first group, or dwarfs of West Africa, includes the Obongo, Akoa, and Babongo, which vary between 4 and 5 feet in height The second, or Central African group, contains the Akka, Wambutti, and Batua, of even smaller stature, inhabiting the Congo Basin, scattered amongst Bantu tribes The third group is that of the East African pygmies, whose existence east of the Nile and south of Kaffa was reported as early as 1826, but they are still little known The fourth group, those dwelling south of the Congo basin, is relegated to another paper.

ORDNANCE MAPS of Great Britain are at last coming prominently before the public Although not likely to gratify those engaged in producing the sheets, popular attention will doubtless result in direct and early benefit to cartography and even to geography at large A Parliamentary Committee, on which scientific geographers are well represented, has the whole matter under investigation, and the energetic criticisms of Mr Crook, which have so long passed unheeded, are now receiving further expression in a series of articles in the *Times* The particular object of attack is the new quarter inch outline map of England and Wales, a map put forward by the Survey with some natural diffidence, for it is founded on measurements the most recent of which were made twenty years ago, and the earliest at the very beginning of the century The delineation of the country, in consequence of the want of subsequent revision, resembles a star-chart, in so far as it represents each point as it existed at some different time in the past Unlike a star-chart, however, the quarter inch map of England is of no scientific and little practical value The more thoroughly this matter is investigated, and the more speedily it is rectified, the better will it be for the Survey officers, whose magnificent triangulations and unparalleled accuracy of observation have made the mapping of the British Islands a model for the world to admire It is high time that steps be taken for regular periodical revision of all Ordnance maps, and for publication in a form comparable with that of the Staff maps of France and other Continental nations

AN appreciative article on the late Prof Freeman and his services to geography appears in the June number of the *Proceedings* of the Royal Geographical Society. Freeman's most important service was to demonstrate that the physical geography of a region largely determines the political geography of the countries upon it, and that a knowledge of past geographical conditions is essential in order to understand history

THE report of an expedition to Argentine Tierra del Fuego by Señor Julio Popper has been recently published by the Argentine Geographical Society The region in question is the eastern half of Tierra del Fuego, the geological structure of which is mainly Tertiary rocks much disintegrated, the coast line is little indented, with few harbours, the sea shallow and abounding in sand-banks, while the climate, dominated by the warm Brazil current is equable and moist The south coast bordering the Beagle Channel is rugged, rocky, and under the climatic influence of the cold Antarctic drift The tribes inhabiting the island of Tierra del Fuego proper are the Ona (compare NATURE, xlv 577), who are described as of fine physique, resembling the Indians of North America, and susceptible of civilization Indeed, Señor Popper contrasts their magnanimous and forgiving character very favourably with the unreasoning cruelty of the white gold-seekers who have invaded their territory, yet the Onas are said to be inveterate thieves The map accompanying this report is covered with new names for features already designated, and it can hardly be expected that these will be accepted by European geographers

MRS BISHOP (Miss Bird) read an interesting paper on her recent journey to Little Tibet, before the London branch of the Royal Scottish Geographical Society, on May 31, the Duke of Argyll presiding Lady travellers are not encouraged to describe their expeditions to the Royal Geographical Society, and as the British Association, which receives communications from men and women on an equal footing, cannot meet in London, this opportunity for a metropolitan audience to hear at first hand the account of an adventurous journey, and the sympathetic estimate of the inhabitants of a little-known region, by a woman of Mrs Bishop's tried courage and trained observing powers was naturally taken advantage of to the utmost.

MICRO-ORGANISMS IN THEIR RELATION TO CHEMICAL CHANGE[1]

ALMOST exactly on this day twenty-two years ago the subject of micro organisms was introduced to the audience of the Royal Institution in one of those charming discourses, which so many of us well know were always to be heard from Dr Tyndall The title of his discourse on that occasion was "Dust and Disease," and its contents should be studied by all interested in this department of science, forming, as it does, a part of the classical literature of the subject in which it marks the commencement of a new epoch

It has probably rarely, if ever, happened before, that in so short a period as twenty two years any science has undergone such a marvellous advance, such a many-sided development, as that which has taken place in the case of bacteriology the science which is devoted to the study of those low forms of life which we group together under the name of *micro organisms* This advance has been made through the ungrudging expenditure of self denying labour by a great body of earnest workers of nearly every nationality The subject is, indeed, one calculated to draw forth interest and enthusiasm, for the problems involved are not only of high scientific importance, but are also of incalculable moment to mankind, and, indeed, to the entire living creation

The great impetus which this new science received at its outset was imparted by Pasteur, who has not only laid the foundations, but has also added, and is still adding, so much to the superstructure of its many mansions

The side of bacteriology with which the general public is most commonly brought in contact is that which relates to disease, but of this I propose saying absolutely nothing to night It has been dealt with by others in this place, and notably by my friend Dr Klein

There is a second side of bacteriology which has also a special interest for at least a portion of the public, in consequence of the invaluable assistance which it has afforded to some sections of the industrial world Indeed, chronologically, this industrial department of bacteriology was the first which claimed attention, for the growers of wine, the brewers of beer, and the manufacturers of fermented liquors of all kinds from the highest antiquity have been practical bacteriologists, of the same spontaneous order, it is true, as M Jourdain was an unconscious

1 Friday Evening Discourse, delivered by Prof Percy F Frankland F R S, at the Royal Institution of Great Britain, on February 19, 1892.

author of prose It was Pasteur also who first infused science into the operations of the wine-vat and the fermenting tun, by his classical "Études sur la Bière et sur le Vin" It was he who first showed that the normal work of the brewery was accomplished by particular forms of micro organisms, known as yeast, and that the frequent failures to produce beer or wine of the desired quality was occasioned by the presence of foreign forms of micro-organisms giving rise to acidity and other undesirable changes in these beverages

In these researches of Pasteur's on beer and wine, we are almost for the first time brought face to face with the precise nature of some of the chemical changes which micro organisms bring about The time-honoured vinous fermentation of sugar, the products of which had been valued and indulged in by man even from the days of Noah, is for the first time so accurately studied as to be definable almost with the precision of a chemical equation

Similar attention was also given by Pasteur to some of the other micro organisms which deteriorate the quality of the beer—thus more especially to the bacterium which causes the *acetic* or vinegar fermentation, which is a process of *oxidation*, transforming alcohol into vinegar, to the bacillus inducing the *lactic* fermentation, which is a process of *decomposition*, in which sugar yields lactic acid, as well as to that which brings about the *butyric* fermentation, a process of *reduction*, in which butyric acid is formed

These are the foundations and scaffolding on which subsequent investigators of the phenomena of fermentation have laboured Thus, making use of more refined methods than those which were at the disposal of Pasteur, Christian Hansen, of Copenhagen, has enormously extended our knowledge of the alcohol producing organisms or yeasts, he has shown that there are a number of distinct forms, differing indeed but little amongst themselves in shape, but possessing very distinct properties, more especially in respect of the nature of certain minute quantities of secondary products to which they give rise, and which are highly important as giving particular characters to the beers produced Hansen has shown how these various kinds of yeast may be grown or cultivated in a state of purity even on the industrial scale, and has in this manner revolutionized the practice of brewing on the Continent. For during the past few years these pure yeasts, each endowed with particular qualities, have been grown with scrupulous care in laboratories equipped expressly for this purpose, and these pure growths are thence despatched to breweries in all parts of the world, particular yeasts being provided for the production of particular varieties of beer In this manner scientific accuracy and the certainty of success are introduced into an industry in which before much was a matter of chance, and in which nearly everything was subordinated to tradition and blind empiricism

The Bacteria connected with the Soil

It is, however, with regard to the bacteria connected with other industries than those of alcoholic fermentation that our knowledge has particularly advanced during the last few years Thus some of the most important phenomena in agriculture have recently received a most remarkable elucidation through the study of bacteria

Scientific agriculturists are generally agreed that one of the most important plant foods in the soil is *nitric acid*, indeed they inform us that if a soil were utterly destitute of this material it would be incapable of growing the barest pretence of a crop, *either of corn, or of roots, or of grass*, even if the soil were in other respects of the most superb texture, however favourably it might be situated, however well drained, tilled, and supplied with the purely mineral ingredients of plant food, such as *potash, lime,* and *phosphoric acid*

Yet, notwithstanding the commanding importance of this substance nitric acid to vegetation, it is present in ordinary fertile soils in but little more than homœopathic doses

These facts are gathered from those grand experiments which have during the past half century been going on at Rothamsted under the direction of Sir John Lawes and Dr Gilbert, and which have rendered the Hertfordshire farm a luminous centre of the whole agricultural world

From these experiments it appears that sometimes there is in fertile soil under 1 part, and often under 10 parts, of nitrogen as nitrate per million of soil

Indeed, in order to detect and estimate these minute quantities, the most refined methods of chemical analysis have to be called into requisition [Demonstration of the presence of nitric acid in soil by diphenylamine test.]

Now the cause of such minute quantities only of nitric acid being found in soils is due partly to this material being washed away by the rain, and partly to its being so eagerly taken up by plants for the purposes of nutrition, for it has long been known that by suitable means the quantity can be enormously increased if no vegetation is maintained, and the ground properly protected from rain The soil, in fact, under ordinary circumstances, continuously generates this nitric acid from the various nitrogenous manures which are applied to it, and it is in the form of nitric acid that the nitrogen of manures principally gains access as nutriment to the plant

It was in the year 1877 that two French chemists, Schlœsing and Muntz, showed that this power of soils to convert the nitrogen of nitrogenous substances into nitric acid was due to low forms of life—to micro-organisms or bacteria The proof which they furnished of this statement was of a very simple character, and consisted essentially in demonstrating that this production of nitric acid, or process of *nitrification*, as it is generally called, is promptly inhibited or brought to a standstill by all those materials which have the property of destroying micro-organisms, and which we call *antiseptics*, whilst similarly the process is stopped by heat and other influences which are known to be fatal to life in general

These results of Schlœsing and Muntz were confirmed and greatly extended in this country by Mr Warington and Dr Munro, but although the vital nature of the process was fully established, little practical advance was until recently made in the identification or isolation of the particular bacteria responsible for this remarkable and invaluable transformation

In 1886, however, a very important step was made by Dr Munro, who showed that this process of nitrification could take place in solutions practically destitute of organic matter, or, in other words, that the vital activity of the bacteria of nitrification could be maintained without nutriment of an organic nature

In 1885, I had myself already established the fact that some micro-organisms can actually undergo enormous multiplication in ordinary distilled water —

Multiplication of Micro-organisms in Distilled Water[1]

Hours after introduction of micro-organisms	Number of micro-organisms found in 1 c.c. of water
0	1,073
6	6,028
24	7,262
48	48,100

In taking up the subject of nitrification in conjunction with my wife in the autumn of 1886, I determined to avail myself of this remarkable property of the nitrifying organisms to grow in the absence of organic matter, thinking that in this way it would be possible to achieve a separation of the nitrifying organisms from other forms which can only grow if organic food materials are supplied to them

Proceeding on these lines, we have carried on the process of nitrification over a period of upwards of four years without the nitrifying organisms being supplied with any organic food materials whatsoever —

Composition of Solution employed for Nitrification

Ammonium chloride	5 grm.	In 1000 c.c. of distilled water
Potassium phosphate	1 ,,	
Magnesium sulphate	·02 ,,	
Calcium chloride	·01 ,,	
Calcium carbonate	5·0 ,,	

In a solution of this composition the process of nitrification was carried on over a period of upwards of four years, as indicated in the table on p 137.

In carrying on this series of experiments it was soon evident that although a number of forms foreign to the nitrification process were being eliminated, there were still some remaining alongside of the nitrifying organisms, or, in other words, that a pure culture of the nitrifying organisms had not been obtained. From various considerations, however, we came to the conclusion that the nitrifying organisms probably differed from the other forms which were still present along with them in being unable to grow on the common cultivating medium employed by bacteriologists, and known as gelatin-peptone.

[1] Proc. Roy Soc., 188

Experiments on Continuous Nitrification in Mineral Solutions

Generation	Date of inoculation	Quantity taken for inoculation	Date when nitrification first observed
I	9 5 1887	Original garden soil	20 5 1887
II	25 6 1887	3 needle loops from I	30 6 1887
III	1 7 1887	,, II	7 7 1887
IV.	14 7 1887	,, III	23 7 1887
V	25 7 1887	,, IV	17 8 1887
VI	26 8 1887	,, V	1 10 1887
VII	3 10 1887	1 needle-loop from VI	7 10 1887
VIII	7 10 1887	1 needle-point from VII	17 10 1887
IX	17 10 1887	,, VIII	29 10 1887
X	7 11 1887	,, IX	30 11 1887
XI	1 12 1887	,, X	15 12 1887
XII	16 12 1887	,, XI	13 1 1888
XIII	28 1 1888	,, XII	20 2 1888
XIV	29 2 1888	,, XIII	5 4 1888
XV	7 4 1888	,, XIV	27 4 1888
XVI	30 4 1888	,, XV	10 5 1888
XVII	12 5 1888	,, XVI	26 5 1888
XVIII	19 7 1888	,, XVII	3 9 1888
XIX	3 9 1888	,, XVIII	1 10 1888
XX	11 10 1888	,, XIX	20 11 1888
XXI	24 11 1888	,, XX	26 2 1889
XXII	26 2 1889	,, XXI	4 5 1889
XXIII	28 6 1889	,, XXII	18 10 1889
XXIV	4 11 1889	,, XXIII	17 12 1889
XXV.	27 12 1889	,, XXIV	25 4 1890
XXVI.	16 5 1890	,, XXV	2 7 1890
XXVII	15 7 1890	,, XXVI	30 1 1891
XXVIII	3 3 1891	,, XXVII	28 5 1891

The separation from these foreign forms was ultimately effected by enormously diluting one of these nitrifying solutions, and then taking out small portions of this diluted material and introducing each of these portions into separate ammoniacal solutions In some of these nitrification was established, in others not, whilst amongst those in which nitrification *was* established, some contained organisms which grew upon gelatin, whilst one refused to give any growth on the gelatin at all, although it was seen under the microscope to contain abundantly bacteria of the form shown in the diagram [Lantern slide of nitrifying bacillococcus (Frankland)]

These results, which were published in March 1890, were followed in about a month by a communication in the *Annales de l'Institut Pasteur*, by M Winogradsky, who had also separated a very similar, if not identical, nitrifying organism, and a few months later again a similar separation was made by Mr Warington

But these discoveries had not completely unravelled the problem of nitrification, for the organisms separated in these three independent investigations possessed only the property of *converting ammonia into nitrous and not into nitric acid* The nitrous acid is an intermediate body, which curiously is rarely found excepting in very minute quantities in soil The changes will be more clearly understood by reference to the chemical equations .—

$$(1)\quad \underset{\text{(Ammonia)}}{NH_3} + \underset{\text{(Oxygen)}}{3O} = \underset{\text{(Water)}}{H_2O} + \underset{\text{(Nitrous Acid)}}{NHO_2}$$

$$(2)\quad \underset{\text{(Nitrous Acid)}}{NHO_2} + O = \underset{\text{(Nitric Acid)}}{NHO_3}$$

The organisms separated by Winogradsky, by Warington, and by myself, possessed only the property of effecting the first of these changes, they were absolutely destitute of the power of bringing about the second

Now, the curious thing is that the first of these changes is by far the most difficult to accomplish by *purely chemical means*, whilst the second can be brought about with the greatest facility [Demonstration of addition of acid permanganate to solution of ammonium sulphate, colour not discharged.] [Demonstration of addition of acid permanganate to solution of potassium nitrite, colour discharged.]

Thus the potassium permanganate has no action on the ammonia, whilst the nitrite it oxidizes to nitrate.

In order to bring about the first change, we have to employ one of the most powerful oxidizing agents known to chemists, viz ozone [Demonstration ozone from a Siemens tube was passed through strong solution of ammonia, the production of nitrous and nitric acids was exhibited by the formation of white fumes, as well as by the sulphanilic acid and diphenylamine tests]

We thus see that the power of oxidation possessed by our nitrifying organism is altogether unique, and does not find its parallel amongst purely chemical agents of oxidation *But how then is the nitric acid found in the soil produced when these organisms yield only nitrous acid ?*

At the time when I found that the organism which I had separated produced nitrous acid exclusively, I pointed out that it was doubtless explicable on one of two hypotheses (1) that nitrous and nitric acids are produced by totally distinct organisms, or (2) that the same organism produces the one or the other according to the conditions under which it is growing

More recent researches of Winogradsky have shown that the first of these two alternative hypotheses is the correct one, for, by making cultivations of soil in a solution containing nitrous acid and no ammonia, Winogradsky has succeeded in isolating a micro organism which possesses the power of converting nitrous acid into nitric acid, but has no power of attacking ammonia [Lantern slide of nitric ferment (Winogradsky)]

This second organism or *nitric ferment*, as we may call it, resembles in its activity the purely chemical oxidizing agent—*potassium permanganate*—which, as we have seen, has no action on ammonia, but readily converts nitrous into nitric acid

The process of nitrification in the soil now becomes intelligible in its entirety It is the work of two independent organisms, the first of which converts ammonia into nitrous acid, whilst the second transforms into nitric acid the nitrous acid produced by the first

There is a point in connection with the distribution of nitric acid in nature which is exceedingly remarkable, and which forces itself upon the attention of every student of the process of nitrification Although nitric acid is generally so scantily present in the soil, there is one notable exception to this rule, for in the rainless districts of Chili and Peru there are found immense deposits of nitrate of soda, or Chili saltpetre, as it is called, which would appear to represent the result of a gigantic nitrification process in some previous period of the earth's history The vast quantities of this material which occur in these regions of South America can be gathered from the fact that its exportation has for years been going on at the rate indicated by the following figures —During the first six months of 1890 there were brought to the United Kingdom 90,000 tons, and to the European continent 480,000 tons

From the presence of such altogether enormous quantities, one is almost tempted to hazard the suggestion that in this particular region of the earth, under some special circumstances of which we know nothing, the nitrifying organisms must have been endowed then and there with very much greater powers than they possess to day, and it is particularly noteworthy that in a recent examination of soils from nearly all parts of the earth, one coming from Quito, and therefore not far distant from these nitrate fields, was found to possess the power of nitrification in a degree far beyond that exhibited by any other soil hitherto experimented with Is it not possible, perhaps, that we have in these vigorous nitrifying organisms of the soil of Quito, the not altogether unworthy descendants of the Cyclopean race of nitrifying bacteria, which must have built up the nitrate wealth of Chili and Peru, and thus countless ages ago founded the fortunes of our nitrate kings of to-day ?

But these nitrifying organisms have also assisted in teaching us a highly important lesson in connection with the maintenance of life

The facts which I have already referred to concerning the multiplication of micro organisms in distilled water, and the continuation of the nitrification-process over a period of four years in purely mineral solutions, are strong presumptive evidence in favour of these bacteria being able to gain a livelihood in the entire absence of organic food-stuffs. I refrained, however, from promulgating such a revolutionary doctrine until I should have had an opportunity of repeating these experiments with materials in which the absence of even the merest traces of organic matter had been assured, for, as chemists well know, even distilled water may contain traces of organic matter.

Such a rigid proof as I had contemplated has, however, in the

meantime been attempted by M. Winogradsky, also in connection with his experiments on nitrification, and he has indeed found that the nitrifying organisms flourish, multiply, and actually build up living protoplasm in a solution from which organic matter has been most rigorously excluded Now this living protoplasm in the experiments in question must have been elaborated by these bacteria from carbonic acid as the source of the protoplasmic carbon, and from ammonia and nitrous or nitric acids as the source of the protoplasmic nitrogen If these experiments are correct, and they were undoubtedly performed with great skill and much caution, they are subversive of one of the fundamental principles of vegetable physiology, which denies to all living structures, save those of green plants alone, the power of building up protoplasm from such simple materials

I had occasion to mention in connection with these nitrifying organisms that they refuse to grow on the ordinary solid cultivating media employed by bacteriologists, a fact which presents a great obstacle to their isolation in a state of purity, for it is just by means of these solid culture media that micro organisms are most easily obtained in the pure state

This difficulty has, however, been overcome in a most ingenious manner, originally devised by Prof Kuhne, in which the solid medium is wholly composed of mineral ingredients, the jelly like consistency being obtained by means of silica [Demonstration of preparation of silica jelly, consisting of ammonia sulphate, potassium phosphate, magnesium sulphate, calcium chloride, magnesium carbonate, and dialyzed silicic acid]

Fixation of Free Nitrogen by Plants

But whilst the study of the bacteria giving rise to nitrification has thus led to the subversion of what was regarded as a firmly established principle of vegetable physiology (viz *the incapacity of any but green plants to utilize carbonic acid in the elaboration of protoplasm*), the same science has received another shock, of perhaps equal if not greater violence, through researches which have been carried on with other micro organisms flourishing in the soil

For nearly a century past agricultural chemists and vegetable physiologists have been debating as to whether the free nitrogen of our atmosphere can be assimilated or utilized as food by plants This question was answered in the negative by Boussingault about fifty years since, the problem was again attacked by Lawes, Gilbert, and Pugh about thirty years ago, and *their* answer was also in the negative In the course, however, of their continuous experiments on crops, Lawes and Gilbert have frequently pointed out that whilst the nitrogen in most crops can be accounted for by the combined nitrogen supplied to the land in the form of manures and in rain water, yet in particular *leguminous* crops, such as peas, beans, vetches, and the like, there is an excess of nitrogen which cannot be accounted for as being derived from these obvious sources The origin of this excess of nitrogen in these particular crops they admitted could not be explained by any of the orthodox canons of the vegetable physiology of the time The whole question of the fixation of atmospheric nitrogen by plants was again raised in 1876 by a very radical philosopher, in the person of M Berthelot, whilst the most conclusive experiments were made on this subject by two German investigators, Prof Hellriegel and Dr Wilfarth, who have not only shown that this excess of nitrogen in leguminous crops is obtained from the atmosphere, but also that this assimilation of free nitrogen is dependent upon the presence of certain bacteria flourishing in and around the roots of these plants, for when these same plants are cultivated in sterile soil the fixation of atmospheric nitrogen does not take place Moreover, the presence of these microbes in the soil occasions the formation of peculiar swellings or tuberosities on the roots of these plants, and these tuberosities, which are not formed in sterile soil, are found to be remarkably rich in nitrogen, and swarming with bacteria [Lantern slide of nodules on roots of sainfoin (Lawes and Gilbert)]

Extremely important and instructive in this respect are the experiments of Prof Nobbe, who has not only confirmed the results mentioned, but has endeavoured to investigate the particular bacteria which bring about these important changes, and he has indeed succeeded in showing that in many cases each particular leguminous plant is provided with its particular micro-organism which leads to its fixation of free nitrogen Thus he found that if pure cultivations of the bacteria obtained from a pea tubercle were applied to a pea plant there was a more abundant fixation of atmospheric nitrogen by this pea-plant than if it was supplied with pure cultures of the microbes from the tubercles of a lupin or a robinia, whilst similarly the robinia was more beneficially affected by the application of pure cultures from robinia-tubercles than by those from either pea-tubercles or lupin-tubercles [Lantern-slides exhibiting Nobbe's experiments on pea and robinia]

This subject of the source of nitrogen in leguminous plants has again been taken up by Sir John Lawes and Dr Gilbert at Rothamsted, and their recent results fully confirm the observations of these foreign investigators that it is partially derived from the free atmospheric nitrogen through the agency of bacteria in the soil

To micro organisms again, then, we must ascribe the accomplishment of this highly important chemical change going on in the soil, although it has not hitherto been so fully illuminated as the process of nitrification

Selective Action of Micro-organisms

Any of the ordinary plants and animals with which we are familiar may be regarded as analytical machines, and we ourselves, without any knowledge of chemistry, are constantly performing analytical tests, thus we can all distinguish between sugar and salt by the taste, between ammonia and vinegar by the smell, whilst by a more elaborate investigation we distinguish, for instance, between the milk supplied from two different dairies by ascertaining on which we or our children thrive best In fact, such analytical or selective operations are amongst the first vital phenomena exhibited by an organism on coming into this world It is, however, particularly surprising to find this analytic or distinguishing capacity developed in an extraordinarily high degree amongst micro-organisms From the power which we have seen that some possess of flourishing on the extremely thin diet to be found in distilled water, we should be rather disposed to think that caprice would be the very last failing with which they would be chargeable As a matter of fact, however, the perfectly unfathomable and inscrutable caprice of these minute creatures is amongst the first things with which the student of bacteriological phenomena becomes impressed Let me call your attention to a striking example of this which I have recently investigated

I have here two substances, which have the greatest similarity —

	MANNITE	DULCITE.
Occurrence	Numerous plant-juices	Ditto, but less frequently
Taste	Sweet	Ditto, but less so
Melts	166° C	188° C.
Crystalline form	Large rhombic prisms	Large monoclinic prisms

Not only, however, do these two substances possess such a strong external resemblance to each other, but in their chemical behaviour also they are so closely allied that one formula has to do duty for both of them, for so slight is the difference in the manner in which their component atoms are arranged that chemists have not yet been able with certainty to ascertain in what that difference consists Under these circumstances it would have been anticipated that bacteria would be quite indifferent as to which of these two substances was presented to them, and that they would regard either both or neither as acceptable But such is by no means the case, some micro-organisms, like ordinary yeast, have *no action upon either*, whilst *others will attack mannite, leaving dulcite untouched, others again, being less discriminating, attack both*, representatives of a fourth possible class *which would act upon dulcite but not upon mannite* are as yet undiscovered [Lantern slide and plate culture of *B ethaceticus*]

This bacillus, I have recently shown, has the property of breaking down the mannite molecule into alcohol, acetic acid, carbonic anhydride, and hydrogen, but leaves the dulcite molecule untouched

More recently I have, in conjunction with my late assistant, Mr Frew, succeeded in obtaining a micro-organism which decomposes both mannite and dulcite into alcohol, acetic and succinic acids, carbonic anhydride, and hydrogen. [Lantern-slide and plate-culture of *B ethacetosuccinicus*.]

Optically Active Substances

But these are by no means the ultimate limits to which the selective or discriminating powers of micro-organisms can be

pushed, for although mannite and dulcite are extremely similar substances, they are not chemically identical. We are acquainted, however, with substances which, though chemically identical, are different in respect of certain physical properties, and are hence known as *physical isomers*. It is in explanation of this physical isomerism that one of the most beautiful of chemical theories was propounded by Lebel and Van 't Hoff in 1874, and which remains unsupplanted to the present day.

This theory depends upon taking into consideration the dissymmetry of the molecule which is occasioned by the presence in it of a carbon atom which is combined with four different atoms or groups of atoms, and is most easily intelligible from an inspection of these two models. [Demonstration of tetrahedral models of asymmetric carbon atom.]

This molecular dissymmetry is specially exhibited in the crystalline form of such substances, and in their action upon polarized light.

The molecule arranged according to the one pattern has the property of turning the plane of polarization in one direction, whilst the molecule arranged according to the other pattern has invariably the property of turning the plane through precisely the same angle in the opposite direction. The molecular dissymmetry ceases when two such molecules combine together, the resulting molecule having no action on polarized light at all.

The interest of these phenomena in connection with micro-organisms lies in the fact that they are sometimes possessed of the power of discriminating between these physical isomers. Although this remarkable property was demonstrated years ago by Pasteur in respect of the tartaric acids, it has only comparatively rarely been taken advantage of. Recently, however, chemical science has been enriched in several instances by successfully directing the energies of micro-organisms in such work of discrimination.

During the past few years no chemical researches have commanded more interest, both on account of their theoretic importance and the fertility of resource exhibited in their execution, than those of Emil Fischer's, which have led to the artificial preparation in the laboratory of several of the various forms of sugar occurring in nature, as well as of other sugars not hitherto discovered amongst the products of the animal or vegetable kingdoms. The natural sugars are all of them bodies with dissymmetric molecules, powerfully affecting the beam of polarized light, but when prepared artificially they are without action on polarized light, because in the artificial product the left-handed and right-handed molecules are present in equal numbers, the molecules of the one neutralizing the molecules of the other, and thus giving rise to a mixture which does not affect the polarized beam either way. By the action of micro-organisms, however, on such an inactive mixture, the one set of molecules is searched out by the microbes and decomposed, leaving the other set of molecules untouched, and the latter now exhibit their specific action on polarized light, an active sugar being thus obtained.

The most suitable micro-organisms to let loose, so to speak, on such an inactive mixture of sugar-molecules, are those of brewers' yeast, which decompose the sugar molecules with formation of alcohol and carbonic anhydride. Their action on these inactive artificial sugars of Fischer's is particularly noteworthy.

One of the principal artificial sugars prepared by Fischer is called *fructose*; it is inactive, but consists of an equal number of molecules of oppositely active sugars called *lævulose*.

One set of these lævulose molecules turns the plane of polarization to the right, and we may call them *right-handed lævulose*, whilst the other set of *lævulose molecules* turns the plane of polarization to the left, and we may call them *left-handed lævulose*.

The left-handed lævulose occurs in nature, whilst the right-handed lævulose, as far as we know, does not. Now, on putting brewers' yeast into a solution of the fructose, the yeast organisms attack the left-handed lævulose molecules and convert them into alcohol and carbonic anhydride, whilst the right-handed lævulose is left undisturbed. The yeast organisms thus attack that particular form of lævulose of which their ancestors can have had experience in the past, whilst they leave untouched the right-handed lævulose molecules, which, being a new creation of the laboratory, they have no hereditary instinct or capacity to deal with.

This selective power is possessed also by other forms of micro-organisms besides the yeasts, which are indeed only suitable for the separatory decomposition of sugars, and by means of bacterial forms a much greater variety of substances can be attacked in this manner. Thus I have recently found that glyceric acid can be decomposed by the *B. ethaceticus*, to which I have already referred this evening.

This glyceric acid is thus represented by chemists:—

$$C_3H_6O_4 \quad \text{or} \quad \begin{array}{c} (CH_2OH) \\ | \\ (H)\text{—}C(OH) \\ | \\ (COOH) \end{array}$$

and this should, according to Le Bel and Van 't Hoff's theory, be capable of existing in two physically isomeric forms, as easily shown by our models.

The ordinary glyceric acid known to chemists is, however, quite inactive to polarized light, and must consist, therefore, of a combination in equal molecules of a right-handed and left-handed glyceric acid. Now when the *B. ethaceticus* is put into a suitable solution of the calcium salt of this glyceric acid, it multiplies abundantly, and completely consumes the right-handed molecules of the salt, but leaves the left-handed molecules entirely intact, a powerfully active glyceric acid being thus obtained. [Demonstration of the lævorotary power of solution of new zinc glycerate with projection polariscope.]

A number of derivatives of this new active glyceric acid have recently been prepared in my laboratory:—

Derivatives of Active Glyceric Acid.

Formula	Specific Rotation $[\alpha]_D$
$(C_3H_5O_4)_2Ba + 2H_2O$	9
$(C_3H_5O_4)_2Sr + 3H_2O$	− 10
$(C_3H_5O_4)_2Ca + 2H_2O$	− 12
$(C_3H_5O_4)_2Cd + 1\frac{1}{2}H_2O$	14
$(C_3H_5O_4)_2Zn + H_2O$	22
$(C_3H_5O_4)_2Mg + H_2O$	− 18.5
$C_3H_5O_4Na$	− 16
$C_3H_5O_4Am$	20
$C_3H_5O_4K$	15
$C_3H_5O_4Li$	− 20.5
$C_3H_5O_4Me$	− 4.8
$C_3H_5O_4Et$	9.2
$C_3H_5O_4Pr$ (β)	− 13.0

Here again, then, chemistry has been enriched by a number of new compounds, which we owe entirely to the unaccountable caprice of this micro-organism.

Individuality of Micro-organisms.

Although micro-organisms are thus becoming more and more indispensable reagents in the chemical laboratory, essential as they are for the production of many bodies, it is always necessary to bear in mind that by virtue of their vitality their nature is infinitely more complex than that of any inanimate chemicals which we are accustomed to employ. In a chemically pure substance we believe that one molecule is just like another, and hence we expect perfect uniformity of behaviour in the molecules of such a pure substance under prescribed conditions. In a pure cultivation of a particular species of micro-organism, however, we must not expect such rigid uniformity of behaviour from each of the individual organisms making up such a cultivation, for there may be and frequently are great differences amongst them, in fact, each member of such a pure culture is endowed with a more or less marked individuality of its own, and these possible variations have to be taken into consideration by those who wish to turn their energies to account. In fact, experimenting with micro-organisms partakes rather of the nature of legislating for a community than of directing the inanimate energies of chemical molecules. Thus frequently the past history of a group of micro-organisms has to be taken into account in dealing with them, for their tendencies may have become greatly modified by the experiences of their ancestors.

Of this I will give you an instance which has recently come under my observation:—

Here is a bacillus, which has the property of fermenting calcium citrate; I have found that it can go on exerting this power for years. On submitting this fermenting liquid to plate cultivation, we obtain the appearances which you see here. [Lantern demonstration of plate-culture of bacillus which ferments calcium citrate.]

If one of these colonies be transferred to a sterile solution of calcium citrate, it invariably fails to set up a fermentation of the latter, the bacillus having thus by mere passage through the gelatin medium lost its power to produce this effect. If, however, we take another similar colony and put it into a solution of broth containing calcium citrate, fermentation takes place, on now inoculating from this to a weaker solution of broth containing calcium citrate, this also is put into fermentation, and by proceeding in this manner we may ultimately set up fermentation in a calcium citrate solution which absolutely refused to be fermented when the bacilli were taken directly from the gelatin-plate

Phenomena of this kind clearly indicate that there may be around us numerous forms of micro organisms of the potentiality of which we are still quite ignorant Thus, if we were only acquainted with the bacilli I have just referred to from gelatin cultures, we should be quite unaware of their power to excite this fermentation of calcium citrate, which we have only been enabled to bring about by pursuing the complicated system of cultivation I have indicated It is surely exceedingly probable, therefore, that many of the micro organisms with which we are already acquainted may be possessed of numerous important properties which are lying dormant until brought into activity by suitable cultivation

This power of modifying the characters of bacteria by cultivation is, I venture to think, of the highest importance in connection with the problems of evolution, for in these lowly forms of life, in which, under favourable circumstances, generation succeeds generation in a period of as little as 20 minutes, it should be possible through the agency of selection to effect metamorphoses, both of morphology and physiology, which would take ages in the case of more highly organized beings to bring about

We hear much about the possibility of altering the human race through training from the enthusiastic apostles of education, but even the most sanguine cannot promise that any striking changes will be effected within several generations, so that such predictions cannot be tested until long after these reformers have passed away In the case of micro organisms, however, we can study the effect of educational systems consequentially pursued through thousands of generations within even that short span of life which is allotted to us here

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE —Dr. Peile, Master of Christ's College, has been re-elected Vice-Chancellor for the ensuing academical year

The examination for the Diploma in Public Health will begin on October 4 Candidates are to send their names to the Registrary by September 27

Prof Roy announces a special course in Bacteriology, to be given during the long vacation by Mr Adami, Mr Kanthack (one of the Leprosy Commissioners), and Dr Lloyd Jones, beginning on July 8 It is especially intended for candidates, not necessarily members of the University, for the Diploma in Public Health

An elaborate scheme for the proposed Mechanical Sciences Tripos has been prepared by a special Syndicate, and appears in the *University Reporter* for May 31 The Tripos follows the main lines of the Natural Sciences Tripos, and seems to be free from the objections which have proved fatal to former schemes

It is understood that the persons on whom honorary degrees are to be conferred on June 11, in connection with the Chancellor's inauguration, have been for the most part nominated by his Grace This will perhaps account for the political character of the list, which is, however, partially relieved by the presence on it of General R Strachey, and Mr G W Hill, late of the office of the *American Ephemeris*, and known among astronomers for his fine work on the lunar theory Five of the honorary graduates are Fellows of the Royal Society

The University College of Wales, Aberystwyth, has been admitted to the privileges of a College affiliated to the University The Mason College of Science, Birmingham, has been associated with the Local Lectures Syndicate in the work of University Extension.

Dr. W Howship Dickinson, Dr Bradbury, and Dr. J. F Payne have been appointed Examiners in Medicine, Dr. W. S Playfair and Dr Griffith Examiners in Midwifery, and Messrs Herbert Page, Frederick Treves, and Howard Marsh Examiners in Surgery

Notice of opposition to the appointment of Sir R S Ball to the Directorship of the Observatory has been given. The grounds stated are that the duties of the Professorship of Geometry and Astronomy should occupy the whole time of the Professor, while the energies of the Director, in view of the recent developments of astronomical science, should be entirely devoted to the work of the Observatory It is also held to be unwise in these circumstances to refuse the munificent offer of Mrs Adams to provide £10,000 for the endowment of a separate Director

SOCIETIES AND ACADEMIES

London

Royal Society, May 19 —"On the Changes produced by Magnetization in the Length of Iron and other Wires carrying Currents" By Shelford Bidwell, M A, LL B, F.R S

The changes of length attending the magnetization of rods or wires of iron and other magnetic metals which were first noticed by Joule in 1841, and have in recent years formed the subject of many experiments by the author, have been found to be related to several other phenomena of magnetism Maxwell has suggested that they sufficiently account for the twist which is produced in an iron wire when magnetized circularly and longitudinally at the same time The resultant lines of magnetization, as he points out, take a spiral form, the iron expands in the direction of the lines of magnetization, and thus the wire becomes twisted Prof G Wiedemann, however, to whom the discovery of the magnetic twist is due, appears not to be satisfied with this explanation, believing the effect to be caused by unequal molecular friction

The subject of magnetic twists has been very fully and carefully investigated by Prof C G Knott, and in a paper published last year in the Transactions of the Royal Society of Edinburgh (vol xxxvi, Part II, p 485) he indicates many details in which the phenomena of twist closely correspond with those of elongation and retraction Assuming their essential identity, and noting that "an increased current along the wire affects the points of vanishing twist in a manner opposite to that in which an increased tension affects it," Prof Knott is "inclined to conclude that the pure strain effects of these influences are of an opposite character" Now, since the magnetic elongation of an iron wire is known to be diminished by tension, the remark above quoted amounts to a prediction that in an iron wire carrying a current the magnetic elongation would be increased "We know nothing so far," Prof Knott observes, "regarding the changes of length when an iron wire *carrying a current* is subjected to longitudinal magnetizing forces", and it was with the object of acquiring some information on this point, and testing Prof Knott's prediction, that the experiments described in the present paper were undertaken The results show that it was amply verified, and thus Maxwell's explanation of the twist receives still further corroboration

The apparatus used and the methods of observation were the same as those described in former papers Each specimen of wire examined was 10 cm long, and the indications of the instrument were read to one ten millionth part of the length

The wire first used was of soft commercial annealed iron, 0 75 mm in diameter The changes of length which it exhibited under the influence of magnetizing forces gradually increased from 13 to 315 C G S units are indicated in the second column of Table I, in which the unit is one millionth of a centimetre or one ten millionth of the effective length of the wire

The experiment described in the last paragraph was repeated while a current of 1 ampere was passing through the wire, the several magnetizing forces employed being made as nearly as possible the same as before by inserting the same resistances successively in the circuit The results appear in the third column of Table I, and show that the maximum elongation had risen from 11 5 to 14 5 ten-millionths, while the decrement in a field of 315 had fallen from 22 5 to about 17 5.

The current through the iron wire was then increased, by an alteration of the rheostat, to 2 amperes, and, as appears in the last column of the table, there was again a marked increase of the maximum elongation, and decrease of the retraction in a field of 315.

TABLE I.—*Iron Wire, diameter* 0·75 *mm.*

Magnetic field due to coil. C.G.S. units	Elongations in ten millionths of length.		
	With no current through wire	With 1 ampere through wire	With 2 amperes through wire
13	3	7	
16	6	9	11·5
23	7·5	12	
34	10	14·5	20
40	11·5	14	
50	10	14	20
61	9·5	12	
81	6	9·5	16
97	4	8	
130	0	3·5	8
171	−4	0	
202	9	4	−1
244	13·5		
250	—	9	−5
315	−22·5		
319	—	18·5	
323	—		13

For the sake of easy comparison, the principal results obtained with this wire are collected in Table II.

TABLE II.—*Iron Wire, diameter* 0·75 *mm.*

Current through iron wire. Amperes	Maximum elongation in ten millionths of length	Retraction in field of 315 C.G.S. units	Field in which length is unchanged
0	11·5	22·5	130
1	14·5	17·5	170
2	20	12	200

Similar experiments were afterwards made with nickel and cobalt.

A nickel wire was used, the diameter of which was 0·65 mm. The retractions which it underwent in fields of gradually increasing strength are given in the second column of Table III.

TABLE III.—*Nickel Wire, diameter* 0·65 *mm.*

Magnetic field due to coil. C.G.S. units	Retractions in ten millionths of length.		
	With no current through wire	With 1 ampere through wire	Difference
12	8	8	0
15	10	11	−1
19	15	15	0
28	25·5	25	0·5
36	34	33	1
50	50	48	2
69	74	72	2
84	92	92	0
99	113	112	1
119	134	133	1
150	164	162	2
175	178	178	0
209	196	194	2
256	217	215	2
330	241	240	1

The retractions of the wire when carrying a current of 1 ampere, are given in the third column of the table. Remembering that the figures in the second and third columns denote millionths of a centimetre, the close agreement between the two is very remarkable. Such small discrepancies as exist can hardly be entirely accounted for by observational or instrumental errors; they are probably mainly due to the effect of the rise of temperature (2°·6 C.) caused by the current in diminishing the susceptibility of the nickel.

Tension has a large effect upon the magnetic retraction of nickel: it is, therefore, the more remarkable that the action of a current, which operates so markedly upon iron, should in nickel be practically insensible.

The results with no current obtained for a strip of rolled cobalt, the length of which between the clamps was 10 cm., and the cross section 1·82 sq. mm., are given in the first two columns of Table IV., and those with a current of 2 amperes in the third column.

TABLE IV.—*Cobalt Strip, Section* 1·82 *sq. mm.*

Magnetic field due to coil. C.G.S. units	Retraction in ten millionths of length.		
	With no current through strip	With 2 amperes through strip	Difference
34	1	1	0
50	2	2·5	−0·5
84	4	5	−1
100	6	6	0
119	7·5	8·5	−1
153	11	11·5	−0·5
209	16	16·5	−0·5
331	26	27·5	−1·5

From an inspection of the differences tabulated in the fourth column, it appears that the effect of the current is to increase the retraction very slightly.

According to Rowland the susceptibility of cobalt is *increased* by heating. The small additional retraction indicated when the current was passing was, therefore, no doubt due to the increased susceptibility consequent upon current heating. It may be noted that tension seems to have no material effect upon the magnetic retraction of cobalt.

Summary.

In an iron wire carrying a current, the maximum magnetic elongation is greater, and the retraction in strong fields is less, than when no current is passing. The effect of the current is opposite to that of tension.

The magnetic retractions of nickel and of cobalt are not sensibly affected by the passage of a current through the metals. (Tension considerably modifies the magnetic retraction of nickel, but not that of cobalt.)

"The Human Sacrum." By A. M. Paterson, M.D., Professor of Anatomy in University College, Dundee, St. Andrews University. Communicated by Prof. D. J. Cunningham, D.Sc., F.R.S.

Chemical Society, May 19.—Prof. A. Crum Brown, F.R.S., President, in the chair.—The President announced that the Council had adopted a resolution expressive of the loss the Society and chemists generally had suffered by the death, on May 5, of Prof. von Hofmann. The resolution would be communicated to the family of the deceased, and to the German Chemical Society.—The following papers were read:—The magnetic rotation of compounds supposed to contain acetyl, or of ketonic origin, by W. H. Perkin. The author draws attention to Bruhl's determination of the refractive powers of ethyl acetoacetate, which favours a ketonic constitution, and to its magnetic rotation, which was determined some years ago by himself, and which also supports this view. A list is then given of seven supposed acetyl compounds, of which he has ascertained the magnetic rotation, all giving numbers pointing to a ketonic constitution. As such compounds as these behave sometimes as ketonic and sometimes as hydroxy-derivatives, it was thought desirable to examine a larger number of compounds supposed to contain acetyl, or of ketonic origin, between wide limits of temperature. The following were selected: pyruvic acid, levulinic acid (fused and in solution), ethyl acetonedicarboxylate, ethyl acetoacetate, acetylacetone, methylacetylacetone, and ethyl β amidocrotonate. The last-mentioned four were examined at widely different temperatures. The magnetic rotations of the first five substances agree with a ketonic constitution, though that obtained for ethyl acetonedicarboxylate is rather high. The rotation of acetylacetone is very high, showing it to be an unsaturated or hydroxy-compound, whilst the value obtained for methylacetylacetone stands between the hydroxy and ketonic rotations. At temperatures near 100°, however, these compounds give much lower rotations than when cold,

showing apparently that they change into the more stable or ketonic form when heated. The refractive and dispersive powers of these compounds confirm the magnetic rotations. The magnetic rotation and the refractive and dispersive powers of ethyl β-amidocrotonate show it to be an unsaturated compound —The origin of colour. ii. The constitution of coloured nitro-compounds, by H E Armstrong The author has previously maintained that colour is conditioned by a quinonoid structure in the case of azo-dyes, such as the rosanilines, methylene-blue, &c. This view is clearly seen to be recommending itself to chemists Nietzki makes reference to the quinonoid character of a number of dye stuffs, although he does not seek to apply such a view at all generally The author considers that, in the case of coloured compounds which have been fairly well studied, it is so generally true that a quinonoid formula is applicable, that the reconsideration of the formula of any coloured substance is warrantable if it do not come within the rule The term "quinonoid" must, however, be understood to include compounds of the type of benzil, and in the case of closed chain compounds, it appears to be essential that at least one of the quinonoid carbon atoms be associated with a dyad radicle, and that the ring itself be unsaturated The presence of two ortho- or para carbonyl groups in a saturated ring apparently does not condition colour Nitro-compounds as a class do not come within the suggested colour rule It is well known, however, that nitro compounds are not all coloured, many which are commonly described as yellow, being obtained white if prepared with care, from this it follows that the nitro group does not *per se* condition colour This is confirmed by a comparison of ortho and para-nitrophenol The ortho compound is intensely yellow, very volatile, and insoluble in water, paranitrophenol is colourless, non volatile with steam, and fairly soluble in water Such a difference as this can hardly be ascribed to a mere change in the relative positions of the radicles The difference is rendered all the more striking when the substances are contrasted with the methoxy-compounds prepared from ortho and para-nitrophenol These two substances are colourless, and agree as closely in their general properties as do most i omeric compounds containing the same radicles It therefore appears justifiable to represent orthonitrophenol by a quinonoid formula—C_6H_4 O NO_2H, and to term it quinoneorthonitroxime As only para- and ortho-compounds can have quinonoid formulæ, it would follow that metanitro-derivatives must be colourless, actually, however, metanitraniline has an intense yellow colour, but gives a colourless benzoate The present view of its constitution therefore requires revision —The origin of colour. iii. Colour as an evidence of isodynamic change the existence of isodynamic acids, by H E Armstrong The author applies the colour-rule dwelt on in the preceding paper to the cases of the coloured substances known as paradihydroxyterephthalic acid, dihydroxypyromellithic acid, and the corresponding "diamido" acids These may be represented as quinonoid compounds, thereby accounting for their being coloured Such substances as these readily change in type, yielding derivatives which may be colourless owing to conversion into an isodynamic form.—Studies on isomeric change, No. iv Halogen derivatives of quinone, Part i, by A R Ling Paradichloroquinone on bromination does not yield metadichlorodibromoquinone, as stated by Hantzsch and Schniter, but the normal product, paradichlorodibromoquinone. Contrary to the statement of Levy, this latter substance does not furnish chlorobromanilic acid on treatment with alkali, but a compound of one molecular proportion of chloranilate and two of bromanilate Metadichloroquinone on bromination at a high temperature yields paradichlorodibromoquinone, but at ordinary temperatures the normal product, metadichlorodibromoquinone is chiefly obtained. A number of new compounds are described —Halogen derivatives of quinone, Part ii, by A R. Ling and J L Baker. Chlorotribromoquinone is prepared by brominating monochloroquinol and subsequently oxidizing the product On treatment with alkali, it generally yields a molecular compound of the composition $C_6ClBr(ONa)_2O_2, 2C_6Br_2(ONa)_2O_2 . 12H_2O$ Trichlorobromoquinone is obtained by brominating trichloroquinone. On treatment with soda, it yields the compound $C_6Cl_2(ONa)_2O_2$, $2C_6ClBr(ONa)_2O_2 ; 10\frac{1}{2}H_2O$ —The crystalline forms of the sodium salts of substituted anilic acids, by W J Pope A comparison of the crystallographic dimensions of the sodium salts of the brominated and chlorinated anilic acids referred to in the two preceding papers shows that the crystals possess considerable similarity —Formation of a hydrocarbon, $C_{18}H_{12}$, from phenylpropionic acid, by F S Kipping When phenyl propionic acid is treated with phosphoric anhydride, a resinous mass is obtained which contains at least three products The first of these is a hydrocarbon, $C_{18}H_{12}$, which is oxidized by chromic acid mixture to a quinone, $C_{18}H_{10}O_2$. The hydrocarbon yields a dibromo-derivative, $C_{18}H_{10}Br_2$ The second product is a substance which yields a hydrazone of the composition $C_{15}H_{14}N_2$ It may possibly be $C_6H_4\left<\begin{matrix}CH_2\\CO\end{matrix}\right>CH_2$, owing to the fact that it seems to be formed on treating phenylpropionic chloride with aluminium chloride The third substance produced seems to be an organic derivative of phosphoric acid —Metallic derivatives of acetylene, by R T Plimpton The silver compounds of acetylene, obtained by several methods, viz by precipitation of silver acetate or ammoniacal silver nitrate solutions with acetylene, on analysis gave numbers lying between those required for $C_2Ag_2, \frac{1}{2}H_2O$, and $C_2Ag_2 \frac{1}{4}H_2O$ Aqueous or alcoholic silver nitrate solutions yield precipitates varying in composition from $3C_2Ag_2, 2AgNO_3, H_2O$, and C_2Ag_2, $2AgNO_3, H_2O$ Silver sulphate solutions gave a product of the composition $2C_2Ag_2, Ag_2SO_4, H_2O$ Mercuric acetate solution gives a white precipitate with acetylene, of the composition $3HgO, 2C_2H_2$, which is not explosive, and does not yield acetylene when treated with hydrochloric acid In these two properties this substance differs from the precipitate obtained from mercurous acetate —Isomerism amongst the substituted thioureas, by A E Dixon The author has prepared and examined the properties of isomerides of methylphenylbenzylthiourea and dimethylphenylthiourea.—Note on diastatic action, by H R Moritz and T A Glendinning The authors draw the following conclusions from a series of experiments on diastatic action The attainment of a resting stage in the transformation of starch by diastase by no means shows that the energy of the diastase is exhausted The energy of the "residual" diastase is, in fact, very considerable, but it is lessened to a marked extent by subjecting the diastase for some time to a temperature exceeding the optimum one for saccharification When, however, it is not exposed for any length of time to a temperature exceeding the optimum, it appears capable, after transforming a considerable amount of starch, of transforming further quantities to nearly the same point, when such further quantities are added successively and subsequent to the attainment of the resting stage in the preceding transformation

Zoological Society, May 17 —Prof W H Flower, F R S, President, in the chair —Mr W T Blanford, F R S, exhibited and made remarks on the skin of a Wild Camel obtained by Major C S Cumberland in Eastern Turkestan —In a paper on the geographical distribution of the Land-Mollusca of the Philippine Islands, the Rev A H Cooke showed that the distribution of the different subgenera of *Cochlostyla* affords an interesting clue to the early relations of the various islands of the Philippine group Regarded from this point of view, the central islands, Samar, Leyte, Bohol, Cebu, Negros, and Panay, with Luzon, were closely related, while Mindoro and Mindanao were remarkably isolated even from their nearest neighbours An examination of the intervening seas accounted for these phenomena, the depths between the central islands being inconsiderable, while Mindoro and Mindanao are surrounded by very deep water. The Mollusca of the two ridges between the Philippines and Borneo, formed by Busuanga, Palawan, and Balabac, and by the Sulu Archipelago, were partly Philippine, partly Indo Malay Two remarkable groups of *Helix*, peculiar to Mindoro, Busuanga, and Palawan, showed relations with Celebes and possibly with New Guinea The Mollusca of the Batan, Tular, and Talantse Islands were also discussed Regarded as a whole, the Land-Mollusca of the Philippines were stated to contain (1) Indo-Malay, (2) Polynesian, (3) indigenous elements, the first decidedly predominating.—A communication was read from Graf Hans von Berlepsch, and M Jean Stolzmann, containing an account of a collection of birds made by M Jean Kalinowski in the vicinity of Lima and Ica, in Western Peru The species of which examples were obtained in the localities were eighty in number In an appendix an account of previous authorities on the same subject was added.—Mr G A Boulenger gave an account of *Lucioperca marina*, a rare species of fish, originally described by Pallas from the Black Sea and the Caspian, and little known of late years —A communication from Mr. Oldfield Thomas

ontained a revision of the Antelopes of the genus *Cephalolophus*, of which eighteen species were recognized as valid A new species was described as *Cephalolophus jentincki*, from Liberia —Prof Bell called attention to the remarkable amount of variation presented by *Pontaster tenuispinus*, numerous examples of which he had been able to examine and compare He came to the conclusion that several North-Atlantic species, which had been described as distinct, should be regarded as belonging to it —A communication was read from Mr H H Druce giving an account of the Butterflies of the family Lycænidæ, of the South Pacific Islands Of thirty-one species mentioned, seven were described as new to science

Linnean Society, May 24.—Anniversary Meeting —Prof Stewart, President, in the chair —The Treasurer presented his annual report duly audited, and the Secretary having announced the elections and deaths during the past twelve months, the usual ballot took place for new members of Council, when the following were elected Messrs E L Batters, William Carruthers, Herbert Druce, Spencer Moore, and Dr D H Scott The President and officers were re-elected The Librarian's report having been read, and certain formal business having been transacted, the President delivered his annual address, taking for his subject "Commensalism and Symbiosis" On the motion of Dr R C A Prior, seconded by Mr Jenner Weir, a cordial vote of thanks was accorded to the President for his able address, with a request that he would allow it to be printed —The Society's Gold Medal was then formally presented to Dr Alfred Russel Wallace in recognition of the service rendered by him to zoological science by numerous valuable publications After Dr Wallace had replied, the President announced the gift by Dr R C A Prior of an oxyhydrogen lantern for use at the evening meetings, and moved a vote of thanks to him for his valuable donation This having been carried by acclamation, the proceedings terminated

CAMBRIDGE

Philosophical Society, May 2 —Prof G H Darwin, President, in the chair —The following communication was made —Note on the application of the spherometer to surfaces not spherical, by Mr J Larmor The ordinary form of spherometer, with equilateral triangular frame, gives a definite reading, when applied to a surface of double curvature, which corresponds to the arithmetic mean of the principal curvatures at the point, thus on a cylinder it will indicate half the curvature It may be modified in various ways so as to measure both the principal curvatures by two observations

May 16 —Prof G H Darwin, President, in the chair —The following communications were made —Recent advances in astronomy with photographic illustrations, by Mr H F Newall. A series of photographs was exhibited by the lantern and described, to illustrate recent progress in astronomical photography The series included some interesting specimens taken with the Newall telescope, in which the object glass is not specially corrected for photographic purposes —On the pressure at which the electric strength of a gas is a minimum, by Prof J J Thomson The author showed that when no electrodes are present, the discharge passes through air at a pressure somewhat less than that due to 1/250 mm of mercury, the discharge passes with greater ease than it does at either a higher or a lower pressure Mr Peace has lately shown that when electrodes are used, the critical pressure may be as high as that due to 250 mm of mercury, so that as the spark length is altered the critical pressure may range from 250 mm to 1/250 of a mm It was pointed out that this involved the possession by a gas conveying the discharge of a structure much coarser than any recognized by the kinetic theory of gases The author suggested a theory of such a structure, and showed that the theory would account for the influence of spark length and pressure on the potential difference required to produce discharge —On a compound magnetometer for testing the magnetic properties of iron and steel, by Mr G F C Searle. An aluminium wire, 30 inches long, suspended vertically by a fibre, carries at the top a magnet fixed at right angles to the wire The lower end carries a light fork across which a fibre is stretched horizontally A mirror attached to this fibre carries a magnet at right angles to the fibre The mirror is thus capable of two independent motions. The specimen of iron is placed in a magnetizing coil near the mirror, and the magnetizing current passes also round a coil placed near the upper magnet. The motion of the mirror is observed by the aid of a spot of light On gradually increasing and diminishing the current, the spot traces out the well-known hysteresis curves

EDINBURGH

Royal Society, May 16 —Sir Douglas Maclagan, President, in the chair —The Astronomer Royal for Scotland exhibited a stellar photograph, by Dr Gill, of the Cape Observatory —Dr W Peddie read a note on the law of transformation of energy and its applications A generalization of the second law, applicable to forms of energy other than heat, was shown, by special examples, to lead to results already deduced by other methods —Dr C G Knott and Mr A Shand communicated a short note on the volume-effects of magnetization, which was supplementary to results communicated to the Society last year by the former author When a particular size of iron tube was magnetized, the internal volume was found to undergo the following remarkable series of changes In very weak fields there was first a slight increase, which, as the field was made stronger, passed through a maximum, then vanished and finally changed sign From this point (about field 20) up to a field of 120 there was diminution of volume This diminution was greatest in a field of 64 In fields higher than 120 there was again increase of volume, which attained a maximum about field 400, and fell off very slowly in higher fields This curious variation of cubical dilatation with strength of field was shown to imply a transverse linear dilatation of (in general) opposite sign to the well-known longitudinal linear dilatation The amounts, the positions of the maximum points, and of the vanishing points, of these correlated linear dilatations differed sufficiently in detail to produce this peculiar repeated change of sign in the cubical dilatation —Dr Hunter Stewart read a paper on the ventilation of schools and public buildings The first part of the paper contained an account of an investigation as to the presence of organic nitrogenous matter in expired air Several methods were used for absorbing and collecting these products, *e g* breathing through strong sulphuric acid, condensing the moisture from the breath, &c The organic matter was determined by the process of Kjeldahl, by which the nitrogen is converted into ammonia The results showed that each cubic foot of expired air contained on an average 0 01149 milligrams of ammonia as such, and 0 002 milligrams of ammonia derived from organic matter The water condensed from 10 cubic feet of expired air contained on an average 0 5 milligrams of solid residue which entirely disappeared on ignition These results, confirmatory of the observations of Hermann and Lehmann, proved that the organic matter in badly ventilated rooms did not come from the breath, but from the skin and clothing of the occupants Since this must be variable, depending on obvious conditions, Dr Stewart did not determine it, but relied on the estimation of the carbonic acid and moisture as a measure of the efficiency of the ventilation The following are some of his results taken as averages —

Edinburgh Hospitals, with 2000 cubic feet of space per bed—		
Day	5 5	c.c CO_2 per 10,000
Night	5 85	,, ,,
Churches { Highest	63 5	,, ,,
Churches { Lowest	20 0	,, ,,
Schools, with, per child,		
154 c ft space and 9 8 sq ft area	9 9	,, ,,
141 ,, ,, 8 8 ,,	13 3	,, ,,
116 ,, ,, 7 1 ,,	17 2	,, ,,

All the schools and churches were without mechanical ventilation —Prof James Geikie read a paper on the glacial succession in Europe The deposits which first give evidence of glacial action are generally referred to the Pliocene period These are the oldest ground moraines of Central Europe, the ground moraine underlying the "lower diluvium" of Sweden, and the deposits of the Weybourne Crag with their Arctic marine fauna Genial climatic conditions followed this period, with a wide land area, Britain being joined to the continent Then followed the epoch of maximum glaciation, the Scottish and Scandinavian ice-sheets being continuous Genial climatic conditions followed, Britain being again continental. Then submergence ensued to the 500-feet level, followed by another glacial epoch in which the Scottish and Scandinavian ice-sheets were again continuous This was succeeded by genial conditions, Britain being once more joined to the continent Submergence to the 100-feet level in Scotland followed, and then came Arctic conditions with local ice sheets, succeeded by temperate conditions and the wide land area, and subsequently by submergence to the 50 feet level Another cold period followed with local glaciers—the last in Britain.

PARIS

Academy of Sciences, May 30.—M d'Abbadie in the chair —Introduction of M. Guyon, the new member elected in the place of M Richet —Observations of the small planets, made with the great meridian instrument of the Paris Observatory during the second and third quarters of the year 1891, by M Mouchez —On the propagation of electrical oscillations, by M H Poincaré The disturbance is supposed to be propagated along a thin straight conductor The enfeeblement of the disturbance is theoretically shown to vanish when the diameter of the conductor becomes indefinitely small —Another blow to the ascent theory of cyclones, by M Faye A discussion of recent observations, showing that cyclones are not produced by convection from the soil, but by disturbances in the general circulation of air in the higher regions —On the monkey of Montsaunès discovered by M Harlé, by M Albert Gaudry A portion of the mandible of a monkey, containing three teeth, was exhibited, found by M Harlé, engineer at Toulouse, in the Quaternary of the Haute Garonne It shows the greatest similarity with the magot of Gibraltar and Algiers —Physiological effects of a liquid extracted from the sexual glands, and especially the testicles, by M Brown Séquard —On the relations of the Devonian and Carboniferous formations of Visé, by M J Gosselet —Study of the physical and chemical phenomena under the influence of very low temperatures, by M Raoul Pictet The calorific æther waves corresponding to low temperatures are found to traverse all bodies with hardly any resistance. A test tube filled with chloroform was placed in a nitrous oxide refrigerator at $-120°$ A thermometer in the tube showed a gradual fall to $-68°\cdot5$, when crystallization commenced On removing the test-tube to a refrigerator at $-80°$, the temperature indicated by the thermometer *fell rapidly* from $-68°\cdot5$ to $-80°$, while the crystals formed on the walls of the test-tube fused and disappeared. On replacing it into the $-120°$ refrigerator, the temperature rose to $-68°\cdot5$, and the crystals reappeared. M Pictet explains these extraordinary phenomena by supposing his thermometers to have acted more as thermo dynamometers than as thermoscopes While the crystals were forming in the first refrigerator, the radiation from the bulb was neutralized by the latent heat given out by the chloroform in crystallizing, whereas in the warmer refrigerator the crystals did not form, and radiation alone was active Alcohol and sulphuric ether thermometers were used, which were checked by thermometers containing dry hydrogen at four different pressures —On rectangular co ordinates, by M. Hatt —On the application of the optical properties of minerals to the study of the inclosures in volcanic rocks, by M A Lacroix.—On a property common to three groups of two polygons, inscribed, circumscribed, or conjugate to the same conic, by M Paul Serret —On the canonical developments in series the coefficients of which are differential invariants of a continuous group, by M Arthur Tresse —On the calculation of the coefficient of resistance of air, supposing the resistance proportional to the fourth power of the velocity, by M de Sparre —On a means of bringing two non-miscible liquids into intimate contact in definite proportions, by M Paul Marix. This is done by pouring both liquids into the same vessel at a definite rate, and allowing them to leave it by an orifice in the side They will escape together in the proportion of their volumes, if the level of the liquid is maintained uniform by a constant supply The surface of separation is invariably found at the level of the orifice, and if a flattened spout is used, a lamellar arrangement of the liquids is produced, thus giving a large surface of contact.—On a hydro-silicate of cadmium, by MM G Rousseau and G Tite. This is produced by the action of the glass vessel when the solid hydrate of neutral cadmium nitrate is heated to about 300° On dissolving away the basic nitrate with boiling alcohol, the silicate can be detached from the glass in long scales by hot water Its formula is $2(CdO, SiO_2) 3H_2O$ —On the decomposition by heat of ammoniacal pentachloride of phosphorus, nitrochloride of phosphorus, and phosphame, by M A Besson —On the phosphates of strontium, by M L Barthe.—The calorific power of pit-coal and the formulæ by means of which its determination is attempted, by M Scheurer Kestner.—Mechanical determination of the boiling points of terminal complex substitution products, by M G Hinrichs.—On some reactions of the three amido-benzoic acids, by M Œchsner de Coninck. —On the composition of chlorocruorine, by M A. B. Griffiths —On the antiseptic properties of formaldehyde, by M. A. Trillat —The nervous system of the Neritidæ, by M E L. Bouvier —On the osteological characters of a male *Mesoplodon Sowerbyensis* recently stranded on the French coast, by M. P Fischer.—On a new species of *Gammarus* of the Lac d'Annecy, and on the fresh-water Amphipoda of France, by MM E Chevreux and J de Guerne —Action of various toxic substances on *Bombyx Mori*, by M J Raulin —On the genetic relations of resinous and tannic substances of vegetable origin, by MM Edouard Heckel and Fr Schlagdenhauffen —Researches on the grafting of Crucifers, by M Lucien Daniel —Contribution to the study of the toxic effect of the diphtheria bacillus, by M Guinochet —Contribution to the knowledge of the Saharian climate, by M Georges Rolland A summary of observations made at a meteorological station in the oasis of Ayata, in Southern Algiers The sparse vegetation found here and there seems to derive its moisture from subterranean sources, whence it ascends by capillary attraction, and from certain deliquescent salts found in the soil which absorb moisture at night —On a passage in Strabo relating to a treatment of the vine, by M Ant Aublez.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS —La Distribution de L Électricité, *Usines Centrales* R V Picou (Paris, Gauthier-Villars) —Travail des Bois M Alheilig (Paris, Gauthier Villars).—Medical Electricity Drs. Steavenson and Jones (Lewis).—First Report of the U S Board on Geographic Names, 1890–91 (Washington) —Smithsonian Report, 1890 (Washington) —Lehrbuch der Zoologie Dr R Hertwig 2 vols (Jena Fischer) —Ziele und Wege Biologischer Forschung Dr F Dreyer (Jena, Fischer) —Key to Arithmetic for Beginners J Brooksmith and E J Brooksmith (Macmillan) —Transactions of the Sanitary Institute, vol xii (Stanford) —Bibliography of the Algonquian Languages J A Pilling (Washington) —A Monograph of the Myxogastres G Massee (Methuen) —Popular Readings in Science J Gall and D Robertson (Constable).—Researches on Micro-Organisms, Dr A B Griffiths (Baillière).—Darwin et ses Précurseurs Français, deux. édin, A de Quatrefages (Paris, Alcan).—Trattato di Fisico-Chimico secondo la Teoria Dinamica E dal Pozzo di Mombello (Milano)

PAMPHLETS —The Orthoceratidæ of the Trenton Limestone of the Winnipeg Basin J F Whiteaves (Montreal, Dawson) Ursachen der Deformationen und der Gebirgsbildung Dr E Reyer (Leipzig, Engelmann).

SERIALS —Journal of the Chemical Society, June (Gurney and Jackson).—Meteorological Record, vol xi, No 42 (Stanford) —Quarterly Journal of the Royal Meteorological Society, April (Stanford) —Geological Magazine June (K Paul).—Natural History Transactions of Northumberland, Durham, and Newcastle on-Tyne, vol xi, Part 1 (Williams and Norgate) —The Yale Review, vol I, No 1 (Arnold).—Bulletins de la Société d'Anthropologie de Paris, July to December, 1891 (Paris, Masson).—Archives de Sciences Biologiques publiées par l'Institut Impérial de Médecine Expérimentale à St Pétersbourg, tome I, Nos. 1 et 2 (St Pétersbourg).—Engineering Magazine June (New York) —Himmel und Erde, June (Berlin, Paetel) —Journal of the Straits Branch of the Royal Asiatic Society, June (Singapore)

CONTENTS.

THURSDAY, JUNE 16, 1892.

MECHANICS

A Treatise on Analytical Statics With numerous Examples Vol I By Edward John Routh, Sc D , LL D , F R.S , Hon Fellow of Peterhouse, Cambridge , Fellow of the Senate of the University of London (London Macmillan and Co , 1891)

The Elementary Part of a Treatise on the Dynamics of a System of Rigid Bodies Being Part I of a Treatise on the Whole Subject With numerous Examples By the Same (London Macmillan and Co , 1891)

WITH these two volumes the mathematical student is completely equipped for the course of Analytical Mechanics, as required for Part I of the Cambridge Mathematical Tripos

A second volume is promised of the "Analytical Statics," to cover the parts in Attraction, Astatics, and the Bending of Beams , and this, in conjunction with Part II of the "Dynamics," will complete his library for the second part of the Mathematical Tripos, according to present regulations

The great feature of these works is the very complete collections of examples which the author has brought together with great labour, and enriched with many of his own invention, fit to rank among the theorems of the science, rather than as mere problems

The author is of the opinion that in order to learn Mechanics it is essential to the student to work many examples, taken as far as possible from questions that have actually arisen

In this opinion he agrees with Fourier, who says —

"L'étude approfondie de la nature est la source la plus féconde des découvertes mathématiques Non seulement cette étude, en offrant aux recherches un but déterminé, a l'avantage d'exclure les questions vagues et les calculs sans issue , elle est encore un moyen assuré de former l'Analyse elle-même," &c

This is an opinion, however, that has always divided mathematicians into rival camps, and we find Jacobi remonstrating with these words of Fourier by retaliating —

"Il est vrai que M Fourier avait l'opinion que le but principal des mathématiques était l'utilité publique et l'explication des phénomènes naturels , mais un philosophe comme lui aurait dû savoir que le but unique de la science c'est l'honneur de l'esprit humain , et que sous ce titre, une question de nombres vaut autant qu'une question du système du monde."

The developments of mathematics are now so great that specialization is a necessity, so that these rival theories need not come into collision , and the pure mathematician may allow the writer on Mechanics to treat of what the name of the subject implies without being compelled to regard his own Geometry as mere Land-Surveying, according to the strict meaning of the word

There is a tendency in operation among certain mathematicians, as illustrated by Poincaré's remarks on Maxwell's writings, to degrade mathematical argument to mere Calcul, by reducing the experimental facts on which the theory is based to the barest minimum, and that not always clearly established (we venture to instance the Newtonian Law of Universal Gravitation) A vast array of Analysis is in consequence balanced upon a very small amount of axiomatic experiment, which in many cases the smallest divergence of experimental fact is sufficient to upset

We had hoped at the outset that Duchayla's proof of the Parallelogram of Forces had disappeared, never to reappear again, but it unfortunately pops up on p. 16

Considering that Static leals with the Equilibrium of Bodies would make a great simplification if the word Resultant was abolished, unless when required to mean a single force reversed of a system of equilibrating forces

In this way a much simpler proof of the Parallelogram of Forces can be constructed, as indicated by Prof Maxwell in the Mathematical Tripos , and one figure will now serve for all the possible cases arising in the equilibrium of three parallel forces (p 47)

Again, when the system is in equilibrium, there is no need to introduce the restriction that the bodies are *rigid* (p 12) , the conditions are precisely the same for elastic bodies , but the system having come to rest, the parts are of invariable form Every structure (the Forth Bridge, for instance) is composed of elastic parts, but the theorems of elementary Statics are still applicable in the investigation of the principal stresses

Again, by considering balancing couples, the refined theorems concerning the equivalence of couples in the same or parallel planes, and the composition of couples in different planes, are rendered much more convincing

In accordance with its title of "Analytical Statics," the theorems concerning the composition and equilibrium of forces in space are treated with reference to co-ordinate axes , but Sir Robert Ball's purely geometrical conceptions of the Wrench, Screw, and Cylindroid are introduced, and discussed from a fundamental standpoint

A chapter on the determination of Centre of Gravity appears in all treatises on Analytical Statics, just as works on Rigid Dynamics begin with a long and tedious chapter on Moments of Inertia these subjects should form part of the ordinary treatises on Integral Calculus, and so relieve treatises on Mechanics from at least the principal elements of such calculations

In the application of the Barycentric Calculus to geometry, the author has made a very interesting collection of problems, well calculated to illustrate the power of this method

The principal theorems of Statics involve profound geometrical argument, and consequently prove difficult to the majority of students, whose proclivities are usually analytical , but in the applications to Catenaries the analytical interest comes again to the front Considering that the hyperbolic functions can now be obtained tabulated numerically—for instance, in a table by Mr T H. Blakesley, published by the Physical Society—it is curious that the author does not employ them in the discussion of the ordinary Catenary, where their use introduces great elegance and simplicity into the analysis The figure of the Catenary on p 316 might with advantage be redrawn, so as to exhibit accurately the principal properties of this curve.

Again, in Example 6, p. 352, where the problem of

the catenary is discussed under a central attraction or repulsion, varying inversely as the square of the distance, when the hyperbolic functions are used in conjunction with the circular functions, we are able to write the equation of the catenary in the form—

$$l/r = 1 + \sec \alpha \cos (\theta \sin \alpha), \quad \text{or } 1 + \operatorname{sech} \alpha \cosh (\theta \sinh \alpha),$$

including all possible cases, and it is a curious geometrical result that if these curves are rolled on a straight line, the pole will always describe a circle.

The treatment in § 500 of the catenary curve formed by an elastic rope can also be rendered more elegant by the introduction of the hyperbolic functions.

The chapter relating to Catenaries is headed "Strings." But *string* is used only for tying up parcels; we use a *rope* or *chain* in full scale mechanics, and *thread* in a model; the word *thread* should be used when its own weight is to be neglected, and the words *rope* or *chain* when applied to a true catenary.

A short chapter on Graphical Statics is very welcome, and might with advantage be further developed; and the final chapter, on Machines, is of the usual academic character. The interest of this chapter would be much increased if the diagrams, particularly of the Balance and of the Differential Pulley were taken from objects actually in existence.

The author never employs the absolute units of force, the *poundal* or *dyne*, which he has defined in Chapter I, but works throughout with the gravitation unit. This is in accordance with the universal practice; and to satisfy legal and commercial requirements, these absolute units would require to be defined through the intermediate of the gravitation unit, by taking them as one-gth part of the tension of a thread supporting a pound or gramme weight, the value of g being determined from pendulum experiments. There is no apparatus in existence by which the theoretical definition of the poundal and dyne, derived from dynamical phenomena, could be tested with any pretence to accuracy.

The dyne is the unit of force in the C.G.S. system, but it is a great pity that the commercial units, the metre and the kilogramme, were not adopted; the unit of energy would then be the *joule*, and the unit of power the *watt* or *volt-ampère*. Merely, apparently, for the purpose of making

$$W = s V, \text{ instead of } 1000 s V,$$

the Committee of the British Association recommended these niggling C.G.S. units; but considering that for ordinary substances, metals, &c., variations of texture render it unnecessary to tabulate densities beyond four significant figures, the factor 1000 is a positive advantage in numerical calculations, as $1000s$ may be replaced by a whole number.

The "Analytical Statics" is a completely new work, but Dr. Routh's "Dynamics of Rigid Bodies" has been the text-book in universal use for thirty years or more, a better testimony to its merits than anything that could be said here.

It is a pity that a sufficient working knowledge of the simple ideas of Moment of Inertia is not given in a course of the Integral Calculus, so that the author might start immediately on some familiar problems of the motion of a body which turns as well as advances, and relegate the bulk of Chapter I. to a later chapter, when the motion of bodies in space is considered. This long chapter at the outset chokes off many students, who would be encouraged if the principles were introduced in smaller doses, and only as required. The gentlemanly knowledge of this subject, as Maxwell called it, which does not go beyond motion in a plane, is a very valuable mathematical training, and few students go beyond this stage.

D'Alembert's Principle is historically important, as the first clear statement of the mode of forming the equations of motion; but now, in accordance with the modern principle of considering the Third Law of Motion, "Action and Reaction are equal and opposite," as defining a stress composed of two equal opposite balancing forces, D'Alembert's Principle should now be merely looked upon as a convenient mode of writing down the equations of Dynamics in an analytical statical form, when stated in the words, "The reversed effective forces and the impressed forces form a system in equilibrium," while "the molecular, cohesive, or internal forces form a system in equilibrium among themselves."

The much-abused word "centrifugal force" still survives, and need not cause confusion if used to denote the normal component of the reversed effective force of a body moving in a curve.

Early methods of argument in Dynamics were very similar to what we now employ in Thermodynamics, in the statement of the Second Law.

Sir George Airy's commentary on D'Alembert's Principle, quoted on p. 52, forms a very curious contrast to the corresponding explanation in Maxwell's "Matter and Motion."

It would be a strange skeleton frame that Sir George Airy would have had to create to propagate the attraction between the Earth and the Moon or Sun; and an interesting subject of speculation arises as to the modification of Newton's Law of Universal Gravitation when the inertia of the skeleton frame became appreciable.

The discussion on the Pendulum is very complete; Kater's pendulum is fully described, but we miss the account of Repsold's pendulum. In this pendulum the effect of the drag of the air is eliminated by making it symmetrical in shape, but unsymmetrical in density. A short account of Repsold's pendulum will be found in the Account of the Great Trigonometrical Survey; but the pendulum is obviously looked upon with suspicion by our officers, as being employed by their Russian rivals on the other side of the Himalayas.

The very perfection of the pendulum as a method of determining g is the cause of its defect as a means of recovering the standard of length, so that equally skilled observers would differ to an appreciable extent if set to work to reconstitute the standard yard from the seconds pendulum; the clause in the Act of Parliament defining the length of the seconds pendulum is in consequence superfluous.

There is something mysterious and unconvincing in § 109, on the "Oscillation of the Watch Balance"; considering that the inertia of the spring itself is neglected, it seems that the final equation of oscillation might well be written down immediately, without the introduction of any approximation.

The Ballistic Pendulum and its theory are fully de-

scribed; but it should be pointed out that the pendulum in which the gun itself is mounted gives very untrustworthy records, as the effect of the blast of the powder and of the air dragged along with it is so very great. The Ballistic Pendulum is still useful for determining the velocity of small-arm bullets, but for artillery purposes the electric chronograph has completely supplanted it.

Chapter IV. discusses Motion in Two Dimensions, and is perhaps the most generally important and interesting chapter in the book. A complete dynamical terminology is still a desideratum, and many new words must be coined, for, as De Morgan remarks, "We cannot wait for words, because Cicero did not know the Differential Calculus (or Dynamics)." At the same time it is a pity that the old word *Vis Viva*, meaning Mv^2, was not allowed to drop, to be replaced by *Kinetic Energy*, for $\frac{1}{2}Mv^2$. *Vis mortua* is forgotten as the name for *Work*, and *vis viva*, as the other manifestation of energy, should go too.

The dot notation of Fluxions has been introduced in places: this, though easy to write, is difficult to print, and is inconvenient sometimes with tall letters, while others, like ι and j, are already in their "dotage."

Dr. Routh would, in our opinion, make the working of the illustrative examples more clear, if he always followed the fundamental principle of taking moments about the centre of gravity, as if it was a fixed point: very few students can be trusted to apply the principle to moments about any other moving point, and the equations of relative motion on p. 178 are better kept out of sight of all but a select few.

Dr. Besant's treatment of questions on Initial Motion is in our opinion simpler of application and quite as rigorous as that given in § 199.

A very good collection of illustrative examples completes this chapter, but we miss the extension of the problem of the motion of a cylinder rolling down an incline to the case of a wheeled carriage or of a railway train, when the rotary inertia of the wheels is taken into account, including the determination of the proper position of the coupling chains and buffers; also the investigation of the stresses in the interior of a swinging body like a ship, not only in causing cargo to shift, but also in its physiological bearing on sea-sickness. An ordinary swing is useless as an antidote to sea-sickness, as the seat is close to the centre of oscillation. To feel the disturbing effect we must mount up above the axis of revolution, and to the deck and up the mast of a ship.

As interesting applications, we may mention the dynamics of billiards, §§ 179-98, and of the quintain in § 178.

After Chapter IV. the author launches off into dynamics in space, and now the difficulty of the subject is more than doubled.

Chapter VII., on Energy (or Vis Viva, as Dr. Routh still prefers to call it), precedes in importance and idea the Chapter VI., on Momentum, and might well change place. The idea of energy as $\frac{1}{2}Wv^2/g$ very soon received a name for its unit in the *foot-pound*, but the corresponding name for the momentum, Wv/g, of *second-pound* is as yet hardly known.

In this chapter the Principles of Dynamical Similitude are discussed. In Geometry the Principle of Similitude asserts that a theorem is true whatever the scale on which it is drawn; but in Dynamics the principle is much more complicated, and great care is required in arguing from the performance of a model or of a machine to one to be constructed to a larger scale. The subject is one of great importance at the present time in the discussion of the design of steamers intended to reduce the time of passage across the Atlantic to something under six days; and the statement of the laws to be applied as affecting steamers, first clearly laid down by Mr. Froude, might well find explanation and illustration at this point.

The impact of two rough elastic ellipsoids is treated in §§ 315, &c., by a mathematical *tour de force*; but the expression *perfectly rough* is never met with outside a Cambridge mathematical treatise. What would be the state of things, for instance, between two bodies in contact, one *perfectly rough* and the other *perfectly smooth*? When we wish to produce this so-called perfect roughness between two bodies, we cut teeth on them, to engage together; and in railway travelling the perfect smoothness of the road due to the employment of wheels must be capable of being turned into roughness by the application of the breaks: the continuous breaks now fitted to express trains have enabled a higher average speed to be maintained.

The General Equations of Motion of Lagrange and Hamilton, discussed in Chapter VIII., are not to be employed by any but very advanced students: the formation of these equations and the conversion of one form into the other constituting difficult and refined applications of the Change of the Variables.

In the case where some of the co-ordinates are absent, this part of the subject has received valuable development from Dr. Routh, by means of a principle now called the Ignoration of Co-ordinates.

The volume concludes with an investigation of the Small Oscillations of a System, important as a Stability Test; in such problems the author expresses the result very concisely by means of the length of the simple equivalent pendulum which synchronizes with the oscillations. An interesting problem to discuss is the theory of Mr. Yarrow's Vibrometer, employed for measuring the vertical vibrations of his torpedo-boats: a platform suspended by springs is found to preserve a constant level, if the free period of the vertical oscillations of the platform is incommensurable with the period of the vibrations of the boat.

It is difficult to know where to stop in writing of treatises such as these two of Dr. Routh, so full of detail and interest; and the two treatises together would provide nearly a year's work for an industrious student, who would thereby derive a thoroughly sound and complete knowledge of the subjects.

A. G. GREENHILL.

COLLECTIONS FROM THE ANDES.

Supplementary Appendix to Travels amongst the Great Andes of the Equator. By Edward Whymper. (London: John Murray, 1891.)

THOUGH many travellers in new or little-known regions, who are not naturalists, have been in the habit of collecting to some extent the more remarkable

specimens which they have noticed, in various branches of the animal kingdom, yet, as a rule, both such collections and the reports upon them are more or less unsatisfactory to professed naturalists, partly because they usually represent mere fragments of the fauna of the regions explored, and partly because inexperienced collectors often pass over the most interesting species, and bring back common and wide-ranging forms of comparatively little interest.

Alpine climbers in particular, as a class, have done so little for zoology in Europe or the Caucasus, that we hardly expected that Mr. Whymper, whose reputation for daring, determination, and endurance, puts him among the most distinguished of Alpine climbers, would now turn his attention to zoology. He has, however, shown the best possible example to his *confrères* by his Great Andean expedition, and has proved that it is possible without in any way neglecting the special objects of his journey, to do most valuable zoological work; and as the higher regions of the Andes have been neglected by professional collectors, who depend more or less on their success for payment of expenses, the proportion of new Coleoptera brought home by him is very great. Owing, no doubt, to the late Mr. Bates's good advice, Mr. Whymper has secured the assistance of many specialists of eminence in describing his collections, and the work is profusely illustrated with wood-cuts of the highest class, better by far than many of the coloured illustrations which often appear in scientific periodicals.

The total number of species collected amounts, according to Mr. Bates, to about one thousand, but the Diptera, Lepidoptera-Heterocera, Hymenoptera (except the ants), and Arachnida have not been described, on account of the difficulty of finding anyone to work them up; and as the birds do not seem to have attracted much of Mr. Whymper's attention, and fishes are almost wanting in the higher mountain streams, the greater part of the book is taken up by descriptions of the Coleoptera by Messrs. Bates, Sharp, Gorham, Olliff, and others. Messrs. Godman and Salvin have written a chapter on the butterflies, but of these very few occur at elevations of 10,000 feet and upwards; and only two Satyridæ, two species of Lycæna, two Pieris, and two Colias, were taken at or above 12,000 feet. This is a strong proof of the poverty of the high Andes in endemic forms, as compared with the high Alps of Europe and Asia, where, notwithstanding the severity of the climate, a large number of species are found at elevations which, when allowance has been made for the latitude, are much higher than these. This may be accounted for to some extent by the weather, which appears to be, in the high Andes of Ecuador, very wet and windy during the whole year. It is farther explained by the late Mr. Bates in the following remarks, taken from the introduction which he has contributed to the volume:—

"It seems to me a fair deduction from the facts here set forth that no distinct traces of a migration during the lifetime of existing species, from north to south or *vice versâ*, along the Andes have as yet been discovered, or are now likely to be discovered. It does not follow, however, that the Darwinian explanation of the peculiar distribution of species and genera on mountains in the tropical and temperate zones, and in high latitudes of the Old World, is an erroneous one. The different state of things in the New World is probably due to the existence of some obstacle to free migration, as far as regards insects, between north and south, both during and since the Glacial epoch. The problem, like most others relating to geographical distribution, is a complicated one; but there are one or two considerations, likely to be overlooked, which may tend to its solution. One is the great altitude at which the vigorous denizens of the teeming tropical lowlands flourish on the slopes of the Andes. Mr. Whymper found, for example, species of many of the genera of Longicorn Coleoptera characteristic of the lowland forests at altitudes of 9000 and 10,000 feet, and Kirsch has recorded numerous species of *Lampyridæ*, *Lycidæ*, and other families belonging equally to tropical American forest genera, as met with by Reiss and Stubel in Colombia and Ecuador at 12,000 feet. In Ecuador all the warm moisture brought by the eastern trade-winds is not intercepted even now by the wall of the Andes, and wherever that falls, in the depressions, conditions of climate and vegetation will be created suitable to these encroaching tropical forms. If we add to this the barrenness and generally unfavourable conditions of the zone above those altitudes, there can be little wonder that temperate forms have not freely passed along the Andes. Another consideration is that there may have been a breach of continuity of the land in Glacial times, at the Isthmus of Panama, sufficient to prevent free migration. It may, further, be legitimate to speculate on the possibility of the Andes being lower in the tropical zone during the Glacial epoch. A few hundred feet lower than the present altitude, combined with the copious warm rains which must have accompanied the age of ice, would present conditions undoubtedly favourable to the spread of tropical forms over the whole area which would successfully resist the invasion of high northern or southern species. The main principle in distribution, however, is that forms sooner or later, and in proportion to their intrinsic and extrinsic facilities of dissemination, will find their way all over the world to wherever the conditions inorganic and organic are favourable to their acquiring a footing. That these facilities are possessed in a higher degree by plants than insects and some other groups of animals may be a sufficient explanation of the fact that so many species of plants have surmounted the obstacles to their passage from north to south during the last Glacial epoch, while few or no insects have done so. The more distant, or generic, relationship between the insects of Chili and those of the north temperate zone can only be explained on the assumption of a migration at some epoch far more remote than the last Glacial epoch."

Mr. Whymper's book as a whole is a remarkable example of his talent as an explorer, a mountain climber, and an accurate observer both of physical, geographical, and natural history phenomena, and though we have waited eleven years for its appearance, nothing has been lost and much has been gained by this delay, and his book will take rank among the very best works of scientific travel which have ever been written.

H. J. Elwes.

THE HISTORY OF EPIDEMICS

A History of Epidemics in Great Britain from A.D. 664 *to the Extinction of Plague.* By Charles Creighton, M.A., M.D. (Cambridge University Press, 1891.)

THE task undertaken by Dr. Charles Creighton in writing a history of epidemics in Britain from 664 (the year of the first pestilence recorded by an authority that can be regarded as contemporary) to the

extinction of plague is one of enormous difficulty The materials for such a history must be sought for high and low, chance allusions in private letters or municipal records will supply links in the chain of evidence for which the writings of the medical authorities of the time may be searched in vain, if indeed there be any medical authorities, and Dr Creighton found that for his purposes "medical books proper are hardly available until the end of the Elizabethan period, . . and do not begin to be really important until shortly before the date at which" his present labours end When such evidence as can be found has been found and sifted, there still remains the most intricate problem of all—that of tracing the epidemics recorded to their origin, accounting for their spread, and in some cases explaining why a country should in modern times be spared diseases which scourged it in the Middle Ages

No better illustration of these difficulties could be found than is supplied by chapter ii, "Leprosy in Mediæval Britain" The first point that Dr Creighton has to make clear is that all the so-called lepers were not really lepers In extreme cases the word "leprosus" may have been used simply as meaning "beggar or common tramp", elsewhere it may have been applied to victims of syphilis, lupus, and so forth For the sufferers special provision was no doubt made, on a scale due in part to a morbid or mistaken religious sentiment, but examination of the harters and other documents relating to these charities suggests that, of the supposed foundations for lepers, some were merely refuges for sick and infirm poor, in others provision was made for three or four times as many non-leprous as leprous inmates, while from others, towards the end of the thirteenth century, the lepers were disappearing or getting displaced Finally, the author concludes that the prevalence of true leprosy at any time in England was probably not so great as in the worst provinces of India at the present day, but, however justifiable scepticism as to its supposed ravages may be, that the disease really did prevail can hardly be doubted, and the reasons for doubt are lessened, if a *vera causa* for its presence can be found Such a *vera causa*, compatible with its subsequent disappearance, may be discovered, not in "importation," *e g* by Crusaders—a suggestion Dr Creighton does not consider worth thinking about— but in the staple diet of the times, a semi putrid or toxic character of animal food combining with other depressing influences to give rise to leprosy, just as a similar character of bread or porridge gives rise to pellagra.

We have given the arguments of this chapter somewhat in detail, because the criticism which obviously applies to them, applies elsewhere Considering the uncertainty which surrounds the facts, it is clear that the traditions of the leprosy of the past cannot very materially assist, though they may be explained by, the study of modern leprosy Similarly, in the case of the plague, to which naturally Dr Creighton devotes much of his book, to say nothing of that old question, the value of the evidence of the Bills of Mortality, the inquirer is met at once by the great difficulty of knowing when "the plague" which is spoken of as invading out-of-the-way places really was the genuine plague—a point of vital importance, as soon as any etiological questions are raised, and we may here observe that Dr Creighton writes :—

"In concluding the career of the sweat in England, we may pass from it with the remark that it did not cease until other forms of pestilential fever were ready to take its place The same explanation remains to be given of the total disappearance of the plague from England after 1666 it was superseded by pestilential contagious fever, a disease which was its congener, and had been establishing itself more and more steadily from year to year as the conditions of living in the towns were passing more and more from the mediæval type to the modern"

It would be impossible here to enter into the merits or the reverse of all Dr Creighton's explanations of the facts he records In the chapter on small-pox, which is likely to be the one first consulted, we find a passage which disarms criticism "It has been the fate of small-pox as an epidemiological subject to be invested with bigotry and intolerance" Yellow fever has as yet hardly sunk to that deplorable level, and as Dr Creighton's theory appears to be that "the dysenteric matters of the negroes" carried on the slave ships "had themselves in turn bred an infection of yellow fever for the whites," it may be asked whether the alleged protection of Africans of pure blood from the infection of yellow fever "in all circumstances ashore or afloat, not by acclimatization but by some strange privilege of their race," is either supported by all recent authorities, or not capable of the explanation that in infancy they may pass through some disease too slight to be recognized as yellow fever, but which serves to confer immunity

The general impression left upon the mind by this history is that it would have been a wise policy to make two books instead of one out of the materials collected in one simply to bring together such facts as Dr Creighton's industry has gleaned from the authorities, and in the other to enter upon the questions of etiology, which are bound to give rise to interminable discussion

Besides those we have mentioned, gaol fevers, influenzas, "the French pox," and scurvy in early voyages, are the principal diseases treated of in this volume In dealing with influenza Dr Creighton draws attention to the relation in point of time between the outbreaks in the latter half of the sixteenth century and great epidemics of plague, and a somewhat similar relation between fever and influenza and exceptional climatic conditions in the years 1657-59

OUR BOOK SHELF

Mineralogy By Frederick H Hatch, Ph D, F G S, of the Geological Survey of England and Wales (London Whittaker and Co, 1892)

DR HATCH has followed up the publication of his excellent "Introduction to the Study of Petrology," recently noticed in these pages, by a little book on mineralogy, which will, we think, be of equal service to students He has recognized the fact that for one person who desires to enter upon a systematic study of mineralogy, regarded as a natural-history science, there are twenty who need only such an amount of mineralogical information as will enable them to profitably commence the study of geology We think, therefore, that the prominent place given to the felspars, the pyroxenes, the amphiboles, the micas, and similar common rock-forming species in this work, is fully justified, and not less so the unsystematic but convenient grouping of other minerals as "ores and veinstones," "salts and other useful minerals," and "gems or precious stones" De Lap-

parent has indeed shown how a classification of minerals according to their mode of occurrence may be employed even in a systematic treatise, but Dr Hatch's more humble attempt is not open to the criticism to which an ambitious work on the same lines would obviously be liable It is clear that in a book of this kind there is not much scope for originality of treatment, but Dr Hatch has admirably united brevity and clearness in his treatment of the crystallographical and physical characters of minerals His method of giving the names and commonly employed reference letters to the crystal-combinations which he figures is well adapted to prepare the student for consulting larger treatises on the subject So, too, the reference to the use of symbols, though it must evidently be very slight in a work of the dimensions of that before us, is eminently judicious A short table of symbols of the chief forms belonging to each system, according to Miller and Naumann, will enable the beginner to recognize the meaning of all the very commonly occurring combinations, and it is clearly inexpedient to attempt more than this in such a very elementary work We can confidently recommend the book as an excellent summary of mineralogical science, adapted to the wants of the geological student, and we believe the perusal of this small work may even be of advantage to those who desire to enter upon the more systematic study of the science of mineralogy J W J

To the Snows of Tibet through China By A E Pratt, F R G S (London Longmans, Green, and Co, 1892)

THE author of this book says in the preface that he has done his best "to withstand the temptation to generalize from limited experience, to which travellers in China seem peculiarly liable" Yet in his last sentence he expresses the opinion that several incidents he has mentioned "will show what a credulous and cowardly race the Chinese are" It ought surely to have occurred to him, when he set down this harsh and rather foolish judgment, that it was a striking example of the kind of generalization which he had wished to avoid Fortunately the statement, although it seems to convey Mr Pratt's final impression of the Chinese people, does not represent the general character of his work, in which scientific readers will find a good deal to interest them He went to China in 1887 for the purpose of studying the natural history of the country, and remained until 1890, fixing his head-quarters at Ichang, a town on the left bank of the Yang-tze-Kiang, 1110 miles from its mouth He crossed the frontier of Tibet, and at Ta-tsien-lu met Mr Rockhill, whose excellent account of travels in Tibet we lately reviewed Mr Pratt worked hard in the various regions he visited, and collected many valuable specimens in several departments of natural history He has not a very bright or attractive style, but many of his facts are themselves so interesting, and his enthusiasm as a collector is so keen and persistent, that there are few passages which his readers will desire to skip In an appendix, Dr Albert Gunther gives a list of the species of reptiles and fishes brought by Mr Pratt from the Upper Yang-tze Kiang and the province Sze-chuen, with a description of the new species There are also lists of birds and of Lepidoptera

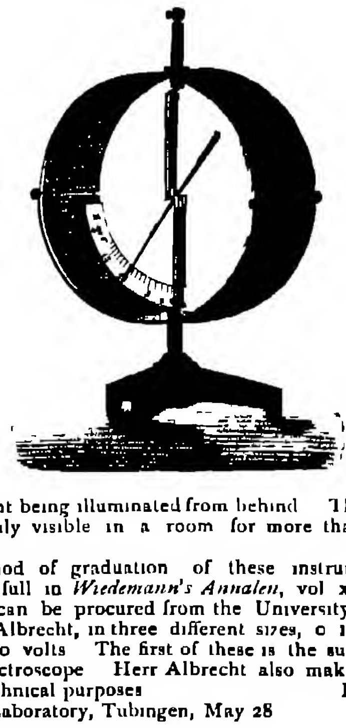
LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Absolute Electrometer for Lecture Purposes

I THOUGHT it might be welcome to some of your readers to be made acquainted with the following simple and cheap instruments which I have now used for some years with advantage in lectures, and also for many scientific purposes. They are electrometers, which are divided directly into volts The needle, which is made of aluminium, moves about a horizontal axis of hard steel, and is repelled from the vertical brass piece connected with the knob above The instruments have the advantage that they are much easier of manipulation than the gold-leaf electroscope, while the sensibility is nearly the same, and fully suffices for all lecture purposes Potentials are read off directly in volts, so that the measurements in the experiments on electrostatics and electrodynamics can all be referred to the same unit, whereby the conception of the student gains in distinctness, and the lecture in simplicity In consequence of the specially careful workmanship, the needle adjusts itself quickly and with certainty, so that readings may be made to about 10 volts The back and front consist of glass disks 1 mm thick, each of which covers a plate of zinc of the same size, out of which are cut two equal and opposite slits, through which the position of the needle on the brass scale is read off The readings of the instrument are only correct when these plates are in position

When the instrument is used in the lecture, the two plates are taken away, and the back glass plate covered with tissue paper,



the instrument being illuminated from behind The deflections are then easily visible in a room for more than a hundred students

The method of graduation of these instruments I have described in full in *Wiedemann's Annalen*, vol xliv, 1891, p 771 They can be procured from the University mechanician here, Herr Albrecht, in three different sizes, 0 1500, 0-4000, and 0-10,000 volts The first of these is the substitute for a gold-leaf electroscope Herr Albrecht also makes the instruments for technical purposes F BRAUN

Physical Laboratory, Tubingen, May 28

Saturn's Rings

THE writer of the "Astronomical Column," in your number of June 2, directs attention to some observations of M Bigourdan on certain peculiarities in the appearance of the following arm of Saturn's Rings observed by him on May 21 He mentions in particular a protuberance situated near Cassini's division This, I think, is easily accounted for in a quite different manner At 9h 6m p m, according to Marth's ephemeris, two satellites, Enceladus and Tethys, were in conjunction with the east end of the ring They were going in apparently opposite directions, Tethys away from Saturn Their conjunctions with the middle of the Cassini division would, I find, take place at 8h 36m p m. for Tethys, and at 9h. 36m. p m for Enceladus Both satellites would be so close to the ring as to appear inseparable from it Tethys, moving in an orbit inclined as much as 65' to the plane of the rings, might easily be half superposed in appearance upon the *northern* boundary of the rings The following remarks are from my observation book of date May 21 —

"9h 13.5m G.M.T. The broadening of the east ansa near its end is probably due to Tethys and Enceladus being on opposite sides of it near its east end. 9h 22m. The east ansa seemed a little longer than the west, perhaps due to Tethys now following it. Dione was seen close to the east end."

With the other observations and remarks of M. Bigourdan I quite agree. The straightening of the northern edge of both ansæ has frequently been noticed by me both before and after May 20. So lately as June 3 both ansæ seemed broadest at a distance of three fifths of their length from the ball, and the following ansa was almost detached from the ball, partly by the shadow thrown by the ball on it, and partly by the more elevated part of the middle ring concealing all within it in the neighbourhood of the ball. A. FREEMAN

Murston Rectory, Sittingbourne, June 6.

Aurora

THE aurora of May 18 was seen here. I first noticed it at 11 p.m. (Dublin time), and watched it until 1 a.m., though I did not see either the beginning or the ending. It extended from west-north-west to north north-east, and had a general altitude of 30°, though occasional streamers reached beyond Polaris. It was moderately bright, but certainly not brilliant, and showed no colour. About 12 o'clock horizontal streamers began to show themselves like electric search lights, and continued for some time, their appearance being accompanied by a lengthening upwards of the radial streamers. The air was slightly hazy, and there was much stratus about, with detached masses of cumulo-stratus coming up from the west. Wind-force 3 of Beaufort's scale; barometer 30.05, stationary.

JAMES PORTER

Crawford Observatory, Queen's College, Cork, May 31.

The Atomic Weight of Oxygen

I NOTICE that Lord Rayleigh gives the following summary of results on the atomic weight of oxygen:—

Dumas	1842	15.96
Regnault	1845	15.96
Rayleigh	1889	15.89
,,	1892	15.882

showing the remarkable fact that the atomic weight has been steadily decreasing for the last fifty years. I would suggest, as the explanation of this, that the increased population of the world, together with the great consumption of coal, have caused great wear and tear of these atoms, so that they are now mostly deficient in weight. It would seem, in fact, desirable that a Congress of chemists should be called to consider the question of providing for the renovation of the oxygen supply, and issuing trustworthy atoms of the standard weight, 16, as sealed patterns.

ROBT. LEHFELDT.

Firth College, Sheffield, June 3.

The Nitric Organisms

I AM most reluctant to occupy any of your space with a claim to priority. A statement made on p. 137 of your last issue can hardly, however, be allowed to pass without notice. Dr. P. F. Frankland states in his lecture at the Royal Institution that the possibility of the existence of a nitric organism was foreshadowed by himself, and that this hypothesis has recently been confirmed by Winogradsky. He then describes the method adopted by Winogradsky for separating the nitric from the nitrous organism, and the chemical properties of the former. The fact that the existence of a nitric organism was proved in the first instance by myself, its separation from the nitrous organism effected, and its chemical behaviour studied, before any publication on the subject by Winogradsky, is *entirely omitted!* Frankland's statement of the case is the more remarkable as Winogradsky frankly admits in his paper that our results were nearly the same, and that his were published subsequently to my own.

R. WARINGTON.

Harpenden, June 10.

Carnivorous Caterpillars

EVERY experienced breeder of Lepidoptera knows to his, or her, cost that many caterpillars are either habitually, or casually, carnivorous and cannibalistic.

Useful hints on this subject are given in Dr. Knaggs' "Lepidopterist's Guide" (Gurney and Jackson).

Lewisham, June 13. R. MCLACHLAN.

The Cuckoo in the East

IN May 1887 I wrote to you that I had heard the cuckoo at Mussoorie. This year, on coming up here, I heard it at Doneira (about 2000 feet) and at Mamul (4000 feet). I have been here five days and have not heard it at all. There has been a deficiency of rain here, and it has been unusually hot. Both notes were very clear and distinct.

Dalhousie, May 22. F. C. CONSTABLE.

THE NEW LONDON UNIVERSITY

WE have received for publication from the Association for Promoting a Professorial University for London the following proposals, adopted by the Association at a meeting held on Tuesday last:—

(1) It is desirable that there should, if possible, be one University in London.

(2) The objects of the University should be to organize and improve higher education and also to promote the advancement of science and learning.

It is desirable that the University be constituted on the following lines:—

(3) Subject to Clauses (9) and (12) the University to be governed by a Senate which shall ultimately consist of the Professors and a certain number of Crown nominees.

(4) The Professors to be nominated in the first instance by some independent authority, such as the Crown or the Commission contemplated in Clause (14), afterwards in such manner as the Senate may determine.

(5) The University to have power to absorb institutions of academic rank in London, which may be willing to be absorbed, due provision being made for protecting the interests of the teachers in such institutions, and for preserving the character of special trust-funds.

(6) The University to have the power of appointing Readers and Lecturers, either to supplement the teaching of the Professors, or to deliver graduation or other courses of lectures within the metropolitan area at such places as may be determined by the Senate.[1]

(7) The University to have power to grant degrees and to institute degree examinations. These examinations may, if found necessary, be different for those who have followed prescribed courses and for those who have not. Each Professor of the University to be *ex officio* an Examiner in the subject of his chair, but not necessarily to take part in every examination in that subject. Examiners, who shall not be Professors in the University, to be appointed by the Senate to take part in all degree examinations.

(8) The Professors, Readers, Lecturers, and other Teachers of the University to be grouped into Faculties, which shall have such consultative and administrative powers as shall be determined by the Senate.

[1] This side of the University work would probably include teaching of the following kinds:—

(a) Teaching, conducted in the University Buildings, supplementary to that of the Professors.

(b) Courses of instruction of a special or advanced character recognized by the University, e.g. of the type given by the German *Privat Docenten*.

(c) Teaching of a more or less academic character conducted by lecturers appointed by the University at Institutions and Colleges, the objects or the standing of which render complete absorption into the University undesirable.

(d) Lectures at various local centres of the type known as "University Extension" lectures.

(e) Courses of lectures or occasional lectures by members of the University staff, or by other persons recognized by the University for which a convenient centre might with the co-operation of the Corporation of London and of the Mercers' Company, be found at Gresham College.

(9) The Body of Graduates in Convocation assembled to have the power of appealing to the Privy Council, but to have no veto upon the action of the Senate The Chairman of Convocation to be *ex officio* a member of the Senate

The Medical Schools will probably require special treatment Though they might advantageously hand over the teaching of pure science to the University, each school might retain control over its own teaching of medicine and surgery and over the funds devoted thereto

(10) The Medical Faculty to consist of representatives elected by the Teachers in recognized London Medical Schools

(11) The recognized Medical Schools to be determined in the first instance by the Commission referred to in Clause (14), but afterwards from time to time by the Senate, subject to appeal to the Privy Council

(12) A certain number of the members of the Medical Faculty to be nominated University Professors in accordance with the provisions of Clause (4) The number of Medical Professors on the Senate not to exceed one-fourth of the total number of University Professors on the Senate

(13) A teacher of pure science in a recognized Medical School to become a Member of the Faculty of Science, whenever the appointment to his post is entrusted permanently or *pro hac vice* to the Senate of the University

(14) To facilitate in the first instance the organization of the University, it is suggested that a small and independent Commission of legal and educational authorities be appointed by Act of Parliament with full powers—

(*a*) To investigate and determine upon the claims of institutions wishing to be absorbed under Clause 5

(*b*) To arrange for the proper disposal of the trust-funds of those institutions which may be absorbed, and to determine the conditions under which their property shall be vested in the Governing Body of the University

(*c*) To arbitrate on all matters concerning the interests of existing teachers as affected by the action of Clause (5), and

(*d*) Generally to make such arrangements as may be necessary for the establishment of the University on the foregoing lines

We are requested to add that the names of those desirous of supporting the Association will be received by any member of the Executive Committee,[1] or may be sent directly to the Secretary (Prof Karl Pearson, Christchurch Cottage, Hampstead, N W) The Association already numbers some seventy members, including Profs H E Armstrong, F R S, W E Ayrton, F R S, F. O Bower, F R S, O Henrici, F R S, E Frankland, F R S, E Ray Lankester, F R S, F Max Muller, O J Lodge, F R S, Norman Lockyer, F R S, W J Russell, F R S, W A Tilden, F R.S, H Marshall Ward, F R S, Principals H R Reichel, W M Hicks, F R S, and C Lloyd Morgan, besides many other names equally well known in literature, science, and art A complete list will shortly be issued

SUBDIVISIONS IN ARCHÆAN HISTORY[2]

I Subdivisions based on Kinds of Rocks

WERNER'S idea that kinds of rocks and grade of crystallization afford a basis for the chronological subdivision of crystalline rocks is more or less apparent in nearly all attempts that have since been made to lay down the general subdivisions of Archæan terranes The "fundamental gneiss" has gone to the bottom and the thinner schists to the top There is a degree of truth in the idea. But the assumptions are so great that at the present time little reason exists for the earnestness sometimes shown by advocates of such systems The idea has little to sustain it in the known facts of geology The following are sufficient to decide the question

According to the thorough petrological and geological study of the rocks of the Bernardston region by Prof B K Emerson[1]—a region in the Connecticut valley, in the towns chiefly of Bernardston, Massachusetts, and Vernon, Vermont—there are the following rocks granite, largely feldspathic, dioryte, so like intrusive dioryte that it had been pronounced trap, quartz-dioryte, granitoid gneiss faintly foliated with biotite and passing into the granite, hornblende schist, quartzyte, quartzyte prophyritic with feldspar crystals, staurolitic and garnetiferous mica schist, hydromica schist, argillyte, massive magnetite, making a bed of magnetite rock, along with coarsely crystalline limestone and quartzytic limestone containing Crinoids, Corals, and Brachiopods all together making one series of rocks of later Devonian age My own observations in the region confirm the conclusions of Prof Emerson Such facts prove, moreover, that "massive" as applied to crystalline rocks does not signify *igneous* The granite is not eruptive granite, but part of a stratum which is elsewhere quartzyte, the quartzyte graduating into granite, the latter was never in fusion

Again on the borders of New England and New York there are schists of all gradations from massive Cambrian gneiss to Cambrian and Hudson River hydromica schist and argillyte, the age fixed by fossils Becker reports similar facts from the Cretaceous of California Such observations, and others on record, make it hazardous to pronounce any gneiss in an Archæan area "fundamental gneiss," or any associated slaty schist the younger of the two It may be true, but it may not be It is probable that the thin-bedded schists are absent from the older Archæan, but not that the thick-bedded and massive are absent from the later Archæan

The little chronological value of kinds of crystalline rocks in the later Archæan comes out to view still more strongly if we consider with some detail the length and conditions of Archæan time

The earth must have counted many millions of years from the first existence of a solid exterior, when the temperature was above 2500° F, to the time, when, at a temperature below 1000° F—probably near 500° F, supposing the atmospheric pressure to have then been that of 50 atmospheres—the condensation of the waters of the dense aerial envelope had made such progress that an ocean, moving in tides and currents, had taken its place on the surface[2] There were other millions afterward along the decline in temperature to the 180° F mark—180° F the mean temperature of the ocean—when, according to observations on living species, the existence of plants in the waters became, as regards temperature, a possibility,[3] and still other millions from the 180° F mark to that of 120° F, or nearly, when marine animal life may possibly have begun its existence And since cooling went on at a decreasing rate toward the end, time was also long from the 120° F mark to that of a mean oceanic temperature of 90° F, or below it, when Paleozoic life found congenial conditions in the water. The mean temperature now is about 60° F.

[1] This Committee at present consists of the following —F V Dickins, G Carey Foster, R S Heath, E Ray Lankester, Karl Pearson, H E Roscoe, A. W. Rücker, T E Thorpe, W C Unwin, W F R Weldon.

[2] Reprinted from the June number of the *American Journal of Science*, from advance sheets forwarded by the author The paper is to be continued in the *American Journal of Science*

[1] A description of the "Bernardston Series" of Metamorphic Upper Devonian Rocks, by Ben K Emerson, *American Journal of Science*, III, xl, 263 1890.

[2] R. Mallet estimated, in view of the density of the atmosphere—over 200 atmospheres to the square inch—that the first drops of water may have been condensed on the earth's surface when the temperature was that of molten iron —*Phil Mag*, January 1880.

[3] They live now in waters having a temperature of 200° F, Brewer, at Pluton Creek, California 185°, W H Weed, Yellowstone Park Moreover germs of Bacilli have germinated after having been boiled for an hour.

The ocean, sooner or later after its inaugural, began the work of making permanent sediments, that is sediments that were not speedily recrystallized, and these sediments, through the millions of years that followed, must have been of all kinds and of great thickness.

The conditions became still more like the present after the introduction of life with the further decline of temperature. Even before its introduction, iron oxides, iron carbonate, calcium carbonate, calcium magnesium carbonate, and calcium phosphate had probably commenced to form, for the atmosphere, although it had lost the larger portion of its water-vapour, still contained, as writers on the "primæval earth" have stated, the chief part of its carbonic acid, amounting to all that could be made from the carbon of the limestones, coal and carbonaceous products now in the world. It had also a great excess of oxygen—all that has since been shut up in the rocks by oxidations. And these most effectual of rock-destroying agents worked under a warm and dripping climate.

The amount of carbonic acid, according to published estimates, has been made equivalent in pressure to 200 atmospheres, or 3000 pounds to the square inch. 200 is probably too high, but 50 atmospheres, which is also large, is perhaps no exaggeration. Hence, the destruction of rocks by chemical methods must have been, as Dr. Hunt and other writers have urged, a great feature of the time; and long before the introduction of living species, the temperature had so far declined that the making of silicates must have given way in part to the making of deposits of carbonates and oxides.

But with the existence of life in the warm waters, through the still later millions of years, there should have been, as Weed's study of the Yellowstone Park has rendered probable, abundant calcareous secretions from the earliest plants, and, additions later, through the earliest of animal life. Great limestone formations should have resulted, and large deposits of iron carbonate, and perhaps iron oxides, over the bottom-sediments of shallow inland or sea-border flats, besides carbonaceous shales that would afford graphite by metamorphism.

In fact, long before the Archæan closed, the conditions as to rock-making were much like those that followed in the Paleozoic. Surely, then, all attempts to mark off the passing time by successions in *kinds* of rocks must be futile. Some *varieties* of the various kinds of rocks are probably Archæan only; but not all those of its later millions of years. Even crystalline and uncrystalline may not be a criterion of chronological value. The beds of the Upper Archæan, under the conditions existing, may well, over some regions, be uncrystalline still, and may include carbonaceous shales that hold to this time their carbonaceous products. Such uncrystalline beds may now exist over the Continental Interior; for the great Interior has generally escaped when metamorphic work was in progress on the Continental borders.

The amount of carbonic acid is most readily estimated by first obtaining the probable amount for all post-Archæan sources, and then adding to this that which is indicated by Archæan terranes. The calculation is here given in detail that others may use it for deductions from other estimates.

For the estimation there are the following data. A cubic foot of pure limestone which is half calcite and half dolomite and has the normal specific gravity 2.75, weighs 171.4 pounds; and this, allowing for $\frac{1}{12}$th impurity, becomes 157 pounds and corresponds to 72 pounds of carbonic acid. A cubic foot is equal to an inch square column 144 feet in height. Since 72 is half of 144, each foot of the column of such limestone contains half a pound of carbonic acid. Hence a layer of the limestone one foot thick would give to the atmosphere, on decomposition, half a pound of carbonic acid for each square inch of surface.

A foot layer of good bituminous coal containing 80 per cent. of carbon, G = 1.5, will give to the atmosphere by oxidation 1.9 pounds of carbonic acid per square inch of surface.

If the mean thickness of the limestone over the whole earth's surface, that of the oceans included, reckoned on a basis of $\frac{1}{12}$th impurity, is 1000 feet, the contained carbonic acid amounts according to the above to 500 pounds per square inch, or 34 atmospheres (of 14¾ pounds), and if the mean thickness of the coal is one foot, the carbonic acid it could contribute would be 1.9 pounds per square inch. Adding these amounts to the carbonic acid corresponding to the carbon in the mineral oil and gas and other carbonaceous products of the rocks and organic life, supposing it to be six times that of the coal, the total is 513.5 pounds, or 35 atmospheres. The mean thickness of Archæan calcium, magnesium, and iron carbonates is not a fourth of that of post-Archæan. Estimating the carbonic acid they contain and that corresponding to the graphite of the rocks at ten atmospheres, the whole amount becomes 45 atmospheres.

To bring the amount up to the estimate for early Archæan time of 200 atmospheres of carbonic acid, the mean thickness of the limestone for Archæan and post-Archæan time should be taken at nearly 6000 feet.

Part of the limestone of post-Archæan terranes was derived from the wear and solution of Archæan limestones, iron carbonate, &c., and hence all the 35 atmospheres to the square inch were not in the atmosphere at the commencement of the Paleozoic. But if we reduce the 35 atmospheres, on this account, to 25 atmospheres, it is still an enormous amount beyond what ordinary life, even aquatic life, will endure. Reducing the estimated mean thickness for the limestone layer over the globe from 1000 to 500 feet would make the amount nearly one half less.[1]

The making of carbonates early began the work of storing carbonic acid and purifying the atmosphere; and the introduction of life increased the amount thus stored, and added to it through the carbonaceous materials from living tissues contributed to the earthy deposits. But with all the reductions that can be explained, the excess is still very large. It has been proved by experiment that an excess also of oxygen diminishes the deleterious influence of carbonic acid on plants; and that if the amount of this gas is made equal to that of the oxygen in the present atmosphere, plants will still thrive. How far this principle worked in early time cannot be known.

2. *Subdivisions based on Stratification.*

The stratification in an Archæan region affords the only safe and right basis for subdivisions. This method has been used in the separation of the Huronian from the older Archæan; and recently, with good success, by Irving and Van Hise in the study of the Penokee-Marquette region, or the Huronian belt of Wisconsin and Michigan. The intimate relation of the beds in the series has been worked out and their unconformability with the lower rocks thus ascertained, besides the stratification and constitution of the iron-ore series within the belt. This is the first step toward that complete study which should be carried on throughout all Archæan areas, however "complex." The distribution of the rocks and their apparent or real stratigraphic succession, whether massive or schistose, the positions of the planes of foliation or bedding, the unconformities in superposition, and those of mere faulting, and all structural conditions, should be thoroughly investigated. Correlation by likeness of rocks has its value within limited areas, but only after

1 A right estimate is very desirable. If made for North America, it could not be far out of the way to assume it to be a mean for like areas of the other continents as regards the limestone. But with the best possible result for the continents, the oceanic area, three times that of the continents, and out of the reach of investigation as to depths of bottom deposits, remains a large source of doubt.

much questioning [1] The work is easy in its methods, yet perplexing because in North America the uplifts and flexures of different periods have in general taken place in parallel directions, so that unconformabilities are disguised, especially when the two formations are nearly alike in grade of metamorphism Follow along the overlying to places where its metamorphism is of low grade, and there may be success

There is a first point of special importance to be accomplished by Archæan investigation The Huronian of the Penokee-Marquette region is partially metamorphic To the east, the iron ore, according to the describers, is mainly metamorphic magnetite and hematite, to the west, especially in the Penokee region, it is largely iron carbonate, or the ore in its original state Other facts show a diminishing grade of metamorphism to the westward In the Penokee district, the ore is underlain by a bed of "cherty limestone," the chert of which, like the interlaminated jasper of the iron ore bed, is regarded by Van Hise as probably of organic origin, like later chert It has among the overlying beds carbonaceous shales containing, according to Chamberlin, 40 per cent of carbon, bearing thus evidence of very large organic carbonaceous contributions when in process of formation The great beds of iron ore, the upward gradation eastward in metamorphism, the relations in position to the admitted Archæan adjoining it on the south, seem to prove the Huronian series to be Upper Archæan, as it has been generally regarded, but in a non metamorphic and partially metamorphic condition The question thence arises Are the ore-bearing rocks of the Archæan of Eastern Canada, New York, New Jersey, and other parts of the Appalachian chain, Huronian in a state of *high-grade* metamorphism? Are the chondroditic limestones, which, in some localities, occur in and with the ore, part of the Huronian formation? Does the eastern iron-bearing series rest unconformably on inferior Archæan?

The *Algonkian* (or Agnotozoic) beds belong either to the Archæan or to the Paleozoic

The Archæan division of geological time is of the same category with the Paleozoic, Mesozoic, and Cenozoic, all are grand divisions based on the progress of life, and they include together its complete range There is no room for another grand division between Archæan and Paleozoic any more than for one between Paleozoic and Mesozoic In contrast, the Algonkian division is not above the Cambrian in grade, it being based on series of rocks Its true biological relations are in doubt, because fossils representing the supposed life of the period are unknown, or imperfectly so The discovery in any rock so called of Trilobites, Crustaceans, Mollusks, Brachiopods, or Crinoids, whatever the species, would entitle such rocks to a place in the Paleozoic, and either within the Cambrian group or below it Walcott has already reported such fossils from the beds at the bottom of the Colorado cañon referred by him to the Algonkian—namely, besides a Stromatoporid, a small Patella-like or Discina-like shell, a fragment of a Trilobite and a small Hyolithes—forms which make the beds Paleozoic beyond question

3 *Subdivisions based on Physical and Biological Conditions*

Although the physical and biological conditions of the early globe are within the range of observation, there are generally admitted facts which afford a basis for a philosophical division of the time, and from it geology may derive instruction The subdivisions to which we are led are the following -

I The ASTRAL æon, as it has been called, or that of liquidity

II The AZOIC æon, or that without life

(1) The *Lithic era*, commencing with completed consolidation the time when lateral pressure for crust-disturbance and mountain-making was initiated, and when metamorphic work began

(2) The *Oceanic era*, commencing with the ocean in its place oceanic waves and currents and embryo rivers beginning their work about emerged and emerging lands, and the tides, the retarding of the earth's rotation

III The ARCHEOZOIC æon, or that of the first life

(1) The *era of the first Plants* the Algæ and later the aquatic Fungi (Bacteria), commencing possibly with the mean surface temperature of the ocean about 180° F

(2) The *era of the first Animal life* the Protozoans, and forms related to the embryos of higher invertebrate species, commencing possibly with the mean surface temperature of the waters about 120° F, and ending with 90° F or below

The subdivisions, as is evident, mark off great steps in the progress of the developing earth, although the rocks bear no marks of them that can be distinguished

The Huronian period covered, probably, much of Archæozoic time, and this is all in the way of correlation that can be said It is well to note here that if the Eozoon is really animal in origin, the "Laurentian" rocks of Canada in which it occurs must be Huronian, or the later of Archæan terranes

Respecting the Oceanic period it is observed above, "*commencing with the ocean in its place*" It appears to be almost a physical necessity that the oceanic depression should have been made in the first forming of the solid crust, if the globe cooled to the surface from the centre outward, that is, unless a liquid layer remained long afterward beneath the crust

The depression was certainly made long before the close of Archæan time For the enormous amount of rock-making of the Archæan over the continent implies the existence of emerged rocks with reach of the decomposing, eroding, and denuding agencies of the atmosphere and atmospheric and oceanic waters A submergence in the ocean of 50 feet is almost a complete protection against mechanical and chemical wear Moreover North America has its Archæan lands not only in the great nucleal mass, 2,000,000 square miles in area, but also in the series of Archæan ranges parallel to the outlines of the nucleus, which extend eastward to the eastern limit of Newfoundland, and westward to the Pacific And it has correspondingly shallow-water Cambrian deposits lying between these ranges from Eastern Newfoundland and the coast-region of New Brunswick and Massachusetts, westward across the continent about most of the Archæan outcrops, to within 300 to 400 miles of the Pacific Ocean, as shown by Walcott

There is hence reason for the conclusion that, at the close of Archæan time, the continent of North America was present not merely in outline, but also in general features, and at shallow depths where not emerged

This fact with reference to North America means much It means that by the end of Archæan time, the continents generally were essentially in a like condition—outlined

[1] As a preliminary in the study of any such region, thousands of dips and strikes of planes of foliation or bedding should be taken (in imitation of Percival's work before 1842, mentioned in the note on p 440 of the last volume of the *American Journal of Science*), and all should be plotted on maps of large scale by means of symbols with affixed numbers recording the dips and strikes for full comparison in the final elaboration Even the Penokee-Marquette region needs further investigation with a clinometer-compass in hand

Before commencing the study of any crystalline rocks, models of flexures should have been studied until the fact is fully appreciated that a flexure having an inclined axis—the commonest kind—ranges through 180°, or nearly in its dips and strikes, and until the characters of the bedding in different transverse sections of flexures are well apprehended. A good model for studying flexures may be made from a cylindrical stick of coarse-grained wood having the bark on (if of a smooth kind), it may be about four inches in diameter and twelve to fifteen long Draw a straight line through the centre of one end and from this line saw across obliquely to the edge at the opposite end After planing smooth the sawed surface, the layers of the wood may then be coloured by groups and three colours, or two besides that of the wood, are better than more The model of a flexure having an inclined axis is then complete. Cross-sections of the model may be cut and the colours added to the new surfaces. For models of overthrust flexures, this method is not practicable, as wood of elliptical section would be required They may be made of paper pulp of three colours

and at shallow depths where not emerged, that, therefore, the oceanic depression was then large and deep enough to hold the ocean. Further, this last fact indicates, 1, the mean level of the continents was coincident with the water's surface, that the oceanic depression had already a depth of 12,000 feet, or that of the present mean depth of the waters, and that the lowering, through later time, of the bed 1500 feet on an average (or 2000 feet according to other estimates) would give the continents their present mean height. And it is a fact of deep geogenic significance, that nearly 1000 feet of this mean height was received after the beginning of the Tertiary.

JAMES D. DANA

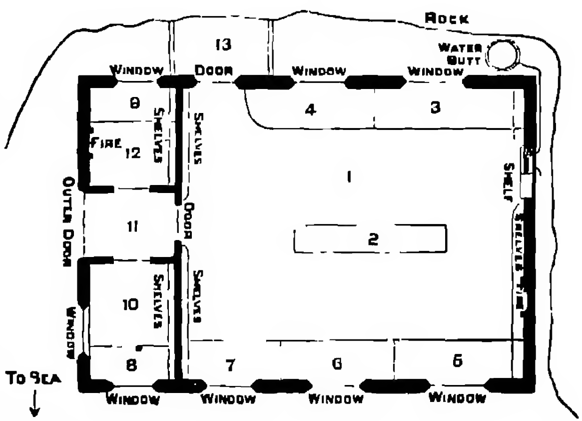
OPENING OF THE LIVERPOOL MARINE BIOLOGICAL STATION AT PORT ERIN

THE Liverpool Marine Biology Committee, which commenced the investigation of the fauna and flora of Liverpool Bay and the neighbouring seas seven years ago, and has kept up a small biological station on Puffin Island Anglesey, for the last five years, passed on Saturday (June 4) into a new phase of its existence, and, it may be hoped, a more extended sphere of labour, when His Excellency Spencer Walpole, Lieutenant-Governor of the Isle of Man, declared the new marine laboratory at Port Erin to be open for work. The Puffin Island establishment has been very useful to the Committee, and well worth the small annual expenditure required for its modest outfit. It has been used by a few students who wished to gain a general knowledge of the common marine animals and plants in a living state, and by a limited number of specialists who went there to make observations, or who had the material for their investigations collected there and sent to them. But the Committee has felt for the last year, at least, that a station which was more readily accessible from Liverpool and with hotel or lodging accommodation obtainable on the spot, would enable their members to do more work, and be of more use both to students and to investigators. Also, it was evident that after five years' work on the shores of the small island the greater number of the plants and animals had been collected and examined, and that a change to a new locality with a rich fauna and a more extended line of coast would yield increased material for faunistic work. On looking round the Liverpool Marine Biology Committee's district, Port Erin, at the southern end of the Isle of Man, at once presented itself as the best available place.

From its position, and the shape of the land, Port Erin has within a distance of a couple of miles in three directions—to Fleshwick Bay, to the Calf, and to Port St Mary—a long and varied coast-line, with a number of small bays, furnishing good collecting-ground and shallow-water dredging. Two of these bays, Port Erin and Port St. Mary, have harbours with sailing-boats, and face in nearly opposite directions, so that in most winds one or other is sheltered and has a quiet sea. The rich fauna around the Calf and off Spanish Head is within easy reach: at a distance of three to four miles from the laboratory are depths of 20 to 30 fathoms, and at fourteen miles 60 to 70 fathoms. Although it is a considerable distance from Liverpool, still it is reached by a regular service of swift steamers and convenient trains, so that there is no uncertainty or delay in the journey.

The plan of Port Erin shows the position and surroundings of the Biological Station. It is on the beach at one corner of the bay, near where the sand and rocks join, and at the foot of the cliff upon which the Bellevue Hotel stands. It is connected with the road by means of a winding gravel path and steps, and is about a third of a mile from the railway station. It is just at the bottom of the hotel grounds, and arrangements have been made with the proprietor by which those working at the Biological Station can live comfortably and economically at the hotel. The sea comes to within a few yards of the windows, and the bay immediately in front is sheltered pure sea-water with a varied bottom, suitable for small boat dredging and tow-netting, while the rocky coast, extending out towards Bradda Head, has many creeks and good shore pools.

The station is a substantially built, three roomed house, measuring a little over 30 feet by 20 feet, and standing on a solid stone and concrete platform, which raises it about 10 feet above high tide. It has windows looking out in three directions, north, south, and west. The front door leads into a passage, from which open to right and left two small rooms, which can be used as the Director's room and the Secretary's office, and will also be available for the use of members of the Committee, or any special students who require a separate room for their work. Opposite the entrance is the door into the main laboratory, which measures about 22 feet by 20 feet, and has windows on both sides. In front of the windows run strong fixed work-tables, which will accommodate five students with ease. At the ends of the room are fire-place, sink, tables, bookcase, and abundance



Plan of the Liverpool Marine Biological Laboratory at Port Erin. 1, Main laboratory (22 × 20), with work places for five students; 2, strong table for aquaria; 3 to 9, tables; 10, small laboratory for Director or members of Committee; 11, passage; 12, small laboratory or Secretary's office; 13, small yard.

of shelving, while along the centre runs a strong table for small aquaria and vessels containing animals. A door in one corner opens into a useful small yard between the house and the cliff, in which the concrete fresh water cistern is placed, and where dredges and other implements can be stored.

The Liverpool Salvage Association had kindly promised to lend their useful steamer, the *Hyæna*, to the Committee for four or five days at the time of opening, but as she was called off on duty at the last moment, they sent the steamer *Mallard* instead, on Friday afternoon, across to Port Erin, where she remained until Monday. Dredging trips in the neighbourhood took place on three of the days, and on Saturday evening tow-netting with submarine electric lights was carried on after dark in the bay.

At one o'clock on Saturday the Lieutenant-Governor, the Bishop, the Manx Attorney-General, and a number of members of the House of Keys, and others, arrived at Port Erin, where they were met by Prof. Herdman, Mr. I. C. Thompson, Mr. A. O. Walker, Mr. J. Vicars, Sir James Poole, and others of the L.M.B.C., along with some biologists from elsewhere, the Liverpool party numbering over thirty. The Governor was conveyed to the front of the Biological Station, where, after being presented by Prof. Herdman with the reports upon the

fauna of Liverpool Bay published by the L M B.C, he declared the building open for work, and then the party entered and proceeded to examine the results of the forenoon's dredging, laid out in dishes and under microscopes At two o'clock the Governor and the Bishop were entertained to luncheon at the Bellevue Hotel by the L M B C, Prof Herdman being in the chair, with the Governor on the right and the Bishop on the left Mr I C Thompson, Hon Sec L M B C, occupied the other end of the table, and about seventy in all sat down to luncheon, including the President and Secretary and some other members of the Isle of Man Natural History Society The Governor proposed the toast of "The Liverpool Marine Biology Committee," to which Prof Herdman replied

The whole of the following day was spent in dredging and tow netting from the *Mallard* to the west and south of Port Erin at the following localities —

(1) 3 miles west of Fleshwick 20 fathoms, 6 hauls of dredge good varied ground, old shells, &c

(2) 14 miles west of Dalby 60 fathoms, 2 hauls, sticky clay mud, with few animals

(3) 8 miles west of Fleshwick 33 fathoms, 3 hauls

(4) 6 miles west of Port Erin 24 fathoms, 2 hauls

(5) 1 mile west of Calf 20 fathoms, 2 hauls

(6) Off Kitterland, Calf Sound 17 fathoms, 1 haul

At each of these localities, besides the ordinary large dredge, tow-nets were used, and also Mr Walker's small dredge with a canvas bag for bringing up samples of the bottom to be washed for small Crustacea, &c

On the following day (June 6), on the way back to Liverpool, dredging from the *Mallard* was conducted at the following places —

(1) 20 miles south east from Port St Mary 26 fathoms

(2) 25 miles south-east from Port St Mary 23 fathoms

Both of these localities were good productive ground, and large hauls were obtained

(3) 20 miles north-west from the Bar 18 fathoms

(4) 15 miles north-west from the Bar 16 fathoms

On all these occasions, besides the surface tow-nets, a bottom tow-net was attached a little way in front of the dredge, and appeared to work well, its contents were usually a good deal different from those of the surface nets

Amongst the forms dredged in these two days were — *Clathria seriata, Spongelia fragilis, Sarcodictyon catenata, Palmipes membranaceus, Stichaster roseus, Porania pulvillus, Antedon rosaceus, Adamsia palliata, Crania anomala, Pandora inaequivalvis, Cynthia echinata*, and the rare little Ascidian *Forbesella tessellata*, and a large number of other species, representing most of the invertebrate groups, which have not yet been sorted out and identified A list of the species previously found in the neighbourhood of Port Erin will be found in "Fauna of Liverpool Bay," vol 1 pp 318-41

The Liverpool Marine Biology Committee's Station at Port Erin is now open, and is provided with a few microscopes, microtome, ordinary reagents, dishes, &c Any biologists wishing to go there for collecting or other work are requested to apply for particulars to Prof Herdman, or to Mr I C Thompson, 4 Lord Street, Liverpool

THE ANNUAL VISITATION OF THE GREENWICH OBSERVATORY

THE report of the Astronomer-Royal to the Board of Visitors this year commences with a reference to the loss sustained by the Observatory by the death of Sir G B Airy, who for sixty years was closely connected with the working of this institution

As regards the buildings, that of the south wing of the proposed Physical Observatory has been authorized by the Admiralty, considerably more space being required for the storing of chronometers and deck watches. The buildings of the three other wings and the two upper stories of the central tower have, for the present, been laid aside, sufficient provision not being made for them in the present financial year The new 36-foot dome, which is being provided for the efficient working of the 28-inch refractor, is still in course of erection, while the pair of semi-domes for the Transit Pavilion in the Front Court has been found to be quite satisfactory The electric light installation, which has in a former report been suggested by the Astronomer-Royal for the photographic equatorial and for other instruments, has been sanctioned by the Admiralty, and will, during the course of the present year, be provided. The advantages of such a means of lighting will at once make themselves apparent, for by the old method the storage cells had to be charged from primary batteries

The Observatory, by the will of the late Sir George Airy, has had several valuable works bequeathed to it Mr Wilfred Airy has as yet transferred 94 volumes and 134 unbound tracts, which will form a valuable addition to the library, together with the manuscript containing the calculations of Sir George Airy's numerical lunar theory His bust, by Foley, has also been received and is now placed in the Octagon Room

With regard to the work done with the transit-circle, the number of observations was not so great as in former years, as the object-glass was removed for repolishing on August 10 to October 5 The definition and colour-correction of this glass has been greatly improved by Mr Simms New steel screws to the R A and Z D micrometers were added at the same time, and the wire system also received a slight modification The wires are ten in number, distant from each other by exact multiples of a screw-revolution, and so arranged that the mean of the ten nearly coincides with one of them A little computation is thus saved in taking the mean of a transit, and the only thing lost is symmetry in the arrangement

During the rest of the year the sun, moon, and planets have been regularly observed on the meridian as before -

Transits, the separate limbs being counted as separate observations	4801
Determinations of collimation error	249
Determinations of level error	335
Circle observations	4463
Determinations of nadir point (included in the number of circle observations)	319
Reflexion observations of stars (similarly included)	436

The annual catalogue of stars observed in 1891 contains 1813 stars

The results from the observations for the determination of variation of personal equation with stellar magnitude, indicated that there was a general tendency with all the observers to observe stars later when the light was diminished by placing a gauze screen before the object-glass, but it was stated that "it is not clear that we are here measuring a real change of personal equation in observations of fainter stars, as the introduction of the screen modifies the image of the star, and this modification of the image may give rise to a change of personal equation unconnected with the diminution of brightness"

It is noted that as the external thermometer rises there is a nearly uniform decrease of the readings of the internal thermometers over that of the standard exterior thermometer, the excess vanishing at something over 70°. This is accounted for by the variation of the temperature of the walls of the room, the permanent temperature of which is always slowly changing.

The total number of observations made with the altazimuth in the year ending 1892 May 10 is as follows —

Azimuths of the moon and stars	345
Azimuths of Mark I	162
Azimuths of Mark II	182
Zenith distances of the moon	166
Zenith distances of Mark I	164
Zenith distances of Mark II	176

These numbers are slightly greater than in recent years, owing to the fact that during August and September, when the transit-circle was under repair, the observations of the moon with the altazimuth were made throughout the lunation instead of being confined to the first and last quarters.

With regard to clocks and chronographs, we may mention that the daily rate of the sidereal standard clock underwent a very considerable disturbance, changing from a daily gain of 1 0s to that of 2 0s The cause of this difference was due to some workmen who were fixing a new shelf, the necessary hammering setting up vibrations in the building

With the reflex zenith tube, eighteen double observations of γ Draconis have been made, but owing to the pressure of work the reductions are not yet complete

Ten occultations of stars by the uneclipsed moon (8 disappearances and 2 reappearances) and 48 phenomena of Jupiter's satellites have been observed with the equatorials, or with the altazimuth These observations are completely reduced to 1891 December 31 On the occasion of the partial eclipse of the moon on 1892 May 11, 7 disappearances and 3 reappearances were observed of the faint stars in a list prepared by Mr Crommelin, and the times of transit of the shadow over some principal craters were also noted But it is to be regretted that, although favoured by fine weather on this occasion, the Observatory was seriously crippled in their instrumental equipment, the 13-inch refractor of the south-east equatorial and the Lassell 2-feet reflector being both dismounted

With the photographic equatorial, 301 plates with a total of 1190 exposures have been taken on 112 nights, many of these being taken for special investigations Of these, 62 plates were taken to determine the relations between diameter of image, length of exposure, and brightness of the star, the results of which have already appeared in the *Monthly Notices* for January of this year The discussion indicated that, through a range of exposures corresponding to 8 magnitudes, "the square root of the diameter increases as the logarithm of the exposure, and further, that for equal photographic effects duration of exposure should vary inversely as the brightness of the star" These results were based on as many as 2200 measures of 150 star images The *réseaux* seem to have given much trouble, the silver film developing pin-holes, the images of which resemble on the photographic plates those of stars M Gautier is now supplying the Observatory with two more, coated this time with a film of collodion, in the hopes that it may be freed from the deficiencies mentioned above The catalogue which has been undertaken at Greenwich of the guiding stars for the zones + 60° to the pole, + 25° to + 29°, and − 3° to − 5°, is very near completion The catalogues of places (epoch 1900) are complete for the Greenwich zones + 65° to + 80° (the reductions for the circumpolar region being deferred), also for the zones + 60° to + 64 to be photographed at Rome, and for the Oxford zones + 25° to + 29° The stars for the San Fernando zone (− 3° to − 5°) have all been selected, and their places have been computed for those between R A 12h and 18h

Spectroscopic and Photographic Observations —The observations of the displacement of the lines in stellar spectra for the determination of their motion in the line of sight have not this year been regularly continued, a preliminary discussion of the former observations suggesting that they were affected to some extent by the position of the spectroscope, Vega and Altair were observed during the summer and autumn at as wide a range of hour-angle as possible, and with the spectroscope set to each of the four positions 0°, 90°, 180°, and 270°, the slit being parallel to the declination circle at 0° The numbers of observations obtained of the F line in the spectrum of Vega are at 0°, 39, at 90°, 42, at 180°, 36, and at 270°, 39, and of the F line in the spectrum of Altair at 0, 30, at 90°, 32, at 180°, 26, and at 270°, 29 The measures are now under discussion, and give clear indications of the existence of the systematic error referred to The observations were interrupted by the dismounting of the 12¾-inch telescope on 1891 November 19

At the appearance of the new star in Auriga the south-east equatorial was unfortunately dismounted, but the object-glass presented to the Observatory by Sir Henry Thompson was mounted as quickly as possible on the Thompson telescope, but alterations of the telescope tube were found necessary to bring the spectrum to focus on the photographic plate, and before these could be completed, the Nova had become nearly too faint for observation

For the year 1891, 360 out of 365 photographs of the sun's surface have been selected for measurement, 136 of these were sent to the Solar Physics Committee from India and Mauritius

The solar activity has increased in a remarkable manner during the past year While there were 175 days without spots in the year 1890, there were only 21 such days in 1891, and since 1891 March 28, the sun has not been free from spots on a single day on which it has been observed The number of groups visible on the disk at the same time and their average size and complexity, have all greatly increased during the past twelve months, the group of February 5–18 being the largest ever photographed at Greenwich This group has had an unusually long life, appearing first on 1891 November 15, and persisting till 1892 March 17

Magnetic Observations —The continuous register by photography of the magnetic elements has been satisfactorily maintained It has been found that serious disturbances of the earth-current registers is due to the trains of the City and South London Electric Railway, situated at a distance of 2½ miles from the nearest earth plate, and about 4½ miles from the Observatory The change of potential takes place every two or three minutes, varying in amount from "a small fraction of a volt to one-third of a volt or more"

The following are the principal results for the magnetic elements for 1891 —

Mean declination (approximate)	17° 23′ West
Mean horizontal force	3 9587 (in British units) 1 8253 (in Metric units)
Mean dip	67° 19′ 49″ (by 9-inch needles) 67° 21′ 0″ (by 6 inch needles) 67° 23′ 22″ (by 3-inch needles)

In the year 1891 there were five days of great magnetic disturbance, but there were also about twenty other days of lesser disturbance, for which tracings of the photographic curves will be published, these days having been selected in concert with M Mascart according to the arrangement mentioned in the last report The calculation of diurnal inequalities from five typical quiet days in each month, commenced in 1889 at Prof Rucker's suggestion, has been continued

From February 13 to 14 a very large disturbance was recorded, commencing a day after the large sun-spot was on the central meridian Considerable magnetic disturbances also occurred on March 6, 11, and 12 Other disturbances occurred on 1891 September 9, 1892 April 25–26 and May 1, and may perhaps "be connected with spots then on the sun's disk"

Meteorological Observations —The mean temperature of the year 1891 was 48 4, being 1° 1 below the average

of the fifty years, 1841-1890 The highest air temperature in the shade was 85°·1 on July 17, and the lowest 12·0 on January 10 The mean monthly temperature in 1891 was below the average in all months excepting June, September, October, December In January it was below the average by 4°·4, in April and August by 3·0, and in May by 2°·8

The mean daily motion of the air in 1891 was 278 miles, being 4 miles below the average of the preceding twenty-four years The greatest daily motion was 960 miles on December 10, and the least 34 miles on February 23 and 24 The greatest pressure registered was 31·5 lbs on the square foot on November 11 On December 10 the pressure plate was not in action

The number of hours of bright sunshine recorded during 1891 by the Campbell-Stokes sunshine instrument was 1222, which is about 66 hours below the average of the preceding fourteen years, after making allowance for difference of the indications with the Campbell and Campbell Stokes instruments respectively The aggregate number of hours during which the sun was above the horizon was 4454, so that the mean proportion of sunshine for the year was 0·274, constant sunshine being represented by 1

The rainfall in 1891 was 25·0 inches, being 0·5 inches above the average of the preceding fifty years

Chronometers, Time Signals, and Longitude Operations—The number of chronometers and deck watches now being tested at the Observatory is 157 (91 box chronometers, 19 pocket chronometers, and 47 deck watches) The annual competitive trial of chronometers commences on July 2, and the trial of deck watches on October 22

In the year ending 1891 May 10, the average daily number of chronometers and deck watches being regularly rated was 243, the total number received was 765, the total issued 750, and the number set to repair 442

At the annual trial of chronometers the performance was good, the average trial number of the first six was 21·4, which compares favourably with those of previous years

The dropping of the time balls is next referred to The Greenwich one was not raised on October 14, December 10 and 13, 1891, owing to the violence of the wind, on April 1, 1892, the springs of the mean solar clock failed to act, and on October 19 and November 22 failure in the connections was the cause

The return signal from Deal was interrupted last November several times, owing to an accumulation of grease which had been applied to the piston Signals from Devonport clock failed on 51 days, and those from the Westminster clock on 14 days

The publication of the observations for the Paris-Greenwich longitude in 1888, and of those for the Dunkerque-Greenwich longitude in 1889, has been delayed pending a redetermination of the former longitude which was commenced on June 6 of the present year, and it is hoped to settle several questions of importance raised by the discussion of the results obtained in 1888

The first stage of the operations for the longitudes Montreal-Canso Waterville-Greenwich was completed on May 23 The time of transmission along the cable Waterville-Canso was about a quarter of a second—a result confirmed by a rough comparison of signals on 1892 May 11 Prof McLeod, of Montreal, paid a similar preliminary visit to Canso in 1891 June, and found an accordant value for the time of transmission Four portable transits were used for the time determinations These latter were made in all on 14 nights at Greenwich, 12 at Waterville, and about the same number at Canso and Montreal The preliminary reduction gives every promise of satisfactory accuracy at Greenwich and Waterville

Captain Grant, R.E, has been at work at the Observatory practising the requisite transit observations for determining the boundary of Mashonaland

In the Astronomer-Royal's general remarks at the conclusion of his report, he refers to a plan he has devised for making observations out of the meridian with a transit-circle He proposes to have it so constructed that by means of a turn-table it can be placed and firmly fixed in certain definite azimuthal, the instrument "being used essentially as a transit-circle for a complete series of observations in the selected azimuths plane" This instrument, as he says, would advantageously replace the existing altazimuth, and could be used "not only for the important object of making extra-meridian observations of the moon but also for observations of the sun, planets, and stars (in the meridian as well as out of the meridian), for the elimination, as far as practicable, of systematic errors, and for the more accurate determination of astronomical constants" The aperture of the instrument he suggests should be 8 inches, with circles of 3 feet diameter, read by four microscopes, and he thinks that a suitable position for it could be found about 90 feet north of the declination magnet, where "an unobstructed view could be secured by mounting it with its axis at a height of about 20 feet above the ground"

NOTES

THE Ladies' *Soirée* of the Royal Society is being held this evening as NATURE goes to press

THE annual meeting of the American Association for the Advancement of Science will be held at Rochester, N Y, from August 18 to 24

THE late Dr W J Walker placed at the disposal of the Boston Society of Natural History a grand honorary prize "for such investigation or discovery as may seem to deserve it, provided such investigation or discovery shall have been made known or published in the United States at least one year previous to the time of award" This prize has been unanimously awarded to Prof James D Dana In recognition of the value of Prof Dana's scientific work, and in testimony of the Society's high appreciation of his services to science, the maximum sum of one thousand dollars has been awarded

IN the new number of the Journal of the Marine Biological Association Mr Ernest W L Holt gives an interesting account of the work he has lately done in connection with his North Sea investigations The objects of these investigations, as explained in the report of Mr Calderwood, the Director of the Plymouth Laboratory, are —(1) to prepare a history of the North Sea trawling grounds, comparing the present condition with the condition say twenty or thirty years ago, when comparatively few boats were at work, (2) to continue, verify, and extend operations as to the average sizes at which the various food-fishes become sexually mature, (3) to collect statistics as to the sizes of all the fish captured in the vicinity of the Dogger Banks and the region lying to the eastward, so that the number of immature fish annually captured may be estimated, (4) to make experiments with beam trawl nets of various meshes, with a view to determine the relation, if any, between size of mesh and size of fish taken It is obvious that a considerable time must elapse before trustworthy data can be collected on all these points by one inquirer Mr Calderwood therefore notes that in Mr Holt's early reports it has been thought advisable not to treat each heading in detail, since one season of the year may be more suitable for collecting information on one point than on another, but rather simply to state the results of work accomplished. During the spawning season most attention must necessarily be given to heading No. 2, so that in Mr Holt's present report the relation of size to immaturity is principally mentioned. Work of a similar nature done by Mr Holt himself in Ireland, by Dr Fulton in Scotland,

and by observers at Plymouth, shows that a very considerable variation takes place in the sizes at which fishes become sexually mature in different localities, and Mr Calderwood thinks it is probably not too much to say that as surely as legislation will have to be resorted to for the preservation of fish until they have spawned, so surely will the matter have to be studied for each coast separately

MR CALDERWOOD records in his report that the demand on the Plymouth Laboratory for specimens to be used in laboratories and museums throughout the country increases, and requires constant attention The Laboratory can supply specimens which, in very many cases, could not otherwise be obtained The proper preservation of certain classes of soft animals is in itself an art developed during the last fifteen years, almost entirely by the persevering efforts of Signor Lo Bianco, of Naples Within the past year these methods have been published, and it is hoped that with practice the specimens sent out from the Plymouth Laboratory may gradually gain the character so long possessed by the Naples specimens alone

AT the general monthly meeting of the Royal Institution on Monday, June 13, the special thanks of the members were returned for the following donations —Mrs Bloomfield Moore, £80, Sir David Salomons, Bart, £50, Mr Charles Hawksley, £50, for carrying on investigations on liquid oxygen

A COMMITTEE appointed by the Botanical Club of Washington to consider the questions of a botanical congress and botanical nomenclature has lately presented its report, which the Club has unanimously adopted While favouring the final settlement of disputed questions by means of an international congress, the committee do not regard the present as an opportune time. They recommend the reference of the question of plant nomenclature first to a representative body of American botanists, and suggest the consideration, by such a body, of various questions Among these questions are the following the law of priority, an initial date for genera, an initial date for species, the principle "once a synonym always a synonym," what constitutes publication ?, the form of ordinal and tribal names, and the method of citing authorities

THE anticyclone, which at the time of our last issue had lain over these islands for some days, then began gradually to give way, and in the night of the 9th northerly winds and cloudy weather set in over Scotland, while depressions formed over England, causing thunderstorms in this country and in Ireland, with heavy rainfall in places, as much as 1 1 inch being measured at Mullaghmore during the twenty four hours ending 8h. a.m on Saturday, the 11th. These changes in the distribution of pressure caused great fluctuations of temperature, the maxima observed over Scotland on the 10th were in some cases as much as 30° lower than those of the previous day, while in England, on the 11th and 12th, a still larger decrease of temperature was experienced A small depression which lay over the south east of England on Sunday, caused a steady rain for some hours in that part of the country, the maximum temperature registered in London was 51°, being about 18° below the average maximum for June. In fact, so low a maximum temperature has not occurred in London, in June, for at least a quarter of a century On the night of the 19th the temperature on the grass fell to 29° at Oxford During the early part of the present week an anticyclone, lying to the westward, extended over the western and northern parts of the country, and a large depression appeared to the southward of these islands, causing moderate northerly and north-easterly breezes, while temperatures continued low in all parts of the country

THE Meteorological Council have just issued, as the completing portion of the *Weekly Weather Report* for 1891, tables giving improved monthly and annual means of temperature, rainfall, and bright sunshine for all the stations (65 in number) used in the preparation of that publication The large amount of labour expended on the calculations, and the trustworthiness of the values may be judged of from the fact that the temperature means extend over 20 years, the rainfall over 25 years, and the sunshine over 10 years A glance at the figures at any station is sufficient to show the chief characteristics of its climate, as compared with any other locality They show that London has the highest mean maximum temperature in July, 72° 4, Cambridge, the lowest mean minimum, 31° 6 in December, although several other stations have a mean minimum of 31° 7 in that month, and Cambridge and Hillington have 31° 7 and 31° 8 respectively in January The wettest station is Laudale, N B, with an annual rainfall of 79° 57 inches, and the driest, Spurn Head, 20 92 inches The stations with most and least sunshine are Jersey and Glasgow respectively, the deficiency of the latter being due to smoke

DR J HANN laid before the Academy of Sciences at Vienna, on May 5, another of those elaborate investigations for which he is so well known, entitled "Further Researches into the Daily Oscillations of the Barometer" The first section of the work deals with a thorough analysis of the barometric oscillations on mountain summits and in valleys, for different seasons, for which he has calculated the daily harmonic constituents, and given a full description of the phenomena, showing how the amplitude of the single daily oscillation first decreases with increasing altitude, and then increases again with a higher elevation The epochs of the phases are reversed at about 6000 feet above sea level as compared with those on the plains The minimum on the summits occurs about 6h a m, and in the valleys between 3h and 4h p m The double daily oscillation shows, in relation to its amplitude on the summits, nearly the normal decrease, in proportion to the decreasing pressure, but the epochs of the phases exhibit a retardation on the summits, of as much as one or two hours In the tropics, however, this retardation is very small He then endeavours to show that these modifications of the daily barometric range on mountain summits are generally explained by the differences of temperature in the lower strata of air In connection with this part of the subject, he considers that even the differences in the daily oscillations at Greenwich and Kew are mostly explained by the different altitude of the two stations, and by the fact that Greenwich is on an open hill In the second section he has computed the harmonic constants for a large number of stations not contained in his former treatise of a similar nature, including some valuable observations supplied by the Brazilian Telegraph Administration, and others at various remote parts of the globe

A SECOND attempt is to be made to build an Observatory at the top of Mont Blanc As the workmen who tunnelled last year through the snow just below the summit did not come upon rock, M Janssen has decided that the building shall be erected on the frozen snow. A wooden cabin was put up, as an experiment, at the end of last summer, and in January and early in the spring it was found that no movement had occurred According to the Lucerne correspondent of the *Times*, the Observatory is to be a wooden building 8 metres long and 4 metres wide, and consisting of two floors, each with two rooms The lower floor, which is to be embedded in the snow, will be placed at the disposition of climbers and guides, and the upper floor reserved for the purposes of the Observatory The roof, which is to be almost flat, will be furnished with a balustrade, running round it, together with a cupola for observations The whole building will rest upon six powerful screw-jacks, so that the equilibrium may be restored if there be any displacement of the snow foundations The building is now being made in Paris, and will shortly be brought in sections to Chamounix. The transport of the building from Chamounix to the summit of

Mont Blanc and its erection there have been intrusted to the charge of two capable guides—Frederick Payot and Jules Bossonay

Lectures on subjects of great practical interest are being delivered daily in connection with the International Horticultural Exhibition Mr H Cheshire will lecture to day on "Guano its origin and composition, use and abuse" Among the subjects of other lectures for which arrangements have been made are "The relation of insects to flowers," "Strawberry culture," and "The tomato its diseases," by Prof F I Cheshire, "Hatching the management of the brooding hen," by Mr W Cook, and "Plant food and the formation of composts," by Mr H Cheshire

Dr W L Abbot has prepared for the Smithsonian Institution an excellent descriptive catalogue of the collection of ethnographical objects from Kilima-Njaro, presented by him to the National Museum Dr Abbot expresses his belief that Kilima Njaro, with its cool, healthy, and bracing climate, will some day be a great sanatorium for Europeans from the hot and fever-stricken coast regions He would be sorry, however, to see civilization invade this region, and hopes the day may be far distant when a railway shall open the way into the interior, and drive off "the herds of game that still pasture within sight of Africa's great snow mountains"

Messrs Joseph Baer and Co, booksellers, Frankfort, are selling the botanical library of the late Prof J Just, director of the botanical garden connected with the Polytechnicum at Carlsruhe The list includes many important works in various departments of botanical science

Mr L Ryboi writes to us from Southampton that he caught a very perfect specimen of the rare crimson speckled *Deiopeia pulchella*, on the afternoon of Friday last (June 10), in a field on the right bank of the Itchen, not far from Southampton

In 1874 the British Association published a volume of "Notes and Queries on Anthropology," the object being to promote accurate anthropological observation on the part of travellers, and to enable those who were not anthropologists themselves to supply information wanted for the scientific study of anthropology at home A second edition has long been wanted, and a Committee was appointed by the British Association to consider and report on the best means for bringing the volume up to the requirements of the present time The Committee recommended that the work should be transferred to the Anthropological Institute, and this proposal was accepted, the Association making grants amounting to £70 to aid in defraying the cost of publication The new edition has now been issued, the editors being Dr J G Garson and Mr C H Read, and every one who may have occasion to use it will find it thorough and most suggestive The first part—Anthropography—has been entirely recast, the second part—Ethnography—has been revised, and additional chapters have been written Among the contributors to the volume are Mr F Galton, Mr A W Franks, Dr E B Tylor, General Pitt Rivers, and many other well-known authorities

Mr Cyrus Thomas announces in *Science*, of May 27, that he has discovered the key which will unlock the mystery of the Maya codices, and, probably, the Central American inscriptions. The progress of decipherment will be slow, but he is confident that it will be ultimately accomplished He has already determined the signification of some dozens of characters, and in several instances ascertained the general sense of a group forming a sentence, although there are a number of conventional symbols. Mr. Thomas holds that the great majority of the characters are truly phonetic, and that the writing is of a higher grade than has hitherto been supposed

The members of the Johns Hopkins Marine Station accumulated during the summer of 1891, in addition to the results of their special researches, many general observations upon the fauna of Jamaica These notes are printed in the April number of the Johns Hopkins University Circulars, and will be of considerable service to any one who may desire to obtain what is called in the Circular "a preliminary view of the material"

The new number of the *Internationales Archiv für Ethnographie*, contains interesting notes (in English) by A Ernst, Caracas, on some stone yokes from Mexico R Parkinson contributes (in German) a paper on tattooing among the natives of the district Siarr, on the east coast of New Mecklenburg, New Ireland A paper on the development and geographical distribution of the various types of building in use among Finnish peoples is contributed by Axel O Heikel, of Helsingfors The illustrations, as usual, have been carefully prepared

The Society for Promoting Christian Knowledge has issued a fresh series of coloured representations of plants They have been printed in Germany, and ought to be of good service to students and teachers of botany

The first volume of "A Treatise on Hygiene," edited by Dr Thomas Stevenson and Mr Shirley F Murphy, will shortly be issued by Messrs J and A Churchill It consists of articles, by eminent writers, on many different phases of hygienic science The second volume is in the press

Mr C F Mabery gives in *Science*, of May 13, a full account of the new chemical laboratory of the Case School of Applied Science, Cleveland Ohio In devising plans for the laboratory, Mr Mabery felt that while it was not good economy to construct a building several times larger than present needs demanded, it was important to provide for the possibility of unlimited extension A plain, rectangular form was therefore designed, and it was found that extension of the main hall into a wing of any size would not interfere with a convenient arrangement of the rooms for present use

Icebergs seem to be unusually plentiful in the Atlantic this year According to a writer in the *Times*, the log of the Inman liner *City of Berlin*, which arrived on the 3rd inst, shows how dangerously close to the Transatlantic path the icebergs are hovering On the afternoon of May 31, about 5 45 o'clock, the *City of Berlin* was in latitude 50° 20′, longitude 42° 15′ It was a clear and pleasant evening, and almost all the passengers were on deck About 5 o'clock the air became very chilly, and the temperature of the water was very low Captain Land at once suspected icebergs, and steered a more southerly course in the hope of avoiding them About 6 o'clock, only a few miles to the north, a towering double-pinnacled berg was sighted The berg was fully 200 feet high and about 600 feet long Twenty minutes later another berg was sighted on a direct line with the first, between 6 and 8 30 o'clock four bergs were sighted None of them was less than 100 feet high and 300 feet long, all were in a good state of preservation, and looked as though they would be able to drift about for some time Icebergs have also been sighted by other vessels

The Todas, inhabiting the Nilgiri plateau, are not dying out gradually, as has long been supposed The last census figures show that they have increased by no less than 10 per cent during the last ten years, there being now nearly eight hundred of them altogether

In the new number of the Journal of the Straits Branch of the Royal Asiatic Society there is an interesting note on the little insectivore, *Tupaia javanensis*. It is very common in Singapore, and especially in the Botanic Gardens, where it may be often seen running about among the trees It is easily mis-

taken for the common little squirrel (*Sciurus hippurus*), of which it has much the appearance When alarmed it quickly darts up the trunk of the nearest tree, but it is a poor climber, and never seems to go high up like the squirrel Besides these points of resemblance, it appears to be largely frugivorous It was found that the seeds sown in boxes were constantly being dug up and devoured by some animal, and traps baited with pieces of coco nut or banana were set, and a number of tupaias were caught These being put into a cage appear to live very comfortably upon bananas, pine apple, rice, and other such things, refusing meat The Rev T G Wood, in his "Natural History," states that *T ferruginea* is said to feed on beetles, but to vary its diet with certain fruits The common species at Singapore seems to be almost entirely frugivorous, though its teeth are those of a typical insectivore

THE thirtieth Bulletin of the Botanical Department, Jamaica, contains a careful paper, which ought be be very useful, on the sugar cane borer, by which much damage is being done in sugar plantations The author is Mr. T D A Cockerell, Curator of the Institute of Jamaica Another contributor to the Bulletin, writing of gardening in Jamaica, mentions that about a year ago Messrs Cannel and Sons, Swanly, Kent, sent her some small plants of chrysanthemums by post They were all new and valuable, and the English season being so short, Messrs Cannel and Sons begged her to try whether she could succeed in getting seed from these for them, offering to send her a collection of choice chrysanthemums in repayment of her trouble should she be successful Out of the six plants one died, killed by a grub, the rest turned out magnificent, blowing with a profusion such as she had seldom seen before -they were perfect umbrellas of bloom, but the flowers died off without seeding The plants then threw out a perfect little forest of offsets, and she finds that any cuttings broken off from the old plants will root easily

A METHOD of rabbit-destruction which has been tried with considerable success in the Hay district is recommended by the *Agricultural Gazette of New South Wales* as worthy of the consideration of pastoralists throughout the colony, more especially where the rainfall is light The destroying agent is poisoned water, which is prepared as follows —Cover 1 ounce of strychnine with concentrated hydrochloric acid, or what is commonly known as strong muriatic acid or spirits of salts, and leave to soak all night The mixture easily dissolves in half a gallon of boiling water After making the solution, bottle off and use as required A pint of the mixture will poison 60 gallons of cold water, possibly a weaker mixture might be efficacious This system has been adopted at Benerembah Station, sixteen shallow 8- to 10-gallon troughs being used to each tank, and the number of rabbits poisoned at each tank nightly is stated to be 10,000 In the Mossgiel district no less than 27,000 rabbits were destroyed in two weeks by the use of poisoned water

THE idea of flower-farming for perfumes seems to be exciting a good deal of interest in New South Wales, as many inquiries on the subject have lately been submitted to the Agricultural Department. There are at present in the colony no means of illustrating the practical operations of this industry, but the *Agricultural Gazette of New South Wales* hopes that this deficiency will soon be supplied by the institution of experimental plots on one or more of the experimental farms The *Gazette* points out that in scent farms large quantities of waste material from nurseries, gardens, orchards, and ordinary farms might be profitably utilized, while occupation would be found for some who are unfit for hard manual labour A Government perfume farm was lately established at Dunolly, in Victoria, and this promises to be remarkably successful

AT the meeting of the Field Naturalists' Club of Victoria on March 14, Prof. Baldwin Spencer, the President, gave an interesting account of a trip he had made to Queensland in search of Ceratodus Special interest attaches to this form, since it is the Australian representative of a small group of animals (the Dipnoi) which is intermediate between the fishes and the amphibia Ceratodus has its home in the Mary and Burnett Rivers in Queensland, whilst its ally, Lepidosiren, is found in the Amazon, and another relative, Protopterus, flourishes in the waters of tropical Africa Although unsuccessful in obtaining the eggs of Ceratodus, owing to the early season, Prof Spencer was able, from a careful study of the surroundings under which the animal lives, to infer that its lung is of as great a service to it during the wet as during the dry season—a theory in direct opposition to the generally accepted one that the lung functions principally during the dry season, when the animal is inhabiting a mud-cocoon within the dry bed of the river

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr Oswald Norman, a Common Fox (*Canis vulpes*), British, presented by Mrs Onslow Wakeford, two Four horned Antelopes (*Tetraceros quadricornis* ♀♀) from India, presented by Mr. W F Sinclair, a Magellanic Goose (*Bernicla magellanica*) from the Falkland Islands, presented by the Rev J Chaloner, six Common Lizards (*Lacerta vivipara*), a Slowworm (*Anguis fragilis*), British, presented by Mr Percy W Farmborough, three Little Green winged Doves (*Chalcophaps chrysochlora*) from North Queensland, deposited, two Diamond Snakes (*Morelia spilotes*), a Punctulated Tree Snake (*Dendrophis punctulatus*), a Bearded Lizard (*Amphibolurus barbatus*), a Burton's Lizard (*Lialis burtoni*) from Australia, received in exchange, a Great Kangaroo (*Macropus giganteus*), born in the Gardens

OUR ASTRONOMICAL COLUMN

THE LATE NEW STAR IN AURIGA —A very interesting table, showing a summary of all the observations made with regard to the magnitude of the late new star in Auriga, will be found in *L'Astronomie* for June Commencing with the photographs taken by Prof Pickering, when the Nova was very nearly of the 12th magnitude, the table shows a tremendous increase of brilliancy up to December 18, when it had reached a maximum, its magnitude then being about 4 5 From that date to March 2, the diminution in intensity was only very slight, being reduced only by about one magnitude, but, subsequent to this, the fading was nearly as rapid as the brightening, the star diminishing, on an average, a magnitude in a period of about 3 2 days

PHOTOGRAPHIC MEASURES OF THE PLEIADES —The third number of the "Contributions from the Observatory of Columbia College, New York," consists of the Rutherfurd photographic measures of the group of the Pleiades reduced by Mr Harold Jacoby These photographs were among the complete set of original negatives that were presented to this Observatory by Mr Rutherfurd, and were taken in the years 1872 and 1874 This special group was chosen for reduction in order to investigate the accuracy obtainable by the methods employed, and the results show that the reduced places can be thoroughly relied upon The table containing a catalogue of the stars in question gives the places for the epoch 1873 0, together with the precessional and secular variation In the discussion of the results, the Yale and Konisberg heliometer measures have been used for the sake of comparison, and Mr Jacoby clearly demonstrates that the photographic results are of very considerable accuracy Taking the case of the right ascensions, the difference of the residuals, obtained from the Yale and New York results, and those from Yale and Konisberg, amounts in only two cases to as much as 0" 50, while the mean may be roughly estimated as less than 0" 25 That part of the table relating to the declinations furnishes equally satisfactory values, showing us that, for any future study regarding the determination of proper motions in this region, these photographic observations ought to be taken into account The average probable errors in right ascension

and declination amount to ± 0′.05 and ± 0″.05 respectively, the actual probable errors somewhat exceeding these values, as they involve the scale inaccuracies and other possible sources of error.

THE PLANET MARS.—In the early morning Mars is now visible on our eastern horizon. This period of 1892 will be the most favourable for observation that we have had since the year 1877. The opposition takes place on August 4 next, when the planet is near perihelion, so that its proximity to us will not be quite so great as was the case in 1877. The longitude of the planet at the time of its perihelion passage will be 333° 49, but our earth will not reach this until August 27. The apparent diameter on the 18th of this month will amount to 17″.66, while on August 5 it will be 24″.78; the phases for these two dates will be respectively 1″.34 and 0″.05. The positions for the 17th, 21st, and 25th of this month are as follows:—

June	R.A.	Decl.
17	21h. 16m.	−20° 4′
21	21h. 20m.	20° 7′
25	21h. 22m.	20° 13′

L'Astronomie for June contains a very interesting article by M. Camille Flammarion, in which some quite recent observations of this planet are inserted. There are also several illustrations of the physical features, including the new map by M. Lohse and the drawings made by M. Niesten during the year 1888.

GEOGRAPHICAL NOTES.

THE French Ministry of Public Instruction has authorized M. Ch. Almand, of the Natural History Museum of Limoges, to study the Seychelles Islands in detail with special reference to their fauna.

THE Geographical Society of Lima has just issued the last number of the first volume of its *Boletin*, a most creditable publication containing many articles bearing on the geography of Peru and the Andes. Amongst the more important papers in the current issue are a monograph on Lake Titicaca, a discussion of the climatology of Peru, by Dr. Luis Carranza, and the report of a recent Commission sent out by the Peruvian Government to inspect the new road across the Andes leading to the highest navigable point on the eastern rivers. The road starting from Chicla, the temporary terminus of the Oroya railway, crosses the watershed at Casapalca at 17,500 feet of elevation, passes Tarma, Palca, La Merced, and thence runs northward through a little known region inhabited by native tribes to Puerto Tucker, at the junction of the Pichis with the navigable tributaries of the Ucayali. In referring to this road at a recent meeting of the Royal Geographical Society, the Peruvian Consul pointed out that it would be easy, if a railway were constructed following the line of this road, and connecting steamers run on the Amazon and Ucayali, to reach Lima from London in twenty days instead of a month as is now necessary. Other papers in the *Boletin* deal with the archæology of the Andes region; all branches of geography being well represented.

A NEW Russian Expedition to Eastern Tibet and Sze-chuan in China has been decided on, and will set out next year, under the leadership of M. Potanin. It is intended to spend three years in the exploration, a sum of 30,000 rubles (about £3000) being granted by the Russian Government towards the expenses. Capt. Roboroffski accompanies the expedition, on the staff of which various scientific specialists will also be placed.

AT the May meeting of the Paris Société de Géographie the great gold medal was presented to M. Elisée Reclus for his "Nouvelle Géographie Universelle," a work which, though unfinished, is of unique value, and is respected and consulted in all countries. This award is significant of the feeling that careful and conscientious collation and generalization of the work of explorers and travellers occupies a much higher place in the science of geography than has been hitherto accorded it. Amongst those to whom other gold medals were awarded are the Prince of Monaco, for oceanographical research; M. A. Paine, for explorations in Indo-China; M. J. de Morgan, for travels in Persia and Kurdistan; M. H. Coudreau, for ten years of exploration in the interior of French Guiana; and M. Alfred Fourneau, for exploration in French Congo.

NAPLES ACADEMY OF SCIENCES.[1]

THIS volume has been much delayed on account of a memoir by Prof. Trinchese on *Rhodope veranii*. That paper should have constituted the first of the present volume, but a notice leaf after the title page informs us that it will be sent later on as a separate pamphlet. In consequence the volume starts with an elaborate paper in French, of 72 pages and three plates, by M. S. Kantor, "Sur la solution canonique du problème des transformations birationnelles periodiques," iv.e partie. This memoir treats of "Méthodes et problemes; les caractéristiques internes et les caractéristiques permutables; les caractéristiques à 6, 7, 8 points; théorie arithmétique des caractéristiques de transformations birationnelles; les complex anallagmatiques de singularités et de la réductibilité des caractéristiques par equivalence birationnelles; les groupes impropres; les matrices birationnelles de M. de Jonquière; et sur plusieurs groupes de caractéristiques et de transformations."

Prof. F. Bassani contributes a paper on the Miocene Ichthyolites of Sardinia, from specimens collected and placed in his hands by Prof. Lovisato. The tables, cross references, and index are admirable, and of great use to specialists in this branch. Many of our English workers, and above all, Societies, should take a lesson from this. It is occasionally the author of a paper, but far more frequently the responsible authorities of some scientific body, that are the cause of such valuable details not appearing in a paper. How often does it occur that for a paltry economy, a valuable memoir is cast upon the world a dismembered trunk, little comprehensible to the reader, and often a curse to the writer, who is exposed to all sorts of absurd criticisms because his original statements have been pruned to deformed stumps and his tables entirely suppressed.

Several old species are more fully illustrated by descriptions and neat plates drawn by Mrs. Bassani, as well as a new species of Thyrsites, Thynnus, Lamna, Myliobatis, &c.

Prof. Eugenio Scacchi has a memoir on the crystallography of certain new salts obtained by Prof. F. Mauro. The fluoximolybdate of copper is found to be monoclinic. Hypofluoximolybdate of copper is also monoclinic, whilst the hypofluoximolybdate of zinc is rhombohedral. Observations were difficult on account of the great deliquescence of these salts. The memoir is accompanied by one plate of crystal drawings.

Dr. Otto Schmiedeknecht, on his return from an entomological excursion to the Ionian Islands, placed in the hands of Prof. A. Costa all the Tenthredinidæ and Cephina that he had collected there. Prof. Costa describes these under 68 species, 9 of which are new. This is followed by a new genus of Italian Tenthredinidæ, named Laurentia, represented by the species *Laurentia Craverii*. The third section of this "Miscellanea Entomologica" is constituted by the description of four species of Armenian Hymenoptera: *Hylotoma cyanura*, *Allantus violacæpennis*, *Lissonota ducalis*, and *Lissonota decorata*. The "Miscellanea Entomologica" terminates with a new African Blattid, the *Derocalymma Brunneriana*, and is illustrated by one plate of figures in black.

Prof. G. Nicolucci, in a "Glimpse at the Ethnology of Egypt," discusses the different theories concerning the origin of the ancient Egyptians. By comparing the results obtained from historical records, monuments, anatomical observations, and descriptions of the people by ancient writers, he concludes (1) that the Egyptians belong to a white family related in prehistoric times to a Semitic branch; (2) that their physical characters form a type apart, which is clearly revealed in the monuments and the skulls obtained from the tombs of all periods; (3) that this type is the purer the more remote is the period of the monuments; (4) that it is true the immigration of other people into Egypt modified in part the primitive type of the population, but that the principal part of the Egyptians have always retained their primitive characters; (5) at the present, although the type has been crossed by intermarriage with different people in the cities, and other points frequented by strangers, it retains its original character in the Fellah, who are the true and legitimate modern descendants of the constructors of the Pyramids.

Prof. Nicolucci considers the Copts to be descended from ancient Egyptians, but with some infiltration of negro blood. The paper is accompanied by two plates, one of several modern Egyptian types, and one of the portrait of Rameses II. side by side with that of a Fellah.

[1] *Atti della Reale Accademia delle Scienze Fisiche e Matematiche di Napoli*, Serie Seconda, vol. iv; Napoli, 1891.

Signor G F Mazzarelli contributes some researches on the morphology and physiology of the glands of Bohadsch in the Aplysiidæ (the opaline gland of Vayssière) He also gives the diagnosis of a new species of Aplysia The author gives an elaborate histological description of the organ illustrated by two coloured plates, and amongst other conclusions shows that three liquids are secreted—a white odoriferous, a violet, and a mucous—which he declares to have an important biological value, and to concur with the secretions of the mantle for the defence of the animal

Dr. N Terracciano in a note on some plants of the flora of Terra de Lavoro describes several species so far not met with in that district, others not included in the Italian flora, and some new species and varieties Figures are given of *Arabis surculosa*, *Amaranthus crispus*, and *Kœleria collina*

Next follows a monograph of the fossil Pristis, with a description of a new species (*Pristis lyceensis*) from the Miocene limestone of Lecce, and of course figured

Dr L Manfredi has an interesting paper on the contamination of the street surface of large cities, from a hygienic and sanitary engineer's point of view, with special reference to Naples Sweepings of the streets were made at 9 a m —that is, after the regular cleansing had been performed, so that the materials collected represented what remains all the day to contaminate the air and whatever objects it comes in contact with The materials, collected with all due precautions, were submitted to bacteriological and chemical analysis One gramme of fresh sweepings contains from 910 000 to 668,000,000 vital or living bacteria, or double the amount found in fresh fæces, or about 1319 times richer than drain water Compared with the streets of Munich we find that the author there found 8000 to 12,840,000 He demonstrates that, so far as Naples goes, the more cleanly kept are the streets the lower is the number of bacteria in their sweepings, whilst they or their spores have great resisting powers to heat, sunlight, and desiccation They are most abundant in the temperate seasons of spring and autumn, small rains increase them, torrents markedly diminish them The Schizomycetes are the predominant type, but ferments and moulds are common The chemical examination is equally interesting, and, as the author shows, the material is a most favourable culture medium for micro organisms which research leads up to a series of experiments to show how the number of these increase up to a certain date and then diminish in a given sample of sweepings, the effects of rain in facilitating this growth are demonstrated, and also the gases given off as the result of such changes The inoculation experiments are also not without interest An examination of the sub soil on the same lines is of great importance, and several practical and important conclusions are drawn from these researches, which the limits of space forbid our more fully reviewing The memoir is one that should be consulted by every municipal officer

Signor G F Mazzarelli has another long paper on the morphology and physiology of his favourite Aplysiæ of the Gulf of Naples, and illustrated by four plates

Altogether this volume does credit to the Academy, but one regrets not to see papers by some more of its members

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD —In a Convocation held on June 7, the thanks of the University were ordered to be conveyed to Mr C D E Fortnum, Hon D C L, for his munificent gift to the Ashmolean Museum, and an indenture was sealed, the provisions of which place the Ashmolean Museum on an entirely new footing

In the year 1888 Dr Fortnum gave to the University a large portion of his collection of antiquities and works of art, which had been exhibited on loan in the upper room of the Ashmolean Museum Dr Fortnum has now notified his intention of bequeathing to the University the remainder of his collection together with his library, and he has undertaken to transfer to the University a sum of £10,000 on certain conditions, the main object of which is to provide for the care and maintenance of the Museum in the future Under the indenture which was signed on Tuesday last, the University is bound—

(1) To provide a sum, not exceeding £11,000, for the erection of a new Ashmolean Museum, on ground adjoining the University Galleries.

(2) To provide a sum, not exceeding £4000, for the fitting up and furnishing the Museum

(3) To augment to £600 a year, at least, the income arising from Dr Fortnum's benefaction of £10,000

Dr Fortnum's kindly intentions to the new Ashmolean Museum include a further bequest to the University of £5000 contingent upon the University voting the £15,000 for buildings, fitting, and furniture With regard to this amount the University authorities make the following remark —"Of the £11,000 required for the building, it appears that the Curators of the University Chest will have funds in hand in the course of this year and next, out of which this expenditure may be defrayed It is right however, to state that this will leave the University Chest for the present without further resources, in the form either of stock or of cash, for meeting any other new expenditure upon a large scale"

It is proposed that the old Ashmolean Museum, when no longer required for its present purpose, shall be available as an extension for the Bodleian Library, for which additional accommodation must have soon been provided

The University Observatory —The annual meeting of the Board of Visitors took place on Wednesday, June 8, when the Savilian Professor (Rev C Pritchard, D D, F R S) read his annual report After remarking on the present condition of the buildings and instruments, the Professor said —

"As anticipated in the last report, the work connected with stellar parallax is now complete, and I have placed upon the table a manuscript containing the result of that research I need hardly say that it has been a work of unremitting labour, and one which has occupied the strenuous efforts of myself and the Observatory staff during the last four years The manuscript thus completed consists of (1) the concise but complete history of all effective researches in stellar parallax up to the present date, (2) the results of the parallax work completed in this Observatory, extending on the whole to some thirty stars, (3) a catalogue of all parallactic determinations effected by other astronomers

"The provision of photometric catalogues of stars of the ninth and eleventh magnitudes, within small specified areas for the use of the eighteen Observatories engaged on the international chart of the heavens, has been effected, and the results distributed through the agency of the Paris Observatory The cause of this proceeding originated in the unsuccessful attempts to secure the required uniformity of stellar magnitude on the photographic plates by the employment of metallic gauze screens of one definite mesh Much time was consumed on the experimental research into the action of such screens on the photographic image, and in the course of the inquiry certain unexpected and interesting results came to light, the substance of which I communicated to the Paris Academy, and which were subsequently published in the Transactions of that body It is satisfactory to find that these photometric determinations have been appreciated and found to be of practical service, and have been acknowledged as such by both the Directors of the Greenwich and Paris Observatories

"Notwithstanding these very serious interruptions, considerable progress has been made in securing the photographic plates for the international chart and catalogue In number these plates amount to about 150, and it is hoped in future they will accumulate more rapidly, since the work on the preparation of these aforementioned photometric catalogues is now complete"

The report concludes with the usual acknowledgments to the assistants, and with this very satisfactory expression, on which we beg to congratulate the Savilian Professor—"The state of my health and other circumstances prevented my being present at the last meeting of the Board, but I am glad to say that the anticipation of the speedy and complete recovery, mentioned in the last report, has been fully realized"

Radcliffe Travelling Fellowship —The Examiners for this Fellowship give notice that a Fellowship is thrown open this year to all persons who have been placed in the First Class in the School of Natural Science, without further restriction The examination will be as far as possible in the subjects specified by the candidates who offer themselves for examination, and will take place in the first week in November

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 19 —"On the Measurement of the Magnetic Properties of Iron." By Thomas Gray, B.Sc, F.R S E. Communicated by Lord Kelvin, P R.S.

This paper gives the method of experiment and results

obtained in some investigations on the time rate of rise of current in a circuit having large electromagnetic inertia. The experiments were made on a circuit containing the coils of a large electromagnet having laminated cores and pole pieces. The mean length of the iron circuit was about 250 cm., and its cross section 320 sq. cm. The magnetizing coil had 3840 turns, when all joined in series, and a resistance of 10.4 ohms. The coils were so arranged that they could be joined in a variety of ways so as to vary the resistance, inductive coefficient, &c., and also to allow the magnet to be used either as an open or a closed circuit transformer.

The electromotive force used in the experiments was obtained from a storage battery, and the method of experiment was to trace the curve, giving the relation of current to time, on a cronograph sheet.

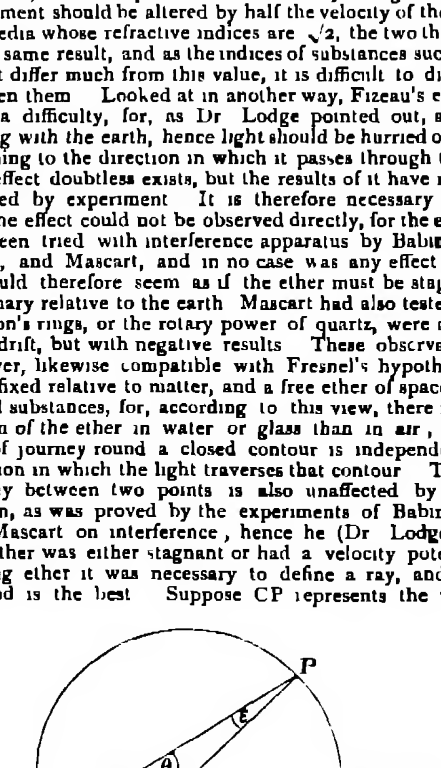
One set of experiments shows the effect of varying the impressed E.M.F. on the time required for the current to attain any given percentage of its maximum strength. The results show that for any particular percentage there is always a particular E.M.F. which takes maximum time. Thus for the circuit under consideration, and with successive repetitions of the current in the same direction, it takes longer time for the current produced by an impressed E.M.F. of 4 volts to reach 95 per cent. of its maximum than it takes for the current produced by either 3 or 5 volts to reach 95 per cent. of their maximum. The results show also that, within considerable limits, the time required for the current to become uniform is on the whole nearly inversely proportional to the impressed E.M.F., and that for moderate values of the E.M.F. the time may be very great; when the E.M.F. was 2 volts, and the current sent in such a direction as to reverse the magnetism left in the magnet by a previous current of the same strength, the time required for the current to establish itself was over three minutes. The difference of time required for repetition and for reversal of previous magnetization was also very marked when the iron circuit was closed. The results show that great errors may arise by the use of ballistic methods of experiment, especially when weak currents are used, and that for testing resistances of circuits containing electromagnets, a saving of time may be obtained by using a battery of considerable E.M.F.

Another set of experiments gives the effect of successive reversals of the impressed E.M.F. at sufficient intervals apart to allow the magnetization to be established in each direction before reversal began. In this set also the effect of cutting out the battery and leaving the magnet circuit closed is illustrated, showing that several minutes may be required for the magnet to lose its magnetism by dissipation of energy in the magnetizing coil. The effect on these cycles of leaving an air space in the iron circuit is also illustrated. It is shown that a comparatively small air space nearly eliminates the residual magnetism, and diminishes considerably the rate of variation of the coefficient of induction and the dissipation of energy in the magnet.

Several cycles are shown for the magnet used as a transformer with different loads on the secondary. The results give evidence that there is less energy dissipated in the iron the greater the load on the secondary of the transformer.

Some experiments are also quoted which go to show that the dissipation of energy due to magnetic retentiveness (magnetic hysteresis) is simply proportional to the total induction produced when the measurements are made by kinetic methods. Reference is made to the recent experiments of Alexander Siemens and others which seem to confirm this view.

Physical Society, May 27.—Mr. Walter Baily, Vice President, in the chair.—The following communication was read:—On the present state of our knowledge of the connection between ether and matter: an historical summary, by Prof. O. J. Lodge, F.R.S. Referring to difficulties connected with the aberration of light, if the medium were supposed to be carried along by the earth in its orbit, Dr. Lodge described Boscovich's suggested experiment with a telescope filled with water, carried out by Klinkerfues, who was led to conclude that the aberration constant depended on the medium within the telescope. Klinkerfues's experiments were repeated by Sir G. B. Airy, but not confirmed. Astronomical observations were not necessary to determine the point at issue, for a fixed source near a collimator might be used with advantage. Hoek had examined the subject in this way with similar negative results. It might therefore be concluded that surveying operations are unaffected by terrestrial motion. This result, however, did not prove the existence or non-existence of an ether drift relative to the earth, for, since the source and receiver move together, any effect produced by such a drift would be compensated by aberration due to motion of the receiver. Speaking of refraction, he pointed out that, if the ether were stationary in space, glass and other terrestrial bodies would have ether streaming through them, and that the refraction of, say, glass might differ as the direction of the ether drift through it varied. To test this, Arago placed an achromatic prism over the object glass of a telescope on a mural circle, and observed the altitude of stars. To vary the direction of the ether drift through the prisms, stars in different azimuths were observed; but the results showed no appreciable change in the deviation produced by the prism due to direction of the earth's motion. Maxwell used a spectroscope to test the same point. Light from illuminated cross wires passed through the telescope, prisms and collimator, and was reflected back along the same path by a mirror and viewed through the telescope. Observations made with different aspects of instrument showed no change in the relative positions of the wires and their images. Mascart had also tried the experiment with simpler apparatus, but was unable to detect any change. These observations naturally suggest that the ether is at rest relative to the earth, but the apparently simple nature of aberration makes this view difficult to hold. Both phenomena are consistent with Fresnel's hypothesis that only the excess of ether, which the substance possesses over that of surrounding space, moves with the body, for on this supposition the effects of altered refraction and ether drift compensate each other. Fresnel's view is practically established by Fizeau's well known experiment on the effect of moving water on the velocity of light, and by the more accurate numerical results obtained by Michelson. The only other theory which accounts for the experimental results is one by Prof. J. J. Thomson, which requires that the velocity of light in Fizeau's experiment should be altered by half the velocity of the medium. For media whose refractive indices are $\sqrt{2}$, the two theories lead to the same result, and as the indices of substances such as water do not differ much from this value, it is difficult to discriminate between them. Looked at in another way, Fizeau's experiment raises a difficulty, for, as Dr. Lodge pointed out, all water is moving with the earth, hence light should be hurried or hindered according to the direction in which it passes through the water. This effect doubtless exists, but the results of it have never been detected by experiment. It is therefore necessary to inquire why the effect could not be observed directly, for the experiment had been tried with interference apparatus by Babinet, Hoek, Jamin, and Mascart, and in no case was any effect observed. It would therefore seem as if the ether must be stagnant, *i.e.* stationary relative to the earth. Mascart had also tested whether Newton's rings, or the rotary power of quartz, were affected by ether drift, but with negative results. These observations are, however, likewise compatible with Fresnel's hypothesis of an ether fixed relative to matter, and a free ether of space permeating all substances, for, according to this view, there is no more motion of the ether in water or glass than in air; hence the time of journey round a closed contour is independent of the direction in which the light traverses that contour. The time of journey between two points is also unaffected by terrestrial motion, as was proved by the experiments of Babinet, Hoek, and Mascart on interference; hence he (Dr. Lodge) inferred that ether was either stagnant or had a velocity potential. In moving ether it was necessary to define a ray, and Lorentz's method is the best. Suppose CP represents the velocity of



light (V) in still ether, and SC the velocity of the ether (v), then a disturbance originating at S will travel along SP, which is the

direction of the ray, whilst CP is the wave normal In the above figure,

$$\frac{\sin \epsilon}{\sin \theta} = \frac{SC}{CP} = \frac{v}{V} = \alpha, \text{ the constant of aberration}$$

The velocity along the path of the ray is SP Calling this velocity V′, we have

$$V' = V \cos \epsilon + v \cos \theta$$

The path of a ray is determined by the time of journey being a minimum, and the formula

$$T = \int_A^B \frac{ds}{V} = \text{a minimum},$$

is the equation to a ray, where A and B are the extremities, and ds an element of the path If the ether be moving, V′ must be substituted for V, and we get—

$$T' = \int_A^B \frac{ds}{V\cos \epsilon + v \cos \theta} = \text{a minimum}$$

This integral can be written exactly—

$$T' = \int \frac{ds}{V} \frac{\cos \theta}{1 - \alpha^2} - \int \frac{v \cos \theta}{V^2(1 - \alpha^2)} ds$$

$$= \frac{T \cos \theta}{1 - \alpha^2} - \int \frac{v}{V^2} \frac{\cos \theta}{1 - \alpha^2} ds$$

The last term is the only one involving the first power of ether drift, and it vanishes in case there is a velocity potential, for, since $v \cos \theta = \frac{d\phi}{ds}$, where ϕ is the velocity potential, it may be written $\frac{\phi_B - \phi_A}{V^2(1 - \alpha^2)}$, and so its value depends only on the end points and not on the path If these points are the same, *i e* the contour is closed, it becomes zero, and reconciles all the experiments hitherto made It must be admitted, however, that if α is not a constant, the question is again opened, but there is no reason to suppose it can vary in the same horizontal plane If the medium be changed, V becomes $\frac{V}{\mu}$, and, in order to retain the same velocity potential in the changed medium, v must become $\frac{v}{\mu^2}$, which is Fresnel's law Hence Prof Lodge pointed out that the velocity potential condition includes Fresnel's law as a special case It can, in general, be inferred that *no first order optical effect due to terrestrial motion can exist in a detectable form* It is always compensated by something else Quantities of the second order of magnitude must, therefore, be attended to From the first equation above, it follows that

$$\cos \epsilon = \sqrt{1 - \alpha^2 \sin^2 \theta},$$

and the time of journey in moving ether is given by

$$T' = T \frac{\sqrt{1 - \alpha^2 \sin^2 \theta}}{1 - \alpha^2},$$

where T is the time if everything were stationary This is, in brief, the theory of Michelson's recent experiment If the light travels along the ether drift, $\theta = 0$ and $T_1 = \frac{T}{1 - \alpha^2}$, whilst if $\theta = 90°$, $T' = \frac{T}{\sqrt{1 - \alpha^2}}$ Therefore the velocity along the ether drift should differ from that across the drift in the ratio of $\sqrt{1 - \alpha^2} : 1$ This point has been very carefully tested by Michelson, but nothing approaching to a quarter of the theoretical effect was observed. His negative result would seem to preclude any relative motion, even irrotational, and shows that the ether is at rest relative to the earth's surface On the other hand, the author (Dr Lodge) had recently made experiments on the influence of rapidly rotating steel disks on the ether, which prove that the ether is not affected by the motion of contiguous matter to the extent of 1/200 part of the velocity of the matter Thus, these two experiments are at present in conflict Prof Fitzgerald has suggested a way out of the difficulty by supposing the size of bodies to be a function of their velocity through the ether Returning to the statements which have been made of Fresnel's law, Glazebrook has shown that actual extra-density of ether is not necessary, for, if the virtual mass be altered, the same results follow; all that is required is a term depending on the relative acceleration of ether and matter To modern ideas the loading of the ether by the presence of matter is most likely to be correct, and the observed effects of relative motion are regarded as the results of secondary reactions of matter on ether On this view, the ether of space may be wholly unaffected by the motion of matter On the vortex ring theory of matter, it is not unnatural to suppose that the ether in its neighbourhood should be only affected irrotationally by its motion And if the velocity potential be granted, nothing of the nature of viscosity being admissible, the results of all the interference, refraction, and aberration experiments could be predicted, and the whole theory is as simple as it can possibly be The only trustworthy experiment ever made which tends against this view is that of Michelson The author surmised that this must somehow be explained away In reply to a question from Prof Ayrton, Dr Lodge said that when air was substituted for water in Fizeau's experiment no effect was observed This might have been expected, for the difference in the times of journey by the two paths depended on $\frac{\mu^2 - 1}{\mu^2}$, and as μ is nearly unity for air, the air effect is too small to see [In Hoek's interference experiment it might be said that the effect of ether moving in stationary water is balanced by that of the ether moving in stationary air; but while motion of water itself would disturb the balance, motion of air would do nothing appreciable The only kind of motion that could display an optical effect is rotational motion, or motion of layers at different speeds, not a simple uniform drift Prof J V Jones asked how the Fizeau experiment could be expressed on the loaded ether theory, for, since the speed of matter affects the velocity of light, it seemed to involve a directional loading A mere extra density term, or acceleration coefficient, will not explain this, it seems to require a co efficient of a velocity term This question has been hinted at by Lord Rayleigh, who points out (under the heading "Aberration," NATURE, xlv p 499) that the rate of propagation of waves on a loaded string will be affected by a travelling of its load The question is not perfectly simple, and the analogy not complete A good deal depends on the nature of the connection symbolized as "loading" [1]]

Royal Microscopical Society, May 18 —Dr R. Braithwaite, *President, in the chair* —Mr R T Lewis, in his paper on the process of oviposition as observed in a species of cattle tick, said that the tick was observed under a low power, after some time the head with the extended rostrum and palpi was retracted, producing a deep depression, the softer adjacent portions of the ventral surface between the basal joints of the first pair of legs being drawn over the margin. Parts surrounding the depression changed colour, and a white vesicle appeared upon the lower internal wall The palpi separated, so that they rested on each side of the vesicle A membranous body, glistening with mucus, was protruded from the cavity, from the lateral extremities of which two papillæ were thrown out, extending across the depression The vesicle was then elongated and embraced by the papillæ, through its walls an egg was seen in motion, which, being delivered into the grasp of the papillæ, the ovipositor at once retracted The papillæ closed round the egg, covering it with an albuminous secretion, and withdrew, leaving it suspended from the under surface of the dorsal plate The palpi closed together until in contact with the rostrum, the head elevating, clearing the egg out of the depression, leaving it adhering to the outer margin the entire process of laying each egg occupying a period of 2 min 42 sec Mr A D Michael remarked that the word "head" was somewhat misleading, because these animals had no heads in the sense in which the term applied to insects, but the whole movable organ was really the rostrum —Mr E M Nelson read a note on penetration in the microscope, showing that for his own sight the penetrating power was only one-seventh of that given by Prof Abbe, whose myopic sight accounted for the difference in the estimate —Mr Nelson also read a note on rings and brushes of crystals, for the observing of which a petrological microscope was generally thought to be necessary This was not essential, as it was really a telescopic object All that had to be done was to convert the microscope into a telescope by placing an objective inside the tube of the instrument

Geological Society, May 25 —W H. Hudleston, F R.S., President, in the chair —The following communications were

[1] Note by O J L.

read:—On *Delphinognathus conocephalus* (Seeley) from the Middle Karoo Beds, Cape Colony, preserved in the South African Museum, Cape Town, by Prof H G Seeley, F R S The skull described in this paper is believed by Mr T Bain to have been collected by himself near Beaufort West The preservation of the specimen leaves something to be desired, but notwithstanding defects the skull belongs to a most interesting Anomodont, indicating a new family of fossil Reptilia The skull is fully described in the paper, and its relationships are discussed The author has already given reasons for regarding *Ælurosaurus felinus*, *Lycosaurus curvimola*, and their allies, as referable to a suborder *Gennetotheria*, which is nearly related apparently to the *Pelycosauria*, and lies midway between the typical *Theriodontia* and the *Dicynodontia* It is to this sub order that *Delphinognathus* may be referred, though it forms a family-type distinct from the *Ælurosauridæ*, distinguished by the conical parietal with a large foramen, the anterior supra condylar notch in the squamosal bone, and other modifications of the skull and teeth —On further evidence of *Endothiodon bathystoma* (Owen) from Oude Kloof, in the Nieuwveldt Mountains, Cape Colony, by Prof H G Seeley, F R S Two bones found by Mr T Bain at Oude Kloof consist of the left ramus of the mandible and what the author regards as the left squamosal bone of *E bathystoma* The small cranial fragment preserved shows that the cerebral region probably conformed to the type of skull seen in some of the Dicynodonts A description of the remains is given, and the author notices that the form of the articular condyle indicates a difference from *Dicynodontia* and all other *Anomodontia* hitherto described, it implies an oblique forward inclination of the quadrate bone—a character important in defining the suborder *Endothiodontia* All the characters of the dentition of the animal suggest near affinity with the *Theriodontia*, especially the long lanceolate teeth strongly serrated —On the discovery of Mammoth and other remains in Endsleigh Street, and on sections exposed in Endsleigh Gardens, Gordon Street, Gordon Square, and Tavistock Square, N W, by Dr Henry Hicks, F R S In this paper the author gives a description of the deposits overlying the loam in which the remains of the Mammoth and other animals were found in Endsleigh Street, N W Under about six feet of made ground there was about ten feet of a yellowish brown clay containing flints and much "race" Below the clay there was about five feet of sand and gravel, and under this about one foot of clayey loam, in which most of the bones were embedded This loam contained many seeds, recognized by Mr Clement Reid as being those of plants usually found in marshy places or ponds, and having a range at present from the Arctic Circle to the South of Europe A list of the bones found is given by Mr E T. Newton, of the Museum of Practical Geology, Jermyn Street, who describes them as being those of one full grown Mammoth, of another about half grown, of the Red Deer, the fossil Horse, and of a small rodent The author gives sections through Endsleigh Street and along the southern side of Endsleigh Gardens, and shows that where the bones were found there was a distinct valley in the London Clay, running in a direction nearly due north and south, the inclination of the valley being towards the north The London Clay reached nearest to the surface towards St Pancras Church and in Upper Woburn Place, the total thickness of the overlying deposits and the made ground there being only about 12 feet Other sections, given along the southern sides of Tavistock and Gordon Squares, and through Gordon Street and the western side of Gordon Square, show varying thicknesses of the deposits, overlying the uneven floor of London Clay, of from 16 to 21 feet, the greatest thickness here is found at the north-western corner of Gordon Square Seeds were also discovered in a loam near the bottom of Gordon Street, at the same horizon as that containing the mammalian remains, and some shells were found in a band of sandy clay, under a calcareous deposit, about half way down the western side of Gordon Square The author says that the deposits above the mammaliferous loam overlying the London Clay in this area cannot be classed as post-Glacial river deposits, but must be considered as of Glacial origin The animals, therefore, which evidently died on the old land-surface where their remains were found, lived there early in the Glacial period The reading of this paper was followed by a discussion, in which the President, Mr Monckton, Sir Henry Howorth, and the author took part —The morphology of *Stephanoceras zigzag*, by S S Buckman.

Entomological Society, June 1 —R McLachlan, F R S, Treasurer, in the chair —The Hon Walter Rothschild sent for exhibition *Neptis mimetica*, n s, from Timor, mimicking *Andasena orope*, one of the Euplœidæ, and *Cynthia equicolor*, n s, a species remarkable for the similarity of the two sexes, from the same locality, also a hybrid between *Saturnia carpini* and *S pyri*, and specimens of *Callimorpha dominula*, var *romanovii*, var *italica*, and var *donna*, bred by a collector at Zurich, he further exhibited a very large and interesting collection of Rhopalocera made by Mr W Doherty in Timor, Puru, Sumba, and other islands, during October and November 1891 Colonel Swinhoe remarked that the various species of *Neptis* were usually protected and imitated by other insects, and did not themselves mimic anything, and that the pattern of the *Neptis* in question was very common among the butterflies in the Timor group Mr Jenner Weir, Prof Meldola, Mr Trimen, and others continued the discussion —M A Wailly exhibited fertile ova of *Trilocha varians*, which are arranged in small square cells, fastened together in large numbers, and present an appearance quite different from the usual type of Lepidopterous ova.—Mr F Merrifield exhibited a series of *Drepana falcataria*, half of which had been exposed for a week or two, in March or April, to a temperature of about 77°, and the other half had been allowed to emerge at the natural out door temperature The latter insects were in all cases darker than the former, all being equally healthy Mr McLachlan, Mr Barrett, Mr. Jenner Weir, and others took part in the discussion which followed —Mr McLachlan called attention to the reappearance in large numbers of the Diamond-back Moth, *Plutella cruciferarum*, which was very abundant in gardens near London, and expressed his opinion that the moths had been bred in the country and had not immigrated —Mr Jenner Weir, Mr Bower, and Prof Meldola stated that they had recently seen specimens of *Colias edusa* in different localities near London —The Hon Walter Rothschild communicated a paper on two new species of *Pseudacræa*

CAMBRIDGE

Philosophical Society, May 30 —Prof G H Darwin, President, in the chair —The following communications were made —The hypothesis of a liquid condition of the earth's interior considered in connection with Prof Darwin's theory of the genesis of the moon, by Mr Osmond Fisher It was contended that a liquid condition of the earth's interior is not negatived by the existence of a semi diurnal ocean tide, because it appears by calculation that a tide in an equatorial canal would in that case be diminished by only one-fifth of what its height would be upon a rigid earth It was then recalled that all Prof Darwin's numerical results in Table IV of his paper on the precession of a viscous spheroid, as for instance that the moon was shed from the earth about 57 millions of years ago, depend upon the assumption of a certain high value for the internal viscosity, and will not hold good for a liquid interior The total amount of heat, however, which must have been generated since that event, does not depend upon the viscosity, and will have been the same in the case of a liquid interior This, if applied all at once, Prof Darwin says, would raise the whole earth through 3000° F if it had the specific heat of iron Lord Kelvin holds that the earth is solid, and that it solidified in a short space of time, and that the matter of the interior at every depth is at the temperature of solidification for the pressure there But if heat is being continually communicated to the interior, and chiefly to the more central regions, it seems impossible that the state of solidity supposed could be maintained. The author has shown in his "Physics of the Earth's Crust" that, if the crust is as thin as many geologists suppose, then there must exist convection currents in the interior, which prevent the crust from growing thick by melting off the bottom of it nearly as fast as it thickens The central heat imparted to the interior by tidal action explains the maintenance of such currents But the difficulty arises that the heat generated has been so great that there seems no obvious adequate mode of getting rid of it The heat conducted away through the crust would not have been sufficient to reduce the mean temperature of the globe by more than about 209° F in 100 million years from the first formation of a crust Volcanic action on an extravagant estimate would help only to the extent of 4° or 5° F, and the work of deformation of the crust would account for still less. It appears from the above that, if Prof Darwin's theory is true, the solidification of the

crust cannot have commenced until long after the birth of the moon, so that the still molten surface would be able for ages to radiate its heat directly into space Otherwise we are thrown back on the nebular hypothesis, according to which the moon was left behind in the process of evolution of the system —On Gynodiœcism in the Labiatæ, by Mr J C Willis Among the hermaphrodite flowers of *Origanum* and other Labiatæ, there occur (on the *same* plant) female flowers, and also flowers with one or more imperfect stamens, the corollas of these flowers are usually smaller than those of normal hermaphrodites Their number varies from 1 to 7 5 per cent of the total flowers Experiments conducted in 1891, to determine if these abnormalities varied in number with the season, gave no result, no two plants (though all were from one stock) gave similar results Observations were also made on *Nepeta Glechoma*, the relative numbers of female and hermaphrodite flowers were determined weekly during the flowering season, and the proportion of females found to be greatest at the beginning of the season It was also noticed that the female plants bear more open flowers at one time than the hermaphrodites (3 1 to 2 1) It was observed that the amount of protandry in the flowers appears to vary, being small at the beginning, and larger towards the end of the season Further observations are in progress upon this subject —On the steady motion and stability of dynamical systems, by Mr A B Basset —Note on the geometrical interpretation of the quaternion analysis, by Mr J Brill The last two papers were taken as read

DUBLIN

Royal Dublin Society, May 18 —Dr G J Stoney, F R S, Vice-President, in the chair —Mr G H Carpenter presented a report upon the Pycnogonida collected in Torres States by Prof A C Haddon The collection comprises only three species *Pallene australiensis*, Hoek, for which (together with a new species) a new genus (*Parapallene*) is suggested, and a new *Ascorhynchus* —Mr H H Dixon gave a preliminary note on the mode of walking of some of the Arthropoda, illustrated by means of instantaneous photographs He found that the limbs move together in "diagonals", in insects the first and third legs on one side move with the second on the other, in spiders the first and third on one side with the second and fourth on the other, while the antenna of an insect is moved with the first leg on the same side - Sir Howard Grubb, F R S, described his new chronograph for the Cape Town Observatory This chronograph is built on the model of that at Dunsink Observatory, Dublin, with such improvements as have been suggested by recent developments in the clock work of equatorial telescopes The barrels, two in number, either or both of which can be brought into action, are 28 inches long and 9 inches in diameter The screws which carry the wagons are one tenth pitch, revolving once per minute The circumference of the barrel being about 27 inches, the seconds are four tenths of an inch long, and each barrel is available for about four and a half hours' work The principal modifications upon the Dunsink instrument consist in the application of the electrical control of the clock, as described in the Proceedings of the Institution of Mechanical Engineers for the year 1888 The governor shaft of the clock gears directly into the driving spindle without any intermediate wheels, and as there is maintaining power to the clock barrel, it is possible to wind during the operation without at all affecting the rate of the clock The axes of the barrels are supported upon sets of bicycle balls, in hardened steel boxes The wagons carrying the electro-magnets for the registration of the signals are carried on one plain roller and two grooved rollers, the latter having hardened steel end plates to insure accuracy of position With the main instrument, which is inclosed in a glass case, is supplied a distributor for the purpose of working the electrical control, for the explanation of the action of which the above paper may be referred to —On a new electrolytic galvanometer, by J. Joly In the ordinary methods of determining the strength of a current by means of electro-chemical action, the element of time enters into the measurements, which further require considerable care in carrying out. In this instrument the observer is not concerned with time observations, and its indications follow fairly rapid variations of current. It consists of a glass bulb containing dilute sulphuric acid, in which are immersed platinum electrodes placed close together to diminish resistance This vessel communicates below with a tube bent twice at right angles and carried up to a height of about 50 cm above the level of the bulb A little mercury contained in the bulb rises normally into this tube to a level which is the zero of the instrument The tube is open at the top The bulb is furnished with two tubulures on its upper surface One is kept closed by a stopper, and merely serves to admit the electrolyte into the bulb when filling it The other is furnished with a brass attachment upon which is cemented a small piece of platinum foil pierced by a hole of very small bore The puncture is protected above and below from obstruction by receptacles containing cotton wool When a current is passed between the electrodes the gas evolved can only escape through the fine puncture At normal pressures this will only let the gas pass out slowly Hence there is an accumulation of gas in the bulb, and the increased pressure causes the mercury to rise in the vertical index tube, but as the pressure rises, the rate of efflux of the gas increases till it equals the rate of evolution, when the mercury column comes to rest The reading of a scale alongside the tube then gives the current in amperes The instrument constructed for trial is very satisfactory It reads on a very open scale up to 2 5 amperes The electrodes are not large enough to carry heavier currents, if they were so, of course by enlarging the orifice the range could be increased At the higher readings there is some delay before the mercury column becomes stationary, due probably to a rise of temperature in the bulb There is probably some small variation of the readings with atmospheric temperature change The calibration is effected by placing it in circuit with a trustworthy galvanometer The inventor has had but little leisure to develop the instrument, and brings it before the Society in hopes that someone may think it worth while to further investigate its capabilities

PARIS

Academy of Sciences, June 7 —M d'Abbadie in the chair —On the application of M Linstedt's method to the problem of three bodies, by M H Poincaré —On a class of analytical functions of one variable dependent on two real arbitrary constants, by M Emile Picard —On the products of the residual life of the tissues, especially of the muscular tissue separated from the living being, by MM Gautier and Landi (continued) The authors found that meat when kept at a temperature not exceeding that of the living animal, acquired an acidity of about 0 5 per cent after several weeks, during which it was protected from air and bacteria They attribute this acidity to the formation of acid phosphate of potassium under the influence of fatty acids, and especially to the partial peptonization of the albuminoids Two substances, found in milk, but not in fresh meat, are also abundantly produced, viz casein and nucleo-albumin The albuminoids steadily decrease, whereas there is a proportional increase of alkaloids, these being identical with those produced during the life of the organism —Effects produced upon numerous morbid states by subcutaneous injections of a liquid extract from the testicles, by M Brown Séquard —On the densities of liquefied gases and their saturated vapours, and on the constants of the critical point of carbonic acid, by M E H Amagat —On new methods of forming certain substitution imides, by M A Haller —Reports of the Committee charged with the examination of the calculator Inaudi, by MM Charcot and Darboux Jacques Inaudi, a peasant born in Piedmont in 1867, learned to reckon before he acquired the art of reading and writing, which he did not master till twenty He therefore owes his extraordinary calculating powers to an abnormally developed memory for figures, aided by a mental representation of numbers which the Committee proved by a series of careful experiments to be purely acoustical, and quite independent of visualization The rules of Inaudi's operations are original In addition and subtraction he begins on the left side, and deals with each whole number in its turn The extraction of roots and the solution of equations are performed by tentative approximations, executed with remarkable rapidity At the end of a long sitting Inaudi was able to recount the whole series of numbers dealt with, amounting to some 400 figures.—On the stability of motion in a particular case of the problem of three bodies, by by M Coculesco —Solar observations during the first quarter of the year 1892, by M Tacchini At the Roman College, during this period, the frequency of metallic eruptions, spots, and faculæ was greater in the southern hemisphere of the sun, whereas the protuberances were more frequent in the northern, and nearer the pole. The auroral maximum is probably more dependent

on that of the protuberances than that of the sun-spots —On a property common to three groups of two polygons, inscribed, circumscribed, or conjugate to one conic, by M Paul Serret —On discontinuous groups of non-linear substitutions with one variable, by M Paul Painlevé —On the acceleration of mortality in France, by M Delauney From a calculation based upon certain tables published by the Bureau des Longitudes, it appears that the death-rate is accelerated during the ages ranging from 16 to 32 and 54 to 82, while it is retarded between 1 and 16, 32 and 54, and after 82 This gives the numbers 16, 32, 54, and 82, which may be regarded as natural epochs of human life They may be derived from the equation $3x^2 \quad 5x + 4$, by substituting for x the values 3, 4, 5, and 6 The equation represents a parabola.—Optical method of determining the conductivity of metallic bars, by M Alphonse Berget This is based upon an application of interference fringes or Newton's rings produced at the ends of two bars to be compared, by means of which the ratio of their elongations is found Applicable to bars of rare metals —On the propagation of heat within crystallized substances, by M Ed Jannettaz —On a new determination of the ratio v between the electro magnetic and the electrostatic C G S units, by M H Abraham Obtained by measuring the same capacity—of a plane condenser with guard ring—in both systems The value obtained for v was $299{\cdot}2 \times 10^5$ —On the basic nitrates of zinc, by M J Riban —On the permolybdates, by M F Péchard —On a reproduction of leucite, by M A Duboin —Contributions to the study of mineral waters preservation of these waters, by M P Parmentier --On the fixation of iodine by starch, by M Gaston Rouvier —Mechanical determination of the boiling points of alcohols and acids, by M G Hinrichs —Preparation and heat of formation of monosodic resorcin and hydroquinone, by M de Forcrand —Thermal study of the dibasic organic acids: methyl malonic and methyl-succinic acids, influence of isomerism, by M G Massol —On an oxidation product of starch, by M P Petit —Organo-metallic combinations of the aromatic acetones, by MM E Louise and Perrier —On the chlorine derivatives of the isobutylamines, by M A Berg —Researches on the ptomaines in some infectious diseases, by M A B Griffiths —On the dioptase of the French Congo, by M E Lacroix —Researches on the filtration of water by the Mollusca, and applications to ostreiculture and oceanography, by M H Viallanes.—On a parasite of the locusts, by M J Trabut —Tuberculous vaccination of dogs, by MM Héricourt and Ch Richet. The effect was tried of vaccinating some dogs with aviary tuberculosis, which proved a perfect prophylactic to human tuberculosis, the injection of which proved fatal to those not so vaccinated, the rest being unaffected

BERLIN

Physiological Society, May 13 —Prof Munk, President, in the chair —Prof Loewy gave an account of experiments on respiration under reduced atmospheric pressure, carried out in a confined space which admitted of very rapid reductions of pressure (to half an atmosphere) with constant composition of the inclosed air The amount of reduction which was borne without ill effects differed in the case of the three persons on whom the experiments were made, in accordance with the magnitude of their respiratory activities the greater the latter, the greater was the reduced pressure which could be withstood For any one person it appeared that a greater reduction could be borne while fasting or during work than after a meal or during repose Both oxygen and carbon dioxide were found to do away with the discomfort resulting from over rarefaction of the air Slightly reduced pressure had no effect on respiratory interchange, while if the reduction was considerable, more carbon dioxide was expired, notwithstanding the diminished supply of oxygen The reduced pressure of the latter gas was found to act on the respiratory mechanism in such a way as to lead to deeper, and hence compensatory, respiratory movements —Dr Wertheim spoke on the blood-vessels of the avian eye in both the embryonic and fully developed state, illustrating his remarks by injected specimens of embryonic eyes.

Physical Society, May 20 —Prof Lampe, President, in the chair —Prof Neesen gave an account of his researches on the motion of loose disks centred on an axis rotating at high speeds. The disks were of varying mass and moment of inertia, and had at one side an excentrically-placed pin, in order that the least weight might be determined which, when applied to this pin, stopped the rotation of the disk The necessary weight, as thus measured, was found to vary with the rotational velocity of the axis and with the mass and moment of inertia of the disk It varied also according as the axis was dry or smeared with old or new oil, and also with the material of which the disk was made, &c —Dr Wien spoke on Maxwell's electro magnetic theory, and the additions made to it by Poynting, and gave, in conclusion, a hypothetical conception of the nature of magnetism which corresponded to the existing formulæ

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS —Notes and Queries on Anthropology, second edition edited by J G Garson and C H Read (Anthropological Institute).—The Birds of the Sandwich Islands, Part 3 S B Wilson and A H Evans (Porter)—Irrigation and Water Storage in the Arid Regions Letter from the Secretary of War (Washington) —Die Grundzüge der Theorie der Statistik Prof H Westergaard (Jena Fischer). —Die Bewegung der lebendigen Substanz M Verworn (Jena, Fischer) —Ostwald's Klassiker der Exakten Wissenschaften, Nos 1 to 30 (Leipzig Engelmann) —The Threshold of Science, second edition Dr C R A Wright (Griffin).—Untersuchungen über mikroskopische Schäume und das Protoplasma O Bütschli (Leipzig Engelmann) —Die Epiglottis C Gegenbaur (Leipzig Engelmann).—Jethou, or Crusoe Life in the Channel Islands E R Suffling (Jarrold) —Six Botanical Diagrams (S P C K) —Essays upon Heredity and Kindred Biological Subjects Dr A Weismann edited by E B Poulton and A E Shipley, vol ii (Oxford, Clarendon Press)

PAMPHLET —Present Problems in Evolution and Heredity Prof H F Osborn —Church and State in Early Maryland Dr G Petrie (Baltimore)

SERIALS —Journal of the Marine Biological Association, vol ii, No 3 (Dulau) —Proceedings of the American Philosophical Society, vol. xxx, No 137 (Philadelphia) —Proceedings of the Academy of Natural Sciences, Philadelphia 1892, Part 1 (Philadelphia) —Transactions of the Leicester Literary and Philosophical Society April (Leicester) —Rendiconto dell' Accademia delle Scienze Fisiche e Matematiche, January to March (Napoli) —Proceedings of the Royal Society of Victoria, vol iv (new series), Part 1 (Williams and Norgate).

CONTENTS.

THURSDAY, JUNE 23, 1892.

THE NEW LONDON UNIVERSITY.

IN our last issue we laid before our readers a statement of the proposals adopted by the Association for Promoting a Professorial University for London at a meeting held at Burlington House on the 14th inst It may tend to clear the issue if we now briefly compare these proposals with the provisions of the Gresham Charter

The Gresham Charter seeks to federate two Colleges and ten medical schools, primarily for examination purposes Such a University, if created, would have had two competing staffs in the Faculties of Arts and Science and twelve in the Faculty of Medicine Provision is also made, under certain conditions, for the federation of other institutions, if it can be shown to the satisfaction of the Council—that is, of the Chancellor, the Lord Mayor of London, and the representative members of the Councils of the two constituent Colleges and the ten medical schools —that such institutions are on a basis justifying the expectation of permanent existence; that they are under the independent control of their own governing bodies, and that they are reasonably well equipped in some one Faculty Such a federation, created not primarily for the true business and proper functions of a University, but solely in the interests of a degree-granting body, could only have one result The examination schedules must perforce be within reach of the lower grades of instruction, the various constituent elements would be actively competing bodies, and no attempt to create a single competent staff and a single set of fully-equipped University laboratories would be feasible Is it at all probable that the true work of a University would flourish under such a system as that? Is it in the least degree likely that we could hope to see created in London, a teaching organization worthy of the greatest and richest capital in the world, or even such as many of the smaller European capitals now possess? The fame of a University, if it is to be anything more than a social function, must depend on the character of its teaching Would the best men be attracted and retained by such a system? There can be only one answer to these questions The Gresham scheme is not only a wholly inadequate solution of the University question, but in so far as it tends to accentuate and perpetuate the existing state of things its provisions are positively mischievous. No solution of the question can be either just or final which ignores the existence of the present University of London If London is to have two degree-granting bodies existing, practically, side by side, we shall have confusion worse confounded Burlington Gardens would inevitably be driven to establish a teaching organization of its own, unless it was supremely indifferent to its fate or supinely content with the teaching of the Correspondence Colleges and the crammers Why should we neglect, and not only neglect but positively so arrange as to destroy, the prestige of the existing University of London? This University is not effete—it has still within it a great potentiality for good Surely, in common gratitude, the University which has hitherto consistently upheld a high standard of attainment for its degrees, and which has done so much for the spread of natural science in this country, is worthy of better treatment at the hands of those who profess to minister to the true interests of learning The Gresham scheme is really an attempt on the part of certain of the medical schools and some of the arts and science teachers to cheapen degrees and so attract students. It is true that the new University medical degrees would carry no license to practise But is it likely that the University would permanently put up with this unique position, or that its students would continue to submit themselves without a murmur to a double examination system? As the document issued by the Victoria University indicates, the result, in all probability, would be to reduce the two examinations to a single standard by compromise with the licensing body The scheme, moreover, gives an overwhelming preponderance to the most purely professional of all the faculties, and far too large a share of control to persons of small academic experience who devote occasional spare hours to academic affairs It makes no attempt to satisfy the demand for the recognition in some form of University work among the people No wonder, then, that it was strenuously opposed by a powerful section of the governing body, and by a majority of the teachers in the Faculties of Science and Arts, of the most influential College that it proposed to incorporate The Council of University College, indeed, has never openly ventured to place the scheme before the governing body

The Gresham University Commissioners are authorized by the terms of their reference "to consider and, if they think fit, to alter and to amend and extend the proposed charter, so as to form a scheme for the establishment, under charter, of an efficient teaching University for London" It is impossible to conceive how the charter submitted to them can be amended so as to form such a scheme if its salient features are preserved That fact is becoming more and more patent every day The Association which put forward the proposals we have already referred to now numbers among its members—medicine excepted—a majority of the leading London teachers If these teachers say that they do not wish the Gresham Charter at any price, it is difficult to see how it can be imposed upon them Any attempt to resuscitate that charter, even with amendments, will meet, as before, with the opposition of the provincial Colleges, the minor London teaching bodies, and, what is perhaps more important, the organized opposition of a large section of the London teachers, and of some of the most powerful and influential friends of higher education in this country

The fact is that it is at last clearly recognized that the foundation of a Metropolitan University, which will bear comparison with those of the great Continental cities, is a matter of national importance. The action of the House of Commons with regard to the Gresham Charter offers an opportunity, such as may not soon occur again, for attempting the formation of a University in London on the same ample lines as those to be found in other European capitals Watchful observers of what has been going on during the past three or four years have deliberately come to the conclusion that it is quite impossible to improve the condition of higher education in London by means of any federation of Colleges The creation of a homogeneous academic body with power to *absorb*, not

to federate, existing institutions of academic rank, is the only real solution of the problem An academic body of this character might well be organized, so far as teaching is concerned, on the broad lines of a Scottish University Such a corporation may be conveniently spoken of as a *professorial University*, to distinguish it from a federal University A federal University may be all that is possible when the constituent Colleges are situated in different towns, as is the case in the Victoria University, but it cannot be efficient in London, where these Colleges would appeal to the same public for support

The scheme put forward by the Association for Promoting a Professorial University for London is not open to the objections urged against the Gresham scheme It would found a University on the same broad lines as those of France, Germany, and Switzerland It would bring to the new University all the power and prestige of the existing University It will meet with no opposition from the provincial Colleges, on the contrary, it has the active support of many of the leading provincial teachers It satisfies the demands of the Victoria University that the medical degree shall carry the license to practise, and that the medical representation shall not preponderate It has, for the first time in the history of the movement, brought the most influential teachers from a variety of London teaching bodies into close and active sympathy, and animated them with a desire for a University of definite type It is significant that the Council and staff of Bedford College are at one in favour of a University on the general lines laid down in the Association scheme The Senate of University College has carried a motion urging their Council to adopt a similar resolution in favour of the scheme of absorption The Association scheme makes full provision for the recognition of work of the University Extension character, and for the appointment of University lecturers at minor and non-absorbed teaching institutions Whilst proposing central control and central University laboratories of the highest type, it provides for local teaching such as is required for pass degrees or for the lower stages of honours graduation Lastly, it provides for post-graduation courses and specialized instruction, such as that of the Collège de France and of the greater German Universities

As regards medicine, it recognizes that it is impossible to "absorb" the medical schools owing to their close relation to great public charities, but at the same time it endeavours to grant much of what the Medical Faculty gained by the Gresham Charter The Medical Faculty will be elected by the medical teachers themselves There will be, as in every University of standing, medical professors appointed by the Senate from the Medical Faculty on the recommendation of the faculty The existence of such a medical professoriate will enhance the dignity of the University and of the medical schools, whilst at the same time it holds out a strong inducement to those schools to select members for the Medical Faculty on the ground of their scientific as well as their administrative reputation The limitation of the number of medical professors on the Senate will safeguard the character of the medical degree The scheme, whilst giving very extended powers to the medical schools, meets the objections of the provincial opponents of the Gresham Charter. Lastly, it provides for the due University recognition of the pure science teaching of the medical schools

We have thus indicated as shortly as possible the main features of the two schemes which are at present before us The one is essentially parochial in its conception, and vestry-like in its character The other has in it the elements of a great teaching organization which shall be both metropolitan and imperial in its aims and influence —a University which shall be worthy of London, the capital alike of Great Britain and of the Greater Britain beyond the seas

THE ANALYSIS OF WINES

Analyse des Vins Par le Dr L Magnier de la Source (Paris Gauthier-Villars et Fils, 1892)

ALTHOUGH wine is gradually becoming more and more important as an item in the national drink-bill—last year we imported 16,782,038 gallons, valued at £5,995,133—its analysis and the methods for the detection of its sophistication have received comparatively little attention from the chemists of this country On the other hand, in France and Germany the subject has been very thoroughly investigated in practically all its many details, and carefully worked-out methods have been prescribed for the guidance of the public analysts of those countries Indeed, there is probably no article of food or drink, with the possible exception of milk, of which the chemistry has been so well thrashed out Wine is in reality a highly complex fluid, and on account of the character of certain of its proximate constituents it is frequently liable to change It contains various alcohols, glycerin, acids, salts, "extractive matter," together with those principles which give to it its particular colour, special flavour, smell, or "bouquet" Whilst some of these constituents can be accurately isolated and described, others can only be detected by the sense of smell The principal alcohol is, of course, ethyl alcohol, but butyl and amyl alcohols, together with ethylene glycol and isobutyl glycol are not unfrequently present in greater or less quantity The quantity of alcohol in natural wines may be said to vary from 6 to 12 per cent, and the quantity of glycerin from 7 to 10 per cent of the alcohol present Tartaric, malic, succinic, glycollic, and oxalic, together with tannic and acetic, are the chief acids in wine These are said to aid in its preservation, by preventing the formation of fungi Traces of other fatty acids, such as propionic, butyric, and œnanthic acids are also present, as well as acetaldehyde, and possibly its homologues Tartaric acid occurs mainly as the dextro variety · lævo-tartaric acid is only of comparatively infrequent occurrence. If tartaric acid is not found, as, for example, in certain samples of sherry, its absence is almost certainly due to its removal by "plastering" The amount of free acid in sound wine, reckoned as tartaric acid, varies between 0 3 and 0 7 per cent, a greater amount than this imparts sourness to the wine

Old wines have an acid reaction in consequence of the presence of a certain amount of free acid and potassium bitartrate A wine not exhibiting this acid reaction tastes flat, the acidity is its most important flavour For a long time it has been believed that the free acid of

wine is tartaric acid alone. Nessler's researches have, however, shown that this is seldom the case; tartaric and malic acids often exist together, and frequently the free acid consists of malic acid entirely. Wines containing tartaric acid taste more tart than those with only malic acid, or a mixture of malic and tartaric acids.

The characteristic smell of wine is said to be due to œnanthic ether; the compound ethers probably confer the bouquets which distinguish one vintage from another; among these are aceto-propylic, butylic, amylic, caprylic, butyro-ethylic, caprylo-ethylic, capro-ethylic, and pelargo-ethylic, and the tartaric ethers. According to Jacquemin, these bouquets are primarily due to the special characters of the yeast used in the several districts. One and the same "must" fermented with the yeast obtained from several different districts gave wines having the bouquet characteristic of the district from which the particular yeast had come. Rommer fermented the juice of an inferior grape and of hot-house grapes respectively with yeast cultures obtained from the Champagne, Côte d'Or, and Buxy districts, and found that in each case the wines had the bouquet of those from which the yeast had been derived. The sugars occurring in wine are dextrose and lævulose. Cane-sugar is never naturally present, even in "must"; it is sometimes added, as in the case of champagne, but it is then rapidly transformed into invert sugar. In some wines, as, *e.g.*, Sauternes and sweet Rhine wines, sugar occurs in the form of inosite. The colouring-matter of normal wine is derived partly from the oxidation of the so-called extractives contained in the juice, and in the case of red wines from matter (œnolin or œnotannin) contained in the husks, stalks, and seeds, which is soluble only by the joint action of acid and the alcohol formed during fermentation. The albuminous substances in the "must" are removed when the fermentation is properly carried out, but in imperfectly fermented wines a certain amount remains, and in the case of white wines may again render them liable to fresh fermentation. In red wines this danger is obviated by the presence of the tannin of the husks.

The inorganic substances contained in wine are potash, soda, lime, and magnesia, in combination mainly with tartaric, phosphoric, and hydrochloric acids. Sherries contain potassium sulphate in excess, owing to the practice of adding gypsum to the "must." This practice, which prevails not only in Spain, but also in Portugal, the south of France, and to some extent in Italy, probably has for its object the precipitation of certain albuminous matters which injuriously affect the wine. It is alleged that the fermentation is in consequence much more rapid and complete, that the wine keeps longer, and that its colour is richer and more lasting. Its real advantage to the wine-maker is that it clarifies the wine rapidly, and allows it to be quickly brought to market. It is chiefly employed with the coarser qualities of red wine, and the gypsum is either added to the grapes and trodden with them, or, in fewer cases, added to the expressed juice; the quantity used is generally 1 to 2 kilos to every 100 kilos of fruit, but it is some times as much as 10 kilos. The action of the calcium sulphate on the bitartrate of potash present in the juice produces an acid sulphate of potash, which gradually forms the normal salt by decomposition of the phosphate present forming free phosphoric acid. Hence a "plastered" wine is relatively rich in potash and sulphuric acid.

Although much has been said as to the baneful effects of plastered wine, very few trustworthy cases of injurious action have been recorded. The Academy of Medicine of Limoges instituted a lengthened inquiry on the subject in 1888, and reported unfavourably on the effects of plastered wine upon health. The French War Department also appointed a Commission, and its conclusions, which, on the whole, were unfavourable to the practice, have been recently confirmed by Nencki, who was requested by the Government of the Canton Berne to report on the advisability of modifying a law, which operates in many parts of the Continent, forbidding the sale of wines containing more than 2 grams of potassium sulphate to the litre. As to the question whether a plastered wine should be called adulterated, it has been contended that a product which, by treatment, is deprived of one of its most characteristic constituents, viz. tartaric acid, whilst another substance, calcium sulphate, not normally present, is introduced, cannot be called anything but adulterated.

As may be supposed, the art of the falsifier is very largely directed to the improvement of the colour of wine; and unfortunately it is upon the product which popular prejudice associates with the name of an eminent statesman, and which has no other attribute of claret than its colour, that his skill is mainly expended. It has been estimated that the whole yield of the "classed growths" of the Médoc does not, even in the best years, now exceed 5,000,000 bottles. Much of this, it is true, comes to England, but enormous quantities of *paysan*, *artisan*, and *bourgeois* wines from the Gironde and Languedoc, mixed with the produce of North Spain and Italy, are worked up and sold as "claret" in this country. This product is not exactly poisonous, nor even, as a rule, positively hurtful, but, it need hardly be said, it has no special merit or individuality. Formerly, the pharmacopœia of the wine-doctor, like that of the physician of old, was restricted to products of the vegetable kingdom; but, in addition to the colouring-matter of *Phytolacca* berries, *Althæa rosea*, bilberries, mallow, elder-berries, privet-berries, logwood, alkanna red, lichen reds, all of which are still used to a greater or less extent, he has not been unmindful of the wealth of colouring-matter which is latent in coal-tar; and to-day the banks of the Rhine have their part in the manufacture of other wines than hock. Biebrich scarlet, fuchsine (magenta), the various Ponceaus, Bordeaux reds, crocein scarlet, and similar colouring-matters, find their way to the south of Europe for the purpose of wine sophistication. A substance known as *tintura per los vinos* is largely used in the district of Huesca for colouring Spanish wines. It contains two coal tar derivatives, one of which is that form of Biebrich red which is turned blue by sulphuric acid, whilst the other, which exists in smaller proportion, closely resembles the colouring matter known as *cerise*. According to an analysis by Jay, the composition of *tintura* is: organic matter, mainly Biebrich red, 66.4; sodium sulphate, 26.10; arsenious oxide, 1.62; iron oxide, lime, &c., 5.88. In view of the peculiar nature of this substance, it is reassuring to know that there is a ten-

dency to return to vegetable colouring-matters, and that large quantities of maqui berries are being imported into Europe from Chili for the purpose of colouring wines In the three years ending 1887 the exports of this substance were respectively 26,592, 136,026, and 431,392 kilos, by far the largest proportion finding its way to France

The little book before us has no pretensions to be regarded as a complete treatise on the analysis of wines Its aim is to furnish the analyst with a number of carefully tested methods for the detection of sophistications and adulterations, and for the rapid determination of those constituents on which the character of wine mainly depends Dr Magnier de la Source is well known in France as an authority on the subject, and the *Bulletin* of the French Chemical Society contains papers by him relating to the analysis of wine His methods are, for the most part, similar to those adopted by the Association of German and Austrian analysts, although they are not described with that minute attention to detail which has been found desirable by the German-speaking chemists As may be seen on turning over the pages of Fresenius's *Zeitschrift fur analytische Chemie*, the "musts" and wines of Germany are periodically examined and reported upon with all the method and regularity adopted in the case of the London water-supply, and it has happened in the past that the modes of determining such constituents as the vegetable acids, glycerin, and "extractive matters" have been discussed and wrangled over in a manner which recalls the famous fights over "organic carbon," "albuminoid ammonia," and "previous sewage contamination" of years ago The only fault that we have to find with this book is that its author hardly does justice to his German brethren, although, it is but fair to add, some reference to their work is to be found in the excellent bibliography at the end of the volume T E T

MODERN THERAPEUTICS

An Introduction to Modern Therapeutics By T Lauder Brunton, M D, &c (London Macmillan and Co, 1892)

THIS work is a reprint of the Croonian Lectures delivered before the Royal College of Physicians, London, in 1889 Whatever Dr Brunton writes is sure to be interesting, and the present lectures have lost none of their lucidity or freshness though three years have elapsed since they were before the medical profession It is hardly necessary to say that the subject is one with which Dr Lauder Brunton is eminently fitted to deal, and the non-medical reader will be convinced when he has read the volume that medicine and therapeutics are far from being the inexact sciences they were not many years ago The elementary nature of some of the early pages will be understood when it is remembered that the audience before which the lectures were originally given consisted in a large measure of men who had learnt chemistry before the days of Crookes, Lockyer, and Mendeleeff It was necessary that the author should lead them through a brief survey of the chief facts and theories relating to atoms and molecules until the more difficult subject of the composition, constitution, and methods of union of organic radicles is reached. This is done in an admirably clear summary, assisted by those apt illustrations drawn from every-day life for which Dr Brunton is so well-known Our new drngs are now made by the chemist, so great has been the advance of organic chemistry, that the pharmacologist has hard work to keep pace with all the new combinations that issue from the laboratory. But the two classes of investigators, the chemists and the experimental therapeutists, have at least gone hand in hand so far, that it is now possible to judge the action of a drug by its composition This, however, as Dr Brunton points out, is not a rule without exception There are many drugs which behave in unexpected ways, they no doubt, in the future, will be brought into harmony with laws of nature yet to be discovered. At present it is not possible to prophesy the physiological action of a chemical compound with that mathematical accuracy which enables astronomers to foretell eclipses; pharmacology is yet, and perhaps always will be, an experimental science

The lectures stand practically in the same condition as that in which they were delivered A volume of equal size to that under consideration would have been necessary to include all the new work that has appeared in the last few years The tuberculin of Koch, the importance of poisonous proteids, and the diminishing popularity of the ptomaines, the action of the intestinal epithelium (*vice* the liver) as the gatekeeper protecting the body from the entrance of albumose, the application of phagocytosis to the problems of disease, together with the views of the antiphagocytists—these are a few of the big questions that have come to the fore in the last three years, and it is only active pathologists who would be able to realize how much longer these lectures would have been if full reference had been made to all of them The main facts, and the principal conclusions adduced by Dr Brunton, will, however, still remain; and all those who read the lectures in the medical journals before will welcome their appearance in a more permanent form now, and to those who missed them in 1889 we can confidently recommend the book as one which will not only be interesting but also useful W D H

OUR BOOK SHELF

Elementary Hydrostatics By W H Besant, Sc D, F R S "Cambridge Mathematical Series" (Cambridge Deighton, Bell, and Co, 1892)

THE success this work has achieved will be gathered from the fact that this is the fifteenth edition, so that any further criticism on our part would be quite unnecessary The brief snatches of historical matter, together with the lucid and simple explanations, all tend to stir up in the student an amount of interest which in the reading of many other works on this subject lies dormant By a careful study of the illustrations, especially those relating to pumps, presses, &c., the beginner may gather much knowledge about the principles on which they are based In this edition the text has undergone a careful revision, several alterations and additions having been made A uniform system of units has been maintained throughout, and the chapters on the motions of fluids and on sound, which in previous editions were inserted among those on the equilibrium of fluids, have here been separated The examples and problems at the termination of each chapter are as numerous as ever, a new edition of

their solutions being near completion Both at the Universities and elsewhere, the work will still continue to occupy the high position which it has held among treatises of its kind W

The Threshold of Science By C R Alder Wright, F R.S Second Edition, Revised and Enlarged (London Charles Griffin and Co, 1892)

THE primary aim of this book is to interest young readers in various simple and amusing experiments, illustrating some of the chief physical and chemical properties of surrounding objects, and the effects upon them of light and heat In the present edition the author has made no change which is likely to interfere with this object, but he has added various scientific appendices, and an excellent chapter on the systematic order in which class experiments should be carried out for educational purposes These additions will be of great service to all who may wish to use the volume not merely as a "play book," but as an instrument for the training of the mental faculties Any one who may still have doubts regarding the value of elementary science as an organ of education, will speedily have his doubts dispelled if he takes the trouble to understand the methods recommended by Dr Alder Wright The majority of the experiments he has selected must not, of course, be studied merely in his exposition It is intended that each reader shall make them himself If that is done, they cannot fail to quicken the intelligence even of "the average boy"

Key to J B Lock's Elementary Dynamics By G. H Lock, M A (London Macmillan and Co, 1892)

THIS key will be found most useful both to beginners and teachers alike The examples are all carefully worked out, many of the more difficult problems being treated at greater length with the view of helping those who are studying without the aid of a teacher By an intelligent use of this book, a student should acquire a good knowledge of the method of working out problems as well as the important factor of attacking them in the right way W

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

Ice in the South Atlantic

THE following account of ice met with in the South Atlantic at the commencement of last April, which has been supplied to the Meteorological Office by Captain Froud, of the Shipmasters' Society, may be of interest to your readers

ROBERT H SCOTT,

June 17 Secretary, Meteorological Office

Ship *Cromdale*, London

SIR,—I now send you a short account of my unusual encounter with ice in the above ship on our homeward passage from Sydney

We left Sydney on March 1, and having run our easting down on the parallel of 49° to 50° S, rounded the Horn on March 30 without having seen ice, the average temperature of the water being 43° during the whole run across

At midnight on April 1, lat 56° S, long 58° 32′ W, the temperature fell to 37° 5, this being the lowest for the voyage, but no ice was seen, although there was a suspicious glare to the southward

At 4 a.m, April 6, lat 46° S, long 36° W, a large berg was reported right ahead, just giving us time to clear it At 4.30, with the first sign of daybreak, several could be distinctly seen to the windward, the wind being north-west, and the ship steering north east about nine knots At daylight (5 20) the whole horizon to the windward was a complete mass of bergs of enormous size, with an unbroken wall at the back; there were also many to the leeward. I now called all hands, and after reducing speed to seven knots, sent the hands to their stations and stood on At 7 a m there was a wall extending from a point on the lee bow to about four points on the quarter, and at 7 30 both walls joined ahead I sent the chief mate aloft with a pair of glasses to find a passage out, but he reported from the topgallant yard that the ice was unbroken ahead Finding myself embayed, and closely beset with innumerable bergs of all shapes and sizes, I decided to tack and try to get out the way I had come into the bay The cliffs were now truly grand, rising up 300 feet on either side of us, and as square and true at the edge as if just out of a joiners' shop, with the sea breaking right over the southern cliff and whirling away in a cloud of spray Tacked ship at 7 30, finding the utmost difficulty in keeping clear of the huge pieces strewn so thickly in the water, and having in several cases to scrape her along one to get clear of the next We stood on in this way till 11 a m, when to my horror the wind started to veer with every squall, till I drew quite close to the southern barrier, having the extreme point a little on my lee bow I felt sure we must go ashore without a chance of saving ourselves Just about 11 30 the wind shifted to the south west with a strong squall, so we squared away to the north-west, and came past the same bergs we had seen at daybreak, the largest being about 1000 feet high, anvil-shaped, and at 2 p m got on the north-west side of the northern arm of the horse-shoe shaped mass It then reached from four points on my lee bow to as far as could be seen astern, in one unbroken line A fact worthy of note was that at least fifty of the bergs in the bay were perfectly black, which was to be accounted for by the temperature of the water being 51°, which had turned many over I also think that had there been even a small outlet at the eastern side of this mass the water between the barriers would not have been so thickly strewn with bergs, as the prevailing westerly gales would have driven them through and separated them

I have frequently seen ice down south, but never anything like even the smaller bergs in this group I also had precisely the same experience with regard to the temperature of the water in our homeward passage in the ship *Derwent* three years ago, as we dipped up a bucket of water within half a mile of a huge berg and found no change in the temperature

I trust you will warn, as far as possible, those about to sail for the Cape, as these bergs must soon reach that part

I remain, yours truly,

(Signed) EDGAR H ANDREW, Master

June 12

Land and Freshwater Shells peculiar to the British Isles.

MR COCKERELL, in his article in NATURE of May 26 (p 76), draws attention to a list of land and freshwater shells peculiar to the British Islands in Dr. Wallace's new edition of "Island Life" This work is of such very great importance to every one engaged in the study of the geographical distribution of animals, that it is regrettable the author should have repeated an error made in the first edition. *Geomalacus maculosus*, as is mentioned in Mr Cockerell's article, is not peculiar to the British Islands A specimen was discovered in Northern Spain as far back as 1868 by Mr von Heyden, and recorded in the *Nachrichtsblatt d deutschen Malakozool Gesellschaft* by Heynemann in 1869 The allied species, supposed to have been found in France, has been proved to be an Arion, but several species of the interesting genus Geomalacus have been recently described by Simroth from Portugal

Mr Cockerell also states that several varieties in the list of peculiar British forms may have to be eventually struck out, and this is certainly the case, as the variety *albolateralis* of *Arion ater*, mentioned as "very distinct," was found near Bremen, in Germany, and is described in Simroth's "Naturgeschichte der deutschen Nacktschnecken" (*Zeitschr. f wiss Zoologie*, vol 42, 1885) R F SCHARFF

22 Leeson Park, Dublin, June 13.

THE IMPERIAL INSTITUTE

THE Imperial Institute is no longer a castle in the air, an abstraction the meaning of which is to be guessed at through a veil of mist, but a solid and hand-

some structure, affording a pleasant contrast to those in its immediate vicinity

The objects and purposes which this institution should fulfil have been fully ventilated and discussed in these columns ever since the idea of such a national memorial, commemorative of the fiftieth year of the reign of Her Majesty, was suggested This being so, it will be interesting to many of our readers if we make one or two comparisons of the scheme as it exists at present with the past suggestions In an article on "Science and the Jubilee" in 1887 (NATURE, vol xxxv p 217), we wrote —

"There is room for an Imperial Institute which might without difficulty be made one of the glories of the land, and which would do more for the federation of England and her colonies than almost any other machinery that it is possible to imagine But it must be almost exclusively a scientific institution Its watchwords should be 'Knowledge and Welcome' England, through such an institution, should help her colonies in the arts of peace, as she does at present exclusively in the arts of war In an Imperial Institute we can imagine the topography, the geology, the botany, and the various applications of science, and the industries of Greater Britain going hand in hand"

Again, referring to the proposed inclusion of an Emigration Office in the scheme, it was remarked —

"With this we cordially agree But the return current must be provided for Those who have lived in England's colonies and dependencies know best the intense home feeling, and in many cases the stern necessity there is of close contact with the mother country Let the Imperial Institute be England's official home of her returning children—the hall in which she officially welcomes them back Let them here find all they need, and let information and welcome be afforded with no stinted hand"

An inspection of the parts already ready for occupation in the new building took place on Saturday last, and we confess frankly that the idea of "Welcome" referred to in the preceding paragraph has been fully carried out The building is admirable architecturally, and in the various halls set apart for the purpose the children of the Greater Britain beyond the seas will find no unworthy home when they visit the mother country Their intercourse will not be confined to meeting each other, the proposal to create home Fellows of the Institute will, no doubt, be taken advantage of by all interested in all the larger questions on which the progress of the Empire must depend By this means an Imperial Club of a very real kind has been created

So far, then, as one of the watchwords, "Welcome," is concerned, there is cause for sincere congratulation It is too soon to discuss the many proposals regarding the other watchword, "Knowledge," with the future activity of the Institute in the second direction The lines of activity already actually taken up and provided for in the building as now arranged may be gathered from a glance through the pages of the pamphlet and papers distributed on Saturday

The contents of the galleries will constitute "a living representation of the resources of the Empire and of the condition of its industries and commerce" The permanent collections will illustrate "the natural and industrial products of the United Kingdom, of the several Colonies, and of India," while, from time to time, occasional exhibitions will be held which will, "it is hoped, stimulate and enlist the sympathies of Colonial, Indian, and British producers, and promote active co-operation with the industrial section of the Empire."

The collections will be arranged and described in such a manner as to afford full "scientific, practical, and commercial information relating to the sources, nature, facilities of supply, and applications of well-known natural products, and of those whose industrial or commercial value still needs development" The libraries, offices of reference, reading-rooms, &c, in conjunction with the above exhibits, should form therefore a mine of wealth We note also an arrangement by which samples of products will be given to anyone who may be desirous of obtaining specific information respecting any particular product included in the collection

Ample opportunities are to be offered for conference on matters of common interest, and for the interchange of information relative to both Great and Greater Britain

Such, then, are some of the points included in the preliminary arrangement of the building No one, we suppose, considers them as final Natural selection will come in, and it rests with the representatives of the scientific bodies among the governing body to determine which parts of "Knowledge" of the higher kind shall be fostered This is a problem for the future We need not stop to consider it now

One word about the building itself and the allocation of space

Passing through the principal entrance, which is constructed altogether of Portland stone, the large reception hall is reached, which, when finished, will constitute one of the finest we have, various marbles and Indian teak panelling being profusely used

The principal floor contains in its western corridor the British-American and British-Australasian conference rooms, the council chamber, and the secretarial and clerical offices, and in the eastern corridor the British-Indian and British-African conference rooms, the writing, reading, and news rooms, and the temporary library The principal stairway, leading to the second floor, will, when finished, be a handsome piece of work, the steps will be of Hopton Wood stone, with marble balusters and rails, while the walls will be lined with specimens of British and Colonial marbles, and the ceiling profusely decorated with arabesque plaster

On the first floor the Fellows' dining and reading rooms are situated The rooms in the east corridor, occupied at present by a very interesting exhibition of Indian art metal work, will subsequently be used for the commercial department and commercial conferences In the west corridor various rooms will be put at the disposal of various Societies "whose objects are kindred to those of the Imperial Institute"

On the second floor will be situated the public dining and refreshment room Here also the rooms in the west corridor and on the south side will be used as sample examination rooms there will also be a map room and a Fellows' smoking room The east corridor will, we are somewhat ambiguously informed, be occupied probably by "certain Societies who are seeking the splendid accommodation which the Institute affords for carrying on their work" When these Societies are named, the policy of the governing body in this direction will become more obvious

TIME STANDARDS OF EUROPE

THE era of world time is yet far off, and it is certain that the desirable scheme for a uniform horary standard put forward by the Astronomer-Royal (NATURE, vol. xxxiii. p 521) will not be realized this century But though this be so, signs of better times in the reckoning of the hours of the day have recently appeared, and the practical outcome of the Prime Meridian Conference at Washington (NATURE, vol xxxiii p 259) is already of importance Time is a problem to us all—a problem which has baffled the philosopher, driven the astronomer to devices which closely resemble subterfuges, and harassed the watchmaker beyond all other craftsmen. Much light on the difficult but all-important question is focussed in Mr Lupton's article in NATURE, vol xxxix. p 374, but education will do more than it has yet done

when the average man succeeds in understanding what he cannot but believe, that forenoon events in Australia are printed in British newspaper offices before daylight on the day they occur, while morning doings in Hawaii cannot fly fast enough by cable to catch the latest edition of the evening papers In strict justice the time of no two meridians should be the same, and as a matter of fact, in pre railway days every town, and every garden large enough to boast a sun-dial, set itself by its own local time Railways have made the uniformity of time within narrow belts of longitude a necessity, and so largely does the railway affect modern civilized life that railway time soon comes to regulate all affairs The vexation of frequent changes of time standards is familiar to all who have travelled on the Continent, and for many practical purposes the change which has been quietly progressing for the last few years is a benefit of great value This change was brought home to the dwellers in Belgium and the Netherlands on May 1, 1892, by the retardation of all the railway clocks by from ten to twenty minutes from local to Greenwich time, an alteration of the time gauge of two countries far more significant than the conversion to standard gauge of the railways of England

At the Poles, where all meridians converge, there can be no natural standard time, for it is every hour of the day at once, but the regulation of time at these singular points has not yet become a burning question Were the system of time-reckoning recommended by the Prime Meridian Conference carried out in its entirety, the minutes indicated on all well-regulated clock-dials throughout the world would be the same at a given instant, but the hours would differ at each 15° of longitude by steps of one, twenty-four standards encircling the globe Thus, for example, at 25 minutes past noon of the prime (or rather the zero) meridian, clocks 90° E would show 25 minutes past 6 p m (18h 25m), those 90° W, 25 minutes past 6 a m (6h 25m), and those at 180°, 25 minutes past midnight The zero meridian adopted by the Prime Meridian Conference is that of Greenwich, and definite time standards based on hourly intervals from this starting-line have been used since 1883 on the railways of North America That continent is divided into strips 15° in width, in each of which a separate time standard prevails, from the Gulf of Mexico to Hudson Bay Atlantic time in the eastern provinces of Canada, and in Newfoundland, shows 8 a m at Greenwich noon, Eastern time in the Atlantic States of the Union marks 7 a m at the same moment, while Central, Mountain, and Pacific time indicate respectively 6, 5, and 4 a m The meridians which set the clocks across America are those of 60°, 75°, 90°, 105°, and 120° W

The conditions in Europe are more complicated than in America Each small closely-peopled country, with its national Observatory, naturally tends to adopt throughout its particular national time, although even this is still a desideratum in some In the difficult subdivisions of Imperial Germany especially, the number of independent and unrelated standards was a grievous obstacle to the interpretation of through railway time-tables

The British Islands, lying at the extreme west of Europe, should logically keep time of the zero meridian, which intersects Greenwich Observatory, while the Russian Empire (in Europe at least) was by its system of central government and State control of railways equally committed to the time of St Petersburg. But Pulkova Observatory lies two hours east of Greenwich plus one minute and a quarter, and the alteration required is so small that it may be said already to constitute East European time, two hours in advance of Greenwich, or the standard time of West Europe The meridian of 15° E, running through Norway, Sweden, Germany, Austria, and Italy, corresponds to Central European time, one hour in advance of that of Greenwich, and if national prejudices and local inertia were overcome, the time of Europe would be placed on a very simple footing by its adoption The railways of Austria-Hungary have used Central European time on this system since October 1, 1891 More than fifty towns in the monarchy have since then regulated their clocks to correspond, Vienna being the only conspicuous exception, where local time is used for local purposes Servian time-tables have been assimilated to those of Central Europe, and Bulgarian to Eastern Europe, while Turkey, pulled two ways, yields on both sides, following Central European time on the Salonika railway and Eastern European time on the Constantinople line.

In Sweden railway time has been that of Central Europe (15° E) since 1879, and in South Germany the change to the same standard took place on April 1, 1892, a fact of much greater importance, because a feat very difficult to accomplish The four standards of Bavaria, Wurtemberg, Baden, and Alsace-Lorraine were previously in use concurrently, and the change involved retarding the nominal hours of all trains from 14 minutes in the case of Bavaria to 34 minutes in that of the Reichsland Luxemburg came into harmony with the rest of Central Europe at the same date, with the loss of 36 minutes

By a decision of the Federal Council in May last, mean solar time of the 15th meridian will become standard time for the whole German Empire on April 1, 1893, when it exclusively will be employed for railway, telegraph, and all State purposes Already several places in North Germany have adopted the new time, and it can only be a matter of a few years for the simpler uniform system to acquire a footing for all the purposes of private life

The number of European time standards is stated by Dr Busschere [1] to have been 24 on January 1, 1891, and by the end of 1892 it will only be 13 Of these, three are meridional standards, while ten are the times of capitals, viz Paris, Madrid, Lisbon, Rome, Berne, Bucharest, Athens, Copenhagen, Berlin, and St Petersburg, but the last, as already mentioned, practically belongs to the former category It now remains only for France, Spain, and Portugal to adopt Western European time, for Denmark, Switzerland, and Italy to accept Central time, and for Greece and Rumania to join the other Balkan States in using Central or Eastern time, and the change will be complete

Strangely enough, although foreign writers tacitly assume that the British Islands are at one in their time standard, there exists in the United Kingdom a diversity as illogical as that which formerly reigned in the States of Southern Germany While Great Britain and the small island groups associated with it keep the time of the initial meridian, now extended to Belgium and Holland on the east, Ireland is regulated by Dublin time Thus it happens that when the post-office clock in Stornoway (6° 15′ W) shows noon, that in Donaghadee (5° 30′ W) only marks 11h 35m

As long ago as 1888, Japan adopted for its standard time that of the ninth hour interval from Greenwich (135° E), so that the clocks which regulate the movements of the Japanese are set nine hours in advance of ours

India, Australia, and Cape Colony remain independent in their time relations, although so simple a readjustment as is required might form a graceful concession to the spirit of federation without sacrifice of local dignity or utility.

There is no authentic publication known to us which sets forth the time standards actually employed in the chief towns of the world, but fallacious information on the subject is to be found in many atlases and clock-face diagrams Even so eminently practical a work as "Bradshaw's Railway Guide" contains month after month a map graduated on the margin to show the difference of time between Greenwich and the rest of

[1] Bulletin of the Royal Belgian Geographical Society, 1892, No 2, p 196. From this paper many of the statements given above have been derived

England, leaving it to be implied that the local time thus shown is that actually employed, and Kelly's famous directories are disfigured with similar tables

It is much to be regretted that the system of numbering the hours of the day from 0 to 24 has failed to hold the popular fancy Despite the big clock-face on Greenwich Observatory, people still know their hours by the old ambiguous titles. Usually there is no room for misunderstanding, but mistakes are sometimes possible A foreign potentate visiting this country recently was much *fêted* during his short stay, breakfasts, luncheons, and dinners being given in his honour, when a certain judge issued a card of invitation to a "Reception at 10 o'clock," which some of the guests interpreted as a m, and others as p m Missing a foreign Prince through such ambiguity is a trifle compared with missing a train or miscalculating the length of a journey, and yet we know of no English time-table (we have heard of American) in which the simple plan of naming the afternoon hours from 12 to 23 is adopted The method is occasionally used in the record of scientific observations, and always with advantage

The present time-standards on the railways of Europe may be summarized as follows —

(1) *Time of the initial meridian* (Western Europe) 0° (12 0) —Great Britain Belgium, the Netherlands

(2) *Time of the first hour interval* (Central Europe), 15° E (13 0) Sweden, Luxemburg, Germany (Prussia excepted temporarily), Austria-Hungary, Servia, Bulgaria, Western Turkey

(3) *Time of the second hour interval* (Eastern Europe), 30° E (14 0) Eastern Turkey, Russia (practically)

Countries conforming to national standards or to no system, with the hour adopted in their capitals at Greenwich noon Ireland (11 35), France (12 9), Spain (11 46), Portugal (11 23), Switzerland (12 30), Italy (12 50), Rumania (13 44), Greece (13 35)

Hugh Robert Mill.

NOTES

Mr H T Stainton, F.R S, the well-known entomologist, has been appointed one of the Curators of the Hope Professorship at Oxford, to fill the vacancy caused by the death of Prof Moseley

Signor Giuseppe Fiorelli is retiring from the general direction of the antiquities of Italy, and his friends and admirers have resolved to mark the occasion by giving expression to their high appreciation of his work as an archæologist A committee has been appointed by the Accademia dei Lincei to make the necessary preparations It is proposed that a medal shall be struck in his honour, and that any sum which may remain after this has been done shall be set apart for the encouragement of archæological studies in accordance with Signor Fiorelli's suggestions

The second International Congress of Physiology is to be held at Liége on August 28 to 31

On Tuesday a conference was held at Lord Brassey's house for the consideration of the best means of establishing a laboratory of marine biology in Jamaica in commemoration of the fourth centenary of the discovery of America Lord Rosse moved the first resolution, "That an observatory of marine biology in tropical seas is necessary for the development of science" Prof. Ray Lankester seconded the resolution, and in doing so said that nothing could do more to advance our knowledge of biology at the present moment than the work of such a laboratory as that which it was proposed to establish They wanted a place where the naturalist could work, and above all they wanted an organization, with a permanent official in charge who would gradually accumulate knowledge of the animals and plants which were to be found in the surrounding waters. They wanted in such a laboratory the means of dredging He hoped they would have a steam vessel, and that the vessel would be large, and the actual building of the laboratory small He trusted that there would be an adequate private subscription to enable them to build the laboratory, but the carrying on of the work would require an annual income, which he hoped the home Government and the island Government would be prepared to find The resolution was carried unanimously Mr Villiers Stuart moved, and Mr Wellesley Bourke (M L C, Jamaica) seconded, "That no tropical sea promises so rich a harvest of biological specimens as the great gulf of the West Indies, that Jamaica is the most central and most suitable station for such an observatory, and that its establishment would be a suitable memorial of the fourth centenary of the discovery of the Western Hemisphere" This also was unanimously agreed to

The Crystal Palace on Saturday last was specially visited by Lord Kelvin to view the National Electrical Exhibition at present being held in its buildings This Exhibition, as everyone who has seen it must be aware, is a thoroughly representative one, and besides illustrating the present condition of the application of electricity for practical purposes, carries one back especially in the Post Office exhibit, to the time of its infancy the historical collection is of considerable importance, and has been well selected Instruments are there shown, which have five needles on their dials, the presence of which was once necessary to carry on a conversation, the number of words spoken per minute amounting only to single figures Very interesting old specimens of cables are also shown, together with the part of a telegraph post connected with the pathetic case of a poor woodpecker which, in the endeavour to find the insect that was producing (so he thought) the humming noise in the post, had pecked a large hole in it In the demonstration room of Messrs Siemens Brothers, some truly wonderful sights were displayed The flame produced by exciting an induction-coil by means of an alternating current was produced on a very large scale, and as it issued from the secondary poles, was made to pass through pieces of wood, lumps of salt and slate, the most striking case being its passage through a large piece of plate glass, for which a very strong current was required. Among the many other exhibits, we may mention the demonstrations in cooking by electricity The bottom of the kettle or saucepan is coated with a specially prepared enamel, into which a fine wire resistance is embedded, by this means, as the wire becomes heated, the temperature of the kettle, and therefore of the water in it, is raised We may note that the Exhibition closes on Saturday, July 2, so that those who have not already visited it should do so without delay

A Reuter's telegram from Vizagapatam, Madras, announces the death of Mr Narasinga Row, the well-known native astronomer He died on Saturday last.

The death of Hermann Burmeister, the well known German zoologist, at Buenos Aires, is announced He died on May 1 in his eighty-sixth year In his early days he was a Professor of Zoology at Halle During the revolutionary period of 1848 and the following years he associated himself prominently with the Liberals, the result being that in 1850 he had to quit Germany He travelled for some time in Brazil, and then returned to his native country He went back to South America in 1856, and not only visited most parts of the Argentine Republic, but crossed the Andes by a way which had never before been taken by a European After another brief visit to Germany, he finally settled in Buenos Aires in 1861, where he formed the well-known National Museum of Natural Science Only an accident made it necessary for him to resign his position as Director, and the community, by which his services were highly appreciated, took care that he was properly pensioned He was buried at the cost of the State, and the President was present at the funeral.

DURING the latter part of last week an area of high pressure lay over the Bay of Biscay and the west of France, and an area of low pressure over Scandinavia and the North Sea, causing moderate north westerly and westerly winds over these islands The temperature had continued low, the maxima only exceeding 60° at a few places, chiefly in the southern parts of the kingdom, while the nights were very cold for the time of the year, with ground frosts over the inland parts of England Thunderstorms occurred in many parts, with heavy showers of rain, and hail in the south-east of England At the beginning of the present week the low barometer extended gradually over the kingdom, and shallow depressions were travelling from west to east With this distribution of barometric pressure, the winds were from north and east over Scotland, and chiefly from between north west and south west over England and the Channel, subsequently the barometer readings became more uniform, and the winds light and variable The weather continued very unsettled, although there was some increase of temperature The report issued by the Meteorological Council for the week ended the 18th instant shows that the mean temperature was below the average for the week in all districts, the deficit ranging from 3° in the Channel Islands to 8° in the Midland and Eastern Counties of England Rainfall was only slightly above the mean in the east of Scotland

THE Washington Weather Bureau has just distributed two important meteorological papers prepared by General A W Greely, Chief Signal Officer (1) A series of thirty seven charts showing the absolute maximum and minimum temperatures in the United States for decades, and for all years combined, compiled from observations taken from 1872 to June 1891 The values, together with the date of occurrence, are printed over the names of the stations on ordinary maps, and show very clearly for each locality the limits within which the temperature may be expected to range (2) Diurnal fluctuations of atmospheric pressure at twenty-nine selected stations in the United States The tables give the corrections necessary to reduce the mean pressure at any hour of the day to the true daily mean The values have been obtained by freehand curves from all the available observations from January 1877 to June 1888 It is found that the fluctuations of the secondary maxima and minima diminish from south to north, especially during the summer months The daily variation in pressure decreases with increasing latitude, especially in the winter months; in summer the same conditions exist, except that the daily range increases inland from the coast The principal maximum occurs over the whole of the United States in January, about 9h 45m a m (local time), except along the New England coast, where it is earlier, as the year advances the hour gradually shifts towards the earlier morning until June, after which a reversal gradually occurs The delay in the hour of the principal minimum is more marked it gradually becomes later with increasing longitude, the most decided lagging in the summer minimum is in the neighbourhood of the Great Lakes

PROF. R KOBERT gives, in the *Chemiker Zeitung* (1892, 16, No. 39), an account of Williams's frog heart apparatus The apparatus, as modified by Maki, Perles, and Kobert, consists of an arrangement of glass vessels and india-rubber tubes, whereby a heart taken from a newly-killed frog can be made to maintain an artificial circulation of blood, fresh or injected with any poison the effect of which it is sought to determine The tubes and vessels are mounted on a stand about 1 foot high The heart is suspended by a cannula leading into a three-way tube communicating with two vertical glass cylinders fitted with glass valves. Through one of these the heart is supplied with blood, either fresh from a rabbit, calf, or dog, and diluted with 0 75 per cent. salt solution, or poisoned The other vertical cylinder leads back from the heart to the vessel from which the fresh blood is supplied To start the action, fresh blood is allowed to enter the heart, which is thereby excited to a contraction, and pumps it back into the reservoir The height through which it is raised, and the quantity that is raised in a given time, gives the work done, and the number of pulsations, and the volume raised in a given time determines the pulse volume. The force exerted is measured by a small mercurial manometer, which may be rendered self registering To study the action of poisons on the power and vitality of the heart it is only necessary to admit the poisoned blood from the second reservoir When the pulsation has ceased or diminished, fresh blood may be re-admitted, which in many cases restores the pulsation We have received a letter on this subject from Count F Berg, of Livonia, who says Prof Kobert is of opinion that the apparatus, if it were more generally known, would be of great service for the advancement of science, and would render unnecessary many an otherwise indispensable experiment in vivisection

WE have received a new planisphere, which is being sold by the *Register* Publishing Company, Ann Arbor, Mich The rotary disk, on which the constellations are clearly marked, is made of good stiff cardboard, and the days of the year round the edge are neatly printed in white figures on a blue background The planisphere is arranged for latitudes 38 to 48°, and shows on its disk all the principal stars in each constellation, with their lettering, and in some cases their names, thus, α Bootis = Arcturus, α Lyræ = Vega, &c By simply turning the disk round until the day of the month comes opposite the time of day, the stars above the horizon at that time can at once be seen On the back is a table for finding the times of visibility and positions of the planets, while there is also a key to enable one to determine the name of a planet which cannot be recognized When once used, the handiness of such a planisphere as this will soon make itself apparent, and not only will it be adopted by possessors of telescopes, but it should be in the hands of all those who wish to be able to find and correctly name the various constellations

INQUIRIES have recently been made by the British Consuls in Japan as to the various native industries that have sprung up for the production of articles which have hitherto been imported into that country from abroad A summary of the information thus obtained has been prepared by Mr Gubbins, Secretary of Legation at Tokio, and has been printed in the Foreign Office Miscellaneous Series Mr Gubbins says that in the case of some of the industries introduced into Japan, the country is now self-supporting, foreign competition being no longer possible, in others so much has been accomplished as to render it certain that the time is not far off when importation will altogether cease The future of other industries again—such as that of cotton-spinning—though not so assured, is still hopeful, while even in those branches in which the least results have been obtained she possesses a constant advantage in the great cheapness of labour Mr Gubbins thinks that this progress has not been made at the sacrifice of any of the various artistic industries which are more peculiarly her own. While admitting that there is truth in the criticism that would disparage her progress for the reason that it is imitative and not constructive, he holds that the fact that Japan, an Oriental country, has been able to dissociate herself from her sister countries of the East and to profit by Western inventions to the extent that is in evidence augurs well for the years to come

IN the new number of the *Records of the Australian Museum* (vol ii, No 1), Prof Alfred Newton, F R S, has a note which may be of interest to ornithologists in Australia Having lately occasion to investigate the range of the sanderling (*Calidris arenaria*), he came across a memorandum made in the yea

1860 of his having then seen, in the Derby Museum at Liverpool, two specimens of the larger race of this species, one in winter dress and the other in incipient spring plumage, both being marked as females, and as having been obtained at Sandy Cove in New South Wales, April 20, 1844, by the late John Macgillivray This wandering species does not seem to have been hitherto recorded from Australia Prof Newton finds little verification of Temminck's assertion in 1840 ("Man d'Ornithologie," iv p 349), often repeated in one form or another, that the sanderling occurs in the Sunda Islands and New Guinea, or even of a statement made by a recent writer in general terms, that it is a winter visitor to the islands of the Malay Archipelago ("Geographical Distribution of the Charadriidæ, &c," p. 432) Java seems to be the only one of these islands in which its presence has been determined, and though it was included with a mark of doubt in the lists of the birds of Borneo by Prof W Blasius (1882) and Dr Vorderman 1886) respectively, it has been omitted, and apparently with reason, from that of Mr Everitt (1889) It is well known to pass along the whole of the west coast of America, and it has been obtained in the Galapagos and the Sandwich Islands, but Prof Newton knows of no instance of its having been observed in any Polynesian group or within the tropics to the eastward of Java

IN the same number of the *Records of the Australian Museum* is a valuable paper (with plate), by Mr Charles Chilton, on a Tubicolous Amphipod from Port Jackson Among some Australian Crustacea sent to Mr Chilton as exchanges by the trustees of the Australian Museum was a tube-dwelling Amphipod collected in Port Jackson There was a plentiful supply both of specimens and of the tubes formed by them, and after a full examination and comparison of them with Mr Stebbing's description and figures, Mr Chilton has no doubt that they belong to *Cerapus flindersi*, Stebbing, a species described from a single female specimen taken in Flinder's Passage during the voyage of the *Challenger* Mr Stebbing says nothing of the tube in his description, and Mr Chilton presumes, therefore, that he has not seen it Mr Chilton is able to supplement Mr Stebbing's description in this respect, and to describe the male of the species, and to give the points in which it differs from the female, and also some interesting facts on the changes in form that occur during the growth of the male

SOME time ago the *Ceylon Observer* gave an account of the killing of a wild boar by a cheetah near Galle In its issue of May 25 it prints a letter from Mr Clive Meares, who says that the fortune of war has now gone the other way, a cheetah having been killed by a wild boar The coolies of Ginniedominie estate, Udagama, on going to work on the morning of May 23, discovered in a tea field near the jungle signs of a severe struggle having taken place between a cheetah and a wild boar —judging by the marks On further search the dead body of a cheetah was discovered in the tea, death having evidently been caused by the severe handling it had received from the boar The brain being very much congested with blood and several teeth marks deeply buried in the neck, there could be no doubt as to the cause of death On the animal being skinned the wounds were found to be very deep She weighed 42 pounds, and she was 71 inches long from nose to tip of tail, and 24 inches in height at the shoulders

MR A REA, the Superintendent of the Archæological Survey, Madras, has reported an important discovery he has made of another casket, some relics, and inscriptions in the Buddhist stupa at Bhatuprolu in the Kistna District. In Sewell's *List of Antiquities*, vol i p 7, mention is made of a casket found in the dome of the stupa some years ago. It struck Mr. Rea that as the chief deposit was usually placed near the centre of the foundations, it was probable that another casket might be found Copies of his report, with inscriptions, have been ordered to be sent to Dr. Hultzsch, the Government Epigraphist; to archæological experts in India, and to various learned Societies

MINING seems likely to be splendidly represented at the Chicago Exhibition It is announced that "all of the precious minerals, all of the economic minerals, all of the precious stones, all of the coals, all of the building stones and marbles, all of the clays and sands, all of the salts and pigments, as well as the machinery, implements, and appliances employed in their conversion to the uses of man, will be fully represented" Especial attention will be devoted to the iron industry The Exhibition will provide ample data as to the location and extent of the greater iron deposits, the analyses of the ores, with all the machinery and devices employed in mining, hoisting, conveying, storing, &c

PROF DANIEL G. BRINTON contributes to the new number of the Proceedings of the American Philosophical Society, vol xxx, No 137, valuable papers on the Chintantec language of Mexico, the Mazatec language of Mexico and its affinities, and South American native languages Of the latter languages he says that they are the least known of any in the world

A VOCABULARY of the Eskimo language has been compiled by M Ryberg, a Danish official in Greenland. It represents work carried on during fifteen years.

THE publication of the quarterly journal for cryptogamic science, *Grevillea*, will still be continued under the proprietorship of Mr E A. L Batters, and the editorship of Mr George Massee

MR E D MARQUAND has published a list of the flowering plants and vascular cryptogams of Guernsey It includes the remarkable number of 636 flowering plants, 18 ferns, and 9 fern allies Of these about 130 are not recorded for Guernsey in Prof Babington's "Primitiæ Floræ Sarnicæ"

THE latest researches of the Finnish expedition to the Kola Peninsula will modify the position of the line which now represents on our maps the northern limits of tree-vegetation in that part of Northern Europe The northern limit of coniferous forests follows a sinuous line which crosses the peninsula from the north west to the south-east But it now appears that birch penetrates much farther north than the coniferous trees, and that birch forests or groves may be considered as constituting a separate outer zone which fringes the former The northern limits of birch groves are represented by a very broken line, as they penetrate most of the valleys, almost down to the sea-shore, so that the tundras not only occupy but a narrow spac along the sea-coast, but they are also broken by the extensions of birch forests down the valleys As to the tundras which have been shown of late in the interior of the peninsula, and have been marked on Drude's map in Berghaus's atlas, the Finnish explorers remark that the treeless spaces on the Ponoi are not tundras but extensive marshes, the vegetation of which belongs to the forest region The Arctic or tundra vegetation is thus limited to a narrow and irregular zone along the coast, and to a few elevated points in the interior of the peninsula, like the Khibin tundras, or the Luyavrurt (1120 metres high) The conifer forests, whose northern limit offers much fewer sinuosities than the northern limit of birch-growths, consist of fir and Scotch fir, sometimes the former and sometimes the latter extending up to the northern border of the coniferous zone

THE British Consul in Hainan, in his last report, says that during the past year he has made two journeys in that island, one to certain prominent hills near Hoihow, known as the "Hummocks," which lie fifteen miles to the west, on the road to Ch'eng-mai, the other a gunboat cruise to Hansui Bay. The people at both these places, and presumably all along the north-west coast, though believing themselves Chinese, speak a language which is not only not Chinese, but has a large percentage of the words exactly similar to Siamese, Shan, Laos, or Muong. The type of the people, too, is decidedly Shan, without the typical Chinese almond eye. At one time (1000 years ago) the Ai lau or Nan-chau Empire of the Thai race extended from Yun-nan to the sea, and the modern Muongs of Tonquin, like the Shans of the Kwangsi province, the ancestors of both of which tribes belonged to that empire, probably sent colonies over to Hainan, or the Chinese generals may have sent prisoners of war over. It is certain that some at least of the unlettered, but by no means uncivilized, tribes in the central parts of Hainan speak a type of language which is totally different from that spoken by the Shan speaking tribes of the north west coast. Yet the Chinese indiscriminately call all the non-Chinese Hainan dialects the Li language. The subject, Mr. Parker says, is one of great interest, well worth the attention of travellers. It was his intention to pursue the inquiry when making a commercial tour of inspection round the island, but his transfer to another post compels him to abandon his scheme.

THE additions to the Zoological Society's Gardens during the past week include a Brown Capuchin (*Cebus fatuellus*) from Guiana, presented by Mr. Edward Solomon; two Black Swans (*Cygnus atratus*) from Australia, presented by Lady William Osborne Elphinstone; a Greater Spotted Woodpecker (*Dendrocopus major*), two Common Cormorants (*Phalacrocorax carbo*), British, presented by Sir H. B. Lumsden, K.C.S.I.; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. F. R. Brown; two Common Rheas (*Rhea americana*) from the Argentine Republic, deposited; an Erxleben's Monkey (*Cercopithecus erxlebeni* ♂) from West Africa, a Victoria Crowned Pigeon (*Goura victoriae* ♀) from the Island of Jobie, two Wonga-Wonga Pigeons (*Leucosarcia picata*) from New South Wales, a Rosy-billed Duck (*Metopiana peposaca* ♀) from South America, twenty Common Teal (*Querquedula crecca*), European, purchased; a Thar (*Capra jemlaica*), two Burrhel Wild Sheep (*Ovis burrhel* ♂ ♀), an Axis Deer (*Cervus axis* ♂), four Temminck's Tragopans (*Ceriornis temmincki*), a Himalayan Monaul (*Lophophorus impeyanus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

COLOURS ON THE SURFACE OF MARS.—During the last opposition of Mars a series of observations was made by Prof. Pickering with the object of determining the general colour of this planet's disk, and that of the various markings distributed over its surface. In a preliminary account of this work which he has contributed to the June number of *Astronomy and Astro-Physics*, we are made acquainted with some of the observed facts, which will be read with keen interest, as we are nearing a time when like observations can be repeated. The instruments used were the 12-inch and 15-inch at Cambridge, and the 13-inch at Arequipa, Peru. With the two former sixty paintings were made, together with sixty-six uncoloured drawings, and with the latter some of the more recent observations were undertaken. The general light from the planet, although usually termed ruddy, was found to lie about midway between that of a candle and electric light of equal brilliancy, being somewhat bluer than the former and redder than the latter.

Great difficulty seems to have been found in matching Mars's colour in the day and night time, the presence or absence of the bluish white light reflected from the atmosphere bringing about a great difference in the colour of the pigments used. The colour finally settled upon may be represented by equal parts of dragon's blood and sienna. The ruddiness, as the limb was approached, gave way to a distinct yellow tint, due perhaps to atmospheric absorption, an effect, as Prof. Pickering remarks, which is quite at variance with the action of our own atmosphere. In addition to these colours grays and greens have been noticed, indeed at times the greens have been more intense than the red. The grey objects were found, when the seeing was very good, to have a slightly yellowish tinge about them, but when viewed by daylight a browner tint more accurately represented their colour.

Numerous observations were made also with the intention of determining the colour of those parts more darkly tinted, and the colour of the canals; but Prof. Pickering only mentions that there were indications of slight colour alterations, reserving his opinion on these points in order not to bias those of other observers, who will be able in the coming opposition to examine this planet's surface from this point of view.

During the months of July and August the planet excepting for its low altitude, will be most favourably situated for observation, the opposition occurring on August 4, when its distance from the earth will be about 35,000,000 miles.

OBSERVATIONS OF THE MOON.—The *Monthly Notices* (vol. lii., No. 7) contains, besides the observations of the right ascensions and north polar distances of the moon made during the year 1891 at the Radcliffe Observatory, Oxford, a comparison of these results, with the tabular places taken from Hansen's lunar tables. The two suppositions on which these results are compared are, as Mr. Stone says: (1) that the mean times found in the usual way from the sidereal times at mean noon given in the *Nautical Almanac*, were not altered in scale, or affected with any different systematic errors of determination, by the adoption in 1864 of a different ratio of the Julian year of 365¼ "mean solar days" to the mean tropical year. (2) that the "mean times" which accurately correspond to a given "sidereal time of a meridian" were necessarily changed in 1864 by the use of a different ratio of the "Julian year," and therefore of the "mean solar day" to the mean tropical year, to fix the tabular right ascensions of the clock stars at the meridian transits. It is from these tabular right ascensions of the clock stars that the observed right ascensions are deduced by the aid of clocks; and the right ascensions thus found are finally rendered definite by the direct reference to the positions of the sun deduced from the north polar distances and obliquities of the ecliptic.

During the period included in the years 1847 to 1863 the mean annual error in longitude of Hansen's tables amounted to −1″.85, no regular law of increase being indicated. Taking the case of those observations made up to the end of last year, the mean annual error, as shown in the third table, has steadily increased from the year 1863 at an average rate of 0″.75 per annum, the error now amounting to as much as 19″.30. If the corrected argument be used for taking out the mean annual error of Hansen's tables during the same period, this value becomes −1″.49, which differs from −1″.85 (the value for the preceding period) by a quantity which in such a case is very small.

A PLANET BEYOND NEPTUNE?—For some time it has been thought that in all probability our sun is accompanied by one or two other planets which lie outside the orbit of Neptune. The idea gained a considerable footing in many minds after Prof. Forbes's paper, which he read in 1880 before the Royal Society of Edinburgh, his prediction being based on cometary aphelia positions. In order to investigate this question more fully, Mr. Isaac Roberts, having obtained the necessary approximate positions of these hypothetical bodies, undertook to make a search for them, employing the method of long exposure photography. The result of this search he communicates to the May number of the *Monthly Notices*.

The probable position indicated by Prof. Forbes lay between R.A.'s 11h. 24m. and 12h. 12m., with declinations 0° 0′ to 6° 0′ north, and over this region Mr. Roberts took two sets of eighteen plates, each plate covering more than four square degrees, the exposure being of 90 minutes' duration. A close examination of the plates showed that, in Mr. Roberts's words, "no planet of greater brightness than a star of the fifteenth magnitude exists on the sky area herein indicated."

GEOGRAPHICAL NOTES

THE Royal Geographical Society's *soirée* took place on the 17th inst at the South Kensington Museum, when the guests were received by the President and Council The attendance was very great The attractions of the evening included selections by the Coldstream Guards band, solo and part singing in the lecture theatre, and an exhibition by the dioptric lantern of maps and views, with explanation by Mr H J Mackinder

SOME interesting particulars as to the present state of the Marshall Islands are published in the *Deutsches Kolonialblatt* The population is estimated at 15,000 aborigines, and about 100 whites Cocoa-nuts and copra are the staple exports, pandanus, breadfruit, and arrowroot being cultivated on a small scale The natural grass is not suitable for pasture, but with the introduction of foreign grass seed, cattle and sheep breeding may become profitable Taking into consideration the character of the soil and the density of population, the future of the German protectorate in the Marshall Islands is acknowledged not to be very bright, although the authorities hope that it may become of enhanced importance for trade with Germany

THE *National Geographic Magazine* has just published an account by Dr Charles Willard Hayes of the expedition through the Yukon district in 1891, conducted by Mr Schwatka on behalf of a syndicate of American newspapers Entering by the Yaku inlet, the expedition made its way by canoe, as soon as the ice disappeared, up the Yaku River, thence it crossed the watershed, and continued on Lake Ahklen and the Teslin River to Lewes River, a tributary of the Yukon A traverse survey was made all the way, and the route laid down in a serviceable manner, though of course without the precision of an actual survey This district has been several times visited by prospectors, and parts of it mapped by previous explorers, but the expedition opened up, probably for the first time, the unknown region extending from the Yukon to the St Elias Mountains. Across this blank, usually filled in hypothetically on maps, the expedition surveyed a line of 330 miles, from Selkirk, on the Yukon, to the junction of the Chittenah and Nizzenah rivers The report gives a clear summary of the topography, drainage, orographic system, and geology of the region traversed

PRINCE HENRY OF ORLEANS has returned to France after a difficult journey from the Upper Mekong, through the Shan States and Siam, where he reached the coast at Bangkok

CAPTAIN W G STAIRS, whose quiet heroism in Stanley's Emin Relief Expedition was brought prominently before the world two years ago, has fallen a victim to African travel He was born at Halifax, Nova Scotia, in 1863, and educated at Merchiston Castle School, in Edinburgh, subsequently studying at the Royal Military College, Kingston, Ontario After his training in Canada he spent some time in New Zealand as a civil engineer, but obtaining a commission in the Royal Engineers, he came to Chatham, and completed his military training When the Emin Relief Expedition was fitting out in 1887, he volunteered to accompany it, and from the first he impressed Mr Stanley as a man of exceptional qualities —an opinion strengthened by the strict obedience and absolute loyalty which distinguished him throughout the trying years that followed As the only member of the advance party (Dr Parke excepted) who had much interest in scientific matters, Captain Stairs would undoubtedly have made large additions to knowledge had it not been for the imperative exclusiveness of his work as an officer He was selected for the best piece of geographical exploration attempted during the expedition—the ascent of Mount Ruwenzori Last year Lieutenant Stairs was promoted to a captaincy, but the fatal attraction of Africa led to his resignation in order to accept command of the Katanga Company's expedition This Company was formed in Belgium to administer and exploit the south eastern corner of the Congo Free State, in what is known as Msidi's country Stairs left Zanzibar last summer, crossed to Lake Tanganyika by the familiar trade route *viâ* Tabora, and reached Mpala on October 31, after a remarkably rapid and easy journey Thence he traversed Msidi's country in the rainy season, where he suffered much from fever, but succeeded in reaching the Ruo on May 13, and arrived at Vicenti, near the mouth of the Zambesi, on June 3 But at Chinde, just as the expedition had overcome all the difficulties of the way, and only waited for a passage to Zanzibar, Captain Stairs died. This sad event has removed from the list of African travellers one of the bravest, most prudent and modest of young explorers

THE MICROSCOPE'S CONTRIBUTIONS TO THE EARTH'S PHYSICAL HISTORY[1]

MEN will have forgotten much when the second half of this nineteenth century is no longer remembered. Whatever may have been its faults, it has no rival in the past history of the world as an epoch of scientific progress. This progress has been largely due to the felicitous co operation of the mind of the student with the skill of the craftsman in the more perfect construction of instruments of research By them darkness has been made visible, the opaque, translucent, the unseen, conspicuous, the inert, sensitive, silence, vocal A thousand methods of experiment, tests of the most delicate nature, have been devised, so that vague conjecture has been replaced by exact knowledge, and hypothesis by demonstration. In such an epoch it may seem a little fanciful to select any one term of years as exceptionally fruitful, but it is remarkable that in the first decade of this half century, science was enriched by three contributions, each of which has led to consequences of far-reaching import. In 1858 Charles Darwin and Alfred Russel Wallace announced simultaneously the conclusions as to the origin of species at which they had independently arrived, and the well known book by the former author appeared in the following year They thus formulated the results of protracted investigations and patient experiments with the simpler appliances of earlier days They subjected, more strictly than ever before, the facts of nature to an inductive treatment, and thus lent a new impulse to biological science Their hypothesis gave a definite aim to the researches of students, and kindled an unquenchable flame of intellectual activity In 1860, Bunsen and Kirchoff announced the results of applying the spectroscope to problems in chemical analysis. By means of this instrument not only have investigations attained a precision hitherto impossible, but also the student, no longer cribbed, cabined, and confined, to the limits of the earth, can question the stars in their courses, and bid nebulæ and comets reveal the secrets of their history Lastly—though the problem be in a humbler sphere, dealing with neither the immensities of stellar physics nor the mystery of life—Henry Clifton Sorby, in 1856, described the results of microscopic investigations into the structures of minerals and rocks Strictly speaking, indeed, the method was not wholly novel So long since as 1827, William Nicol, of Edinburgh, had contrived to make sections of fossil wood sufficiently thin for examination under the microscope, but the device, so far as I know, had not been generally applied, or its wide possibilities apprehended

You have heard in this place on former occasions of the triumphs of the spectroscope in extra terrestrial space, of the revelations of the microscope in regard to the least and lowest forms of life, I have ventured to ask your attention to day to the work of that instrument in a humbler and more limited field —the constitution and history of the earth's crust My task is beset with difficulties Did I address myself to experts, these would be but a small portion of my audience, if I speak to the majority, it will be hard to make intelligible a subject bristling with technicalities Moreover, as this building is so ill suited for the usual methods of illustration, I have decided to dispense with diagrams or lantern slides, and will try to tell, in the plainest language at my command, the conclusions as to the genesis of rocks and the earlier history of the earth to which the researches of the last few years seem to be tending

I have excluded from my story investigations which bear upon the biology of the past, though the work of the microscope in this field has not been less fruitful or interesting, because these are more widely known Moreover, they have not specially engaged my attention, and there is, I believe, an expectation amounting to an unwritten law, that whoever has the honour to occupy my present position should be so far egotistical as to talk of the particular plot, however small it may be, on which he has laboured in the garden of science So I will crave the indulgence of the few experts present, and the patience of the majority of my audience, while I try to tell the story of microscopical research into the history of the earth's crust

Twenty years ago, I believe, not half that number of geologists in the British Isles made any real use of the microscope Now they may be counted by scores, not only in the United Kingdom, but also in every civilized land Obviously in a science so new, in a research which is extending so rapidly,

[1] The Rede Lecture for 1892, delivered before the University of Cambridge, by T G Bonney, Sc D, F R S

much diversity of opinion must exist on some theoretical questions. Into the details of controversies it is not my purpose to enter, but I shall content myself with indicating the conclusions to which I have been led in the time which the many inevitable duties of life permitted me to devote to this branch of geology.

Before doing this it may be well to indicate very briefly the mode in which the microscope is applied to the examination of rocks. Commonly it is as follows: slices, cut by the lapidary's wheel from minerals or rocks, are ground down smoothly till they are about one one thousandth part of an inch thick, and are then mounted on glass. By this means most minerals, including the great majority of the ordinary constituents of rocks, become translucent, if not transparent. They are then examined under a specially constructed microscope, fitted with Nicol's prisms and other contrivances for optical tests. Occasionally also certain chemical tests can be applied. To what extent an object is magnified depends on the nature of the investigation. A very minute crystal can sometimes be studied, under favourable circumstances, when enlarged to at least 800 diameters; but in ordinary cases, where the chief constituents of a rock and their mutual relations are the object of research, a magnification of from 50 to 100 diameters is commonly the most advantageous. Sands, clays, and incoherent materials can be readily studied by mounting them temporarily or permanently on glass; sometimes, also, good work can be done, and time saved, by crushing up fragments of minerals and of rocks, and by treating the powder thus obtained in the same way. Investigations, which promise to throw light on the problem of the development of minerals, have been recently made by examining the insoluble residues of those rocks which are chiefly composed of carbonates. Solutions of different specific gravities have proved very useful in the determination of the mineral constituents of a rock, which are sorted out by them, as by a strainer, from a sand, mud, or a powdered mass, so that each kind can be studied separately either by microscopical or by chemical analysis.

The subject evidently, in process of time, tends to divide itself into two branches: the one concerned mainly with the characters of the individual constituents of a rock, the other with the wide problem of their mutual relations, or, in other words, with the history of the rock-mass: branches properly denoted by the words *petrography* and *petrology*, though these terms are often confused. The former is more strictly a department of mineralogy; the latter a department of geology. This it is of which I chiefly speak to-day; this it is in which the most marked advances have been recently made.

How great these have been may be more readily appreciated if I mention a few matters, concerning which, even a quarter of a century since, great uncertainty prevailed. Though it was then generally admitted that one great group of rocks, such as clays, sandstones, limestones, &c., were sediments, and that another great group, the rocks called igneous, had solidified in cooling from a fused condition; the origin of a third, and by no means unimportant group, the crystalline schists and gneisses—the metamorphic rocks, as they were commonly called—was considered very doubtful. Many geologists also believed that not a few igneous rocks had been once sediments, like those in the first group, which had been subsequently fused or "digested" by the combined action of heat, water, and pressure. Thus it was supposed that clays and felspathic sandstones could be traced through various stages till they became granite, and rocks of the most diverse chemical composition could be transmuted one into the other. The province of metamorphism was the fairy-land of science; it needed but a touch of the magic wand, and, like Bottom the weaver, a rock was at once "translated." It would be easy, were it worth while, to enumerate instance after instance of these alleged transmutations, every one of which has been proved to be groundless. No doubt, even at the time named, these assertions were questioned by some geologists, but that they could be made so confidently, that they could be inculcated by the official representatives of geology in this country, shows the hopeless confusion into which petrology had fallen.

By means of the microscope also much light has been thrown upon the history even of the better known rocks. The classification of the igneous group has been simplified, and the relations of its several members have been determined. The microscope has dispelled many an illusion, and reduced a chaos to order. In regard to the sedimentary group, it often has determined the true nature of their constituents, and has suggested the sources from which they have been derived or the agents by which they have been transported. Thus, through its tube, we have been enabled, not only to gaze at the most intimate structure and composition of rock masses, but also to catch glimpses of the earth's physiography in ages long before the coming of mankind.

But in speaking of the services rendered by the microscope, I must not forget a needful caution. If the instrument be employed for petrological rather than petrographical purposes, it must never be divorced from work in the field. No training in the laboratory, however complete, no research in a library, however laborious, can of themselves make a petrologist. No question can be completely mastered, unless it be also studied in the field; nay, even the specimens for examination under the microscope, as a rule, should be collected by the student himself, and the characters and relationships of the rock-masses from which they are detached should be carefully noted. It was said, on no mean authority, some fifty years since, that, in the education of a geologist, travel was the first, the second, and the third requisite. Perhaps the statement, like most epigrams, was somewhat one-sided, but the truth in it has not been diminished by the increased perfection of our instrumental methods. In petrology, the chimæras of the home-keeping student of the laboratory have been, and still are, as hurtful to progress, as the dreams of the peripatetic geologist, whose chief appliances are a stout pair of legs and a hammer.

This, then, was the problem which, some thirty years since, presented itself to geologists who were interested in petrology. Here are two groups of rocks, the sedimentary and the igneous. The origin of these we may be said to know, but as to that third group, which, though not as large, is far from unimportant—what is its history? what are its relations to the other two? The records of its rocks at present are illegible. Is there any hope that success will reward the attempt to decipher them? Time and perseverance have given an answer, and though much is still uncertain, though much remains to be done, some real progress, in my opinion, has been made. As the stones sculptured of old by the hand of man are yielding up their secrets, as the hieroglyphs of Egypt and the cuneiform characters of Assyria are telling the tale of the conquerors whose bones are dust, as the tongues of the children of Heth, and of the black-headed race of Accad, are being learnt anew, so the records of the rocks, wherein no trace of life is found, are being slowly, painfully, but ever more surely deciphered, and knowledge grows from year to year.

To obtain success the problem must be attacked in the following way. As the first step, the two great groups already mentioned, the origin of which is known, must be thoroughly studied. The examples selected must be nearly or quite unaffected by any agent of change, such as heat, water, and pressure. Among the specimens representative of the sediments, the materials must range from fine to coarse—for the grains in the latter serve also as samples of the rocks from which they have been broken, and suggest their own inferences. Among the igneous rocks, types ranging from the most glassy to the most crystalline forms must be examined, in order to ascertain not only the constituent minerals, but also their associations and mutual relations. Suppose this done—suppose a fairly good idea obtained of the characteristic structures and possible variations in either class—we have then to ascertain how far and in what way each representative can be modified by natural agencies. At the outset, probably, it will be found convenient to trace the processes of mineral and even of structural change without any immediate reference to the efficient cause. It soon appears that in the case of minerals, which differ in physical properties, but not in chemical composition, the one species replaces the other; the less stable gradually altering into the more stable form. Thus calcite takes the place of aragonite, hornblende of augite; one mineral may be broken up into a group, as a colloid into crystalloids, or felspar into quartz and white mica; new species may be produced by addition or subtraction of constituents from without, or by exchange from within; the replacement of silicates by carbonates, the conversion of granite into tourmaline-rock, the formation of epidote, chlorites, and serpentine, are a few among the many instances of this kind of change. By tracing the process from one part of a rock to another, numerous facts are collected and relationships ascertained. But during these investigations questions are raised in a student's mind which begin to clamour for an answer. Why does such and such a rock change, now in

this way, now in that? So it becomes necessary to correlate our observations, to frame hypotheses, and open out new lines of inquiry.

So far as we know, water, pressure, heat, are the main agents in producing change in rocks, after the latter have been once deposited or solidified. In most cases it is not easy to insulate perfectly the effect of each agent, for probably every rock, which has undergone important changes, has been to some extent affected by all of them. Still many examples can be found, in which the influence of one has predominated greatly over that of the other two. For instance, it is now agreed that the structure of a slate is the result of pressure, though this probably produced a slight rise of temperature, and the rock is not likely to have been perfectly dry. Again, when a clay has been converted into an assemblage of crystalline silicates in the vicinity of an intrusive mass of granite, this is mainly the effect of heat, though the pressure cannot have been inconsiderable, and the presence of water is almost certainly essential.

Thus, in one series of examples, properly selected to illustrate the slaty rocks, we can watch the development of new minerals. We can observe which of these are readily produced and quickly attain to a considerable size, which are more slowly formed, or seem incapable, even if common, of much enlargement. We are thus led by inductive processes to conclusions as to the effects of pressure in the development of minerals in a mass of materials of a particular composition. In another series of rocks which has been affected by the heat of intrusive masses, we can watch the gradual growth of new constituents, as we proceed inward towards the originally heated mass, till we have passed from clay or slate to a crystalline aggregate of minerals, such as quartz, micas, andalusite, staurolite, and garnet. Similar effects may be noted in other kinds of sedimentary rock. Changes also are produced mainly by the action of water, but on this I need not enlarge.

Again, as another line of inquiry, the effects produced on igneous rocks by the same agents must be studied. Here the results which are more or less directly due to the action of water are often highly interesting, but as these are only indirectly connected with the main subject of this lecture, I content myself with a passing reference. With igneous rocks the effects of heat seem generally less important than with sedimentary; probably because the mineral constituents of the former are usually in a more stable condition than those of the latter, so that these also need only be mentioned; but the effects of pressure in some cases, especially with the more coarsely crystalline igneous rocks, are highly interesting and significant.

In a region such as the Scotch Highlands or the European Alps the rocks, in the process of mountain making, have been obviously subjected, perhaps at more than one epoch, to tremendous pressures. The effect of these appears to have been sometimes a direct, sometimes a shearing fracture; that is to say, a mineral or rock, in the one case, has been crushed, as in a press, in the other, during the process of powdering it has been dragged or trailed out, with a movement somewhat similar to that of a viscous substance. As an example, let us take the effects produced in a granite by crushing. The grains of quartz are broken up; the crystals of felspar are first cracked and then reduced to powder; the mica flakes are bent, riven, and tattered. By pressure also the solvent power of water, already present in the rock, is increased; by the crushing its access to every fragment and its subsequent percolation are facilitated. Thus the black mica is often altered in various ways; the felspar dust is changed into white mica and chalcedonic quartz; the constituents are reduced in size and tend to assume a roughly parallel order; the mineral character and structure have been alike changed; a massive rock has been replaced by a foliated one; a coarse granite by a fine grained quartzose or micaceous schist. This change can be demonstrated at every stage; it suggests that many foliated rocks—many gneisses and crystalline schists—may be igneous rocks of which both the mineral character and the structure have been modified by pressure.

We may presently see how far this inference can be justifiably extended, but, as a first step, the effect of pressure on one of the more basic igneous rocks must be considered. Let us take as an example a coarse grained variety of the rock, which is familiar to us as basalt. It consists of a felspar, different from that of granite, of augite, of some iron oxide, and perhaps of olivine. In studying this rock we are confronted by greater difficulties, for, of the two dominant minerals, the felspar is rather less stable than that which occurs in granite, and the augite passes readily into hornblende. Thus, when the latter change occurs we are at first unable to determine whether it is due to pressure or to some other agent. Some petrologists, I believe, would not hesitate to appeal to the presence of hornblende in a rock such as we are considering as a proof that it had been modified by pressure. With this opinion I cannot agree. On examination of the numerous instances in which we are convinced that the hornblende is not an original constituent but has replaced augite, we notice that the former mineral is not constant in its characters. It may be granular in form; it may assume its usual crystalline shape; it may be more or less bladed or needle-like. Have these differences, we ask, any significance? In order to answer the question, specimens of hornblendic rocks must be sought in regions which obviously have been subjected to tremendous pressure, as is testified by the fact that every other rock has been more or less crushed or rolled out; others must be obtained from regions where the associated masses exhibit no signs of extraordinary disturbance, even though they may be more brittle than the subject of our study. In the former case the change may be reasonably attributed to pressure, in the latter it must be due to some other cause. Are hornblendic rocks from the one region similar in structure to those from the other? By no means. Where no evidence can be offered in favour of pressure, there the hornblende either retains wholly or almost wholly the outline of the mineral which it has replaced, or else assumes its normal prismatic form; but where an appeal to pressure seems justifiable, we find that the hornblende appears as unusually elongated prisms, blades, or even needles, and the structures of the rock as a whole can be readily recognized by a practised eye. The evidence for the latter statement is yet unpublished, but it will, I hope, appear before long.

So our investigations have led us thus far: that, in sedimentary rocks, in the presence of water, certain changes are mainly produced by heat, and certain by pressure. In the latter case, however, the new minerals, though very numerous individually, are generally minute; the longest diameter being seldom so much as one hundredth of an inch. Even where this rule is broken, it is only by minerals which are proved by other experiments to be so readily developed that their presence on a large scale has no real significance. The rule holds also to some extent in the case of crystalline schists produced by the crushing of crystalline rocks, markedly in the case of those derived from granites and rocks of similar composition, but less conspicuously in those which were originally augitic or hornblendic. Though even here, where the decreased size of the minerals is less uniformly marked, new and distinctive structures are assumed.

I have spoken only of two or three common types of rocks, but it would be easy, did time permit, to support the principles enumerated, by quoting from a great variety of examples. There are, I believe, few, if any, important kinds of rock which have not been examined, and it appears to me demonstrated that, while pressure is a most important agent of change,[1] while many schists may be regarded as resulting from it, a considerable group remains, which are separated from the others by a very wide chasm, and this can only be jumped by deserting reason and trusting hypothesis.

In this last group of rocks (supposing no disturbances produced by subsequent pressure, for which, however, we can generally make allowance) the constituent minerals are commonly fairly large—say from about one-fiftieth of an inch upwards in diameter. Very many of these rocks, when studied in the field, exhibit every indication of a sedimentary origin. Though as a rule no original constituent grain can be certainly determined, though they are now crystalline, yet their general structure and association are inexplicable on any other supposition. They bear some resemblance to the sediments which have been altered by contact metamorphism, though they present different characters. These, moreover, remain invariable through considerable thicknesses of rock and over wide areas. The alteration is regional, not local, so that such rocks cannot be regarded as cases of simple contact metamorphism, even though heat may be suspected of having been an important agent in producing the change. But to another large series, including many of the rocks commonly called gneisses, the sedimentary origin is less easily attributed. Not a few of these in mineral com-

[1] It is probable that some changes of importance are produced in rocks by long-continued and repeated pressures, which are insufficient to give rise to crushing; but these I have passed by, because, as it seems to me, further evidence is needed before we can diagnose, with any certainty, the results of this particular disturbing cause.

position correspond with granites, and sedimentary rock thus constituted, though not unknown, is rare. The minerals commonly exhibit a parallel or foliated and not seldom even a banded arrangement; in the latter case the layers of different mineral composition in their mutual relations and associations imitate with remarkable success the structure of a banded sedimentary rock. Even a dozen years since little doubt was entertained that this group also had a detrital origin. Occasionally, however, its members, when studied in the field, exhibited characteristics which were difficult to explain on any such hypothesis, and presented resemblances in habit to certain crystalline igneous rocks, from which, however, they were proved to differ in their microscopic structures.

In rocks which have crystallized from a state of fusion some of the mineral constituents usually exhibit their proper crystalline outlines; but in these others the same minerals had no definite shape, and were simply granular. Of this structure two types were observable: in the one the grains were elongated, in the other they were roundish in outline but slightly wavy or lobed. The former type was commonly found in the more distinctly banded varieties; the latter in the more massive and faintly foliated kinds which in hand-specimens were not readily distinguished from true granite.

As in rocks, no less than in living beings, diversities of structures are nature's record of a difference in history, it became a question whether these peculiarities were significant of origin or of environment. By prolonged observations the following results were established:—(1) That crystalline rocks, which could be proved, by their relation to others, to be truly igneous, sometimes exhibited banded structures. (2) That these structures, in certain cases, could not be attributed to any subsequent pressures or crushings, for no sign of them could be found in neighbouring rocks, which, from their composition and nature, ought to have yielded more readily. (3) That a faint foliation or banding, especially in the case of granitic rocks, could be sometimes detected in irruptive veins, in which cases the aforesaid granular structure was detected on microscopic examination. (4) That cases were occasionally found where a light-coloured granite had broken into a dark hornblendic rock, and the fragments of the latter had been gradually softened, elongated, and even drawn out into bands, together with the intruder, till they perfectly simulated, as already mentioned, a stratified mass. (5) That in certain of these cases, where a rock, exceptionally rich in hornblende, had been partially fused by a pale coloured granite, a banded black mica gneiss had been produced, indistinguishable, macroscopically and microscopically, from those which have been already mentioned.

It follows from these observations that the great group of crystalline rocks, which are connoted comprehensively as schists and gneisses, includes rocks which may have originated in one of three different ways:—(1) Some have once been molten, but have become solid under rather exceptional circumstances, probably having lost heat slowly, and having continued to move very gradually during the process of consolidation. (2) Others have been produced by the thorough alteration of sedimentary materials, in which a high temperature has been maintained for a long time, in the presence of water and under considerable pressure. (3) Others, again, have been the result of great pressure, which has acted on rocks already crystalline, and has produced mineral changes, sometimes to the complete obliteration of the original structure. The second and third of these groups are truly metamorphic rocks, to the first the term, strictly speaking, is not applicable.

As a rule, it is not difficult to distinguish between these three groups, and in all probability the ambiguities which still remain will be solved by patient and persevering work. Cases, no doubt, will occur on which no inference can be founded; cases where, from one cause or another, nature's record has become illegible. But to this disappointment the scholar and the archæologist has to submit equally with the geologist. Negative evidence of this kind has no disturbing power; any amount of it is outweighed by a single scrap of clear and positive testimony. It is generally a waste of time to puzzle over bad specimens; they are much more likely to produce a perplexed agnosticism than a rational faith; for a creed has its place in science no less than in theology.

I have mentioned one mode in which materials rather markedly different in mineral character may be, in a certain sense, interstratified and to some extent blended, but should add that recent researches render it highly probable that there are other modes in which mineral or chemical constituents may be differentiated in a magma which was once homogeneous. To discuss these would carry us into questions of crystallogenesis, which have no direct bearing on my present subject, though in these also the microscope has rendered the most valuable services by suggesting inferences and by testing theoretical conclusions; questions upon which so much light has been thrown by the researches of Guthrie, Lagorio, Sorby, and others; but I may refer in passing to the law established by Soret, that by a change of temperature a homogeneous solution may be rendered heterogeneous; since any compounds by which it is nearly saturated tend to accumulate in the colder parts. Gravitation also, when certain minerals are crystallizing from a magma, may cause them to rise or to sink, and in this way also heterogeneity may be produced. So when the mass of mingled fluids and solids is constrained to move, a streaked or banded structure may be the result produced; as in a process familiar to the glass-blower.

But when the geologist has learnt from the microscope to recognize differences of structure in crystalline rocks, and to appreciate their significance, he finds that a wider problem is presented to his mind, provided he has not been led by the fascinations of laboratory studies to despise or neglect work in the field. Granted that one group of rocks, covered by the term metamorphic, has undergone great changes since its members were first deposited or solidified, can these be connected with any phase in the earth's history? Have they any chronological significance? Even twenty years since few geologists would have hesitated to reply:—"None whatever; a rock may have undergone metamorphism at any epoch in the past. Muds and sands of Eocene, Jurassic, Carboniferous, Silurian, of any geological age, have been converted into crystalline schists. Proofs of some part of this assertion can be found even within the limits of the British Isles; it can be completely established within those of Europe." But during the last few years this hypothesis has been on its trial; witness after witness in its favour has been, so to say, brought into court, and has broken down under cross-examination. I can assert this without hesitation, for I have some personal knowledge of every notable instance in Europe which has been quoted in the debate. Microscopic study, combined with field work, has invariably discovered that some very important link in the supposed chain of proof is wanting, and has demonstrated without exception that these crystalline schists are very old; much more ancient always than any neighbouring rock to which a date can be assigned, if not older than the first rocks in which any trace of life has been found. It has been also demonstrated that sedimentary masses, after they have been buried deep beneath superimposed strata and exposed to great pressure, have emerged comparatively unchanged. Such rocks are most valuable as illustrations of the effects of dynamical and other agencies; but they are sufficiently distinct from the crystalline schists to indicate that the environment in the one case must have differed greatly from that in the other. The results of contact metamorphism prove that heat is an important agent of change; but as these also present their own marked differences, they fail to afford a complete solution of the problem.

Moreover, among ordinary sedimentary rocks, we cannot fail to notice that, as a rule, the older the rock the greater the amount of mineral change in its constituents. A good illustration of this is afforded by the Huronian system of North America, the rocks of which are rather older than the Cambrian of this country. Some of them, while still retaining distinct indications of a sedimentary origin, have become partially crystalline, and supply examples of a transition from a normal sediment to a true crystalline schist. Even the older Palæozoic rocks almost invariably exhibit considerable mineral changes, though with them it is only on a microscopic scale. Hence, taking account of all these results, we seem to be forced to the conclusion that the environment necessary for changing an ordinary sediment into a crystalline schist existed generally only in the earliest ages, and but very rarely and locally, if ever, since Palæozoic time began.

Further, in regard to those peculiar structures which, as already stated once led geologists to consider certain rocks, really of igneous origin, as metamorphosed sediments; they also appear to have been much more frequently produced in the earliest ages. They are common in association with the ordinary crystalline schists; they are found, so far as I know, rarely, if ever, with little altered sediments. The microscopic study of

the coarser stratified rocks—grits, sandstones, &c.—lends some support to this view, by showing that, as we go back in time, a larger proportion of their materials, *cæteris paribus*, has been derived from crystalline rocks, and that even the fragments, obviously of sedimentary origin, exhibit signs of some mineral change, that is to say, the mudstones and sandstones in the later grits are apt to be represented in the earlier by phyllites and quartzites.

So the results of microscopic study, in alliance with, not divorced from, work in the field, lead us to the conclusion that in the early ages of this globe's history conditions generally prevailed which became gradually, perhaps even rapidly, rare and local, or, in other words, that in geology the uniformitarian doctrine must not be stated in terms wholly unlimited though, since this was first enunciated by Lyell, nothing has been discovered to shake our faith in its general truth, or to resuscitate the catastrophic hypothesis which it replaced But geologists are forbidden by students of physics to regard the universe as a "self winding clock" The latter affirm, and the former frankly admit, that this globe through long ages has been losing heat by radiation, that there was a time when the temperature of its surface far exceeded that of molten iron a temperature which now would be reached only at a depth of many miles If this be so, the conditions under which rocks were formed on the surface of the globe in early days must have been very different from those which subsequently prevailed Suppose, for example, this surface to have been just white hot—namely, at a temperature much below that at which most, if not all lavas, consolidate In that case the ocean would be vapour, and the weight of the atmosphere would be augmented by that of a shell of water of the area of the globe, and two miles in thickness, or, in other words, the atmospheric pressure would be about 350 times its present amount If so, even a lava flow would consolidate under a pressure equivalent to that of some 4000 feet of average rock But after the surface temperature had become low enough to permit the seas to be gathered together, and the atmospheric pressure had become normal, after rain and rivers, winds and waves, had commenced their work, after sediments, other than the "dust and ashes" of volcanoes, had begun to accumulate, still these at a short distance below the surface would find a very different environment from that which now exists It has been proved by Lord Kelvin that at the end of about one twenty fifth portion of the whole time which has elapsed since the first solidification of the earth's crust, the underground temperature must have risen at nearly six times its present rate To reach a zone, the general temperature of which is 212° F, it would now be necessary to descend, as a general rule, at least 8200 feet, and probably rather more But in those early days the crust would have been at this temperature at a depth of about 1600 feet, and at 10,000 feet it would have risen to 1050° F., instead of 250° F, which now would be exceptionally high To this depth many rocks, both in Palæozoic and later ages, have been buried, and they have emerged practically unchanged Hence it follows that the latter temperature is comparatively ineffective, the former, however, could not fail to facilitate mineral changes and the development of coarsely crystalline structures

These changes, these structures, have been produced in sedimentary rocks in the immediate neighbourhood of a large mass of intrusive igneous rock, such as a coarse granite To what temperature the former have been raised cannot be ascertained Suppose, however, it were 1500° F, which probably is not a very erroneous estimate, this temperature, at the epoch mentioned, would be found at a depth of 15,000 feet It is now, probably, at least 15 miles beneath the surface In other words, the zone at which marked mineral changes could be readily produced, quickly sank, and has long since reached a depth practically unattainable The subterranean laboratory still exists, but the way to it was virtually closed at a comparatively early period in the earth's history

Another effect of this rapid downward increase of temperature must not be forgotten When it amounted to 1° F for every 10 feet of descent, a temperature of 2000° F would have been reached at a depth of not quite four miles. This would be rather above the melting point of many rocks, if they were at the surface, so that, even under the pressure, they would be either very near it or imperfectly solid. If the thickness of the crust were only about four miles, flexures would be readily produced, and the effects of tidal stresses would be considerable, but even if the earth had become solid as a whole, there would have been large masses of rock, comparatively near to the surface, in an unstable condition, and thus liable locally to slow deformations, displacements, fluxional movements, and intrusion into other masses already at a high temperature, with the result of partial melting down and mutual reactions Disturbances such as these, slow, but constantly recurring, would produce structures imitative of stratification It is a remarkable coincidence, to say the least, that these structures are characteristic of Archæan rocks, and are extremely rare, if ever present, in those of later date

But some geologists are so rigidly uniformitarian as to shrink from admitting that any portion of the earth's original crust can possibly be preserved "Take time enough," they say, "and the changes can be made" But will time alone suffice for every kind of change? How long will it be before gunpowder explodes at blood heat? But passing over this obvious difficulty, we may ask Is there time enough? So geologists once thought, as fancy travelled back over endless æons But they are checked by the physicist "earth and sun alike," he affirms, "are masses subject to the laws of radiation, these countless millions of years of which you dream will bring you to a period when not only the earth, but also the whole solar system, was nebulous All the history of your planet, physical as well as vital, so far as it can be covered by your records, must be compressed into a very moderate number of millions of years, for we have to consider the possibilities not only of a cooling earth, but also of a cooling sun" If this be so, and it seems difficult to dispute the decision, if we are forbidden to look back along "the corridors of time" till they vanish in the perspective of infinite distances, it becomes more and more probable that the whole volume of the earth's history is within our reach, and that its opening chapters will some day be deciphered

The progress which has been made since the microscope was pressed into the service of geology augurs well for the future, if we work in a spirit of scepticism and a spirit of hope Of scepticism, lest we trust too much either in ourselves or in even the princes of science, for experience proves that the seductive charms of phantom hypothesis may lead all alike astray from the narrow path of truth into the morasses of error Of hope, for experience also proves that by patient labour and cautious induction many an illusion has been dispelled and many a discovery been made Our eyes must soon grow dim, our hands become nerveless, but other workers will be found to take warning from our mistakes and to profit by our toil The veil which shrouds the face of Nature may be never wholly withdrawn, but its fringe has been already raised, even in our own generation so much has been accomplished that the hope may be indulged of at last learning something of the history of these earliest ages, when the earth had but lately ceased to glow, and when the mystery of life began

THE LADIES' CONVERSAZIONE OF THE ROYAL SOCIETY

THE Ladies' *Conversazione* of the Royal Society took place on the evening of June 15 last, and in every way was a distinct success, the attendance being the greatest on record, and all the available space both for the guests and exhibits being fully occupied The exhibits, although they included a few that were shown at the last *soirée*, were for the most part new, and the following is a brief summary of the most noticeable of them —

Dr H Hicks, F.R S, showed the remains of a mammoth found in Endsleigh Street, in March last, at a depth of only 22 feet The bones were of enormous proportions, and in their proximity was discovered a tusk which was estimated to have been 12 feet in length

A series of enlarged transparent sections of the fossil plants of the Coal-measures were exhibited by Prof W C Williamson, F.R S

Most interesting were the water colour drawings of Greek temples, &c, by Mr F C Penrose, which illustrated his current investigations on the astronomical orientation of ancient Greek temples. The drawings included those of the Propylæa, the Temple of the Wingless Victory, Parthenon, west and east fronts of the Parthenon, north portico of the Erechtheum, east portico of the Theseum, and the Temple of Jupiter Olympius.

Mr W M Flinders Petrie showed some excellent water-

colour drawings of the pavement which he has recently discovered in the Palace of Chuenaten at Tell el-Amarna (1400 B.C.) during his recent excavations. This pavement is quite unique in Egypt, and is especially valuable owing to the marvellous treatment of the plants depicted.

The water-colour sketches exhibited by Prof. F. W. Oliver (for the Scientific Committee of the Royal Horticultural Society) illustrated some typical examples of the damage done to plants by London fog. The injuries shown, he said, were exceedingly prevalent amongst cultivated hot-house plants in the London district during this kind of weather, and extended to a considerable distance from the metropolis, cases occurring as far as Cooper's Hill and Dorking. The sulphurous acid of the fog seemed, in many cases, to have acted directly on the living substance of the foliage and leaves, producing these lesions, while in others there seemed to have been evidence of an accumulative action of the deposits of sulphuric acid.

Mr. W. Crookes, F.R.S., who at the last *soirée* repeated some of Tesla's wonderful experiments, exhibited a novelty in the form of burning nitrogen. He employed an electric current of 65 volts and 15 amperes, alternating 130 times a second, passing it through the primary of a large induction coil. From each of the secondary poles, flames became visible, and met at the centre, being composed mainly of burning nitrogen; when the terminals were separated, so that the flames could not strike across but were in consequence extinguished, it was found that by putting them nearer together a lighted taper was sufficient to re-ignite them. The temperature of the flame exceeds slightly that of a good blowpipe, and a spectroscopic examination of the flame itself shows simply a faint and continuous spectrum. Mr. Crookes pointed out that such a method of exciting an induction coil was first employed by Mr. Spottiswoode in 1880, but "it is not known, however, that any chemical explanation of the flame has before now been published."

Mr. A. A. C. Swinton showed some very interesting photographs of electrical discharges that had been obtained by simply causing the discharges to take place across the surfaces of prepared sensitive dry plates, and consequently without the intervention of any lens. The distinctive character of the figures by the two kinds of discharges were very noticeable, so also was the evidence of their oscillatory nature.

Other electrical exhibits were:—

An ingenious device for disconnecting the supplier of electricity if a dangerous voltage happened to be established in a house, and a leakage indicator for high tension currents, both exhibited by Messrs. Drake and Gorham.

Electrical discharges over prepared surfaces, by Mr. J. Wimshurst, showing that over imperfectly conducting surfaces of large area branch-like forms of flashes are produced, and with a great difference of potential sparks of seven feet in length can be attained.

High-tension electrical apparatus, by Mr. L. Pyke, for working a considerable number of vacuum tubes from one generating source, the tubes in this case being each connected with terminally connected inductors, themselves counterpoised against two external conductors connected to the terminals of the transformer.

The Director of the Royal Gardens, Kew, exhibited a specimen of a double cocoa nut (*Lodoicea seychellarum*), with illustrations showing its germination. This palm is tall and fan-leaved, and peculiar to two of the Seychelles Islands; its fruit weighing from 25 to 30 pounds. At the germination of the seed, "the embryo is gradually pushed out of the seed by the growth of the seed leaf (cotyledon). One end of this remains attached to the seed, and conveys to the embryo the nutriment derived from the gradual absorption of the endosperm." Three of the drawings and a model had an additional interest in that they were made by the late Major-General Gordon.

Mr. Romanes's exhibits of living rats and rabbits attracted much attention, and would perhaps have attracted slightly more if any of the former animals had by chance got astray. They were illustrative of some of the results of experimental breeding with reference to theories of heredity. The examples clearly showed that the male and female elements did not *always* so blend together that the offspring presented characters more or less intermediate between those of the parents, but that the progeny sometimes took wholly after the father or wholly after the mother.

Another animal exhibit consisted in a living specimen of a remarkable non-venomous South African snake (*Dasypeltis scabra*), from the Zoological Society of London. This animal lives solely on birds' eggs. Each egg is swallowed whole, and by a muscular contraction of the gullet, its contents flow into the stomach, while the shell is rejected by the mouth in the form of a pellet.

Among the other exhibits we may mention the systematic and simple construction of the dark absorption bands A, B, and *a* in the solar spectrum, after Mr. Higgs's photographs, by Prof. A. S. Herschel, F.R.S.; the photographs of stellar spectra, including Nova Aurigæ, Arcturus, &c., by Mr. Norman Lockyer, F.R.S.; the photographs of leguminous plants for the determination of the fixation of free nitrogen, by Sir J. B. Lawes, Bart., F.R.S., and Dr. J. H. Gilbert, F.R.S.; and an ingenious instrument for measuring the thermal expansion of very minute solid bodies up to high temperatures, and tracing the volume charge of the silicates up to and over the interval of plasticity, by Mr. J. Joly, F.R.S.

The exhibit in the Archives Room, by the Postmaster-General, was during the whole evening thoroughly appreciated, the Telephone Company's installation being the means by which the guests were able to listen to the music of Salammbô from the grand opera at Paris. Previous to the switching on of the opera, conversation was carried on with some of the officials at the Paris end, and the accuracy with which the peculiarities of the various voices were transmitted was little short of marvellous.

The lantern demonstrations also attracted considerable attention. Mr. Saville Kent and Mr. C. V. Boys, F.R.S., as at the previous *soirée*, both showed their photographic slides, those of the former dealing with coral reefs, &c., and those of the latter with flying bullets. Mr. Norman Lockyer exhibited some photographs taken both at home and foreign Observatories, illustrative of the application of photography in astro-physical researches. The slides included some beautiful photographs of stellar spectra and solar prominences, from the Paris Observatory; of the moon and Jupiter, taken with the large Lick instrument; of the nebulosity surrounding η Argûs, photographed by Dr. Gill, F.R.S.; of the great February sun-spot, taken in India and forwarded to the Solar Physics Committee; and of the spectra of Nova Aurigæ and Arcturus, taken at Kensington. The most striking slide of all was that of the great nebula of Orion, taken by Dr. Common, F.R.S., with his five-foot reflector at Ealing. The apparent brilliancy of the stars, and the wonderful tracery in the nebulous parts, appealed to the eye not so much as an image of a slide on a screen, but as a direct view of this beautiful object through the great telescope itself. The slides shown by Mr. E. B. Poulton, F.R.S., were illustrative of the methods by which the originally opaque wings of certain butterflies and moths had become transparent and usually scaleless; numerous stages in the generation of scales were also shown.

THE FOURTH CENTENARY OF COLUMBUS.

DURING the present year great celebrations will take place in Spain, Italy, and America, in memory of Columbus and his first adventurous voyage of 1492. Although no public commemoration is arranged for in this country, the Royal Geographical Society, fully conscious of the momentous nature of that first voyage, and of the enormous expansion of geographical science which has resulted from it, set apart last Monday evening for a special Columbus meeting. The usual exhibition of maps and pictures included a number of early charts of great beauty, and a fine photograph of a contemporary portrait of Columbus, recently made known by Mr. Markham. The paper of the evening, read by Mr. Clements Markham, C.B., F.R.S., was occupied with an account of recent discoveries with regard to Columbus, and the correction of many erroneous ideas widely entertained until now. As a critical summary of perhaps one of the most difficult branches of research—that into the actual life of a popular hero enhaloed with centuries of tradition—this paper is of great value. An abstract of it, and of the appendices on other fifteenth century explorers, is given below.

Much new light has been thrown upon the birth and early life of Columbus of late years by the careful examination of monastic and notarial records at Genoa and Savona.

There is no doubt as to the birthplace of Columbus. His father was a wool weaver of Genoa, whose house was in the Vico Dritto di Ponticelli, which leads from the gate of San

Andrea to the church of S Stefano It was battered down during the bombardment of Genoa in the time of Louis XIV, was rebuilt with two additional stories, and is now the property of the city of Genoa.

Here Columbus was born, the date of his birth being fixed by three statements of his own, and by a justifiable inference from the notarial records He said that he went to sea at the age of fourteen, and that when he came to Spain in 1485 he had led a sailor's life for twenty-three years He was, therefore, born in 1447 The authorities who assign 1436 as the year of his birth rely exclusively on the guess of a Spanish priest, Dr Bernaldez, Cura of Palacios, who made the great discoverer's acquaintance towards the end of his career

The notarial records, combined with incidental statements of Columbus himself, also tell us that he was brought up, with his brothers and sister, in the Vico Dritto at Genoa, that he worked at his father's trade and became a "lanerio," or wool weaver, that he moved with his father and mother to Savona in 1472, and that the last document connecting Cristofero Colombo with Italy is dated on August 7, 1473 But in spite of his regular business as a weaver, he first went to sea in 1461, at the age of fourteen, and he continued to make frequent voyages in the Mediterranean and the Archipelago—certainly as far as Chios

When Columbus submitted his proposition for an Atlantic voyage to the Spanish sovereigns, they referred it to a committee, presided over by Father Talavera, which sat at Cordova, and condemned it as impracticable It is generally supposed that the proposals of the Genoese were subsequently submitted to an assembly of learned persons at the University of Salamanca, and again condemned The truth was quite different Columbus was gifted with a charming manner, simple eloquence, and great powers of clear exposition It was an intellectual treat to hear him recount his experiences, and the arguments for his scheme Among those who first took an interest in his conversation, and then became a sincere and zealous friend, was the Prior of the great Dominican Convent of San Estevan, and Professor of Theology at Salamanca, who shrewdly foresaw that the most effectual way of befriending Columbus would be by affording ample opportunities of discussing the questions he raised For this object there could be no better place than the University of Salamanca, where numerous learned persons were assembled, and where the Court was to pass the winter The good Prior lodged his guest in a country farm belonging to the Dominicans, called Valcuebo, a few miles outside Salamanca Hither the Dominican monks came to converse on the great deductions he had drawn from the study of scientific books, and from his vast experience, discussing the reconciliation of his views with orthodox theology Later, in the winter, Columbus came into the city and held conferences with men of learning, at which numerous courtiers were present These assemblages for discussion—sometimes in the quiet shades of Valcuebo, sometimes in the great hall of the convent—excited much interest among the students and at Court The result was, that the illustrious Genoese secured many powerful friends at Court, who turned the scale in his favour when the crucial time arrived Such is the slight basis on which the story of the official decision of the Salamanca University against Columbus rests

Captain Duro, of the Spanish Navy, has investigated all questions relating to the ships of the Columbian period and their equipment with great care, and the learning he has brought to bear on the subject has produced very interesting results The two small caravels provided for the voyage of Columbus by the town of Palos were only partially decked The *Pinta* was strongly built, and was originally lateen rigged on all three masts, and she was the fastest sailer in the expedition, but she was only 50 tons burden, with a complement of eighteen men The *Niña*, so called after the Niño family of Palos, who owned her, was still smaller, being only 40 tons The third vessel was much larger, and did not belong to Palos She was called a "nao," or ship, and was of about 100 tons burden, completely decked, with a high poop and forecastle. Her length has been variously estimated Two of her masts had square sails, the mizen being lateen rigged The crew of the ship *Santa Maria* numbered fifty-two men all told, including the admiral

Friday, August 3, 1492, when the three little vessels sailed over the bar of Saltes, was a memorable day in the world's history It had been prepared for by many years of study and labour, by long years of disappointment and anxiety, rewarded at length by success. The proof was to be made at last To the incidents of that famous voyage nothing can be added. But we may at least settle the long-disputed question of the landfall of Columbus. It is certainly an important one, but it is by no means a case for the learning and erudition of Navarretes, Humboldts, and Varnhagens It is a sailor's question If the materials from the journal were placed in the hands of any midshipman in Her Majesty's Navy, he would put his finger on the true landfall within half an hour When sailors such as Admiral Becher, of the Hydrographic Office, and Lieutenant Murdoch, of the United States Navy, took the matter in hand, they d so Our lamented associate, Mr R H Major, read a paper on this interesting subject on May 8, 1871, in which he proved conclusively by two lines of argument that Watling Island was the Guanahani or San Salvador of Columbus.

The spot where Columbus first landed in the New World is the eastern end of the south side of Watling Island This has been established by the arguments of Major, and by the calculations of Murdoch, beyond all controversy The evidence is overwhelming Watling Island answers to every requirement and every test, whether based on the admiral's description of the island itself, on the courses and distances thence to Cuba, or on the evidence of early maps We have thus reached a final and satisfactory conclusion, and we can look back on that momentous event in the world's history with the certainty that we know the exact spot on which it occurred—on which Columbus touched the land when he sprang from his boat with the standard waving over his head

The discoveries of Columbus, during his first voyage, as recorded in his journal, included part of the north coast of Cuba, and the whole of the north coast of Española. The journal shows the care with which the navigation was conducted, how observations for latitude were taken, how the coasts were laid down—every promontory and bay receiving a name—and with what diligence each new feature of the land and its inhabitants was examined and recorded The genius of Columbus would not have been of the same service to mankind if it had not been combined with great capacity for taking trouble, and with habits of order and accuracy

Columbus regularly observed for latitude with Martin Behaim's astrolabe or the earlier quadrant, when the weather rendered it possible, and he occasionally attempted to find the longitude by observing eclipses of the moon with the aid of tables calculated by old Regiomontanus, whose declination tables also enabled the admiral to work out his meridian altitudes But the explorer's main reliance was on the skill and care with which he calculated his dead reckoning, watching every sign offered by sea and sky by day and night, allowing for currents, for leeway, for every cause that could affect the movement of his ship, noting with infinite pains the bearings and the variation of his compass, and constantly recording all phenomena on his card and in his journal Columbus was the true father of what we call proper pilotage

On his return his spirit of investigation led him to try the possibility of making a passage in the teeth of the trade wind It was a long voyage, and his people were reduced to the last extremity, even threatening to eat the Indians who were on board One night, to the surprise of all the company, the admiral gave the order to shorten sail Next morning, at dawn, Cape St Vincent was in sight This is a most remarkable proof of the care with which his reckoning must have been kept, and of his consummate skill as a navigator

In criticizing the Cantino map showing Cortoreal's coastlines, Mr Markham showed that absurd mistakes had been made, not by the voyager or his pilots, but by the cartographer, and subsequent commentators Vespucci's description of his "first voyage" in 1797, was subjected to very thorough criticism, and shown, in spite of the arguments of authors who have tried to support the veracity of that ingenious romancer, to have been a pure fabrication Little or no credit could be given to Vespucci in any case, as he was forty eight years old on first going to sea, and in those days apprenticeship from boyhood was indispensable for a knowledge of seamanship

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD —The Science Examiners have issued the following Class Lists —

Chemistry —First Class · C. L Fort (New), R. E. Hughes

(Jesus), G Ingham (Merton), A L Ormerod (New) Second Class: D. Berridge (Wadham), P Henderson (Queen's), A E Richardson (Wadham), F R L Wilson (Keble) Third Class C J M Parkinson (Jesus), H Wynne Finch (New) Fourth Class · S Wellby (Trinity)

Physiology —First Class P S Hichens (Magdalen), H H G Knapp (non Coll), A C Latham (Balliol), E Mallam (Magdalen), W Ramsden (Keble) Second Class G J Conford (Christ Church), E Stainer (Magdalen) Third Class S B Billups (non-Coll) Fourth Class J S Clouston (Magdalen)

Physics —First Class S. A F White (Wadham) Second Class G M Grace (Jesus) Third Class none Fourth Class F W Bown (University), J C W Herschel (Christ Church)

Morphology —First Class R W T Gunther (Magdalen)

Botany —Second Class O V Darbishire (Balliol)

Women —Louisa Woodcock is placed in the Second Class, Morphology

University Extension —In a Convocation held on Tuesday the following persons were declared on a scrutiny to be duly elected as delegates, under the provisions of the statute Of the delegates for the extension of teaching beyond the limits of the University —H J Mackinder, M A, Student of Christ Church, W W Fisher, M A, Corpus Christi College, Aldrichian Demonstrator of Chemistry, J F Bright, D D, Master of University College A Sidgwick, M A, Fellow of Corpus Christi College, J Wells, M A, Fellow of Wadham College, and the Rev W Lock, M A, Fellow of Magdalen College

The Encaenia —In a Convocation holden in the Sheldonian Theatre on Wednesday, June 22, the degree of D C L (*honoris causâ*) was conferred upon the following persons —

His Excellency, William Henry Waddington, Ambassador Extraordinary and Minister Plenipotentiary from the French Republic at the Court of St James, Honorary Fellow of Trinity College, Cambridge, Hon LL D

His Highness the Thakore of Gondal

The Very Rev Henry George Liddell, D D, late Dean of Christ Church

Edward Caird, M A, Professor of Moral Philosophy in the University of Glasgow, formerly Fellow of Merton

W M Flinders Petrie

The Rev John Gwynn, D D, Regius Professor of Divinity in the University of Dublin

Daniel John Cunningham, M D, Professor of Anatomy and Chirurgery in the University of Dublin

Edward Dowden, LL D, Erasmus Smith's Professor of Oratory in the University of Dublin

The Rev John P Mahaffy, D D, Professor of Ancient History in the University of Dublin

Benjamin Williamson, M A., Sc.D, Fellow of Trinity College, Dublin

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 2 —"On Current Curves" By Major R L Hippisley, R E Communicated by Major MacMahon, F.R S

(1) Starting with the equations

$$i = \frac{E}{R}\left(1 - e^{-\frac{Rt}{L}}\right)$$

and

$$i = \frac{E}{\sqrt{(R^2+p^2L^2)}}\sin(pt - \theta),$$

which represent the curves of currents in circuits *without* iron cores, according as the impressed E M F is constant or varying as $\sin pt$, we can determine the curves according to which the current rises and falls in circuits *with* iron cores, both for a constant impressed E M F and for a sinusoidal E M F

(2) In the first case, with constant applied E M F, we can determine by Lagrange's formula of interpolation the equation to the (B, H) curve of the particular core under consideration This will be of the form

$$B = a_0 + a_1H + a_2H^2 + \ldots + a_nH^n,$$

where n is one less than the number of observed simultaneous values of B and H from which the equation is calculated Substituting in the equation

$$E - \frac{dB}{dt} = Ri,$$

we get, after integration,

$$t = b_0 \log \frac{E}{E - Ri} - b_1 i - b_2 i^2 - \&c, \text{ to } n + 1 \text{ terms},$$

b_0, b_1, b_2, &c, being numerical The paper gives b_0, b_1, b_2, &c, in terms of the constants of the circuit, &c

The corresponding equation when the E M F is removed and the current is dying away is

$$t = c_0 \log \frac{E}{Ri} - c_1 i - c_2 i^2 - \&c + \text{a constant}$$

From these two equations the curves can be plotted

(3) This method is not applicable to the case in which the impressed E M F is sinusoidal, on account of difficulties of integration But both cases can be treated in another way —Take a series of points on the (B, H) curve of the iron core, such that the chords joining them practically coincide with the curve itself Let B_κ, H_κ, and $B_{\kappa+1}$, $H_{\kappa+1}$, be the co ordinates of two consecutive points The equation to the curve between these points is approximately

$$B = m_{\kappa+1}H + \text{constant},$$

where

$$m_{\kappa+1} = \frac{B_{\kappa+1} - B_\kappa}{H_{\kappa+1} - H_\kappa}$$

Substituting in the equation

$$E - \frac{dB}{dt} = Ri,$$

we get, after integration,

$$t_{\kappa+1} = t_\kappa + \frac{m_{\kappa+1}L}{R} \log \frac{E - Ri_\kappa}{E - Ri_{\kappa+1}},$$

which is true to a very close approximation for any simultaneous values of t and i between the above limits From this equation, by determining the various values of m, and remembering that t_0 and i_0 are both zero, we can determine in succession the times at which the current has the known values 0, $\frac{H_1}{L}$, $\frac{H_2}{L}$, &c, and the current curve can be plotted

On making E = 0 in the original differential equation, and observing the proper limits, we get

$$t_{n+1} = t_n + \frac{m_{n+1}L}{R} \log \frac{H_n}{H_{n+1}}$$

as the equation to the curve representing the dying away of the current when the E M F is withdrawn, m_n, m_{n+1} being determined from the descending (B, H) curve

(4) When the impressed E M F is sinusoidal, we substitute for dB/dt in the equation

$$E \sin pt - \frac{dB}{dt} = Ri,$$

having determined the various values of dB/dt, as in the foregoing

As by the present method the value of m changes *abruptly* from m_κ to $m_{\kappa+1}$, we must employ the *general* solution of the above, which for the interval t_κ, $t_{\kappa+1}$, is

$$i = \frac{E}{\sqrt{(R^2 + m_{\kappa+1}^2 p^2L^2)}}\sin(pt - \theta_{\kappa+1}) + A_{\kappa+1}e^{-Rt/m_{\kappa+1}L},$$

in order that the current at the commencement of the interval t_κ, $t_{\kappa+1}$, may have the same value which it had at the end of the interval $t_{\kappa-1}t_\kappa$ The complementary function

$$A_{\kappa+1}e^{-Rt/m_{\kappa+1}L},$$

enables us to insure this condition, for, by taking the constant $A_{\kappa+1}$ of such a value that the above equation is satisfied when $i = i_\kappa$ and $t = t_\kappa$ there is no abrupt change in the current The complementary function, in fact, represents the gradual dying away of whatever excess or defect of current there would be in the circuit when m changes

This equation is true for all values of i between t_κ and $t_{\kappa+1}$ and, therefore, enables us to find the time, $t_{\kappa+1}$, at which the current attains the known value $H_{\kappa+1}/L$

By changing κ into $\kappa + 1$, we obtain similarly the time $t_{\kappa+2}$ at which the current has the value $H_{\kappa+2}/L$, and so on

Thus the determination of $t_{\kappa+1}$ is made to depend upon t_κ, and

in order to make a start we must assume that the value of i is known for some definite value of t It is not of much consequence what assumption, within reason, is made, as, though the calculated curves will vary with the assumption made, they will all eventually merge into the true periodic current curve at some point which will be exhibited when the *first* evanescence of $Ae^{-Rt/mL}$ takes place

As this complementary function is a continually decreasing quantity, it becomes negligible when it is allowed time enough. This opportunity is afforded when the straighter portions of the (B, H) curve are reached

In the paper are given diagrams showing the plotted curves of current calculated from the above equations, together with tables of calculated values

"The Conditions of the Formation and Decomposition of Nitrous Acid" By V H Veley

The main points of this inquiry may briefly be summarized as follows —

(1) The formation of the impurity of nitrogen peroxide in nitric acid, imparting to it the well known yellow tint, takes place in the case of the more concentrated acid, even at a temperature of 30°, and of the less concentrated acids at from 100°–150°, even when the acid is not unduly exposed to sunlight

(2) The reaction between nitric oxide and nitric acid may be regarded as reversible, thus —

$$2NO + HNO_3 + H_2O \rightleftarrows 3HNO_2,$$

provided that the acid be sufficiently dilute, and the temperature sufficiently low Under these conditions equilibrium is established between the masses of nitric acids when the ratio of the former to the latter is, roughly speaking, as 9 1 The actual ratio varies slightly on the one side or the other, according to the conditions of the experiments With more concentrated acids and at higher temperatures the chemical changes taking place are more complicated, and the decomposition of the acid more profound

(3) The decomposition of solutions containing both nitric and nitrous acids is also investigated, the rate of the change is shown to be proportional to the mass of the nitrous acid undergoing change The curve representing the amount of chemical decomposition in terms of the mass present is shown to be hyperbolic, and illustrative of the law

$$(I)\ \frac{dC}{dT} = \frac{C^2}{M}$$

This holds good, whatever be the method employed for the production of the nitrous nitric acid solution

The observed values for C or the concentration of the nitrous acid are concordant with those calculated according to the above differential equation within the limits of experimental error

The rate is dependent upon the ratio of the masses of the nitrous and nitric acid, being the more rapid, the greater the proportion of the former to that of the latter

In the particular case of the liquid prepared from nitric oxide and nitric acid, wherein the reproduction of solutions of similar concentration presents less difficulty, it is shown that as the temperature increases in arithmetical the rate of change increases in geometrical proportion, in accordance with the equation

$$(II)\ v_t = v_{t_1} k^{(t-t_1)},$$

the value for k being 0 0158.

Finally, though the nitrous nitric acid solutions behave in a similar manner as regards the diminution of the mass of the nitrous acid, yet, in other respects, such as evolution of gases and the action upon metals, they are dissimilar

"On the Method of Examination of Photographic Objectives at the Kew Observatory" By Major L Darwin Communicated by Captain Abney, R E, F R S

The paper describes the method of examination of photographic objectives which has been adopted at the Kew Observatory, chiefly on the recommendation of the author In selecting and devising the different tests, Major Darwin acted in co operation with Mr Whipple, the Superintendent of the Observatory, and was aided by consultations with Captain Abney.

The object of the examination is to enable any one, on the payment of a small fee, to obtain an authoritative statement or certificate as to the quality of an objective for ordinary purposes

An example is first given of a "Certificate of Examination," such as would be obtained from Kew, and then the different tests are discussed in detail The following are the different items in the Certificate of Examination, or the various tests to which the objective is subjected —

(1) to (4) None of this information forms part of the result of the testing

(5) *Number of External Reflecting Surfaces*

(6) *Centering in Mount*

(7) *Visible Defects, such as Veins, Feathers, &c*

(8) *Flare Spot*

(9) *Effective Aperture of Stops*, which is given for each one supplied with the objective In recording the results, it is proposed that the system of numbering recommended by the International Photographic Congress of Paris of 1889 should be adopted

(10) *Angle of Cone of Illumination, &c*

(11) *Principal Focal Length* —This is found by revolving the camera through a known angle, and measuring the movement of the image of a distant object on the ground glass, with the Testing Camera it is so arranged that an angular movement can be given with great ease and accuracy, and that the angle is such that half the focal length is directly read off on a scale on the ground glass The observation is made when the image is at a point some 14 degrees from the axis of the objective, and the effect of distortion and curvature of the field is discussed, it is proved that the focal length thus obtained, even though it may not be identical with the principal focal length as measured on the axis, is nevertheless what the photographer in reality wants to ascertain

(12) *Curvature of the Field*

(13) *Distortion* —This test depends in principle on ascertaining the sagitta or deflection in the image of a straight line along one side of the plate. In the discussion it is shown that to give the total distortion near the edge of the plate would not answer practical requirements, and that the proposed method of examination does give the most useful information that can be supplied

(14) *Definition* —This is found by ascertaining what is the thinnest black line the image of which is just visible when seen against a bright background It is shown that this is the best method that could be devised of measuring the defining power of an objective, and that it is not open to serious objections on theoretical grounds

(15) *Achromatism* —In the Certificate is recorded under this heading the difference of focus between an object when seen in white light and the same when seen in blue or red light

(16) *Astigmatism* —This test is performed by measuring the distance between the focal lines at a position equivalent to the corner of the plate, and by calculating from the result thus obtained the approximate diameter of the disk of diffusion due to astigmatism

(17) *Illumination of the Field* —The method of examination, which is due to Captain Abney, is described

"On Certain Ternary Alloys Part VI Alloys containing Aluminium, together with Lead (or Bismuth) and Tin (or Silver)" By C. R Alder Wright, D Sc, F R S, Lecturer on Chemistry and Physics in St Mary's Hospital Medical School

The experiments described in this paper are a continuation of the previous researches on the miscibility of molten metals under such conditions that whereas two of the metals, A and B, will not mix together in all proportions, the third, C, is miscible in all proportions with either A or B severally The alloys now investigated are those where A is lead (or bismuth), B, aluminium, and C, tin (or silver). They show considerable analogy with, and resemblance to, those previously described containing the same metals as A and C respectively, but zinc instead of aluminium as B, but certain differences are noticeable thus the substitution of aluminium for zinc invariably *raises the critical curve*, causing it to lie *outside* its former position, this being observed whether the heavy immiscible metal, A, be lead or bismuth, and whether the solvent metal, C, be tin or silver. On the other hand, the substitution of bismuth for lead always *depresses the critical curve*, causing it to lie *inside* its former position, this being equally observed whether the lighter immiscible metal, B, be zinc or aluminium, and whether the solvent metal, C, be tin or silver In the case of the metals bismuth-zinc-silver and lead-zinc-silver, peculiar bulges (inwards and outwards) were noticed in certain parts of

the critical curve, due to the formation of definite atomic compounds, $AgZn_6$ and Ag_4Zn_5, no corresponding indications are observed when aluminium replaces zinc in these mixtures, whence apparently similar atomic combinations of silver and aluminium are not formed On the other hand, lead zinc-tin and lead-aluminium-tin alloys correspond sharply with each other in that they are the only alloys yet examined where the direction of slope of the tie lines is not the same throughout, in each case the lower ties slope to the left (lead side), and the upper ones to the right (zinc side), the point where the angle of slope of the lower ties is a maximum corresponds in each case with a ratio between lead and tin in the heavier alloys formed approximating pretty closely to that indicated by the formula Pb_6Sn, suggesting that the sloping of the lower ties is due to the formation of this definite atomic compound The upper ties in each case exhibit a tendency to converge towards a point on the right-hand side of the curve, approximately where the ratios of zinc to tin and aluminium to tin respectively are those indicated by the formulæ Zn_4Sn, and Al_4Sn, suggesting the existence of these definite compounds

In the course of the experiments, it is shown incidentally that bismuth and aluminium are practically immiscible when molten at about 900° C bismuth dissolves less than 0 1 per cent of aluminium, whilst aluminium dissolves about 2 0 per cent of bismuth The binary alloys of bismuth and aluminium stated by previous observers to exist are simply more or less intimate intermixtures of the two metallic solutions

"On the Theory of Electrodynamics as affected by the nature of the Mechanical Stresses in Excited Dielectrics" By J Larmor

The various theories of electrodynamics are examined from the standpoint of their ability to explain the experimental facts as to pressures in liquid dielectrics which have been made out by Quincke and other experimenters

The principal conclusions are as follow —

(1) It follows from the experimental results that the stress in an excited fluid dielectric between two condenser plates consists, at any rate to a first approximation, of a tension along the lines of force and an equal pressure in all directions at right angles to them, superposed upon such stress as would exist in a vacuum with the same value of the electric force

(2) It follows from experiments that the numerical value of these additional equal tensions and pressures is, at any rate to a first approximation, $(K - 1)F^2/8\pi$, where F is the electric force, and K the inductive capacity

(3) Such a distribution of equal tension and pressure is necessarily the result of a uniform volume distribution of energy in the dielectric, irrespective of what theory is adopted as to its mode of excitation

(4) If we consider the mode of excitation to be a *quasi* magnetic polarization of its molecules, the numerical magnitude of these stresses should be

$$\frac{K-1}{8\pi}F^2\left(1+\lambda\frac{K-1}{4\pi}\right),$$

where λ is a coefficient which depends on the molecular discreteness of the medium, and is probably not very different from the value $\frac{4}{3}\pi$ A discrete polarization of the molecules does not account for the stress, so far as this coefficient is concerned

(5) The stress which would exist in a vacuum dielectric is certainly due in part to a volume distribution of energy, as is shown by the propagation of electric waves across a vacuum There is thus no reason left for assuming any part of it to be due to a distribution of energy at its two surfaces, acting directly on each other at a distance There is therefore ground for assuming a purely volume distribution of energy in a vacuous space, leading to a tension $(1/8\pi)F^2$ along the lines of force, and a pressure $(1/8\pi)F^2$ at right angles to them

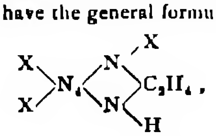
(6) The *quasi*-magnetic polarization theory rests on the notion of a dielectric excited by a surface charge on the plates, and therefore involves a surface distribution of energy, unless in the extreme case when the absolute value of K is very great; in that case a slight surface-charge produces a great polarization effect, and in the limit the polarization may be taken as self excited Thus the absence of a surface distribution of energy leads to Maxwell's displacement-theory, in which all electric currents are circuital, and the equations of electrodynamics are therefore ascertained

(7) It appears that even this limiting polarization theory must be replaced, on account of the stress-formula in (4), by some dynamical theory of displacement of a more continuous character

"The Hippocampus" By Dr Alex Hill

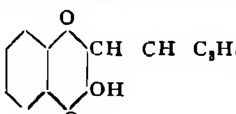
Observations upon the brains of various aquatic mammals which show that, when the sense of smell is completely absent, as judged by the total suppression of the olfactory bulb and nerves, the essential constituent of the "hippocampus," the fascia dentata, is absent also Amongst other mammals the fascia dentata varies in development as the olfactory bulb

Chemical Society, June 2 —Dr W H Perkin, F R S Vice President, in the chair —The following papers were read —Ethylene derivatives of diazoamido compounds, by R Meldola and F W Streatfeild The authors find that ethylene diazoamides result from the action of ethylene dibromide and caustic alkali on diazoamides dissolved in alcohol The products thus obtained have the general formula—

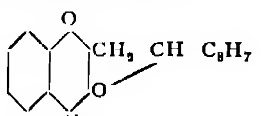


mixed ethylene diazoamides can also be obtained These compounds are very stable, and are decomposed by prolonged contact with concentrated hydrochloric acid at ordinary temperatures —The action of light on silver chloride, by H B Baker The small loss in weight which silver chloride undergoes on exposure to light has led the author to investigate whether oxygen is absorbed at the same time that chlorine is evolved, Robert Hunt having long ago stated that such an absorption does occur Silver chloride was placed in a bulb connected with a long tube standing over caustic potash solution, the atmosphere consisted of air or oxygen On exposing this apparatus to light, the liquid rose in the tube, showing that oxygen had been absorbed. The proportion in which the elements silver, chlorine, and oxygen were contained in the darkened substance was then determined The results agree approximately with the formula Ag_2ClO The experimental difficulties in the way of an exact determination of the composition of the darkened product are very great, owing to the fact that the dark substance is mixed with an enormous quantity of unchanged silver chloride The product of exposure to light never contains more than 0 1 gram of the dark coloured substance per 50 grams of unaltered silver chloride Another cause of inaccuracy complicates the result if the analyses be not made immediately after exposure, the darkened substance turns white again if left in the dark, probably owing to the formation of another oxychloride The thoroughly dried darkened substance yields water on reduction in pure hydrogen, and also evolves oxygen on treatment with pure chlorine The results of determinations of the constituents of the darkened product made by various analytical methods agree as well as could be expected Silver chloride does not darken when exposed to light in absence of oxygen No darkening was observed in a vacuum, in carbon dioxide, or in carefully purified carbon tetrachloride It is, however, difficult to eliminate traces of alcohol, carbon disulphide, &c, from carbon tetrachloride, and the darkening caused by these impurities has hitherto been confounded with that caused by oxygen Darkened silver chloride dissolves completely in boiling potassium chloride solution, and the solution so obtained contains caustic potash The production of this free alkali seems to prove conclusively that oxygen is present in the darkened substance in the combined state —The estimation of slag in wrought iron, by A E Barrows and T Turner Cast iron comparatively rich in non-metallic elements is known to afford a greater yield of puddled bar than do purer samples of iron The loss on reheating and rolling into finished iron is, however, also greater This difference has been attributed to intermingled slag The authors prepared four samples of iron, viz best bar, best sheet from the same bar, common bar, and common sheet from the same Pig iron of known composition was used, the yield of common puddled bar was 6 5 per cent greater than that of the other, but the loss on reheating was also 1 5 per cent greater, leaving a balance of 5 per cent in favour of the common iron The results of analyses show that the silicon is equally, and very slightly, reduced in each case, whilst the phosphorus was much reduced in common iron, and but scarcely affected in best This does not favour the view that much more slag is removed in one case than in the

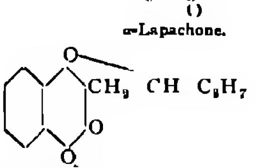
other The authors conclude that for practical purposes the weight of slag in best and common iron may be taken as identical, and that on reheating and rolling each loses about the same weight of slag The additional loss noticed on reheating impure iron is due chiefly to the elimination of phosphorus, probably in the form of ferrous phosphate On attempting to estimate the slag by combustion in chlorine, a method already employed for cast iron, it was found that the slag was readily attacked by the gas at a very low red heat An examination of the behaviour of a number of iron ores and slags showed that action occurs according to the equation $3FeO = Fe_2O_3 + Fe$, the free iron subliming as ferric chloride —Corydaline, II, by J J. Dobbie and A Lauder Analyses of salts of corydaline are given in support of the formula $C_{22}H_{29}NO_4$, originally proposed by the authors for this alkaloid The alkaloid employed by them is identical with that extracted by Adermann from the roots of *Corydalis cava* Corydaline yields four molecular proportions of methyl iodide on treatment with concentrated hydriodic acid, the hydriodide of a new base $C_{18}H_{21}NO_4,HI$ is also obtained The conclusion that corydaline contains four methoxy groups is confirmed by the inability of the authors to obtain any definite reaction with phenylhydrazine or phosphorus pentachloride —The action of bromine on allylthiocarbimide, by A E Dixon Allylthiocarbimide readily combines with bromine, yielding dibromopropylthiocarbimide as an oily liquid which decomposes on distillation under ordinary pressures This compound does not afford dibromopropylphenylthiourea when treated with aniline, but the two substances react with elimination of hydrogen bromide and formation of a compound of the formula $C_{10}H_{11}BrN_2S$, probably *n*-phenylbromotrimethylene ψ thiourea —The hydrolytic functions of yeast, Part I, by J O'Sullivan It is generally stated, on the authority of Berthelot, that the water in which yeast has been washed possesses, like yeast itself, the power of hydrolyzing cane sugar, and that the active substance can be precipitated from the solution by means of alcohol The author shows, however, that healthy yeast yields none of its invertase to water in which it is washed When such yeast is placed in contact with sugar, hydrolysis is effected solely under the immediate influence of the plasma of the cell, no invertase leaving the cell while hydrolysis is taking place A detailed account is given of experiments carried out under various conditions, which show that water which had been in contact with highly active yeast for various times had no hydrolytic power, although on the addition of a mere trace of invertase, it at once became active The author therefore concludes that the resolution of cane sugar under the influence of yeast is entirely due to zymic hydrolysis —The constitution of lapachic acid (lapachol) and its derivatives, by S C Hooker Lapachic "acid" is found in a crystalline state in the grain of a number of South American woods, and derives its name from the lapach tree, which is plentiful in the Argentine Republic On treatment with sulphuric acid, lapachol is converted into an isomeride generally known as lapachone The author proposes to term this latter substance β-lapachone, it being a derivative of β naphthaquinone When lapachol is treated with concentrated hydrochloric acid, α-lapachone, a derivative of α naphthaquinone is obtained The author assigns the following constitutional formulæ to these three isomerides—



Lapachol.



α-Lapachone.



β-Lapachone.

It is shown that Paterno's isolapachone in reality contains less hydrogen than the lapachones, and is doubtless a β-naphthaquinone-propyl-furfuran

Linnean Society, June 2 —Prof Stewart, President, in the chair —The Vice-Presidents for the year having been nominated by the President, a vote of thanks to the officers of the Society was proposed by Mr Thomas Christy, seconded by Mr C J Breese, and carried —Mr H Bernard exhibited specimens and made remarks on the probably poisonous nature of the hairs and claws of an Arachnid (*Galeodes*) —On behalf of Capt Douglas Phillott there was exhibited a curious case of malformation in the beak of an Indian parrakeet, *Palæornis torquatus* The upper mandible was so abnormally decurved as almost to penetrate between the rami of the lower mandible, and although the bird was in good condition at the time it was shot by Capt Phillott at Dera Ismail Khan, Punjab, in March last, it was evident that had it not been killed then, death must have soon ensued from a severance of the trachea by the sharp extremity of the prolonged mandible —Mr D Morris exhibited, and made some very instructive remarks on, plants yielding Sisal hemp in the Bahamas and Yucatan, and pointed out their distribution and mode of growth He also exhibited and described the preparation of a gut silk from Formosa and Kiungchow —Mr Scott Elliott gave a brief account of a journey he had recently made to the west coast of Africa, and described the character of the vegetation of the particular region explored, and the plants collected by him —Mr. Jenner Weir exhibited and made remarks on a species of Psyche —On behalf of Mr Ernest Floyer, a paper was read by the Secretary on the disappearance of certain desert plants in Egypt through the agency of the camel —Mr F Perry Coste gave an abstract of a paper on the chemistry of the colours in insects, chiefly Lepidoptera The paper was criticized by Prof Meldola, who was unable to accept the views expressed, the results of the experiments made being, in his opinion, inconclusive —The meeting was brought to a close by the exhibition of an excellent oxyhydrogen lantern, recently presented to the Society by Dr R C A Prior, when Dr R B Sharpe exhibited a number of coloured slides of birds designed to illustrate the interesting subject of mimicry and protective coloration

Geological Society, June 8 —W H Hudleston, F R S, President, in the chair —The following communications were read —The Tertiary microzoic formations of Trinidad, West Indies, by R J Lechmere Guppy (Communicated by Dr H. Woodward, F R S) After giving an account of the general geology of the island, and noticing previous memoirs devoted to that geology, the author describes in detail the characters of the Naparima Beds, to which he assigns an Eocene and Miocene age He considers that the Nariva Marls are not inferior to but above the Naparima Eocene Marls, and are actually of Miocene date Details are given of the composition and characters of the "argiline," the foraminiferal marls occasionally containing gypsum, and the diatomaceous and radiolarian deposits of Naparima The Pointapier section is then described, and its Cretaceous beds considered, reasons being given for inferring that there was no break between the Cretaceous and Eocene rocks of the Parian area Detailed lists of the foraminiferal faunas of the marls are given, with notes The author observes that the Eocene molluscan fauna of Trinidad shows no near alliances with other known faunas, thus differing from the well known Miocene fauna of Haiti, Jamaica, Cuba, Trinidad, and other localities Only one mollusk is common to the Eocene and Miocene of the West Indies The shallow-water Foraminifera are found in both Eocene and Miocene, whilst the deep-water Foraminifera are nearly all of existing species It would appear that during the Cretaceous and Eocene periods a sea of variable depth (up to 1000 fathoms) occupied the region now containing the microzoic rocks of Trinidad, whilst a mountain range (which may be termed the Parian range) extended continuously from the north of Trinidad to the littoral Cordillera of Venezuela, forming the southern boundary of the Caribbean continent, and possessing no large streams to transport mechanical sediment into the Cretaceo-Eocene sea which opened eastward into the Atlantic An appendix by Mr J W Gregory deals with the microscopic structure of the rocks The reading of this paper was followed by a discussion, in which the President, Dr H Woodward, Mr J W Gregory, Mr. Vaughan Jennings, and Dr Hinde took part —The Bagshot Beds of Bagshot Heath (a rejoinder), by the Rev A Irving —Notes on the geology of the Nile Valley, by E A Johnson Pasha and H Droop Richmond (Communicated by Norman Tate) The rocks on either side of the Nile are chiefly Eocene (and Cretaceous?) from Cairo to Esneh, south of this is sandstone, which the authors believe to be Carboniferous, and to yield possible indications of coal, reaching to near Assouan, where it

meets the granite and basalt of that region, a few miles south the sandstone begins again and continues to Wady Halfa, broken only by granite dykes The granite is intrusive into and alters the sandstone, whilst the latter reposes upon the basalt and in some cases was deposited against upstanding basaltic masses Unmistakable lavas occur near the Nile east of Minieh and west of Assiout A description of some remarkable faults is given, and various minerals are noticed as occurring in the sedimentary rocks and the bed of an ancient river

Mathematical Society, June 9 —Prof Greenhill, F R S, President, in the chair —Prof Henrici exhibited a model of movable hyperboloids of one sheet In 1873 he gave a student at University College the problem to construct a model of a hyperboloid of one sheet by fixing three sticks anyhow, placing others so as to cut these, and tying them together wherever they met He told the student that the system would soon become rigid, but was surprised to find that this was not the case It was easy to see the reason of this fact, and thus he established the theorem If the two sets of generators of a hyperboloid be connected by articulated joints wherever they meet, then the system remains movable, the hyperboloid changing its shape It was also soon found that each point moves during this deformation along the normal to the momentary position of the surface, and that therefore the different positions of the surface constitute a system of confocal hyperboloids He then made a model such that the generators represented by sticks meet at points which lie on lines of curvature of the hyperboloids These describe, therefore, confocal ellipsoids and hyperboloids of two sheets In January 1874, Prof Henrici exhibited this model at a meeting of the Society Shortly afterwards a student made two copies of this model, and these were fastened together in such a manner that both could move together, remaining always confocal It was this last model that was now shown The properties of the movable hyperboloid became more widely known through a question which Prof Greenhill set in 1878 at the Mathematical Tripos Examination, and this led Prof Cayley to give a solution of it in the *Messenger of Mathematics* Since that time several French mathematicians have made further investigation of the property in question MM Darboux and Mannheim, in particular, have made beautiful application of the deformable hyperboloid to the motion of a gyrating rigid body —The following further communications were made —The second discriminant of the ternary quantic, $x'u + y'v + z'w$, by Mr J E Campbell If the ordinary discriminant of this quantic in x, y, z, be formed, the result will be a quantic in x', y', z' The discriminant of this latter the writer believes vanishes identically with certain exceptions Prof Henrici referred the author to a paper by himself in vol ii of the Society's Proceedings —On the reflection and refraction of light from a magnetized transparent medium, by A B Basset, F R S The object of this paper is to apply the theory of gyrostatically loaded media, to investigate the reflection and refraction of light at the surface of a magnetized transparent medium This subject has been partially discussed by Mr Larmor in a paper communicated to the Society last December, in which he has obtained the equations of motion of the medium, but the paper in question contains (Mr Basset thinks) a certain amount of vague and obscure argument, founded upon general reasoning, which is calculated to envelop the subject in a cloud of mystery, rather than to enlighten the understanding He, therefore, finds it necessary to write out the theory *de novo*, and to enter into a careful discussion respecting the boundary conditions The principal results are as follows When the magnetic force is parallel to the reflector, and also to the plane of incidence, the expressions for the amplitudes of the reflected light are the same as those which he obtained by means of an extension of the electro magnetic theory (see *Phil Trans*, 1891, p 371), but when the magnetic force is perpendicular to the reflector, the above-mentioned expressions are of the same form as those furnished by the electromagnetic theory, with the exception that the signs of the magnetic terms are reversed An experimental test of the relative merits of the two theories might probably be obtained by means of certain experiments performed by Prof Kundt (*Berlin Sitzungsberichte*, July 10, 1884, translated *Phil Mag*, October 1884), but the mathematical work, although presenting no difficulty, would be somewhat laborious. Having worked out these results, he endeavours to obtain a theoretical explanation of Kerr's experiments, on reflection from a magnet, by combining the theory of gyrostatically loaded media with the theory of metallic reflection, explained in his book on "Physical Optics," chapter xviii sections 386-87, but the results are not entirely satisfactory This, however, is not surprising, inasmuch as the theory of gyrostatically loaded media takes no account of the statical effects of magnetization —Note on approximate evolution, by Prof Lloyd Tanner This note supplies a deficiency in a paper (Math Soc Proc, vol xviii) in which Prof Hill pointed out the incorrectness of the rule for contracting the processes of finding the square and cube roots of a number—namely, it gives a practical test for determining the cases when the rule can, and when it cannot, be safely applied A proof of the exactness of Cayley's number of seminvariants of a given type, by Mr E B Elliott, F R S —Further note on automorphic functions, by Prof W Burnside

Royal Meteorological Society, June 15 —Dr C Theodore Williams, President, in the chair —The following papers were read —English climatology, 1881 1890, by Mr. F C Bayard This is a discussion of the results of the climatological observations made at the Society's stations, and printed in the *Meteorological Record* for the ten years 1881-1890 The instruments at these stations have all been verified, and are exposed under similar conditions, the thermometers being mounted in a Stevenson screen, with their bulbs 4 feet above the ground The stations are regularly inspected, and the instruments tested by the Assistant Secretary The stations now number about eighty, but there were only fifty-two which had complete results for the ten years in question The author has discussed the results from these stations, and given the monthly and yearly means of temperature, humidity, cloud, and rainfall His general conclusions are —(1) With respect to mean temperature, the sea coast stations are warm in winter and cool in summer, whilst the inland stations are cold in winter and hot in summer (2) At all stations the maximum temperature occurs in July or August, and the minimum in December or January (3) Relative humidity is lowest at the sea coast stations, and highest at the inland ones (4) The south-western district seems the most cloudy in winter, spring, and autumn, and the southern district the least cloudy in the summer months, and the sea coast stations are, as a rule, less cloudy than the inland ones (5) Rainfall is smallest in April, and, as a rule, greatest in November, and it increases from east to west —The mean temperature of the air on each day of the year at the Royal Observatory, Greenwich, on the average of the fifty years 1841 to 1890, by Mr W. Ellis The values given in this paper are derived from eye observations from 1841 to 1848, and from the photographic records from 1849 to 1890 The mean annual temperature is 49° 5 The lowest winter temperature, 37° 2, occurs on January 12, and the highest summer temperature, 63° 8, on July 15 The average temperature of the year is reached in spring, on May 2, and in autumn on October 18. The interval during which the temperature is above the average is 169 days, the interval during which it is below the average being 196 days

SYDNEY

Royal Society of New South Wales, May 4 —Annual Meeting —H C Russell, F R S, President, in the chair —The report stated that 61 new members had been elected during the year, and the total number on the roll on April 30 was 478 During the year the Society held eight meetings, at which the following papers were read —Presidential address, by Dr A Leibius —Notes on the large death-rate among Australian sheep in country infected with Cumberland disease or splenic fever, and Notes on a spontaneous disease among Australian rabbits, by Adrien Loir —Compressed-air flying machines, Nos 13 and 14, and on a wave-propelled vessel, by L Hargrave —A cyclonic storm or tornado in the Gwydir district, Preparations now being made in Sydney Observatory for the photographic chart of the heavens, Notes on some celestial photographs recently taken at Sydney Observatory, and Notes on the rate of growth of some Australian trees, by H. C Russell, F R S —Some folk-songs and myths from Samoa, translated by the Rev. G Pratt, with introductions and notes, by Dr John Fraser —Notes on the use, construction, and cost of service reservoirs, by C W Darley —On the constitution of the sugar series, by W. M Hamlet —On kaolinite from the Hawkesbury Sandstone, by H G Smith —A contribution to the microscopic structure of some Australian rocks, by the Rev. J. Milne Curran.—On some New South Wales and other minerals (note No. 6), by Prof. Liversidge, F R S —Artesian

water in New South Wales (preliminary notes), by Prof T W E David ——The Medical Section held four meetings The following papers were read —A brief account of the histology and development of tubercle, by Prof Anderson Stuart —Remarks upon the nature and treatment of diphtheria, by Dr W Camac Wilkinson —Glimpses of the past a series of sketches with pen and pencil of the medical history of Sydney, by Dr Honlson ——The Microscopical Section held five meetings The following paper was read —Notes on slicing rocks for microscopical study, by the Rev J Milne Curran ——The Civil and Mechanical Engineering Section held eight meetings. The following papers were read —Recent researches on the strength, elasticity, and endurance of materials of construction with especial reference to iron and steel, by Prof Warren —The bridge over Lane Cove River at the head of navigation, by H H Dare —On the calculation of stresses by means of graphic analysis, by J I Haycroft —On the tacheometer and its application to engineering surveys, by W Poole, Jun —On the sewerage of country towns the separate system, by Dr Ashburton Thompson ——The Clarke Medal for 1892 had been awarded to Prof W T Thiselton Dyer, F R S The Council had issued the following list of subjects with the offer of the Society's bronze medal, and a prize of £25 for each of the best researches if of sufficient merit —(To be sent in not later than May 1, 1893) Upon the weapons, utensils, and manufactures of the aborigines of Australia and Tasmania, on the effect of the Australian climate upon the physical development of the Australian born population, on the injuries occasioned by insect pests upon introduced trees (To be sent in not later than May 1, 1894) On the timbers of New South Wales, with special reference to their fitness for use in construction, manufactures, and other similar purposes, on the raised sea beaches and kitchen middens on the coast of New South Wales, on the aboriginal rock carvings and paintings in New South Wales —The Chairman read the Presidential address, and the Officers and Council were elected for the ensuing year, Prof Warren being President.

PARIS

Academy of Sciences, June 13 —M d'Abbadie in the chair.—A new contribution to the history of the truffle, *Terfezia Camboni*, "Terfâs" of Southern Algeria, by M A Chatin —On subcutaneous or intra-venous injections of liquid extracts from several organs as a therapeutic method, by MM Brown-Séquard and d'Arsonval —In the place of the late Dom Pedro d'Alcantara, M von Helmholtz was elected Foreign Associate —Researches on the solar atmosphere, by Mr George E Hale, of the Kenwood Astrophysical Observatory, Chicago A photograph of a metallic protuberance, obtained with an aperture of 12 inches and a large grating spectroscope, shows all the lines previously announced in the ultra-violet, and the following additional ones 3961 7 (manganese?), 3900 7 (calcium), 3886 4 (hydrogen), and 3860 4 (iron?) The writer has succeeded in photographing faculæ in the centre of the disk —On the general problem of the deformation of surfaces, by M L. Raffy —On the theory of the fuchsian functions, by M Ludwig Schlesinger —On transformations in mechanics, by M P Painlevé —On considerations of homogeneity in physics, by M A Vaschy —On the non-realization of the spheroidal state in steam boilers reclamation of priority, by M de Swarte.—On the co existence of dielectric power and electrolytic conductivity, by M E Bouty A rigid condenser is formed of iron disks separated by small wedges of mica, and joined by iron screws isolated by mica and placed opposite the wedges This condenser is plunged into a fused mixture of equal parts of the nitrates of sodium and potassium Air bubbles are carefully removed with plates of mica, and the condenser is withdrawn at the moment when the salt commences to solidify The liquid, retained by capillarity, forms between the disks an adherent regular solid layer. The apparatus while yet hot is plunged into melted paraffin, which surrounds it with an isolating layer devoid of hygroscopic power The experiments give a value for k approaching 4, and nearly constant within the limits of temperature in which the specific resistance in ohms may vary from $3{\cdot}6 \times 10^{11}$ to $2{\cdot}6 \times 10^{9}$, *i e* in the ratio of about 138 to 1 Here the conductivity and the dielectric capacity belong to molecules of the same kind It is probable that if the experiments could be extended to ordinary electrolytes, they would give results of the same kind—that is, finite values of the dielectric constant k The distinction between dielectrics and electrolytes would thus solely reside in the amount of their conductivity. Dielectric polarization, established in a very short time in comparison with the ten-thousandth of a second, would correspond, in Grotthuss's scheme, to the initial orientation of the compound molecules, their conductivity to their progressive rupture —On the retardation in the perception of the different rays of the spectrum, by M Aug Charpentier On suddenly illuminating the slit of a spectroscope by white light, the red portion of the spectrum is seen first, and the light seems to shoot across from the red to the violet This was confirmed by rotating an inverted sector of a circle, 1 cm broad at the base, and 8 to 10 cm long once in two or three seconds The extreme point seemed drawn out into a kind of spectrum extending from the red to the green The maximum duration of excitation compatible with the isolation of the colours does not exceed about four or five thousandths of a second —On the anhydrous crystallized fluorides of nickel and cobalt, by M C Poulenc —Action of nitric oxide upon the metals, and upon the metallic oxides, by MM. Paul Sabatier and J B Senderens —Thermochemical study of guanidine, of its salts and of nitroguanidine, by M C Matignon.—Researches on the diiodic derivatives of the three isomeric diphenols, by M de Forcrand —On normal pyrotartaric or glutaric acid, by M G Massol —Study of the decomposition of the diazo compounds, by MM J Hausser and P Th. Muller.—The folds in the Secondary formations in the neighbourhood of Poitiers, by M Jules Welsch —On the genesis of the ophiolitic rocks, by M L Mazzuoli —Three cases of increase in the velocity of transmission of sense impressions, under the influence of injections of the testiculary liquid, by M Grigorescu.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS —Country Thoughts for Town Readers K B B de la Bere (Simpkin) —The Etiology and Pathology of Grouse Disease Dr E Klein (Macmillan) —Marine Shells of South Africa G B Sowerby (Sowerby).—Atlas of Clinical Medicine vol I. Dr B Bramwell (Edinburgh, Constable).—The Standard Course of Elementary Chemistry, Parts 1–5 E J Cox (Arnold) —English Botany, Supplement to the Third Edition, Part 2 N E Brown (Bell) —Volcanoes, Past and Present Dr E. Hull (Scott) —Den Norske Nordhavs-Expedition 1876–78, xxi Zoologi, Crinoida D C Danielssen (Christiania Grondahl).—Coal Gas as a Fuel, fourth edition T. Fletcher (Liverpool, Tinling)

PAMPHLETS —Twenty second Annual Report of the Wellington College Natural Science Society, 1891 (Wellington College) —Johns Hopkins University of Baltimore Register for 1891–92 (Baltimore) —British Universities (Manchester, Cornish)

SERIALS —Astronomy and Astro Physics, June (Northfield, Minnesota) —L Anthropologie, tome iii No 2 (Paris, Masson) —Journal of the Royal Microscopical Society June (Williams and Norgate) —Contributions from the U S National Herbarium, vol ii, No 2 (Washington) —Bulletin of the New York Mathematical Society, vol 1 No 9 (New York)

CONTENTS.

THURSDAY, JUNE 30, 1892

THE LONDON UNIVERSITY OF THE FUTURE

AMONG the many points discussed in relation to the schemes for providing London with a University which have been under consideration during the last few years, scarcely any reference has been made to the higher teaching which ought to be at the disposal of the citizens of the most important and largest city in the world Attention has been almost exclusively directed to the class teaching necessary to pass certain examinations which open the door to professional employment

It is not necessary to enlarge upon this remarkable omission, although the reason for it is not far to seek, but we think it may be desirable, in order to show that such teaching is not Utopian, and that other nations freely provide what is so conspicuous by its absence in London, to give an indication of the quantity and quality of the teaching in the metropolis nearest our own

The indications, to be exhaustive, would occupy several pages of NATURE, we must perforce content ourselves by giving the courses open to the citizens of Paris at the Sorbonne and the Collège de France

The question does not concern science alone We have not, therefore, limited ourselves to the scientific subjects, and it will be understood that, besides the undergraduate and graduate courses, there are special courses connected with the many other institutions in Paris allied either with the various professions directly, or with the national culture generally

Among the former we may content ourselves at present with referring to the École Normal and the Ecole Polytechnique, among the latter are the Museums of Natural History, of Physical Science, of Antiquities, Art and Archæology, each of these with lectures on the subjects which are illustrated by their contents

We shall, if possible, take a subsequent opportunity of giving lists of these special courses, but the lectures at the University and College alone exhaust our space for this week Comment on the breadth of the teaching and of the men to whom it is confided in Paris, and on the absence of anything approaching it here, is needless

SORBONNE FACULTY OF SCIENCES
1892—*Second Scholastic Term*

Day	Hour	Subject	Professor
MONDAYS	8 30	Differential and Integral Calculus Ordinary Differential Equations and Equations with Derived Partials	Picard
	8 45	Lectures on Geology General	Vélain
	9	Lectures on Chemistry Manipulations for the Licentiate	Riban
	10	Lectures in Natural Science	Chatin
	10 30	Calculus of Probabilities Mathematical Theory of Hydrodynamic Vortices and Application to Electrodynamics	Poincaré
	11	Lectures on Chemistry · Theoretical and Practical Qualitative Analysis	Riban
	1.30	Lectures on Physical Sciences Thermodynamics	Pellat
	2 45	Mineralogy and Crystallography Principal Mineral Species	Hautefeuille.
	3	Lectures on Mathematical Sciences	Puiseux
	5	Lectures on Chemistry	Joly
TUESDAYS	8 30	Astronomy Programme for the Licentiate's Degree	Wolf
	8 30	Lectures on Natural Sciences Botany	Vesque
	8 30	Lectures on Mineralogy	Jannettaz.
	9	Lectures on Natural Sciences Identification of Rocks, &c	Vélain
	10	Mechanics and Experimental Physics Properties of Elastic Solids, &c	Boussinesq
	10	Histology General Character of Elementary Anatomy, Nervous and Muscular Tissue from an Histological Point of View. Zoology	Chatin
	10 30	Lectures on Chemistry	Joly
	2	Physics. Electricity	Lippmann
	2	Lectures on Mathematical Sciences. Differential and Integral Calculus	Kaffy
	3	Do do do do	Kaffy
	3 30	Zoology, Anatomy, Physiology Zoophites, &c	Delage.
	3 30	Course on Spectroscopy and Photographic Chemistry	Salet
WEDNESDAYS	8 30	Mechanics Dynamics of Systems	Appell.
	8 45	Lectures on General Geology	Velain
	9	Lectures on Chemistry Manipulations for the Licentiate	Riban
	10 15	Higher Algebra Theory of Euler's Integrals and Functions of a Variable	Hermite
	1 30	Organic Chemistry Compounds of the Aromatic Series	Friedel
	2	Lectures on Mathematical Sciences	Blutel
	3	Geology Principal Characters of Geological Periods, Geological Formations	Munier-Chalma
	3	Lectures on Mechanics and Astronomy	Puiseux
	3 45	Analytical Chemistry Determination and Separation of Metals	Riban
	4	Lectures on Physical Sciences Questions on the Subjects of Prof Lippmann's Cours	Foussereau
THURSDAYS	8 30	Lectures on Physical Sciences. Thermodynamics	Pellat.
	8 30	Differential and Integral Calculus, &c.	Picard
	9	Lectures on Natural Science Identification of Rocks and the Principal Characteristic Fossils	Velain.
	9	Lectures on Chemistry Manipulations for the Licentiate	Riban.
	10	Lectures on Natural Science	Chatin
	10 30	Calculus of Probabilities and Mathematical Physics Theory of Vortices Hydrodynamics Application to Electrodynamics	Poincaré
	1	Chemistry Lectures and Manipulations for Professors of Colleges	Riban.
	1 30	Lectures on Physical Sciences Reflection and Refraction of Light	Foussereau
	1 30	Lectures on Mathematical Sciences as a Whole	Kœnigs.
	2 30	Do do do.	Kœnigs.
	2 45	Mineralogy and Crystallography, &c.	Hautefeuille.
	4	Lectures on Physical Sciences	Pellat
	5	Lectures on Chemical Sciences	Joly.

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Day	Hour	Subject	Professor
FRIDAYS	8 30	Lectures on Physics	Pellat.
	8 30	Mechanics · Dynamics of Systems	Appell
	8 30	Lectures on Botany	Vesque.
	9	Lectures on Chemistry and Manipulations for the Licentiate	Riban
	9	Lectures on Geology Identification of Rocks and the Principal Characteristic Fossils	Velain
	10	Mechanical and Experimental Physics, &c	Boussinesq
	10.30	Organic Chemistry Compounds of the Aromatic Series	Friedel
	1	Lectures on Chemistry and Manipulations	Riban
	3	Lectures on Mathematical Sciences Differential Calculus	Kaffy
	3	Geology Geological Periods, Secondary Formations	Munier Chalma
	4	Lectures on Physical Sciences Subjects of Prof. Lippmann's Course	Foussereau
	5 30	Lectures in Mathematical Sciences	Kaffy
SATURDAYS	8 30	Astronomy Programme for the Licentiate	Wolf
	8 30	Lectures on Mineralogy	Jannettaz
	10 15	Higher Algebra Euler's Integrals, &c	Hermite.
	10 30	Lectures on Chemistry	Joly
	2	Physics Electricity	Lippmann
	3	Lectures on Mathematical Sciences Mechanics and Astronomy	Puiseux
	3 30	Zoology, Anatomy, Comparative Physiology	Delage
	3 30	Lectures on Organic Chemistry	Salet

FACULTY OF LETTERS 1892—*Second Term*

Day	Hour	Subject	Professor
MONDAYS	9 30	Lectures on French Literature	Gazier
	11	Complementary Course in English Language and Literature	Beljame
	1.15	Pedagogy Lectures (Historical Sciences), General Contemporaneous History	Seignobos.
	1 30	History of Ancient Philosophy Moral and Political Doctrines of Aristotle	Waddington
	1 30	Lectures on French Literature	Gazier
	1.30	Lectures on German Language and Literature History of the German Language	Lange.
	1 30	Lectures on Latin Language and Literature	Lafaye
	2	History Lectures General History of the Seventeenth and Eighteenth Centuries	Zeller
	2 30	French Literature of the Middle Ages History of the French Language History of Literature in France in the Fourteenth Century Froissart	Julleville
	3	Latin Language and Literature	Lafaye
	3	Greek Eloquence · Greek Moralist Writers	Crouset
	3	Foreign Literature Æsthetic and Moral Literature of Goethe, General Character of Faust	Lichtenberger.
	3	Modern History History of Legislation from the Sixteenth to the Eighteenth Centuries	Lemonnier.
	3.30	Literature of Southern Europe Cervantes's Works	Gebhart
	4	History of Philosophy Modern Texts	Boutroux.
	4	Modern History Practical Exercises	Lemonnier.
	4.15	Modern and Contemporaneous History History of Russia in the Sixteenth Century	Rambaud.
	5	History of Modern Philosophy Texts	Boutroux.
TUESDAYS	9	French Literature Practical Exercises	Larroumet
	8 45	Ancient History Commentary on a Text	Bouché Leclercq
	9	Sanskrit, and Comparative Grammar of the Indo-European Languages, &c	Henry
	9 45	Ancient History: Greek and Roman Institutions	Bouché Leclercq
	10	History of Ancient Philosophy	Waddington
	10-11	Latin Poetry Practical Exercises	Cartault.
	10 15	French Poetry Explanation of one of the Authors from the Licentiate and Fellowship Programme	Lenient
	10 30	History Practical Exercises	Zeller.
	1 30	Discourses on Contemporaneous Philosophy	Janet
	1 45	Ancient History History of the Roman Empire from the Time of Nero	Guiraud
	2	Letters of Southern Europe Dante	Gebhart
	2	Greek Language and Literature	Hauvette
	3	Geography History of the Exploration of America since Columbus, &c	Himly
	3	French Literature Practical Exercises	Larroumet
	3 15	Latin Language and Literature History of Latin Literature	Lafaye
	4 15	Greek Language and Literature	Hauvette
	4 45	History of Philosophy Systems of Spinoza and Malebranche	Brochard
WEDNESDAYS	9	French Eloquence	Crouslé
	9 15	Pedagogy (Historical Sciences)	Seignobos
	9 30	Sanskrit Relations of India with the West	Levi
	10	Archæology History of Vase painting in Greece	Collignon
	10 30	Philosophy	Janet
	11	Archæology Practical Exercises in Archæology	Collignon
	1	Latin Eloquence on Roman Eloquence under the Republic	Martha.
	1 30	Ancient History	Guiraud
	1 30	French Literature French Literature in the Seventeenth Century	Gazier.
	1 30	Mental Philosophy	Seailles.
	2 15	History of French Colonization and Beginning of the French Restoration	Pigeonneau
	2.30	Ancient History Practical Exercises	Guiraud.
	2 30	Philosophy	Seailles.
	2 45	Philology and Metre Written and Oral Exercises on Metre	Havet
	3 30	History of the French Revolution History of the National Constitution	Aulard.
	3.30	Sanskrit, and Comparative Grammar of the Indo-European Languages	Henry.
	4	History Practical Exercises	Pigeonneau
	4	Greek Poetry Lyric Element of Greek Tragedy	Decharme
	4.45	History of Modern Philosophy Idea of Natural Law, &c.	Boutroux.
	5	Sanskrit, and Comparative Grammar of the Indo-European Languages	Henry
	5	English Language and Literature	Baret.

Day	Hour	Subject	Professor
THURSDAYS.	8 30	History of the French Revolution Exercises	Aulard
	9	Greek Literature and Institutions Correction of Greek Themes, &c	Girard.
	9 30	History of the French Revolution Explanation of Titles	Aulard
	9 30	Lectures on the History of Philosophy Practical Exercises	Brochard
	10	Latin Poetry Passages from Lucretius	Cartault
	10	Lectures on English Language and Literature Practical Exercises	Baret
	10 15	Lectures on Greek Literature and History Explanation of the Authors in the Programme	Girard
	10 30	Lectures on the History of Philosophy	Brochard
	10 45	History Lectures Bassompierre's Memoirs	Zeller
	1	English Language and Literature Shakespeare—French Literature	Beljame
	1 30	Lectures on German Language and Literature Correction of Themes and Dissertations	Lange
	2	French Poetry Patriotic Poetry in France since the 16th Century	Lenient
	2	English Language and Literature Othello	Beljame
	2	Roman Philology First Chapters of Dante's Inferno	Thomas
	3	Foreign Literature Preparation for the Examination in German	Lichtenberger
	3	Modern History Relation of French Art to Institutions, &c	Lemonnier
	3 30	French Literature of the Middle Ages	Julleville
	4	Foreign Literature Preparation for the Examination in German	Lichtenberger
	4.15	Geography History of the Exploration of America since Columbus	Himly
FRIDAYS.	9	Course of Roman Philology Explanation of Texts with French, &c	Thomas
	9	Complementary Course Auxiliary Sciences—on the History of Latin Literature	Langlois
	9 15	Latin Eloquence Explanation of Latin Authors	Martha
	9 30	Complementary Course in Sanskrit Explanation of Elementary Texts	S Levi
	10	Complementary Course in Philology and Metre on Metre	Havet
	10	Complementary Course of Roman Philology History of the Literature	Thomas
	10.15	Lectures on Pedagogy Theory of History Teaching	Seignobos
	1	Lectures on Greek Language and Literature: History of Greek Literature	Hauvette
	2.30	Greek Poetry Explanation of Texts, and Practical Exercises	Decharme
	2 30	History of the Middle Ages on French Ecclesiastical Institutions	Luchaire
	3.30	Practical Exercises in History	Luchaire
	3 30	Ancient History History of Rome from Scylla to Cæsar	Bouché Leclercq
	3 30	Greek Poetry Explanation of Texts, and Practical Exercises	Decharme
	4	Modern and Contemporaneous History: History of the Hindus under Queen Victoria	Rambaud
	4.15	French Literature (Complementary Course): History of French Literature in the 18th Century	Larroumet
	4.45	Lectures on Geography: Text of the Programme	Dubois.
SATURDAYS	9	Greek Eloquence Explanation of Greek Texts and Letters, &c	Croiset
	9	Complementary Course Auxiliary Sciences—on the History of Palæography	Langlois.
	10	Complementary Course in Literature on the Archæology of the Middle Ages	Langlois
	10 15	French Eloquence French Writers of Prose in the Nineteenth Century	Croiset
	10 15	Lectures on Greek Literature and History History of Greek Poetry since the Fifth Century	Girard
	1 30	Greek Eloquence Practical Exercises	Crouslé
	1 30	Lectures on German Language and Literature	Lange
	1 30	Lectures on Philosophy	Seailles
	2	Lectures on Geography Various Questions in General Geography	Dubois
	3	Latin Poetry Lucretius and Latin Poetry during the Ciceronian Epoch	Cartault
	3	Archæology Sculpture in Greece to the Fifth Century	Collignon
	3	Lectures on Geography Practical Exercises	Dubois
	4	History History of the Doctrine of Economics during the first part of the Nineteenth Century	Pigeonneau

COLLÈGE DE FRANCE

1892—*Second Term*

Day	Hour	Subject	Professor
MONDAYS	9	Modern Philosophy concerning the Soul	Nourrisson
	9	Natural History of Inorganic Bodies	Fouqué
	10	Language and Literature of the Arabs Moallakat and Divans of Six Poets	B de Meynard
	10 15	Æsthetics and History of Art History of Italian Art under Pius II	Lafenestre
	10 15	Celtic Languages and Literature Ancient and Middle Irish Texts	H d'Arbois de Jubainville
	10 30	Organic Chemistry on Organic Synthesis and Hydrocarbons	Berthelot
	11 15	Comparative Grammar Theory of the Verb in Indo European Languages	Bréal.
	12.30	Egyptian Philology and Archæology Pyramid Texts	Maspero.
	1 30	History of Latin Literature History of the Latin Theatre	Boissier.
	2 30	Greek Epigraphy and Antiquities Athenian Constitution of Aristotle	Foucart.
	3	History of Religion History of Judaism during the last Four Centuries of the Christian Era	Réville
	3 15	Experimental and Comparative Psychology Will, Heredity, Perception	Ribot
	3 30	Semitic Epigraphy and Antiquities, with Epigraphic Texts	Clermont-Ganneau.
	4.45	Latin Philology on the Prosody of Vowels in the Latin Language ...	Havet.

Day	Hour	Subject	Professor
TUESDAYS	9	History of Latin Literature	Boissier
	10	Assyrian Philology and Archæology · Deciphering of the Assyrian Characters	Oppert
	10 30	General and Experimental Physics on the Optics of the Atmosphere	Mascart
	1	Greek and Latin Philosophy Epicurean Doctrine	Lévêque
	1	Languages and Literatures of Slavonic Origin	Leger
	1	Analytical and Celestial Mechanics Applications, &c	Kœnigs
	1 30	General History of Science Advent of Grecian Geometry Abstract Science	P Lafitte.
	2	History of Comparative Legislation Political Writings of J de Maistre	J Flach.
	2	Geography Economic Statistics and History on French Colonization	" Levasseur
	3	Robert Browning's Poems	Guizot.
	3 15	Political Economy · John Stuart Mill Principles of Political Economy	Leroy Beaulieu
WEDNESDAYS	10	French Language and Literature of the Middle Age Life of St. Alexis	G Paris
	11 15	Language and Literature of Southern Europe	Meyer.
	12 30	Grecian Language and Literature Sophocles	Rossignol.
	12 30	Egyptian Philology and Archæology History of Egyptian Feudalism	Maspero
	1	General Physics and Mathematics Mechanical Properties of Electric Currents	Deprez.
	1 30	Mineralogical Chemistry Chemical Analysis and History of the Metals	Schutzenberger
	2	Hebrew Language and Literature Chaldean and Syrian Languages and Literatures	E Renan
	2	Comparative Embryology Physiological *rôle* of the Cellular Nucleus	Balbiani
	2	Modern French Language and Literature French Romantic School	Deschanel.
	3	Sanscrit Language and Literature Extracts from Mahâbhârata	Foucaux
	3 30	Semitic Epigraphy and Antiquities Hebrew Inscriptions of Jerusalem	Clermont Ganneau
	3 30	Natural History of Organic Bodies	F Franck.
	4 30	Medicine on the Muscle, and Animal Thermodynamics	D'Arsonval
	5	General Anatomy, on the Vascular System	Ranvier
THURSDAYS	9	History and Morals	Longnon
	9	Natural History of Inorganic Bodies: Work of Richthofen on the Geology of China	Fouqué
	10	Assyrian Philology and Archæology	Oppert.
	10.15	Æsthetics and History of Art History of Italian Art under Peter II.	Lafenestre
	11 30	Language and Literature of Southern Europe: Roman de Jaufre	Meyer.
	12 45	Mathematics: Principles of the Infinitesimal Calculus	Jordan.
	1	Roman Epigraphy and Antiquities	Cagnat
THURSDAYS (*cont.*)	2 15	Russian History from Catherine II to Alexander I	Leger
	3	Chinese Language and Literature Tartar and Manchu Language and Literature	[Denis D'Hervey de St
	3	History of Religion History of Judaism during the last Four Centuries	Reville
	3 15	Experimental and Comparative Physiology	Ribot
FRIDAYS	10	Arabic Language and Literature	Barbier de Meynard
	10 15	Celtic Language and Literature	H d'Arbois de Jubainville
	10 30	Organic Chemistry Hydrocarbons in particular	Berthelot
	11 15	Comparative Grammar Theory of the Verb in Indo-European Languages	Bréal
	12 30	Greek Language and Literature Sophocles	Rossignol
	12 30	Works of Robert Browning	Guizot
	1	Greek and Latin Philosophy Doctrines of Epicurus	Lévêque.
	1	Analytical and Celestial Mechanics, Geometrical and Mechanical Applications	Kœnigs.
	12 45	Roman Epigraphy and Antiquities French and Foreign Inscriptions	Cagnat.
	1 45	Greek Epigraphy and Antiquities Mysteries of Eleusis	Foucart
	2	History of Comparative Legislation Landed Property in England and France since the Eighteenth Century	Flach
	2	Persian Language and Literature Relation between the Pehlvi and Persian	Darmesteter
	2	Geography Economic History and Statistics (Algeria, Colonies)	Levasseur.
	3 15	Political Economy on Public Revenues and Imports	Leroy-Beaulieu
	3 30	Natural History of Organic Bodies	Franck.
	4.30	Medicine Animal Muscle and Thermodynamics	D'Arsonval
	5	General Anatomy on the Vascular System	Ranvier
SATURDAYS	9	Modern Philosophy Spinoza	Nourrisson
	10	French Language and Literature of the Middle Ages Life of St. Alexis	G Paris.
	10 30	Experimental and General Physics Optics of the Atmosphere	Mascart.
	12 45	Mathematics Principles of the Infinitesimal Calculus	Jordan
	1	Mathematics and General Physics Electric Currents	Marcel Deprez.
	1	French Language and Literature Principal Writers	Deschanel
	1 30	Mineralogical Chemistry Analytical Chemistry and History of the Metals	Schutzenberger
	2	Persian Language and Literature Relation between the Pehlvi and Persian	Darmesteter.
	2	Comparative Embryology	Balbiani.
	2	General History of the Sciences	P Lafitte.
	3	Chinese Language and Literature Tartar and Manchu Language and Literature	[Denis D'Hervey de St
	2 30	Hebrew, Chaldean, and Syrian Languages and Literatures	E Renan
	3	Sanskrit Language and Literature: Lalita Vistara (Life of Buddha)	Foucaux
	4.45	Latin Philology Palæography of the Latin Classics	Havet

ENGLISH BOTANY

English Botany. Supplement to the Third Edition Part I. (Orders I-XXII) Compiled and Illustrated by N. E Brown, of the Royal Herbarium, Kew Pp 56, viii, 6 Plates (London Bell and Sons, 1891 [1892])

THE third edition of "English Botany" was begun just thirty years since by Dr Boswell (then Syme), and continued at somewhat uncertain intervals, the flowering plants being completed in 1872 The ferns followed at a later period, and the volume containing them was completed by Mr N E Brown, owing to the failure of Dr Boswell's health

Although styled a third edition, Dr Boswell's work was, as everyone knows, a thoroughly new book. It was the production of one who knew plants in the field as well as in the herbarium, and who had a firm hold of his subject Mr J G Baker, who speaks with authority in matters of this kind, says —

"It is not alone the fulness and accuracy of the descriptions that make the book so valuable, but the power he shows in grasping the relationship of the types, and the acute sense of proportion shown in their arrangement I never cease, when I use the book, to admire the skill which is shown in dividing out the types into species, sub-species, and varieties—a task that was done so thoroughly well that when Sir J D Hooker, with all his wide experience, went over the same ground shortly after, in his 'Student's Flora,' he found extremely little to change"[1]

The book, indeed, had defects, among which may be mentioned the "popular portion" and the bad colouring of the plates, but for these Dr Boswell was not responsible and although the history of our British flora may seem to some to have received less attention than it merited, the author's work well deserves the high praise which Mr Baker bestowed upon it.

The first part of the "Supplement," now before us, is the work of Mr N E Brown Mr Brown has long been recognized as an authority upon certain difficult groups of plants He has probably a greater knowledge of the *Stapelieæ*, for instance, than any man living; he has done much good work among the *Aroideæ*, and his many years' employment in the Kew Herbarium has been productive of other valuable contributions to systematic botany He is careful and painstaking, and a fair draughtsman Yet with all these qualifications he is not the man to whom the "Supplement to English Botany" should have been entrusted Such a task could only be carried out satisfactorily by one whose knowledge of British plants was based upon an acquaintance with them in the field as well as in the herbarium, and Mr Brown's name does not occur to us in this connection

There was, as it seems to us, one way, and only one, in which a "Supplement to English Botany" could have been done satisfactorily During the last thirty years our flora has received many additions of *bonâ fide* types, these should, of course, have been figured and described Having regard to the execution of the third edition, the novelties in certain critical genera—such as *Rubus* and *Hieracium*—might have found a place, although the correlation of English with continental forms which is still proceeding in the former genus, and the (too slow) publication of Mr F J Hanbury's monograph in the latter, would have justified their partial if not entire exclusion But the attempt to put into the old bottles the new wine of recent research could only result, as it has resulted, in failure The Batrachian Ranunculi, for instance, may not have been treated satisfactorily by Dr Boswell, and Mr Brown perhaps does well to reproduce a subsequent note by that author modifying his views But the treatment as it stood was a consistent piece of work—the expression of the opinion of one man Mr Brown endeavours to fit Mr Hiern's well-known paper on these plants into Dr Boswell's original descriptions—a Procrustean undertaking, and one which, in our judgment, is entirely valueless, representing as it does neither Dr Boswell's, Mr Hiern's, nor any other consistent view about these troublesome plants Mr Brown's style is so terribly involved that it is often very difficult to ascertain what he means, and he would have been far wiser had he left the Batrachian buttercups alone

For his rearrangement of *Thalictrum* he made "a careful examination of all the material at [his] disposal" It will hardly be believed that neither in this nor in any other instance has he taken the trouble to consult Dr Boswell's own herbarium, although this, as Mr Brown must know, is readily accessible to all London botanists The craze—we can use no milder term—for burdening our lists with varietal names on the most trivial pretexts receives Mr Brown's support he resuscitates Pritzel's names for the bluish and reddish-flowered forms of *Anemone nemorosa* (identifying the former with the *A Robinsoniana* of gardens), although he adds that they are "mere colour forms," with "numerous intermediate shades" Mr Melvill's name is attached to a "var *rosea*" of *Silene gallica*, although he did not rank it as such, but referred to it as a "form merging by every gradation into" *quinquevulnera*, and Mr Brown enriches our nomenclature with a new name—"*Silene anglica* var *maculata*, N.E Br"

Speaking of Mr Pryor's var *oleracea* of *Silene Cucubalus*, Mr Brown says —

"If the plant intended is the same as *S. inflata* var *oleracea*, Ficinus, 'Flora der Gegend um Dresden,' ed. 2, vol i p 313 (1821), which is figured in Reichenbach, Icones Fl Germ et Helvet, vol vi. pl 300, f 5120 γ, it is," &c

Now, Mr Pryor appends to his varietal name a reference to "Bor Fl Centr, ed. iii, ii, 95," and Boreau cites Reichenbach's t 300 for his plant How, then, can there be any question as to the plant "intended"? If Mr Brown means to say that he is doubtful as to the accuracy of Mr. Pryor's identification, that is, of course, another matter

Prof L H Bailey lately spoke with deserved severity of certain "authors of local floras" as obtaining "a cheap notoriety by making new combinations" in nomenclature, and no one can glance through this "Supplement," or refer to the pages wasted in discussing the nomenclature of *Corydalis* and *Spergularia*, without applying his remarks, to the compiler thereof

Much space is also taken up, and in our opinion wasted by the relegation of species to other genera than those in which they were placed by Dr. Boswell. The following

[1] *Journal of Botany*, 1888, p. 83.

note on "*Lychnis alba*, Mill," is an illustration of this, and will serve at the same time as an example of Mr Brown's style.—

"This is the *Silene pratensis* of vol ii p 67, but, together with *S diurna* of p 69, should be referred to the genus *Lychnis*, where they properly belong, *S diurna* being *Lychnis dioica*, Linn, this name has been objected to on the ground that Linnæus included *L alba* as a variety of *L dioica*, which objection is untenable as it appears to me, still, if Linnæus's name is rejected, then *L diœca*, Miller ('Gardener's Dictionary,' ed 8, No. 3, errata, 1768), must take precedence over *L diurna*, Sibthorp ('Flora Oxoniensis,' p 145, 1794)"

Here is another example —

"*Geranium striatum*, Linn This plant was first published by Linnæus as *Geranium versicolor* in his 'Centuria I. Plantarum,' p 21 (1755); but in 1759, when this same Centuria was republished in his 'Amœnitates Academicæ,' vol. iv, he altered the name to *G striatum*, p 282, which name was retained by Linnæus in all his later works, so that in all probability Linnæus regarded the name *G versicolor* as a clerical error, which appears to me a consistent view to take of the case, the more so as it is also probable that the original Centurias were only printed for a restricted, or possibly private, distribution"

It is evident, in spite of all its defects, that Mr Brown has lavished—we do not like to use a stronger expression—a great deal of time and trouble over this "Supplement" A less careful worker, indeed, might easily have produced a better book, for the trivial corrections and emendations, the questions of synonymy, the minute criticisms, and the unnecessary additions, would not have been put forward by any save the most conscientious of writers There is an appendix of "additions and corrections," occupying an eighth of the whole, but, at any rate so far as "corrections" are concerned, far from exhaustive And yet, with all this elaboration, the book is not as complete as it should be The remarkable *Sagina* described in 1887 by Dr. F Buchanan White as *S Boydii* is not figured, and Mr Brown has not even seen a specimen of the plant Mr Boyd has had it in cultivation for several years, and would, we doubt not, have supplied examples, and it is not easy to understand why Mr Brown omitted to make himself acquainted with this very striking form The plates are mostly poor to one there is no reference in the letterpress, another is wrongly numbered.

Since the foregoing was written, the second part of the "Supplement" has appeared It is mainly occupied with the Rose and Brambles, concerning which Mr Brown says, "I express no opinion, as I have never made any attempt whatever to study them." This is commendably candid, but adds materially to the difficulty of understanding why Mr Brown was selected for the work, while it deprives the compilation of value JAMES BRITTEN

A BACTERIOLOGICAL HAND-BOOK

Bacteriologisches Practicum zur Einführung in die practischwichtigen bacteriologischen Untersuchungsmethoden für Aerzte, Apotheker, Studirende By Dr. W Migula. (Karlsruhe Otto Nemnich, 1892)

ALTHOUGH a knowledge of bacteriological methods is essential not only to those who seriously take up the study of bacteria, but also to many who, like the candidates for the diploma of public health, take but a compulsory glance at bacteriology, yet the supply of manuals describing the details of bacteriological practice is remarkably meagre

Dr Migula's little book should, therefore, prove very welcome to the bacteriological student, for it does not aspire to be an exhaustive work on bacteria in general, the list of which is receiving constant additions, but aims at describing simply and carefully in a handy form the principal methods of working with micro-organisms

A number of varieties are more or less elaborately given, but the main idea has been to seek out characteristic forms which are intended to serve as types to illustrate the various points dealt with in the treatment of bacteria

All the stages in the laboratory life-history of a micro-organism are elaborately entered into, and special chapters are devoted to the formation and staining of spores, and also to the nature of the flagella and most improved methods of exhibiting them in microscopic preparations The latter are beautifully displayed in a photograph, showing the numerous flagella attached to the typhoid bacilli The preparation of the various culture-media is described very minutely, and there are many useful laboratory hints and it is the more surprising, therefore, to find the method of sterilizing milk without altering its chemical composition omitted This mode of preparing milk is naturally of importance in any inquiry as to the vitality of pathogenic micro-organisms in this medium Again, the plan of cultivating bacteria on potatoes in tubes is not given, although it presents many decided advantages over the "dish method"

Dr Migula repeatedly insists upon the necessity of unremitting care in carrying out all bacteriological operations to prevent the access of contamination either from the air or by contact with unsterilized or imperfectly sterilized objects Such precautions are naturally of the utmost importance, but possibly it is unnecessary to warn students against contaminating their platinum needle through testing its temperature after heating by placing it to their lips Such a proceeding, if ever attempted, would certainly not be quickly repeated!

But there is one piece of advice upon which the author lays great stress, and which in our opinion is not only unnecessary, but a constant menace to success. On almost every page, in one capacity or another, we find the use of corrosive sublimate most strongly recommended as a means of assisting sterilization and of affording additional protection from external contamination It cannot be impressed strongly enough upon the student that he must depend for the success of his cultivations, not on the use of *antiseptics*, but by working on strictly *aseptic* principles, through the most conscientious devotion to every detail and precaution with which he is acquainted The fear of contamination must ever appear to him as threatening as the "sword of Damocles," which will descend with unerring certainty as soon as the least evidence of relaxation is visible Not only is the use of corrosive sublimate demoralizing, then, but on account of its very germicidal properties, unless handled with the utmost care, will prove a positive danger, destroying where it is least expected or wanted This opinion is unfortunately the result of experience and not of mere imagination

The examination of water is given *in extenso*, but there is no mention, when discussing the presence of typhoid bacilli in water, of the latest methods for their detection amongst other micro-organisms contained in natural waters

The investigation of air for micro-organisms is entirely left out, an omission which renders the book less complete than it would otherwise appear to be

But there is a great deal of instruction, together with many valuable hints, contained in the comparatively short space of 200 pages, and whilst, interspersed in the text, wood-cuts serve to supplement some of the descriptions of apparatus, it also boasts some very good photographs from original preparations of the *Staphylococcus pyogenes aureus*, the *Streptococcus erysipelatis*, the *Bacillus anthracis* with spores, the tuberculosis Bacillus, Koch's comma Spirillum, and others

There is also appended a useful list of all the requisite appliances for bacteriological work

GRACE C FRANKLAND

OUR BOOK SHELF

Neue Rechnungsmethoden der Hoheren Mathematik Von Dr Julius Bergbohm (Stuttgart Selbstverlag des Verfassers, 1892)

Neue Integrationsmethoden auf Grund der Potenzial-, Logarithmal-, und Numeralrechnung. (The same)

THE first of these pamphlets contains an account of what the author calls the *Immensalrechnung*, the *Potenzialrechnung*, the *Radikalrechnung*, the *Logarithmalrechnung*, and the *Numeralrechnung* In the *Immensalrechnung* an attempt is made to provide a calculus of the infinitely great (*das Immensal*), which shall form a complement to the differential calculus, or calculus of the infinitely small The *Potenzialrechnung* contains an account of exponential functions in which the base is an infinitely small or an infinitely great quantity, and the exponent is infinitely small, and the *Radikalrechnung* an account of the inverse functions that are obtained from these by changing the exponent into its reciprocal So, too, in the *Logarithmalrechnung*, logarithmic functions are considered in which the base and the argument are either infinitely small or infinitely great, and in the *Numeralrechnung* the inverse functions (antilogarithms or exponential functions) are discussed The pamphlet is occupied, for the most part, with an exposition of the author's notation, a discussion of certain indeterminate forms, and a calculation of some algebraic functions containing an infinitely small argument, to a first, second, or third approximation It is hardly possible to compliment the author on his accuracy, seeing that the statement occurs that Lt. $\log x$ is finite when x is zero or infinity, the reason given being that Lt $(x \log x)$ and Lt $(\log x/x)$ are zero, for these values of x

The second pamphlet begins with a *résumé* of some of the results of the first one; and then proceeds to discuss the application of these results to the evaluation of certain elementary integrals The author's avowed object is to provide a method for the direct calculation of integrals, comparable with that now employed in differentiation, so that it may no longer be necessary to resort to the indirect methods of integration at present employed It is impossible to deny that the object is a laudable one, but, to judge from the examples given in this pamphlet, it does not seem likely that the method will be of much use in the case of integrals of any degree of complexity Dr Bergbohm promises to supply us in the future with further examples of the application of his methods; but, until these have appeared, it is hardly possible to say that students of mathematics will find these pamphlets repay them for the trouble of reading them and of mastering the author's notation

R E A

An Elementary Course in Theory of Equations By C H Chapman, Ph D (New York John Wiley and Sons, 1892)

THIS is really an excellent little book, but is rather misnamed in being called an elementary treatise The study of the theory of equations, although generally expanded far too considerably, is here dealt with in rather the reverse way, the treatment being somewhat too curt For anyone beginning this subject the book would be found slightly difficult, but for a student who has already had a little experience in this direction, it should prove a very useful *vade mecum*, for the author has brought together in a few pages just those portions of the subject that are required in actual practice The three sections treat respectively of determinants, algebraical equations, and the methods by which the real roots of numerical equations are computed, and they are each accompanied by numerous examples

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications*]

"The Grammar of Science"

IT is very idle as a rule to criticize a critic, especially when he happens, like C. G K, to be the disciple of a school which the author of the criticized work is gently laughing at throughout his pages. But some of C. G K's remarks might lead your readers to believe that the "Grammar of Science" is nonsense, even when looked at without the spectacles of the Edinburgh physical school, and his review may therefore justly call for a few words of reply

Because C G K found himself entirely unable to follow my argument as to the universality of scientific law, he was hardly justified in putting an antecedent before a consequent, and making nonsense of it The universality of scientific law depends on the similarity of the perceptions and of the reflective faculties in normal civilized man Why does this similarity exist? asks C G K, and then turns for an answer to an antecedent in the argument—namely, that a condition of this universality is the similarity in those perceptions and reflective faculties. As a matter of fact in the "Grammar" itself, it is pointed out that a society of beings with different perceptions and reflective faculties could hardly survive in the struggle for existence with societies where there was an approach to similarity, that as soon as the divergence reaches a certain magnitude we lock up the individual as a madman or an idiot, or, in milder cases, bring great social pressure to bear upon him, and mould him to the ordinary standard.

"The laws of Nature are a mental product, yet a certain evolution theory logically based upon them quite eliminates the mental," writes C. G K of the "Grammar." Where he found this statement I know not, but what the "Grammar" itself states is that the laws of evolution are themselves a mental product, a description in shorthand of the sense-impressions and stored sense-impresses of the mind at a given instant. They are a mental mode of briefly classifying sense-impressions, and not inherent in something behind sense-impressions themselves.

C G K then quotes my statements as to Maxwell's descriptions of energy and matter. Now what the "Grammar" says is that Maxwell's statements are "extremely valuable as expressing concisely the nature of certain conceptual processes by aid of which we describe certain phases of our perceptual experience, but as defining matter they carry us no further than the statement that matter is that which moves," or indeed than Prof. Tait's statement that "matter is that which occupies space." The whole object of the investigation is to show that mass, but

not matter,' is capable of definition As Clerk Maxwell tells us that his statements contain all we *know* of matter and energy, it is clear that these are the only statements by way of *definition* which he conceives it advisable to give of them, and *they are all he does give*. I happened to be one of the unfortunate Cambridge students whose first notions of matter and force were obtained from the "Treatise on the Dynamics of a Particle," and it was therefore a relief to me when I met with Kirchhoff's "Mechanik" in 1876, and found the subjectivity of force clearly insisted on That view of force was in the air of Berlin when I was a student there in 1879 Kirchhoff's services in this matter are referred to with special emphasis on p 139 of the "Grammar" A perfectly consistent view of force and matter had been published by Mach in 1883 Why the fact that Prof Tait put forward the "subjectivity of force" in a work of 1885 makes me therefore "a disciple of Prof. Tait," I fail to understand This statement is the more astonishing, as Prof Tait directly postulates the "objectivity of matter," but in the same work tells us that "matter is, as it were, the plaything of force" How subjective force can have an object plaything, perhaps C G K will inform us, but the statement clearly marks off the standpoint of the "Grammar" from that of Prof Tait. Mass, according to the "Grammar," can only be defined as the ratio of mutual accelerations, and any attempt to connect it with the "quantity of matter" in a body is asserted to be unphilosophical C G K asks if a passage he quotes from Tait's "Properties of Matter" is not *essentially* the theory of "ether squirts"? I reply *No*, the words "*constantly* swallows up an amount proportional to its mass," or "at a rate proportional to its mass," sufficing to exclude the mutually enforced flows of ether on which the "Grammarian" bases his applications of ether squirts to chemical and cohesive actions (*American Journal of Mathematics*, vol xiii, pp 309–62) Had I ever read, or if read, recollected, Sir William Thomson's suggestion, it would have been referred to, and a reference to him will be introduced into later editions of the "Grammar"

C. G K very skilfully tries to turn off the "Grammarian's" criticism of the Edinburgh school by representing it as an attack on Newton. The words in the "Grammar" are "Remembering these points we will now turn *to the version of the Newtonian laws given by Thomson and Tait*" (p 381) Force, say our writers, is any cause that tends to alter a body's natural state of rest, or of uniform motion in a straight line, but force, says Prof Tait, is *subjective*, and corresponds to nothing which exists outside ourselves. Surely it is a "veritable metaphysical somersault" to then assert that it can be "applied in a straight line"? I fail completely to see how the view that force is subjective is consonant with the definitions and laws put forward by Thomson and Tait, and asserted by them to be Newtonian With regard to Newton's own statements, I openly declare that, with all admiration for his genius, I doubt the logical sequence and accuracy of many of his statements with regard to the philosophical basis of dynamics. Those who would bind down all time to his views on matter, force, and motion, are much like the geometricians who think it impious to cast out Euclid from school-teaching Both Euclid and Newton have handed down to us in their pages discoveries which will always form a portion of man's intellectual heritage, but the method in which those discoveries are presented will vary from age to age with increasing clearness in man's conceptions of mental and physical processes.

Finally, C. G K. remarks that my conclusions are "materialistic," by which term I suppose he means that he disagrees with them As one of the chief objects of the "Grammar" is to cast the term *matter* forth from scientific language, it would have been more correct to say that my conclusions are "idealistic." I fear C. G K. has a more supreme contempt than the majority of the countrymen of Reid and Hume for an accurate use of philosophical language. KARL PEARSON

Immunity of the African Negro from Yellow Fever.

THIS point, interesting to anthropologists, is raised anew by a writer on the history of epidemics (NATURE, June 16), who asks whether the alleged protection is supported by all recent authorities. Recent authorities are not so well placed for judging of this matter as the earlier; for the reason that immunity is not alleged except for the African negro of pure blood or unchanged racial characters, and that these conditions of the problem have been much less frequently satisfied in the yellow-fever harbours of the western hemisphere since the African slave trade ceased However, there was a good opportunity in 1866, during the disastrous yellow fever among the French troops of the Mexican expedition when they lay at Vera Cruz Among them was a regiment of Nubians, who had been enlisted for the expedition by permission of the Khedive that regiment had not a single case of yellow fever all through the epidemic The African negro regiment brought over from the French colonies of Martinique and Guadeloupe had two or three cases, with, I think, one death The rest of the troops, including Frenchmen, Arabs from Algeria, native Mexicans and Creoles, had no immunity whatever, but, on the other hand, a most disastrous fatality The medical officers of the French service have recorded the facts principally in the *Archives de Médecine Navale*, their conclusion as to racial immunity being the same that has passed current among the earlier authorities as a truth of high general value (admitting, of course, of exceptions in special circumstances), and a truth that has never, so far as I know, been formally controverted by anyone, although other points concerning yellow fever have been the subject of as obstinate controversy as those touching small-pox itself. The experiences of the French at Gorée, a town with ten times as many negroes as whites, exactly confirmed those of Vera Cruz in the same year (*Arch. de Méd nav*, ix 343)

The immunity of the African negro from yellow fever has become a paragraph in some anthropological text books It is from the anthropologists, and not from medical authorities, that Darwin cites the fact in his 'Descent of Man," adding an original theory of the immunity, which he was unable to establish after much inquiry His theory, I need hardly say, was not that "negroes in infancy may have passed through some disease too slight to be recognized as yellow fever,"—whatever that may mean—"but which seems to confer immunity" The theory, however, is another story, or "another volume," as the writer just cited is pleased to suggest, and as for the historical fact of immunity, no one denies it, unless it be Dr Pye Smith in his recent Lumleian lectures (*Lancet*, April 23, 1892, p 901), who gives no reasons

It is unfortunate that the anthropologists (Darwin among them) should have introduced one element of dubiety in placing mulattoes on the same footing, in respect of immunity, as negroes of pure descent, and another in mixing up malarial or climatic fevers with yellow fever C CREIGHTON.

June 20

The Line Spectra of the Elements

I SEE by Prof Stoney's letter that I have not yet succeeded in making myself understood, as he does not enter on the subject of my objection A function of the time may well, with any assigned degree of accuracy and for any length of time, be approximately represented by a sum of circular functions, and nevertheless the periods, amplitudes, and phases may not approach definite values when the length of time for which the approximation is to hold good is increased indefinitely I think this is quite clear from the example I have given in my last letter (p 100), and it is not necessary to write out other examples Now, Prof Stoney shows how one may find by Fourier's theorem the amplitudes, periods, and phases of a sum of circular functions if one only knows the values of the sum This deduction is not new to me. I worked out the same equations in a slightly different form, when Prof Stoney's first letter made me further think about the subject. The deduction does also apply to functions that are approximately represented by a sum of circular functions, but *only under the restriction* that the time for which the approximation holds good is long in comparison to the longest period of the circular functions. In chapter iv of his paper "On the Cause of Double Lines, &c." (Transactions of the Royal Dublin Society, 1891), Prof Stoney should have added this restriction Then the question would naturally have arisen how the restriction follows from Prof Stoney's hypothesis on the origin of the line spectra I do not venture to say that it does not, but the author would have to prove it.

C. RUNGE.

Technische Hochschule, Hannover.

The Nitric Organisms.

I MUCH regret to learn from your last issue that Mr Warington considers that I failed to do justice to his work on this

subject in my recent lecture at the Royal Institution, and which was reprinted in your columns of the 9th inst Mr Warington complains that I have attributed to Winogradsky, and not to himself, the separation of the nitric ferment, I think, however, that Mr. Warington does not correctly understand the sense in which I employ the word "separate," or rather "isolate" (that is the exact word which I did use), for it does not appear to me that Mr Warington has ever claimed to have *isolated* this ferment; thus, on referring again to his most recent publication on this subject, I read, "An attempt to isolate the nitric organism by the dilution method failed, but apparently only one other organism—a stout bacillus, growing on gelatin—was present in some of the cultures" (Chem Soc Journ, July 1891). In an exhaustive memoir, due reference to the above attempt of Mr. Warington's would, of course, have been made, but in the impressionist sketch, which is alone possible in a Friday evening discourse at the Royal Institution, I take it that a lecturer must be allowed to use his own discretion as to what does and what does not fit into the small frame of sixty minutes without laying himself open to the imputation of having unjustly neglected or emphasized the work of individual investigators Mr Warington's name is so indissolubly connected with the subject of nitrification that it is the more surprising to me that he should have taken exception to the passage in question of my lecture.

PERCY F FRANKLAND

University College, Dundee, June 21.

Protection against Rain in the Elder

IT is quite possible that the mode in which the flowers of the elder protect themselves against the rain has been described before, though I do not recollect to have seen any account of it. I have been noticing the great contrast between the aspect of a large elder-tree in full blossom, visible from my study window, presented yesterday and to-day To-day, which is warm and sunny, every inflorescence is in its normal position, with the flat surface nearly horizontal, so as to get as much sun as possible Yesterday was cold and very wet, and in every one of the inflorescences the upper part of the stalk was so curved as to bring, as far as the foliage would permit, the surface of the inflorescence to an angle of very nearly 90° with the horizon, so that the rain ran off, and scarcely any of it reached the interior of the flowers

June 24. ALFRED W. BENNETT.

THE TOTAL SOLAR ECLIPSE, APRIL 15-16, 1893.

THE total eclipse of the sun, which will take place during the month of April next year, will most probably be very widely observed, not only because the shadow of the moon passes over such a great stretch of land, but because the phenomenon occurs at the period when a sun-spot maximum is approaching, at which time, of course, the disturbed state of the atmosphere of the sun is on the increase The maximum time of totality is also in this case considerable, amounting to as much as 4m 46s

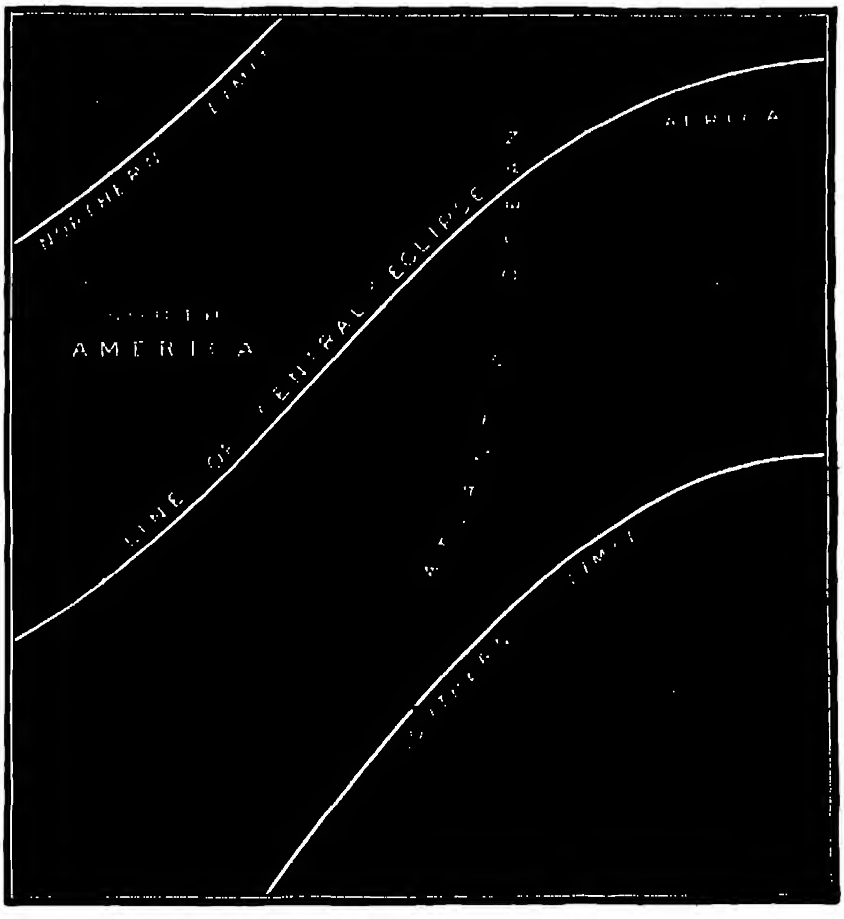


FIG. 1 —Showing the general trend of the line of totality.

Path of Shadow —The general trend of the path of the shadow will be gathered from the accompanying diagram (Fig. 1) This track cuts through Chili, passes to the

north of the Argentine Republic, skirts the provinces of Bolivia and Paraguay, and runs through the heart of Brazil The centre of the shadow leaves South America near the town of Ceara or Fortaleza, and travels across the Atlantic Ocean, striking the African coast between Cape Verde and Bathurst.

Probable Points for Observations.—The special points for observations may be said roughly to be three, viz. the region about Chili, the north-east corner of Brazil, i.e. the region of Ceara, and the Senegambian coast. These localities are so situated on the line of central and total eclipse that photographs of the corona taken at Chili will precede those taken in Africa by about 3½ hours; while those obtained in the north-east of Brazil will be intermediate between the two

Let us deal first with the Chilian district; this, we

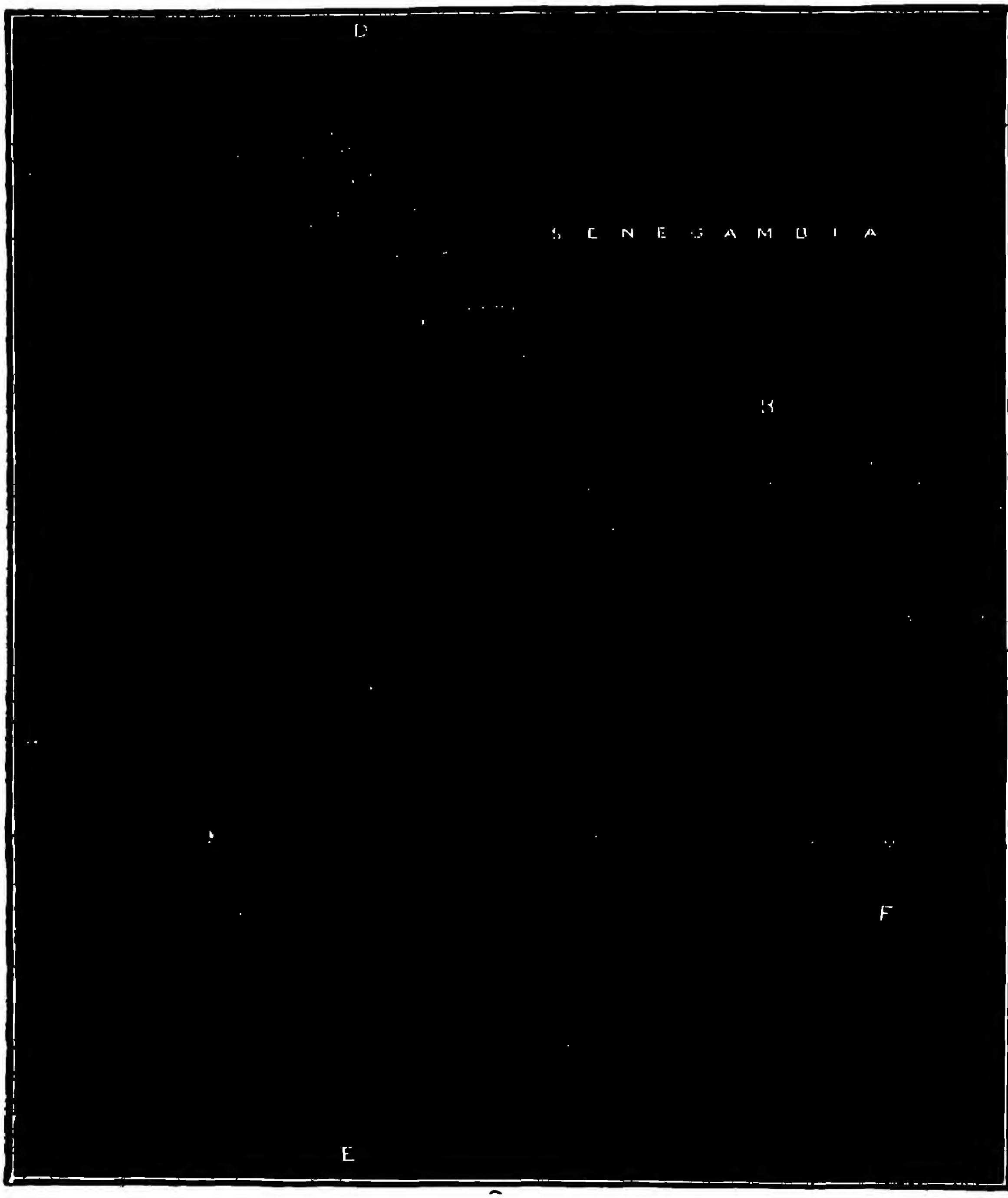


FIG. 2.—Showing the region on the West Coast of Africa over which the line of totality passes

learn, will be occupied by the American astronomers. So far as we know at present, the Lick Observatory will send a party to Chili under the direction of M. Schaeberle, while Prof. Pickering will also direct other observers somewhere about the same spot. To the north of the Argentine Republic, and on the railway which runs up from Buenos Ayres, there seems to be another spot which would be available. This place, Rosario de la Frontera, lies to the north of Tucaman, and to the south of Jujuy, its approximate position being longitude 65° 7′, latitude 25° 48′ S. The duration of totality here amounts to 3m. 8s., the local time of its commencement being April 15, 20h. 40m. This place should, if possible, be made use of, for, besides being easily accessible, the probabilities from all accounts seem to be in favour of fine weather. From observations gathered from the nearest meteorological station, Salta, the mean annual temperature is found to be 63°·6 F., and the rainfall 22·8 inches; the chances for clear weather at this season being estimated at two-thirds.[1]

Following the track of the shadow across Brazil, no suitable spots are reached until the coast is approached; the most favourable place here is no doubt Fortaleza or Ceara, the capital of the province of Ceara, and a city of 20,000 inhabitants. Para Curú is also another very favourable point, lying nearly in the centre of the line of central eclipse; its position is longitude 38° 30′, latitude 3° 42′ S., and the local time of the beginning of the eclipse is April 15, 23h. 40m., the time of its duration being 4m. 44s.

With regard to the weather in this neighbourhood, the chances for clear skies seem, unfortunately, very small. The rainfall is reckoned as over 100 inches per annum, while even in April 10 inches has been usually recorded. For the last five years fifteen days on an average in this month have been rainy, the number in one year reaching twenty-one.

Taking into account the easy accessibility of the place, and its important position on the line of totality, it seems desirable that at any rate there should be some observers there.

Following the shadow over the Atlantic Ocean, we arrive at the shores of West Africa, on which probably both French and English expeditions will take up their respective positions. The accompanying map (Fig. 2) shows the coast-line of this region; AB, CD, and EF indicating the line of central eclipse and the northern and southern limits. The places which seem at present to be the most favourable are Joal and Palmerin, on the coast, if observations there are more convenient than others made inland.

The prospect of fine weather seems to be more probable here than in America. December, January, and February are the cloudy months, the weather during March and April being usually fine; the rains begin about May; sometimes tornadoes occur at intervals of five or six days, being accompanied by heavy rain, lasting generally from one to two hours, leaving the atmosphere afterwards bright and clear. The wind called the "Harmattan" during the first three months of the year is generally from the north-east and dry. It comes from the Sahara Desert, and brings with it consequently minute particles of sand, tending to give the atmosphere a yellowish tint. In April the prevailing wind is westerly to north-westerly, and not usually very strong.

The route which the English expedition will take has up the present not been definitely settled. Several lines of steamers run to Teneriffe and Grand Canary, and if one of Her Majesty's ships picked the expedition up at Teneriffe and carried them either to Bathurst or directly to the Salum River, the matter would be simplified; but failing this the only available route seems to be that by the British and African Steam Navigation Company. These steamers, touching at Madeira, Teneriffe, Grand Canary, Goree, and Dakar, naturally require much time to get to Bathurst. Of the return conditions it seems impossible to get any information at present.

Taking into account the accessibility and proximity to the line of totality, perhaps Palmerin and other places on the same river (River Salum) offer the greatest advantages. The bar at the mouth of the river would prevent a man-of-war of deep draft from proceeding up the river. As the region here is all under French protection, the necessary official letters will of course have to be obtained.

There are one or two other points relating to this region if it should by any chance be ultimately settled upon. Luxuries in the way of tea, sugar, milk (condensed), cocoa and milk, condiments, wine or spirits, flour, biscuits, soups, and preserved meats, should all be brought from England; rice, fowls, sheep, goats, and bullocks being always procurable from the native villages.

Cement and lime should also be taken out, and it seems probable that the huts for the instruments should be constructed at home and carried out there in pieces. The necessary housing of the observers (and escort, if any) would not prove very difficult, for either room could be found in the villages, or bamboo and grass huts could be quickly run up by the natives; it might be advisable to take one or two small tents, as they might prove very serviceable just after landing.

With regard to the packing of the necessary instruments, it may be said that the carriers' loads vary from 40 to 65 pounds; a case capable of being slung on a bamboo can weigh as much as 250 pounds, while to carry a weight of one hundredweight the services of two men would be required. Their wages would, of course, depend on whether they were obtained from Bathurst or the trading wharf on the river at the point of disembarkation, as in the latter case they could be discharged as soon as the selected spot had been reached.

[1] The information for the most part concerning the American stations is gathered from Mr. H. S. Pritchett's article, "The Total Solar Eclipse April 15-16, 1893," in the June number of *Astronomy and Astro-Physics*.

UNIVERSITY OF DUBLIN TERCENTENARY CELEBRATION

The celebration of the tercentenary of the University of Dublin will begin on Tuesday next, and all the necessary arrangements have now been made. Neither the Great College Hall nor the Chapel have been found large enough to hold the number of guests who have accepted the invitation of the Chancellor of the University (Earl of Rosse) and the Provost of Trinity College (Rev. Dr. Salmon), and it has been deemed necessary to hold the Commemoration Service in the Collegiate and Cathedral Church of St. Patrick, and the ceremony of the presentation of addresses in the Leinster Hall, the largest covered area in Dublin. In this hall the College banquet will be given, and the students have also engaged it for a University ball, which is to bring the festivities to a close.

It is expected and hoped that most of the invited guests and delegates will arrive in Dublin in the course of Monday evening, July 4, as the reception by the Provost of Trinity College will be held at 10 o'clock on the Tuesday morning, and immediately after this ceremony the members of the three classes of University officers with the members of the Senate, the other graduates and the undergraduates, will accompany the guests and delegates from the Examination Hall of Trinity College to St. Patrick's Cathedral, a distance of about a mile. Should the weather be fine and the procession properly marshalled, the general effect promises to be as fine as it will in the streets of Dublin be novel.

In the afternoon of the same day there will be a garden party in the College Park, to which upwards of three thousand persons have been invited, and the day will close with the performance by the members of the University Choral Society of an ode written by G F Savage-Armstrong, and set to music by Prof Sir Robert Stewart, and by the civic ball

On the Wednesday morning there will be a special Commencements for the conferring of honorary degrees The Grace has already passed the Senate for eighty-three degrees, being a number equal to one-third of the total number of the expected guests and delegates Among those on whom the degree of Doctor of Letters is to be conferred is Prof Max Muller The following will receive the degree of Master of Engineering Lord Armstrong, Sir Benjamin Baker, Sir Isaac Lowthian Bell, Sir Charles William Wilson The degree of Doctor of Sciences will be conferred on Prof J Burdon-Sanderson, Prof Michael Foster, Prof Ludimar Hermann, Sir George Murray Humphry, Prof Julius Kollmann, Prof Alexander Macalister, Prof Richet, Prof Sir William Turner, Wilhelm Waldeyer, Rev Prof Thomas George Bonney, Rev William Henry Dallinger, Sir Archibald Geikie, Othniel Caleb Marsh, Baron Adolf Eric Nordenskiöld, Abbé Alphonse François Renard, John Hall Gladstone, George Downing Liveing, Lord Rayleigh, Prof Joseph John Thomson, Prof Thomas Edward Thorpe, Prof William Augustus Tilden, Francesco Brioschi, Prof Luigi Cremona, James Whitbread Lee Glaisher, Paul A Gordan, Edward John Routh, George H Darwin, Simon Newcomb, Isaac Roberts, F Tisserand The following are those who have been selected for the degree of Doctor of Medicine H R H Duke Charles of Bavaria, John Shaw Billings, Thomas Bryant, Sir Andrew Clark, Adolf Gusserow, Jonathan Hutchinson, Prof Thomas Grainger Stewart On the same day there will be a garden party at the Viceregal Lodge in Phœnix Park, given by His Excellency the Lord-Lieutenant and Lady Zetland, and in the evening the College banquet will be held in the Leinster Hall Five hundred, including all the guests and delegates, have been invited

Thursday, July 7, there will, in the morning, be a procession, from the Examination Hall of Trinity College to the Leinster Hall, of the College authorities and the delegates and others, to witness the presentation of addresses to the University by the delegates A delegate from each country will make a short address, and the following have been invited to take their share in this interesting ceremony —

Great Britain, her Colonies and Dependencies.—Sir James Paget, Bart, F R.S.
America.—Prof O C Marsh, of Yale University
Austria-Hungary—Prof A Vámbéry, of Buda-Pesth.
Belgium—Prof V D'Hondt, of Ghent
Denmark—Prof M. H Saxtorph, of Copenhagen
France—Prof Lannelongue, of Paris
Germany—Baron Ferdinand von Richthofen, of Berlin.
Holland—Prof. Tiele, of Leyden
Italy—Prof Gaudenzi, of Bologna.
Norway—Prof Hagerup, of Christiania.
Russia—Prof. Wedenski, of St. Petersburg.
Switzerland—Prof. Kollmann, of Basle
Cambridge—Dr Peile, Vice-Chancellor
Oxford—Rev Dr Boyd, Vice-Chancellor

On the evening of this day there will be a dramatic performance by the students of the College, the piece selected being Brinsley Sheridan's comedy, "The Rivals." In the afternoon there will be a garden party at the Royal Hospital, Kilmainham, given by the Right Hon the Commander of the Forces in Ireland and Lady Wolseley.

The ceremonies will be brought to a close on Friday, on which day the following have been asked to address the College students Profs W. Waldeyer, Berlin, F. Blass, Kiel, A. Vámbéry, Buda-Pesth; F. Max Muller, Oxford, L Cremona, Rome B J Stockvis, Amsterdam, Léon Say, Paris, and General F A Walker, Massachusetts The Athletic Union will hold their annual sports in the College Park and the University ball will be given in the afternoon and evening of this day

On Saturday, July 9, the Royal Society of Antiquaries of Ireland have organized an excursion to Kells, the many objects of great antiquarian interest of which can easily be inspected within the limits of a short day from Dublin, the excursionists will leave the Great Northern Railway Station at 9 o'clock a m, and return by the train reaching Dublin by 5 30

Every information can be obtained on writing to the Hon Secretaries of the Tercentenary Committee, Trinity College, Dublin.

EXHIBITION AT NURNBERG BY THE GERMAN MATHEMATICAL ASSOCIATION

THE following prospectus will show the scope and object of this Exhibition —

Deutsche Mathematiker-Vereinigung

Munchen, Mai 1892

From September 12 to 18, 1892, the meetings of the "Deutsche Mathematiker Vereinigung" and of the "Gesellschaft deutscher Naturforscher und Aerzte" will be held at Nurnberg

At the proposition of the "Mathematiker-Vereinigung" the arrangement for an exhibition of models, drawings, apparatus, and instruments used in pure and applied mathematics is proposed The project has secured the support of the Royal Bavarian Government

The undertaking already enjoys the co-operation of a number of competent men of science, of several mathematical institutes of our colleges, besides that of various prominent publishers and well known technical establishments, and thus we may hope that the exhibition will answer the expectations of its founders, viz.

To open to wider spheres the various auxiliaries used in the instruction and investigation of both pure and applied mathematics in the shape of models, apparatus, and instruments and to forward the interests of this kind of scientific work.

At the request of the committee of the Mathematiker-Vereinigung I have the honour to invite you to participate in the exhibition, and to recommend to your special attention the following directions.—

I Die mathematische Ausstellung gelegentlich der Versammlungen der "Deutschen Mathematiker-Vereinigung" und der "Gesellschaft deutscher Naturforscher und Aerzte" in Nürnberg will last from September 10 to 18, 1892. It comprises mathematical models, drawings, apparatus, and instruments serving both for teaching and research in pure and applied mathematics [1]

II The local committee of the Gesellschaft deutscher Naturforscher und Aerzte resp the direction of the Bayerische Gewerbemuseum attends to the gratuitous granting of space required by the exhibitors

III The Deutsche Mathematiker-Vereinigung takes charge of all furniture, tables, screens, &c., attends to the opening and packing, also for supervision and care during the exhibition and

[1] In what belongs to the applications, we include only those having principally a mathematical interest Concerning the experimental part of physics and those instruments, &c., which are of more practical use, it should be mentioned that all those more practical than theoretical relations will be displayed in a second exhibition, separate from ours, which comprises likewise the other branches of natural philosophy and the medicine.

That exhibition, entitled "Fachtechnische Ausstellung," under the authority of the "Gesellschaft deutscher Naturforscher und Aerzte" is arranged by the "Bayerischen Gewerbemuseum in Nürnberg," under the direction of Mr Th. von Kramer, who has issued special programmes for that exhibition, and from whom further information may be obtained

for the insurance against fire But assumes no responsibility either for damage or for loss of articles

IV. Those who desire to exhibit under closed cases must do so at their own expense.

V The charge of transport (to Nurnberg) and, if desired, the insurance of transport is at the expense of the exhibitor In what refers to the return transport, by the courtesy of the directors of the Bavarian and the other main lines of German railways free transport is guaranteed for all unsold objects of the exhibition. All expense of home transport beyond this border is at the expense of the exhibitor

VI An explanatory detailed catalogue of the mathematical exhibition is to be issued

The first part will consist of essays, having reference to problems, results, and methods of geometrical representation

The second part of an enumeration of all articles exhibited in connection with detailed theoretical descriptions Here, if desired, the prices may be added This part of the catalogue will be fully illustrated to give a vivid impression of the exhibited articles We respectfully request all institutes, publishers, &c, to forward woodcuts, *clichés*, &c, which may be inserted in the text

An appendix to the catalogue will be published, including all advertisements which may hereafter serve as a directory for all those interested [1]

VII. As far as possible all technical explanations of the articles will be undertaken by the committee.

VIII The committee will attend to all sales and buyings (which are in view by various mathematical institutes of our Hochschulen) and give all desired information

During the exhibition the sold articles must not be removed from the exhibition rooms, except with special permission of the committee

IX The intention to participate in the exhibition may be given by the use of the "Exhibition Announcement" until July 1 Address Herrn Prof Dr Walther Dyck, Munchen, Hildegardstrasse 1½

At the same time all papers and scientific notices for the catalogue respecting woodcuts and *clichés* for illustration must be sent to the same address [2]

The editors reserve the right of all abbreviation and change in the notes of Part 2 of the catalogue that the uniformity may require.

X All articles proposed for exhibition must be forwarded from September 1 to 7, under the address Mathematische Ausstellung in Nurnberg (Bayern), zu Handen der Herren Danler and Co

The return of all articles will be effected within two weeks after the close of the exhibition under the conditions fixed above (No V)

XI. For nearer information in respect to the intentions and the extent of the exhibition we annex a preliminary classification of the articles

1. *Geometry Theory of Functions*

Models employed in elementary teaching of geometry (solid geometry, trigonometry, descriptive geometry)

Polyhedra. Division of surfaces and spaces in polygons respecting polyhedra

Plane curves

Curves in space Developable surfaces

Surfaces of the second order

Higher algebraic surfaces.

Transcendental surfaces

Models illustrating geometry of complexes

" " curvature of surfaces.

" " theory of functions

" " analysis situs

2 *Arithmetic, Algebra, Integral Calculus*

Calculating machines. Slide rules.

Instruments for solving equations and for construction of functional relations.

Curvometers, planimeters, integrating machines, instruments for solving differential equations

3 *Mechanics Mathematical Physics*

Models employed in elementary teaching

Kinematics. Machines for description and transformation of curves and surfaces Pantographs, perspectographs

Apparatus for demonstration of mechanical principles

Equilibrium and motion of a point

Poinsot motion of a rigid body, precession, nutation, dynamical tops, gyroscopes

Models and articles showing the effect of stress flexion and torsion of solids

Elastic properties of solids (especially of crystals)

Hydrodynamics

Geometrical representations and mechanical apparatus illustrating physical phenomena (for ex vibrations, wave motion, propagation of sound and light Thermodynamic and electrodynamic phenomena)

XII It is understood that the exhibitors declare their willingness to submit to the present rules and further dispositions ordered by the committee for the interest of the exhibition

For all further information please address the undersigned delegate of the committee

Prof Dr WALTHER DYCK,
Munchen, Hildegardestrasse 1½

For the purpose of collecting and forwarding objects of interest, a Committee has been formed consisting of Lord Kelvin (Chairman), Lord Rayleigh, Profs Sylvester, O J. Lodge, G F Fitzgerald, W G Adams, Sir R Ball, A A Common. Secretaries A G Greenhill, O Henrici.

The Secretaries will forward prospectuses and forms of application to intending exhibitors, and will take charge of objects at the Central Institution, Exhibition Road, South Kensington, S W, and forward the objects at the proper time to Nurnberg, unless forwarded direct by the exhibitors

THE KEKULÉ FESTIVAL AT BONN

ON June 1 a remarkable demonstration took place at the University of Bonn The occasion was the twenty-fifth anniversary of the call of August Kekule to the Professorship of Chemistry at that University The details, which we have taken chiefly from the *Kolnische Zeitung*, will be of interest to the student of chemistry, and probably of value to the future historian of the science

The ceremony began in the morning with an enthusiastic ovation on the part of the students The chemical theatre was decorated with plants, on the blackboard figured the benzene hexagon, made up with garlands of flowers, in the midst of which appeared the letters A K. as a monogram of roses At the usual lecture hour Prof. Kekulé entered, and was greeted with great enthusiasm One of the chemical students, Alfred Helle, delivered a graceful address, in which he congratulated his fellows on being privileged to sit at the feet of the greatest of living chemists, ending by calling for three cheers for the Professor, in which the audience heartily joined.

Prof Kekulé then addressed the students, detailing with characteristic humour some passages in his life He was, he said, a pupil at the Darmstadt Gymnasium, where he chiefly devoted himself to mathematics He was destined by his father for the profession of architect, and some houses still existed in Darmstadt, the plans of which he had drawn when a youth at the Gymnasium. At Giessen, where he went to study architecture, he attended Liebig's lectures, whereby he was enticed to chemistry But his relations would not at first hear of his changing his profession, and he was given half a year's grace to think over it He spent this time at the Polytechnicum at Darm-

[1] The fees for insertion in the appendix are 30 Reichsmark for the whole page (great 8°), 18 R M for ½ page, 10 R M for ¼ page, 5 R-M for ⅛ page.

[2] All advertisements for the Appendix and payments for same must not be deferred later than August 1, to the same address, Prof. Dyck.

stadt, from which circumstance arose the myth, affirmed by Kolbe, that he was a "Realschuler," and not, as was really the case, a "Gymnasiast" His first teacher in chemistry at Darmstadt was Moldenhauer, the inventor of lucifer matches His leisure time was spent in modelling in plaster and at the lathe He was then permitted to return to Giessen "I attended," he said, "the lectures, first of Will and then of Liebig. Liebig was at work on a new edition of his 'Letters on Chemistry,' for which many experiments had to be carried on I had to make estimations of ash of albumen, to investigate gluten in plants, &c The names of the young chemists who helped Liebig were mentioned in the book, among them mine. The proposal was then made to me, just at the time when Liebig intended to make me his assistant, that I should go for a year abroad, either to Berlin, which at that time was to Giessen a foreign land, or to Paris 'Go,' said Liebig, 'to Paris there your views will be widened; you will learn a new language, you will get acquainted with the life of a great city, but you will not learn chemistry there' In that, however, Liebig was wrong I attended lectures by Fremy, Wurtz, Pouillet, Regnault, by Marchandis on physiology, and by Payen on technology One day, as I was sauntering along the streets, my eyes encountered a large poster with the words 'Leçons de philosophie chimique, par Charles Gerhardt, ex-Professeur de Montpellier' Gerhardt had resigned his Professorship at Montpellier, and was teaching philosophy and chemistry as *privatdocent* in Paris That attracted me, and I entered my name on the list. Some days later I received a card from Gerhardt, he had seen my name in Liebig's 'Letters on Chemistry' On my calling upon him he received me with great kindness, and made me the offer, which I could not accept, that I should become his assistant My visit took place at noon, and I did not leave his house till midnight, after a long talk on chemistry These discussions continued between us at least twice a week, for over a year Then I received an offer of the post of assistant to Von Plantu, at the Castle of Reichenau, near Chur, which I accepted, contrary to Liebig's wish, who recommended me as assistant to Fehling at Stuttgart So I went to Switzerland, where I had leisure to digest what I had learnt in Paris during my intercourse with Gerhardt Then I received an invitation from Stenhouse, in London, to become his assistant, an invitation I was loth to accept, since I regarded him, if I may be allowed the expression, as a 'Schmierchemiker" By chance, however, Bunsen came to Chur on a visit to his brother-in law, at whose house I first met him I consulted Bunsen as to Stenhouse's offer, and he advised me by all means to accept it I should learn a new language, but I should not learn chemistry So I came to London, where as Stenhouse's assistant I did not profit much By means of a friend, however, I became acquainted with Williamson The latter had just published his ether theory, and was at work on the polybasic acids (in particular on the action of PCl_5 on H_2SO_4) Chemistry was at one of its turning-points The theory of polybasic radicals was being evolved with Williamson was also associated Odling Williamson insisted on plain simple formulæ without commas, without the buckles of Kolbe, or the brackets of Gerhardt It was a capital school to encourage independent thought The wish was expressed that I should stay in England and become technologist, but I was too much attached to home. I wished to teach in a German University But where? In order to get acquainted with the circumstances at the several Universities, I became a travelling student In this capacity I came, among other Universities, to Bonn Here there was no chemist of eminence, and hence there were no prospects. Nowhere did there seem so much promise and so great a future as at Heidelberg I could ask no help of Bunsen. 'I can do nothing for you,' he said, 'at least not openly. I will not stand in your way, but more I cannot promise' I fitted up a small private laboratory in the principal street in Heidelberg at the house of a corn merchant, Gross by name—a single room with an adjoining kitchen I took a few pupils, among whom was Baeyer. In our little kitchen I finished my work on fulminate of silver, while Baeyer carried out his researches, which subsequently became famous, on cacodyl. That the walls were coated thick with arsenious acid, and that silver fulminate is explosive, we took no thought about After two years and a half I received a call to Ghent as ordinary professor There I stayed nine years, and had to lecture in French With me to Ghent came Baeyer Through the kindness of the then Prime Minister of Belgium, Rogier, I obtained the means to establish a small laboratory I had there with me a number chiefly of more advanced students, among whom I may name Baeyer, Hubner, Ladenburg, Wichelhaus, Linnemann, Radziszewski, and Meyer There was not so much a systematic course of instruction as a free and pleasant academic intercourse After nine years' work, I received the call to Bonn" With some account of his work in Bonn, and with a reference to the great attention he had always received from his pupils, Prof Kekulé concluded his address. The enthusiasm it occasioned, says the *Kölnische Zeitung*, baffled description

The Professor then received the congratulations of his personal staff, as well as those of the University officials, among whom were the Rector Prof Strasburger, the Curator Dr Gandtner, and the Dean of the Philosophical Faculty Prof. Schluter In the evening the Bonn students honoured him with a torchlight procession, it being the third time the Professor had received this, the most conspicuous honour which is bestowed by German students The first occasion was in 1875, when he declined the Professorship at Munich The second was in 1878, when he was Rector of the University, held to commemorate the restoration of unity among the students after a long period of disunion Among the torch-bearers on that occasion was the present Emperor of Germany

In addressing the students, Prof Kekulé reminded them of the previous occasions on which they had honoured him in like manner, and impressed on them the necessity of guarding and fostering the unity they had attained Thus ended an impressive and memorable incident in the history of chemical science

J E MARSH

THE TRUE BASIS OF ANTHROPOLOGY[1]

THE Nestor of American philologists, and at the same time the indefatigable Ulysses of comparative philology in that country, Mr Horatio Hale, has just published in the Transactions of the Royal Society of Canada, an important essay on "Language as a Test of Mental Capacity," being an attempt to demonstrate the true basis of anthropology His first important contribution to the science of language dates back as far as 1838-42, when he acted as ethnographer to the United States Exploring Expedition, and published the results of his observations in a valuable and now very scarce volume, "Ethnography and Philology" He has since left the United States and settled in Canada. All his contributions to American ethnology and philology have been distinguished by their originality, accuracy, and trustworthiness Every one of them marks a substantial addition to our knowledge, and, in spite of the hackneyed disapproval with which reviewers receive reprints of essays published in periodicals, it is much to be regretted that his essays have never been published in a collected form

[1] "Language as a Test of Mental Capacity" By Horatio Hale. From the Transactions of the Royal Society of Canada, 1891

Mr. Horatio Hale's object in the essay before us is to show that language separates man from all other animals by a line as distinct as that which separates a tree from a stone, or a stone from a star.

"A treatise," he writes, "which should undertake to show how inanimate matter became a plant or an animal, would, of course, possess great interest for biologists, but it would not be accepted by them as a treatise on biology. In like manner a work displaying the anatomy of man in comparison with that of other animals cannot but be of great value, and a treatise showing how the human frame was probably developed from that of a lower animal must be of extreme interest; but these would be works, not of anthropology, but of physiology or biology. Anthropology begins where mere brute life gives way to something widely different and indefinitely higher. It begins with that endowment which characterizes man, and distinguishes him from all other creatures. The real basis of the science of anthropology is found in articulate speech, with all that it indicates and embodies." He does not hesitate to maintain that solely by their languages can the tribes of men be scientifically classified, their affiliations discovered, and their mental qualities discerned. These premises, he says, compel us to the logical conclusion that linguistic anthropology is the only "Science of Man."

These words explain at once the whole character of this important essay. Mr. Horatio Hale is a great admirer of Darwin, but not of the Darwinians. He contrasts Darwin's discernment of the value of language with the blindness of his followers, who are physiologists and nothing else. Why anthropology has of late been swamped by physiology, Mr. Horatio Hale explains by the fact that the pursuit of the latter science is so infinitely the easier. "To measure human bodies and human bones, to compute the comparative number of blue eyes and black eyes in any community, to determine whether the section of a human hair is circular, or oval, or oblong, to study and compare the habits of various tribes of man, as we would study and compare the habits of beavers and bees, these are tasks which are comparatively simple. But the patient toil and protracted mental exertion required to penetrate into the mysteries of a strange language, and to acquire a knowledge profound enough to afford the means of determining the intellectual endowments of the people who speak it, are such as very few men of science have been willing to undergo." Mr. Horatio Hale has a right to speak with authority on this point, for, besides having studied the several languages of North America, of Australia and Polynesia, no one has more carefully measured skulls, registered eyes, measured hair, and collected antiquities and curiosities of all kinds than he has done during his long and busy life. His knowledge of the customs of uncivilized races is very considerable. No one knows the Indian tribes and likewise the Australians better than he does, and he is in consequence very severe on mere theorizers who imagine they have proved how the primitive hordes of human beings, after herding together like cattle, emerged slowly through wife-capture, mother-right, father-right, endogamy, exogamy, totemism, fetichism, and clan systems, to what may be called a social status. He holds with Darwin that man was from the beginning a pairing animal, and that the peculiar usages of barbarous tribes are simply the efforts of men, pressed down by hard conditions, below the natural stage, to keep themselves from sinking lower. He gives a most graphic description of changes of civilization produced by change of surroundings in the case of the savage Athapascans, and their descendants, the quick-witted and inventive Navajos. He holds that the inhabitants of Australia were originally Dravidians, and that their social and linguistic deterioration is due to the miserable character of the island in which they had taken refuge, possibly from the Aryans, when pressing upon the aboriginal inhabitants of the Dekhan. He points out a few grammatical terminations in the Dravidian languages which show some similarity to the terminations of Australian dialects. The dative, for instance, is formed in the Dravidian Tulu by *ku*, and in the Lake Macquarie and Wiradhurei dialects of Australia by *ko*. In both families the *k* of *ku* and *ko* is liable to be changed into *g*. The plural suffix in Tamil is *gal*, in Wiradhurei *galan*. Thus in Tamil *maram*, tree, forms the nom. plur. *marangal*, the dat. plur. *marangaluk ku*, while in Wiradhurei, *bagai*, shell, appears in the nom. plur. as *bagaigalan*, in the dat. plur. as *bagaigalan gu*. On this point, however, Mr. Horatio Hale ought to produce fuller evidence, particularly from numerals, and the common household words of uncivilized tribes. The pronouns show many coincidences with Dravidian and Australian languages. No one is better qualified for that task than he is, for we really owe to him the first trustworthy information about the Australian dialects. He considers all the dialects spoken in Australia as varieties of one original speech, and he has proved their wonderful structure by several specimens contained in his first book, published nearly fifty years ago, and again in this last essay of his.

There is no doubt that this essay will provoke much opposition, but no one can read it without deriving most valuable information from it, and without being impressed with the singularly clear and unbiassed judgment of the author. It is to be hoped that if there is any controversy it may be carried on in the same scientific and thoroughly gentlemanlike tone in which Mr. Horatio Hale deals with those whom he has to reprove. Thus, when Prof. Whitney, a fertile writer on linguistic science in America, commits himself to the statement that the Dravidian languages have "a general agglutinative structure *with prefixes only*," Mr. Horatio Hale good-naturedly remarks, "this is doubtless a misprint for *with suffixes only*." And when Prof. Gerland, in his continuation of Waitz's invaluable work "Die Anthropologie der Naturvölker," refers to Mr. Horatio Hale as describing the hair of the Australians as *long, fine, and woolly*, he points out that he, on the contrary, described their hair as neither woolly, like that of the Africans and Melanesians; nor frizzled, like that of the Feejeeans; nor coarse, stiff, and curling, as with the Malays; but as long, fine, and *wavy*, like that of Europeans. He naturally protests against Prof. Friedrich Müller charging him with having committed such a blunder, which, as he remarks, would be as bad as if he had described the Eskimos as having black skins. But there is not a single offensive expression in the whole of his essay, though the opportunities would have been many for adopting the style of hitting indiscriminately above and below the belt. Though he differs from Prof. Whitney, he evidently ranks him very high, and as second only to "that eminent Sanskrit scholar, Sir Monier Monier-Williams."

LEWIS MORRIS RUTHERFURD.

ON May 30 last there passed away from us one whose name was familiar to many, and who was respected and beloved by all who were fortunate enough to have made his acquaintance. By the death of Lewis Morris Rutherfurd, who died at the age of seventy-six, at his estate in Tranquillity, New Jersey, astronomical science especially suffers, for he was one of the pioneers of astronomical photography and spectroscopy, and the introducer of many of the practical methods which have opened to us such a vast field of research.

Born at Morrisania, New Jersey, on November 25, 1816, he first devoted himself to the study of law, but finding his mind bent more on astronomical pursuits,

he soon thought fit to leave this profession, and being well equipped with the necessary private resources, he commenced in the year 1848 to erect an observatory in the city of New York at his own residence On its completion, it was furnished with an 11½-inch refractor, which he had made under his own personal direction by Fitz, and a transit instrument

The first work he set himself to do related to the spectra of the stars As soon as Kirchhoff's discovery was announced, Donati, at Florence, in 1860, made the first efforts in this direction, this was followed by other observers, among whom was Rutherfurd In 1863 he published his first paper on the spectra of the celestial bodies, and indicated that the various stellar spectra which he had then observed were susceptible of being arranged in different groups His paper, which was published in *Silliman's Journal*, vol xxxv p 71, contained the following extract with reference to this classification —"The star spectra present such varieties that it is difficult to point out any mode of classification For the present, I divide them into three groups First, those having many lines and bands, and mostly resembling the sun, viz Capella, β Geminorum, α Orionis, &c These are all reddish or golden stars The second group, of which Sirius is the type, presents spectra wholly unlike that of the sun, and are white stars The third group, comprising α Virginis, Rigel, &c, are also white stars, but show no lines; perhaps they contain no mineral substance, or are incandescent without flame"

Turning his attention to object-glasses for visual and photographic purposes, he described in 1865 a new form which he had specially designed for the latter This, needless to say, brought about a great revolution in the processes employed The history of his early attempts to produce photographically corrected object-glasses, and the wonderfully sharp and beautiful photographs of the moon which he finally obtained, will always be marked as an important era in the application of the camera to the equatorial telescope The photographs taken at the present day, even although they are produced with larger lenses and with a more perfect knowledge of photographic processes, and with the advantages afforded by dry plates, excel only in a trifling degree those taken with the small Rutherfurd equatorial

Another important piece of work, which occupied him some considerable time, was the mapping, by means of the photographic process, of star clusters and star groups His ingenuity in devising and constructing accurate micrometers for measuring the impressions of the star clusters opened out a new method by which the proper motion of the stars could be photographically determined, and even their parallaxes, eliminating entirely the errors of observers

It was absolutely essential, as he knew, in order to obtain a perfect method of measurement of the photographs, to attain the utmost perfection in the cutting of the threads of the micrometer screw, and some idea of the care which he bestowed on them may be gathered from the fact that he took three years to make a single screw In order to test its quality, it struck him that it would be a happy thought to see if it would enable him to rule a grating He accordingly set the apparatus up in his bedroom, and by means of an automatic arrangement kept it going all night, as at that time the local vibrations were fewest The result was that he was able to make the most perfect gratings known, which are only now surpassed by those of Rowland, who followed in his wake

The photographic corrector, which consisted of an additional lens to be applied to visual object-glasses, to render them fit for photographic use, was also due to his exceptional mechanical ability, and was brought out in the year 1868.

Owing to failing health he was at last obliged to give up all idea of making observations, so he resigned himself to a thorough supervision of the great number of measurements of the photographs of the star clusters that by this time had very considerably accumulated.

In the year 1884, Columbia College, New York, was the recipient of all his astronomical instruments, apparatus, and completed measures It is only a fortnight ago when a notice of the measures of the Pleiades, which were prosecuted by Mr Jacoby, under the direction of Prof. Rees, was made in these columns, and it will not be long before several other clusters will be published

In this brief notice we have only referred to some of the more salient points with which he enriched the domain of astronomical science; and his was no mean spirit striving to confine to his own use the various methods of work and improvements he introduced. he scattered his gratings with a lavish hand among all who were likely to make any use of them, and his greatest delight was to help others occupied in researches kindred to his own

NOTES

Sir Archibald Geikie has been appointed by the Council of the Royal Society to be one of the Governors of Harrow School

It was with deep regret that we saw the announcement in Monday's *Times* of the death of Admiral Mouchez, the Director of the Paris Observatory In him France has lost one of her most active men of science, whose place it will be no easy task to fill

At St John's College, Cambridge, on July 9, at 2 30 p m, there will be held a meeting of the General Committee that was formed for placing a suitable memorial of the late Prof. Adams in Westminster Abbey This meeting is specially called to consider a modification in the form of the memorial. The resolution, as passed in February, was to the effect that the memorial should "consist of a bust with tablet and inscription," but as the Dean has been unable to sanction any site in that part of the Abbey in which it was first proposed to be placed, but has offered an excellent position for a medallion, near the monument of Newton and the grave of Sir John Herschel, and close to the memorials of Darwin and Joule, the Executive Committee recommend that this offer be accepted, and that the terms of the former resolution be altered to "That the memorial consist of a medallion and inscription."

The *Botanische Zeitung* publishes a programme of the International Botanical Congress to be held in Genoa. On Sunday evening, September 4, there will be a reception of the foreign botanists present On Tuesday the Botanical Institute and Garden, presented to the Municipality of Genoa by Mr. Thos. Hanbury, will be formally opened On Saturday, September 10, the Acclimatisation Garden of Mr Hanbury at Mortola will be visited The rest of the week will be occupied by scientific sittings, receptions, and excursions

Dr Benecke, the Director of the Experimental Station at Klaten, Java, has offered a prize of 1000 marks for the best essay, founded on original observations and experiments in cultivation, on the causes of the red colour in the fibrovascular bundles of *Sorghum*, which accompanies the disease known as "sereh." A very similar disease has recently become very destructive to the sugar-cane crop in Java.

In our account last week of the Ladies' *Conversazione* of the Royal Society we stated that the Telephone Company's installation was the means by which the music from the Paris opera was rendered audible. This, as we have reason now to know, was incorrect The Post Office undertook the whole affair, no company having anything at all to do with it.

PROF. BURT G. WILDER, M.D., of Cornell University, sends us the following correction:—In a circular, "American Reports upon Anatomical Nomenclature," issued last winter by Prof. Wilder, as Secretary of the Committee of the Association of American Anatomists, in the third paragraph of the third page, the Chairman of the Committee of the Anatomische Gesellschaft should be Prof. A. von Kolliker, and the Chairman of the American division (appointed in 1891 by the American Association for the Advancement of Science) of the International Committee on Biological Nomenclature should be Prof. G. L. Goodale. Prof. Wilder desires to express his regret for the errors, due in the one case to his own misapprehension, and in the other to a clerical mistake.

UNDER the title of "The Cambridge Natural History," Messrs. Macmillan and Co. have in active preparation an important series of volumes on the Natural History of Vertebrate and Invertebrate Animals, edited, and for the most part written, by Cambridge men. While intended in the first instance for those who have not had any special scientific training, the volumes will, as far as possible, present the most modern results of scientific research. Thus the anatomical structure of each group, its development, palæontology, and geographical distribution, will be considered in conjunction with its external character. Care will, however, be taken to avoid technical language as far as possible, and to exclude abstruse details which would lead to confusion rather than to instruction. The series will be under the general editorship of Mr. J. W. Clark, the University Registrar, and Mr. S. F. Harmer, Superintendent of the Museum of Zoology. The following writers are engaged upon the groups which precede their names:—*Mammals*, Mr. J. J. Lister; *Birds*, Mr. A. H. Evans; *Reptiles* and *Amphibia*, Dr. Gadow, F.R.S.; *Fish*, Mr. W. Bateson; *Mollusca*, Mr. A. H. Cooke; *Polyzoa*, Mr. S. F. Harmer; *Brachiopoda*, Mr. A. E. Shipley; *Insects*, Mr. David Sharp, F.R.S.; *Myriapoda*, Mr. F. G. Sinclair; *Arachnoida*, Mr. C. Warburton; *Crustacea*, Prof. W. F. R. Weldon; *Cœlenterata*, Mr. S. J. Hickson; and *Sponges*, Dr. W. J. Sollas. It is hoped that some of the volumes which are already far advanced may appear in the course of next year. The series will be fully illustrated.

THE weather during the past week has been unsettled, but considerably warmer generally. Towards the close of last week solar halos were visible in the south, and a depression moved along our west coasts in a north-north-easterly direction, accompanied by showers, while the daily temperatures reached upwards of 70° in the inland parts of England. At the beginning of the present week, a still further increase of temperature occurred, the maxima exceeding 80° in the midland and eastern parts of England, and fog became prevalent over the Channel and the southern parts of England. The atmospheric conditions, which during the greater part of the period were cyclonic, with moderate or strong south-westerly winds, amounting to a strong gale from the westward in Caithness on Monday, subsequently became anticyclonic with light north-easterly and easterly winds over England; but on Tuesday evening a depression lay over the mouth of the Channel, the conditions rapidly became more unsettled, and a very severe thunderstorm occurred on that night in London and the greater part of England, accompanied by heavy rain. The *Weekly Weather Report* for the period ending the 25th instant shows that the rainfall exceeded the mean in nearly all districts; in the eastern and southern parts of England the excess was rather large. But reckoning from the beginning of the year there was still a deficit in all districts, although the amount was trifling in the north east and north-west of England.

A NEW meteorological journal, entitled *L'Atmosphère*, has recently appeared in Paris. It contains several short original articles and miscellaneous notes collected by the director of a private observatory, named Tour Saint Jacques. At present there is no such journal published in France, excepting the *Annuaire* of the Meteorological Society, containing the papers read by its members. The current number (No. 5) contains an article on the optical phenomena of the atmosphere, by A. Cornu, member of the Institute, and one on solar phenomena and terrestrial magnetism, by L. Marchand, of the Lyons Observatory. It also gives a list of the principal meteorological papers published in recent serials.

A SERIES of severe earthquake shocks is reported from Guodolajara, Mexico. The first shock was felt last Friday night, and lasted eighteen seconds. Windows were broken and plastering cracked in numerous houses, and hundreds of panic-stricken people took refuge in the streets until daylight. On Saturday a second shock occurred, wrecking a number of buildings. Several persons were seriously hurt, but in no case are their injuries expected to prove fatal. Several other shocks have been felt since. The volcano Colima is said to be in a state of much activity. Great volumes of sulphur, smoke, and lava are issuing from the crater.

A PAPER setting forth a proposal for a national photographic record and survey, by Mr. W. J. Harrison, was lately read before the Photographic Society of Great Britain, and has now been issued separately. Mr. Harrison's idea is that a pictorial record of the present condition of the country should be secured by photography, the work being accomplished by professionals, individuals (amateurs), photographic societies, and agencies under the control of the Government. In the course of the paper he gives an interesting account of the way in which the local photo-survey of Warwickshire is being carried out.

ANTHROPOLOGISTS will read with interest some folk songs and myths from Samoa, printed in the new number of the Journal and Proceedings of the Royal Society of New South Wales (vol. xxv.). They are translated by the Rev. G. Pratt, and introductions and notes are provided by Dr. John Fraser.

PROF. F. STARR will contribute to the July number of the *Popular Science Monthly* an article on "Anthropological Work in America." It will be accompanied by portraits of seventeen American anthropologists. According to *Science*, the article shows that "both in quality and amount, the work of Americans in this field compares favourably with that of Europeans."

A SOCIETY which may have opportunities of doing much valuable work has been formed in Wellington, New Zealand. It is called the Polynesian Society, "Polynesia" being intended to include Australia, New Zealand, Melanesia, Micronesia, and Malaysia, as well as Polynesia proper. The President is Mr. H. G. Seth Smith, chief judge of the native land court, while the Queen of Hawaii is patron. We have just received the first number of the Society's Journal, in which there are papers on the races of the Philippines, by Elsdon Best; Maori deities, by W. E. Gudgeon; the Tahitian "Hymn of Creation," by S. P. Smith; Futuna, or Horne Island, and its people, by S. P. Smith; Polynesian causatives, by E. T.; and the Polynesian bow, by E. Tregear. There is also a paper giving the genealogy of one of the chieftainesses of Rarotonga, by a native of Rarotonga. The original was written in 1857, and is printed in the Journal, with a translation by Mr. Henry Nicholas, and notes by the editors. The editors are of opinion that the paper "apparently supports by direct traditional testimony the theory propounded by Hale, and subsequently advocated by Fornander, of the occupation of the Fiji Group by the Polynesian race, and of their later migration eastward to Samoa and the Society Group."

THE facility with which enlargements can now be produced, and the introduction of good commercial bromide paper, to say nothing of the artistic effects of the results, have all tended to increase the popularity of the practice of enlarging. When an amateur was formerly in need of moderate sized pictures, he was compelled more or less to use a large camera, but now the inclination is to employ small cameras and therefore small plates, and to subsequently adopt the enlarging process to give him the required size picture. A very useful and handy little book treating of this process, written by Mr John A. Hodges, has lately been issued by Messrs Iliffe and Son, and contains much practical information for working either by artificial light or daylight. Methods of constructing cameras suitable for this work, lanterns, and various accessories, are all very well described and illustrated, and if carefully followed out will render many an amateur independent of the instrument maker. In the section relating to the chemical manipulations there are also some useful hints which will save a beginner much annoyance and help him to produce satisfactory results.

OBERLIN COLLEGE, Ohio, is issuing a series of Bulletins giving the results of special work done in its museum and laboratories. Two have now been published, the first being a preliminary list of the flowering and fern plants of Lorain County. The second, which we have just received, contains a descriptive list of the fishes of Lorain County, and has been prepared by Mr L. M. McCormick.

ACCORDING to the *Pioneer Mail* of June 8, the residents of Howrah have been finding lately that jackals are animals of anything but an attractive temper. In some cases they have come right up to the bungalows in search of prey. A little girl, aged about five years, was playing in a verandah, when a jackal suddenly rushed on her, and was dragging her away, when she was rescued. She was severely bitten. Three natives, while walking along Kooroot Road, were attacked by a jackal, which was only driven off after a stubborn fight, and a tale is told of two women, while standing near a tank, being attacked and bitten. So serious has the state of matters become, that the public propose to submit a memorial to the district magistrate praying for the adoption of measures for the destruction of these pests.

REFERRING to Malta's spring visitors, the *Mediterranean Naturalist* for June says that during the preceding month the valleys and gorges were alive with orioles, warblers, rollers, and bee-eaters. In the rich crimson clover enormous numbers of quails found shelter during their sojourn *en route* for the Continent, while the branches and foliage of the carob, the prickly pear, and the orange trees were thronged with harriers and larks.

MR F. TURNER contributes to the April number of the *Agricultural Gazette of New South Wales* a paper on the carob bean tree as one of the commercial plants suitable for cultivation in New South Wales. The Agricultural Department distributed a quantity of seed last year, and some healthy young plants raised from this seed are now growing in several parts of the colony. Mr Turner expects that when the tree becomes better known to cultivators it will be extensively grown to provide food for stock, more especially during adverse seasons. The carob can not only be trained into a very ornamental shade tree, but may be planted as a wind break to more tender vegetation. He advises all who cultivate it to keep bees, if only a single hive. It is astonishing, he says, how many flowers these industrious insects will visit in the course of a day, and be the agency whereby they are fertilized.

SOME time ago a sugar school was established in connection with the State University, Lincoln, Nebraska, and if we may judge from the first formal report, lately submitted by Prof. Lloyd, it is likely to do much excellent work. The school opened on January 5 with twenty-five students. These students were mostly members of other classes in the chemical department of the University, the only preparation required for entrance being a clear conception of the principles of elementary chemistry, such as may be obtained in some of the high schools of Nebraska. The course consisted of two lectures a week, given by Mr Lyon, with five hours of laboratory work. The lectures embraced the following subjects: (1) chemistry of the sugars; (2) technology of beet sugar manufacture; (3) culture of the sugar beet. During the latter part of the winter term, Prof. DeWitt B. Brace gave the class four lectures on the theory of light, dealing with (1) the wave theory of light; (2) polarization of light; (3) rotation of the plane of polarization; (4) application of these principles to the polariscope and to the different forms of saccharimeters. It is hoped that in the coming year the work may be greatly extended.

A "Dictionnaire de Chimie industrielle" is being issued in parts, under the direction of A. M. Villon, by the "Librairie Tignol." It gives an account of the applications of chemistry to metallurgy, agriculture, pharmacy, pyrotechnics, and the various arts and handicrafts.

MESSRS LONGMANS, GREEN, AND CO. have issued a third edition, revised and enlarged, of Prof. E. A. Schäfer's "Essentials of Histology." The intention of the author is to supply students with directions for the microscopical examination of the tissues.

A WORK on the "Migration of Birds," by Charles Dixon, will shortly be published by Messrs. Chapman and Hall.

A PAPER upon the oxidation of nitrogen by means of electric sparks is contributed, by Dr V. Lepel, to the current number of the *Annalen der Physik und Chemie*. It is well known that small quantities of nitric and nitrous acids and their ammonium salts are produced during the passage of high tension electrical discharges through moist air. Dr V. Lepel's experiments have been conducted with the view of obtaining more precise information concerning the nature of the chemical reactions which occur, and the experimental conditions most favourable for increasing the amount of combination. The first action of the spark discharge appears to be the production of nitric oxide, which is immediately converted by the oxygen present into nitrogen peroxide. The latter then reacts with the aqueous vapour present, forming nitric acid and liberating nitric oxide in accordance with the well known equation $3NO_2 + H_2O = 2HNO_3 + NO$. It has been found, however, that the continued passage of sparks through the same quantity of moist air does not result, as might at first sight be expected, in the conversion of more and more of the atmospheric gases into oxidized products. For the passage of sparks through the gaseous oxides of nitrogen first formed results in their decomposition again into their elementary constituents. If, for instance, spark discharges are passing at the rate of one per second, the whole of the nitrogen peroxide molecules have not time to react with the water molecules to form nitric acid, before the passage of the next spark, and hence some of them suffer decomposition; indeed, it is probable that a number of the nitric oxide molecules first formed have not even time to combine with oxygen to form the peroxide before the passage of the next discharge, which brings about their dissociation. Hence it is that, in a closed space, a limit is soon reached beyond which there is no further increase in the amount of nitric acid. For this reason the yield of nitric acid has hitherto been very small. Dr V. Lepel has made experiments, therefore, with a slowly moving atmosphere, and under different conditions of pressure, and with various types of spark

discharge, with the result that he has already increased the amount of combination to 10 per cent of the total amount of air employed The air is exposed under increased pressure to a series of parallel spark discharges in the same tube. The change of atmosphere is not made continuously, but intermittently, and the gases are expelled from the discharge tube into a large absorption vessel in which the products are absorbed in a solution of water, or of a caustic alkali Detailed accounts are given in the memoir of the efficacy of the various forms of high tension discharge, and Dr V. Lepel is now experimenting with the discharge from a Topler influence machine with sixty-six rotating plates. Of particular interest are his remarks concerning the probable effect of the high voltage discharges of which we have lately heard so much He considers it not improbable that by their aid a new mode of producing nitric acid from the atmospheric gases on the large scale may be introduced, rendering us altogether independent of the natural nitrates as a source of nitric acid

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus*) from North Borneo, presented by the Rev Augustus D Beaufort, two Small Hill Mynahs (*Gracula religiosa*) from India, presented by Lieut Col W S Hore, a Chough (*Pyrrhocorax graculus*) from the Aran Islands, Galway, presented by Miss Balfour, four Sœmmerring's Pheasants (*Phasianus sæmmerringi* ♂ ♂ ♀ ♀) from Japan, presented by Mr Frank Walkinshaw, an Æsculapian Snake (*Coluber æsculapii*), a Vivacious Snake (*Tachymenis vivax*) from Central Europe, presented by Mr Alfred Scrivener, a Cayenne Lapwing (*Vanellus cayennensis*) from South America, two Axolotls (*Siredon mexicanus*) from Mexico, purchased, a Ruddy headed Goose (*Bernicla rubidiceps* ♀) from the Falkland Islands, received in exchange, a Burchell's Zebra (*Equus burchellii* ♂), a Thar (*Capra jemlaica*), a Japanese Deer (*Cervus sika*), born in the Gardens

OUR ASTRONOMICAL COLUMN

VARIABLE NEBULÆ —Mr Barnard, in *Astronomische Nachrichten*, No 3097, mentions the cases of two nebulæ which he supposes must be of a variable type The first has a diameter of about 1′, and appears rather like a comet, the brightness gradually increasing towards the centre, there being no nucleus Its position for 1889 0 was R A 3h 56m 17s, Declination + 69° 30′ 38″ The other nebula was discovered by him in 1888, and was estimated to lie between magnitudes 9 and 10, the stellar nucleus being of the thirteenth magnitude Subsequent observations made in 1891 showed that this nebula had become considerably fainter (13½ mag), there being still a faint nucleus visible, its diameter was estimated as ½′, while its position for 1888 0 was R.A 0h 37m 55 7s, Decl − 8° 48′ 6″ 5

VARIATION OF LATITUDE —Mr. Chandler, toward the latter end of last year, contributed to the *Astronomical Journal* several articles on the variation of terrestrial latitudes, in which the following points were brought out —(1) This variation is truly terrestrial (2) The period of revolution, from 1863 to 1885, of the pole of the earth's figure round that of rotation amounted to 427 days in a west to east direction (3) About the year 1730, the length of this period was a little over a year (4) The velocity of rotation is slowly diminishing In the present number (267) of the same journal he brings together evidence to establish some further conclusions at which he has arrived, basing them on a very considerable number of series of observations The results may be briefly summarized as follows —(*a*) About 1774 the rate of angular motion of the pole was a maximum with a daily rate of 1° 034, and since that period the decrease has taken place at an accelerating rate (*b*) If θ be the daily angular motion and T the interval in days from September 18, 1875, the angular velocity of the polar motion may be put in the form

$$\theta = 0°{\cdot}852 - 0°{\cdot}000\,009\,8\,T - 0°{\cdot}000\,000\,000\,132\,T^2.$$

(*c*) The law of the periodic variation may be expressed as follows —

$$\phi = \phi_0 - 0''\,22 \cos [\lambda + (t - T)\theta],$$

where T is the time when the north pole of the earth's figure passes the Greenwich meridian,
E the number of completed revolutions between a given date, t, and the adopted epoch,
θ the daily angular motion,
ϕ the instantaneous value of the latitude of a place,
ϕ_0 the mean latitude,
and λ the longitude of the same place,
the values of T and θ being obtained from the equations—

$$T = 1875 \text{ Sept } 18\ 5 + 422^d\ 56\ E + 1^d\ 034\ E^2 + 0^d\ 009\ E^3 + 0^d\ 000067\ E^4,$$

$$\theta = \frac{360°}{P},$$

when $P = 423^d\ 62 + 2^d\ 0953\ E + 0^d\ 0274\ E^2 + 0^d\ 000268\ E^3$

(*d*) A sensibly constant angular distance between the poles of figure and rotation during the last fifty years has been maintained

(*e*) By a comparison of absolute and differential determinations the variation is entirely due to zenithal alterations, and not to a simultaneous variation of the zenith and the astronomical pole

COMPARATIVE SPECTRA OF HIGH AND LOW SUN —Mr Edward Stanford has just published five plates, 16½ × 19½ inches, in portfolio form, of Mr McClean's beautiful comparative photographic spectra of the high and low sun from H to A The collotype prints have been reproduced from the mounted photographs by the Direct Photo-Engraving Company, and are enlarged about 8½ times from the original negatives Published simultaneously also are his comparative spectral photographs of the sun and metals, extending from above H to near D The two series include the platinum and iron-copper groups.

THE CORONOIDAL DISCHARGES —The discovery of the presence and power of electricity is, comparatively speaking, very modern, and it is only now we are finding out the diversity of results it is capable of producing The sun being our great source of heat and light, it is only natural that we should suspect him of having a greater quantity of this form of energy in some way or the other, on a scale, of course, very much greater than ours. In a paper read before the National Academy of Sciences, Washington, and published in the June number of the *American Journal of Science*, Mr M I Pupin describes a series of experiments that he has been carrying out with regard to electrical discharges through poor media The apparatus which he used is fully described, so we will only refer to the plates which illustrate the points he wished to emphasize The illustrations are from photographs of discharges taken under conditions under which the solar corona is observed, and suggest in a very striking manner the phenomena that are usually observed at these times In one case, when the vacuum was very poor, the discharge started in the form of four large streamers, together with large jets, their distribution over the whole surface of the sphere being more or less uniform The appearance of the sphere "reminded me very much of the granular structure of the sun's disk, and the very luminous points which appeared from time to time reminded me of the sun's faculæ" Further experiments regarding the rotational motion of the streamers lead him to conclude that two discharge streamers tended to blow each other out, "owing to the motion of the cooler gas between them, this motion being produced by the enormous heating effect of the discharge" The figures shown are very striking indeed, and represent the general appearances of the corona during eclipses with a remarkable degree of accuracy

GEOGRAPHICAL NOTES

M JOSEPH MARTIN, well-known on account of his explorations in North-eastern Siberia, has died at Marghilan while on a journey in Central Asia.

THE Kalahari Desert has been crossed successfully by a "trek" of 150 waggons from the Rustenburg district of the Transvaal, bound for Mossamedes, where an active Boer colony has been established, a large party having embarked at Cape Town to join the overland division Later reports affirm that

a Boer republic has been declared in the plateau region of Angola, one of the healthiest parts of tropical Africa

THE survey of the district surrounding Aden has been completed by the officers of the Survey of India Department after a very arduous campaign Work was on several occasions almost stopped by sickness, and by the open hostility of the natives

STIMULATED by the recent discovery of two complete mammoth carcases in the Government of Irkutsk, the St Petersburg Academy of Sciences has commissioned Prof Tcherski, of Irkutsk, to proceed to Yakutsk, on the Lena, and thence, accompanied by Cossacks and pack-horses, eastward to the Kolyma Valley, pushing on if possible this summer to Nizhne Kolymsk in 69° N, returning before winter to Sachiversk on the Indigirka, a town situated on the Arctic Circle The main object of the expedition is to study the drift geology, but collections will be made in all departments of science, including barometric observations, in order to determine the orography of this rarely visited part of Siberia

Globus announces the formation of a new islet in the Caspian, near Baku, by upheaval It lies three and a half miles from shore, and measures 175 feet by 100 feet, rising about 20 feet above the water Its surface is irregular, and composed of blackish grey and yellow hardened mud

WITH reference to the note on p 65 as to the discovery of a new range of mountains in Benin, it is only fair to former travellers in that region to say that the map by the Intelligence Department, although bearing no mountain shading, has marked upon it "Mt Ara," very near the position where the range seen by Governor Carter is situated.

THE mountaineering expedition, led by Mr Conway, to attempt the ascent of the loftiest Himalayan summits, has been making excursions from Gilgit and mapping the Bagrot Valley, but bad weather has prevented any very important climbing from being done A *Times* telegram from Calcutta conveys news of June 8 from Gilgit, from which it appears that the greatest height yet reached is 17,000 feet, one night having been passed at an elevation of 16,000 feet The party was about to set out for Nagar, *en route* for Askoley, by the Hissar Pass

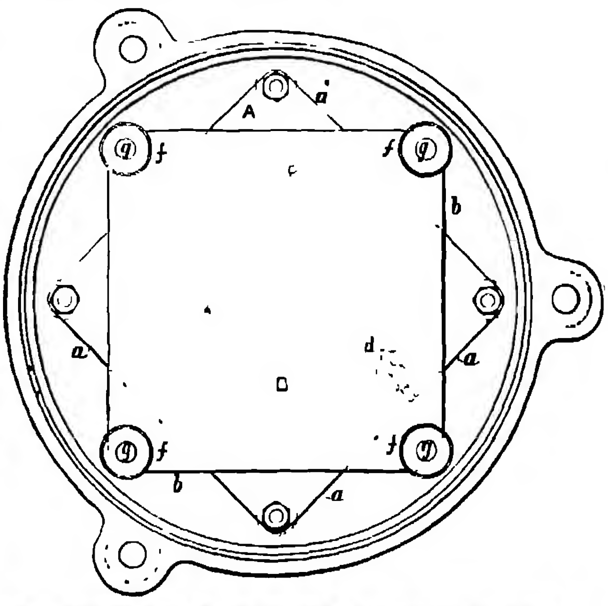
A NEW FORM OF AIR LEYDEN [1]

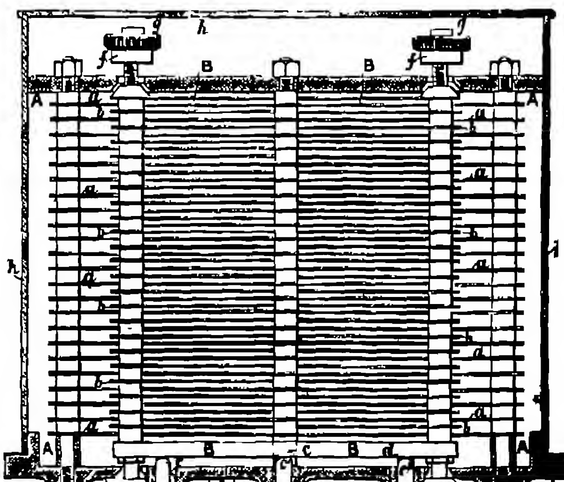
IN the title of this paper as originally offered for communication "*Air Condenser*" stood in place of "*Air Leyden*," but it was accompanied by a request to the Secretaries to help me to a better designation than "Air Condenser" (with its ambiguous suggestion of an apparatus for condensing air), and I was happily answered by Lord Rayleigh with a proposal to use the word "leyden" to denote a generalized Leyden jar, which I have gladly adopted.

The apparatus to be described affords, in conjunction with a suitable electrometer, a convenient means of quickly measuring small electrostatic capacities, such as those of short lengths of cable

The instrument is formed by two mutually insulated metallic pieces, which we shall call A and B, constituting the two systems of an air condenser, or, as we shall now call it, an air leyden The systems are composed of parallel plates, each set bound together by four long metal bolts. The two extreme plates of set A are circles of much thicker metal than the rest, which are all squares of thin sheet brass The set B are all squares, the bottom of which is of much thicker metal than the others, and the plates of this system are one less in number than the plates of system A The four bolts binding together the plates of each system pass through well-fitted holes in the corners of the squares, and the distance from plate to plate of the same set is regulated by annular distance pieces which are carefully made to fit the bolt, and are made exactly the same in all respects Each system is bound firmly together by screwing home nuts on the ends of the bolts, and thus the parallelism and rigidity of the entire set is secured

The two systems are made up together, so that every plate of B is between two plates of A, and every plate of A, except the two end ones, which only present one face to those of the opposite set, is between two plates of B When the instrument is set up for use, the system B rests by means of the well-known "hole slot and plane arrangement,"[1] engraved on the under side of its bottom plate, on three glass columns which are attached to three metal screws working through the sole plate of system A These screws can be raised or lowered at pleasure, and by means of a gauge the plates of system B can be adjusted to exactly midway between and parallel to the plates of system





A The complete leyden stands upon three vulcanite feet attached to the lower side of the sole plate of system A.

In order that the instrument may not be injured in carriage, an arrangement, described as follows, is provided, by which system B can be lifted from off the three glass columns and firmly clamped to the top and bottom plates of system A

The bolts fixing the corners of the plates of system B are made long enough to pass through wide conical holes cut in the top and bottom plates of system A, and the nuts at the top end of the bolts are also conical in form, while conical nuts are also

[1] "On a New Form of Air Leyden, with Application to the Measurement of Small Electrostatic Capacities." By Lord Kelvin, P.R.S. Read at the Royal Society on June 2.

[1] Thomson and Tait's "Natural Philosophy," § 198 example 3.

fixed to their lower ends below the base plate of system A Thumbscrew nuts, f, are placed upon the upper ends of the bolts after they pass through the holes in the top plate of system A

When the instrument is set up ready for use, these thumbscrews are turned up against fixed stops, g, so as to be well clear of the top plate of system A, but when the instrument is packed for carriage they are screwed down against the plate until the conical nuts mentioned above are drawn up into the conical holes in the top and bottom plates of system A, system B is thus raised off the glass pillars, and the two systems are securely locked together so as to prevent damage to the instrument

A dust-tight cylindrical metal case, h, which can be easily taken off for inspection, covers the two systems, and fits on to a flange on system A The whole instrument rests on three vulcanite legs attached to the brass plate on system A, and two terminals are provided, one, i, on the base of system A, and the other, j, on the end of one of the corner bolts of system B

The air leyden which has been thus described is used as a standard of electrostatic capacity. In the instrument actually exhibited to the Society there are twenty-two plates of the system B, twenty three of the system A, and therefore forty-four octagonal air spaces between the two sets of plates The thickness of each of these air spaces is approximately 0 301 of a centimetre The side of each square is 10 13 cm, and therefore the area of each octagonal air space is 85 1 sq cm The capacity of the whole leyden is therefore approximately $44 \times 85\ 1/(4\pi \times\ 287)$, or 1038 cm in electrostatic measure This is only an approximate estimate, founded on a not minutely accurate measurement of dimensions, and not corrected for the addition of capacity, due to the edges and projecting angles of the squares and the metal cover I hope to have the capacity determined with great accuracy by comparison with Mr Glazebrook's standards in Cambridge

To explain its use in connection with an idiostatic electrometer for the direct measurement of the capacity of any insulated conductor, I shall suppose, for example, this insulated conductor to be the insulated wire of a short length of submarine cable core, or of telephone, or telegraph, or electric light cable, sunk under water, except a projecting portion to allow external connection to be made with the insulated wire

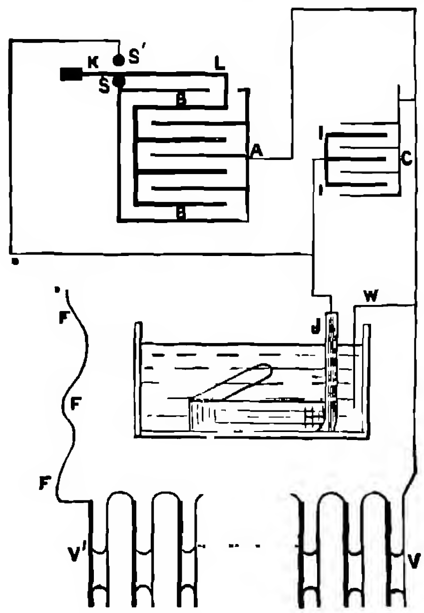
The electrometer which I find most convenient is my "multicellular voltmeter," rendered practically dead-beat by a vane under oil hung on the lower end of the long stem carrying the electric "needles" (or movable plates). In the multicellular voltmeter used in the experimental illustration before the Royal Society, the index shows its readings on a vertical cylindric surface, which for electric light stations is more convenient than the horizontal scale of the multicellular voltmeters hitherto in use; but for the measurement of electrostatic capacity the older horizontal scale instrument is as convenient as the new form

To give a convenient primary electrification for the measurement, a voltaic battery, vv', of about 150 or 200 elements, of each of which the liquid is a drop of water held up by the capillary attraction between a zinc and copper plate about 1 mm asunder An ordinary electric machine, or even a stick of rubbed sealing-wax, may, however, be used, but not with the same facility for giving the amount of electrification desired as the voltaic battery

One end of the voltaic battery is kept joined metallically to a wire, W, dipping in the water in which the cable is submerged, and with the case C of the multicellular, and with the case and plates A of the Leyden, and with a fixed stud, S, forming part of the operating key to be described later The other end of the voltaic battery is connected to a flexible insulated wire, FFF, used for giving the primary electrification to the insulated wire J of the cable, and the insulated cells, II, of the multicellular kept metallically connected with it The insulated plates B of the leyden are connected to a spring, KL, of the operating key referred to above, which, when left to itself, presses down on the metal stud S, and which is very perfectly insulated when lifted from contact with S by a finger applied to the insulating handle H. A second well insulated stud, S', is kept in metallic connection with J and I (the insulated wire of the cable and the insulated cells of the multicellular).

To make a measurement, the flexible wire F is brought by hand to touch momentarily on a wire connected with the stud S', and immediately after that a reading of the electrometer is taken and watched for a minute or two to test either that there is no sensible loss by imperfect insulation of the cable and the insulated cells of the multicellular, or that the loss is not sufficiently rapid to vitiate the measurement When the operator is satisfied with this, he records his reading of the electrometer, presses up the handle H of the key, and so disconnects the plates B of the leyden from S and A, and connects them with S', J, I Fifteen or twenty seconds of time suffices to take the thus diminished reading of the multicellular, and the measurement is complete

The capacity of the cable is then found by the analogy —As the second reading of the electrometer is to the excess of the



first above the second, so is the capacity of the leyden to the capacity of the cable

A small correction is readily made with sufficient accuracy for the varying capacity of the electrometer, according to the different positions of the movable plates, corresponding to the different readings, by aid of a table of corrections determined by special measurements for capacity for the purpose on the multicellular.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof Liveing announces a course of lectures in general chemistry, to be given during the Long Vacation by Mr. Fenton, beginning on July 7. Mr Fenton will also give a series of demonstrations on the chemistry of photography

At the Congregation on June 16, seven graduates in arts were admitted to the degree of Doctor in Medicine, and thirty one to the degrees of Bachelor of Medicine and Bachelor of Surgery These are the largest numbers hitherto admitted at one time

Sir R S Ball, Lowndean Professor of Geometry and Astronomy, has been elected to a Professorial Fellowship at King's College.

At Christ's College the following awards have been made to students of natural science.—Scholarships. E. K Jones (£50), G A Anden (£30), J M Woolley (£30), C F G. Masterman (£50), H Pentecost (£50), A M. Hale (£30) Exhibition A M. Barraclough (£30) At Emmanuel College — Scholarship A Eichholz (£80) Exhibition J C Muir (£30)

At the annual election of scholars in St John's College, the following awards in Natural Science have been made —Foundation Scholarships W L Brown, T L Jackson, W. McDougall, S S F Blackman Exhibitions in Augmentation of Scholarships: Villy, Whipple (First Class Nat. Sci Tripos, Part II.) Hughes Prize (highest in third year): Villy Herschel Prize in Astronomy Pocklington Hutchinson Studentship for Research in Zoology: E W. MacBride.

SCIENTIFIC SERIALS

THE numbers of the *Journal of Botany* for May and June appeal almost entirely to students of systematic and descriptive botany —Mr F J Hanbury continues his notes on *Hieracia* new to Britain, in the course of which he describes three species altogether new —Mr Geo Massee contributes diagnoses of a number of new species of Fungi from St Vincent, illustrated by three coloured plates.—Mr E G Baker continues his Synopsis of genera and species of *Malveæ*, Rev. Moyle Rogers his essay at a key to British *Rubi*, and Mr W A Clarke his first records of British flowering plants

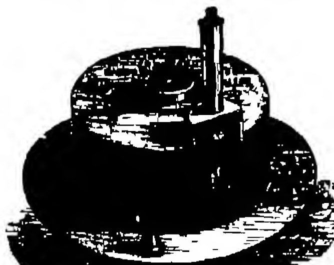
IN the *Botanical Gazette* for May are two original papers of interest —On the archegone and apical growth of the stem in *Tsuga canadensis* and *Pinus sylvestris*, by D M Mottier On the first point the author agrees very nearly with the account by Strasburger, on the second point he is unable to say that there is a single cell at the apex of the stem, unless in the young plant, and even then not with absolute certainty —Germination of the teleutospores of *Ravenalia cassiæcola*, by B M Duggar

SOCIETIES AND ACADEMIES

LONDON

Physical Society, June 10 —Mr Walter Baily, Vice President, in the chair —Dr Gladstone read a paper on some points connected with the electromotive force of secondary batteries, by himself and Mr W Hibbert The communication includes replies to certain questions raised by M Darrieus in a paper read before the Société Internationale des Electriciens on May 4, 1892, and to the views expressed by Prof Armstrong and Mr Robertson in the discussion on a paper by the present authors read before the Institution of Electrical Engineers, on May 12 and 19 It also contains an account of their recent experiments on the subject M Darrieus agrees with Prof Armstrong and Mr Robertson that the large E M F immediately after charge is due to persulphuric acid, and opposes the ordinary theory that the ultimate product of discharge is lead sulphate at both plates, so far as the positive plate is concerned The authors attribute the finding of large quantities of lead oxide by M Darrieus to difficulties in analysis, for it is not easy to imagine that oxide of lead could remain as such in presence of sulphuric acid They have also shown that the changes of E M F during charge and discharge coincide fairly well with those obtained by putting Pb and PbO_2 plates in different strengths of acid, and conclude "that the changes of E M F depend on the strength of the acid that is against the working surfaces of the plates" Prof Armstrong and Mr Robertson disagree with the authors' views, and suppose that the sulphuric acid used was contaminated with soluble peroxides, and they also believe that H_2SO_4 itself takes part in the reactions As regards the first objection, the authors see no reason why the traces of soluble peroxide (if any) on the plates should always vary in amount with the strength of the fresh acid in which the plates were dipped The second point they leave an open question In reply to the criticism on the summation of the two curves obtained respectively with two lead plates and two lead peroxide plates in acids of different strengths, they point out that the resulting curve coincides both in shape and magnitude with that determined when a Pb and a PbO_2 plate were placed in different strengths of acid Whilst admitting the possibility of the lead supports having some influence on the result, they cannot conceive that such large and uniform differences as those given in their paper can be due to accidental operations of local action To show that the increase of E M F does not depend on the presence or absence of persulphuric acid, the authors have tested the E.M F of a Pb and a PbO_2 plate, free from soluble oxides, in sulphuric acid of 15 per cent strength, a porous diaphragm being between the plates The E M F was 1 945 volts After adding 1 per cent of persulphate of potassium to the liquid surrounding the PbO_2 plate, the E M F was unaltered, whilst putting the Pb plate in the same liquid only reduced the E M F to 1 934 Experiments have also been made on cells with phosphoric acid of different strengths, instead of sulphuric acid Changing the density from 1 05 to 1 5, raised the E M F 0 176 volt, whilst calculations from Lord Kelvin's law gave 0 171 volt In this case they consider that no acid analogous to persulphuric acid could be present. They also find that the effects of charging and repose on the E M F of phosphoric acid cells are quite analogous to those obtained with sulphuric acid The researches are being extended chiefly on the thermochemical side Prof. Ayrton thought there was no question that the strength of acid had much to do with the changes of E M F The point at issue, he considered, was whether the changes were direct effects of the strength of acid, or due to secondary actions brought about by alterations in strength Mr E W Smith said Mr Robertson and himself were repeating the author's experiments with two PbO_2 plates without any grid They had obtained results analogous to those mentioned in the paper, but the true explanation of the effects was still to seek Mr W Hibbert contended that the soluble oxides referred to by Prof Armstrong and Mr Robertson were not present in their experiments They had also proved that changes in acid strength altered the E M F, whilst presence of persulphuric acid did not Dr Gladstone, in reply, said they also were making experiments without grids, but had not made sufficient progress to discuss them at present Mr Hibbert and himself believed the effects of local action inconsiderable, whilst Messrs Armstrong and Robertson thought them very important He hoped that ere long the points would be settled conclusively —A paper on workshop ballistic and other shielded galvanometers, by Prof W E Ayrton, F R S, and Mr T Mather, was read by Prof Ayrton The galvanometers described were of the type having movable coils and fixed magnets, the advantages of which are well known In designing the ballistic instruments, their aim had been to obtain sensibility and portability, combined with being screened from external influences, for it was often desirable to measure the magnetic fluxes and fields in dynamos by apparatus near the machines One of the improvements adopted was the narrow coil described in a paper "On the Shape of Movable Coils, &c," read before the Society in 1890 Such coils are particularly advantageous for ballistic instruments, for not only can greater swings be obtained by the discharge of a given quantity of electricity through such a coil than with ordinary shaped coils when the periodic times are the same, but even when the same control is used, the same length of wire in the coil, and suspended in the same field, the narrow coil is more sensitive to discharges than coils of any other shape Another improvement was the use of phosphor bronze strip for the suspensions instead of round wire For a given tensile strength, both the control and the subpermanent set could be diminished by using strip In February 1888 the authors made a d'Arsonval of the ordinary type as a ballistic instrument, and found that although it was suitable for comparing condensers, yet for induction measurements the damping was excessive unless the resistance in the circuit was very large This greatly reduced the sensitiveness In 1890 they tried one of Carpentier's milliamperemeters as a ballistic instrument, but found it insensitive A narrow coil instrument made in the same year was found to be sensitive for currents, but as the coil was wound on copper to get damping, it was not suitable for ballistic work In January 1892 a somewhat similar instrument was constructed for ballistic purposes, and was found very sensitive and convenient Although the coil had only a resistance of 13 ohms, one microcoulomb gave a swing of 170 divisions on a scale 2000 divisions distant, the periodic time being 2 7 seconds The instrument could be used near electromagnets or dynamos, and was so sensitive that for ordinary induction measurements very large resistances can be put in series with it, thus reducing the damping to a very small amount On the other hand, the coil could be brought to rest immediately by a short circuit key It had the further advantage that it was not necessary to redetermine its constant every time it was used The chief disadvantage of such instruments was the variable damping on closed circuits of different resistances This could, however, be overcome by arranging shunts and resistances so that the external resistance between the galvanometer terminals was the same for all sensibilities A portable ballistic instrument, intended for workshop use, was next described This had a narrow coil and a pointer moving over a dial whose whole circumference was divided into 200 parts. The instrument had been designed to give a complete revolution for a reversal of a flux of two million C G S. lines, but the pointer could turn through two or more revolutions To test strong fields a test coil with a total area of 10,000 square centimetres is used, and has a trigger arrangement for suddenly twisting it through two right angles The instrument then reads off directly the strength of

field in C G S lines. To vary the sensitiveness in known proportions, resistances are employed. Referring to the improvements made in movable coil instruments since January 1890, when a paper on "Galvanometers" was read before the Society by Dr. Sumpner and the present authors, Prof Ayrton said Mr Crompton had greatly increased the sensitiveness of Carpentier's instruments by suspending the coils with phosphor-bronze strip Mr Paul had brought out a narrow coil instrument which combined the advantages of portability, dead-beatness, quickness,



and sensibility Specimens of these instruments were exhibited The narrow coils are inclosed in silver tubes, which serve to damp the oscillations Such a coil is suspended within a brass tube which also forms the mirror chamber, and slides down between the poles of a circular magnet fixed to the base To clamp the coil, a plug mounted on a slotted spring passes through a hole in the brass tube A tube can be taken out and replaced by another containing a coil of different resistance in a few seconds An instrument of this kind, with a coil of 300 ohms, gave 95 divisions per microampere, and the damping on open circuit was such that any swing was $\frac{1}{15}$ of the previous one On comparing recent instruments with those mentioned in the paper on galvanometers above referred to, a distinct improvement is apparent, for their sensitiveness is, for the same resistance and periodic time, as great as that of Thomson instruments Prof Perry remarked that the forces dealt with were extremely small Mr Swinburne thought that ballistic galvanometers might be regarded as instruments indicating the time integral of E M F rather than quantity Illustrating his meaning by reference to dynamos, he said that if two machines arranged as dynamo and motor were joined by wires, then, if the armature of the dynamo were turned through any angle, that of the motor would move through the same angle, supposing friction, &c, eliminated Speaking of figures of merit, he pointed out that the power consumed was the important factor Prof S P Thompson inquired what was the longest period yet obtained with narrow-coil instruments. The decay of magnetism in large dynamos was so slow that very long periods were required He himself had used a weighted coil for such measurements He also wished to know why the figures of merit were expressed in terms of scale divisions on a scale at 2000 divisions distance, instead of in angular measure or in tangents Mr E W Smith asked what was the length of strip required to prevent permanent set when the deflection exceeded a revolution Mr A P Trotter thought that, in testing magnetic fluxes by the workshop ballistic instrument, the test coil might be left in circuit instead of putting in another coil He wished to know what error was introduced by the change of damping caused by the resistance of the circuit not being quite constant In his reply, Prof Ayrton said Mr Boys had pointed out that the scientific way to lengthen period was not by weighting the coils or needles, but to weaken the control Periods of 5 seconds had been obtained At present it was not easy to obtain longer periods owing to difficulties in obtaining sufficiently thin strip, and to the magnetism of materials.

Zoological Society, June 14.—Prof W H Flower, C B., F R.S, President, in the chair—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of May 1892, calling special attention to a pair of the rare and beautiful Passerine bird the Grey Coly Shrike (*Hypocolius ampelinus*) from Fao, Persian Gulf, presented by Mr. W D Cumming He also made some remarks on the most interesting objects observed during a recent visit to the Zoological Gardens of Rotterdam, the Hague, Amsterdam, and Antwerp —A communication from Mr T D A Cockerell contained particulars of the occurrence of a species of Jacana (*Jacana spinosa*) in Jamaica —Dr. John Anderson, F.R S, exhibited and made remarks on some specimens of the Mole-Rat (*Spalax typhlus*) from Egypt —Prof Romanes gave an account of some results recently obtained from the cross-breeding of Rats and of Rabbits, and showed that it did not follow that a blending of the characters of the parents was the result of crossing two different varieties —Prof Howes exhibited and made remarks on some photographs received from Prof Parker, of Otago, New Zealand, illustrative of Sea Lions, Penguins, and Albatrosses in their native haunts —Dr Dawson made remarks on the Fur Seal of Alaska, and exhibited a series of photographs illustrating the attitudes and mode of life of these animals —Mr Sclater called attention to the habits of a South African Snake (*Dasypeltis scabra*) as exhibited by an example now in the Society's Gardens —Mr Sclater also read some extracts from a letter addressed to him by Mr H H Johnston, C B, announcing the despatch of a consignment of natural history specimens illustrative of the fauna and flora of the Shiré Highlands —Mr W Saville Kent exhibited and made remarks on some photographs of a species of the genus *Podargus*, showing the strange attitudes of these birds in a living state — Mr F E Beddard read a paper on the brain and muscular anatomy of *Aulacodus* —Mr Gerard W Butler read a paper on the subdivision of the body cavity in Snakes, being a continuation of the subject treated of in a memoir on the subdivision of the body cavity in Lizards, Crocodiles, and Birds, previously read before the Society —Mr J W Gregory gave an account of his researches on the British Palæogene Bryozoa, of which he recognized thirty species, represented in the National Collection by about 750 specimens —Mr Sclater gave an account of a small collection of Birds from Anguilla, West Indies, made by Mr W R Elliott, one of the collectors employed by the Committee for the exploration of the Lesser Antilles —Prof G J Romanes, F R S, read a paper on a seemingly new diagnostic character of the Primates, which was that the terminal joints of both hands and feet in all species of this Order are destitute of hairs This rule did not apply to the Lemurs —Mr O Thomas read a paper on the genus *Echinops*, of the order Insectivora, and gave notes on the dentition of the allied genera *Ericulus* and *Centetes* —Mr G A Boulenger gave an account of the Reptiles and Batrachians collected by Mr C Hose on Mount Dulit, North Borneo Amongst these was a fine new Lizard of the genus *Varanus*, proposed to be called *V heteropholis* Two new Batrachians were also described as *Rhacophorus dulitensis* and *Nectophryne hosii* —A paper was read by Lieut-Colonel H H Godwin-Austen, F R S, on new species and varieties of the Land-Molluscan genus *Diplommatina*, collected by himself, and more recently by Mr W Doherty, in the Naga and Munipur Hill ranges The author described twenty seven supposed new species, the most remarkable being *D unicrenata*, with a peculiarly formed peristome —A communication was read from Mr B B Woodward on the mode of growth and the structure of the shell in *Velates conoideus*, Lamk, and in other *Neritidæ* The mode of growth and the structure of this shell were described as follows Up to a certain point the growth is normal, a change in the direction of growth afterwards takes place, and the test is enlarged by the addition of fresh shelly matter on the exterior of the under side, and by the removal of previously-formed layers on the inner surface The internal septum that serves the purpose of a myophore was shown to have originated in the paries, which, in the course of growth, had been replaced by the septum In this respect *Velates conoideus* epitomized in its life-history conditions which are found in distinct recent species of the closely-allied genus *Neritina* The relations of the paries and septum in this last genus were also described in this paper —This meeting closes the present session The next session (1892-93) will commence in November 1892

PARIS.

Academy of Sciences, June 20 —M d'Abbadie in the chair.—Phenomena of the residual life of muscle taken from the living being: physiological action of the muscular bases, by MM Arm Gautier and L. Landi —On the influence of mineral filters on liquids containing substances produced by microbes, by M Arloing —On the sanitary system adopted by the Venice Conference to prevent cholera from penetrating into Europe through the Isthmus of Suez, by M P Brouardel Four previous conferences for the reform of the quarantine system having failed, that convened at Venice in January 1892 has at last adopted a system chiefly advocated by the French dele-

gates, and practically tested on the Pyrenees frontier during the cholera in Spain two years ago On that occasion the passengers' linen was disinfected in heating ovens by steam under pressure, and the cholera patients, real or suspected, were isolated It having been shown that it is practically impossible for a vessel to pass the Suez Canal in quarantine, without contact with the shores, it was resolved that no vessel should be allowed to pass into the Mediterranean unless it was free from infection or had been completely disinfected Vessels from the Orient which have had no case of cholera since their departure will be allowed a perfectly free passage Those which have had cases of cholera during the voyage, but none for seven days before arrival, will be allowed to pass the Canal in quarantine if they have a medical officer and a disinfecting stove on board If not, they will be retained at the entrance of the Canal, where a sanitary station will be erected, and where the disinfection will take place Infected vessels will be detained at the entrance, the patients will be disembarked and isolated, and the vessels will be disinfected It is calculated that, out of 16,000 vessels that have passed through the Canal in five years, under the regulations now adopted 28 would have had to undergo a delay of a few hours for disinfection, and 2 would have been detained for a few days —On the law of correspondence of tangent planes in the transformation of surfaces by curved symmetry, by M S Mangeot —On the distribution of pressures in a rectangular solid charged transversally, by M Flamant —On the law of resistance of the cylinders utilized in the crusher manometers, by M P Vieille —On the Doppler-Fizeau method, by M Moessard If the relative motions of the source and the observer be alone considered, without reference to the distortion of the wave front due to motion through the connecting medium the ratio of the real to the apparent wave-length will be $\frac{V}{V - v + v'}$, where V is the velocity of wave propagation, v that of the source, v' that of the observer The true formula for this ratio is $\frac{V - v'}{V - v'}$, which, in the case of $V = v$, will differ from the former by infinity —An examination of the possibility of a reciprocal action between an electrified body and a magnet, by M Vaschy Showing that such an action cannot exist unless it be due to a physical quality of the ether different from that implied by the coefficients k and k' in the electric and magnetic laws of attraction, viz. $f = k\frac{qq'}{r^2}$, and $f = k'\frac{mm'}{r^2}$ —Action of nitric oxide on the metallic oxides, by MM Paul Sabatier and J B Senderens — On a bromo nitride of phosphorus, by M A Besson —On permolybdic acid, by M E Péchard —On the alteration of preserved ferruginous mineral waters, by M J Riban —On the transformation of gallic acid into pyrogallol fusion point of pyrogallol, by M P Cazeneuve —On the intestinal calculi of the cachalot (*ambre gris*), by M Georges Pouchet —The heliotropism of the *Nauplius*, by M C Viguier —Researches on the proximate composition of vegetable tissues, by M G Bertrand —On the action of some mineral salts on lactic fermentation, by M Ch Richet.—On the respiratory exchange, by MM Chr Bohr and V Henriquez An account of experiments showing that the lungs are not only the seat of the process of gaseous exchange, but also of the oxidation of tissue elements —Origins and trophic centres of the vaso-dilatatory nerves, by M J P Morat —Researches on the requirements of the vine, by M A. Muntz —On the topography of some lakes of the Jura, the Bugey, and the Isère, by M A Delebecque

AMSTERDAM

Royal Academy of Sciences, May 28 —Prof van de Sande Bakhuyzen in the chair —Mr Behrens dealt with specimens of brass made by compression of the constituents at ordinary temperature by Prof W Spring, Liége, Belgium One of the specimens, kindly forwarded by Prof Spring, was of a reddish colour, and had been produced by compressing a mixture of 9 parts of copper and 1 part of zinc, another, pale yellow, by compressing a mixture of 7 parts Cu and 3 parts Zn Both specimens had been filed up twice, and again consolidated by pressure. The reddish metal was a little softer than common cast brass; it could be somewhat flattened under the hammer. The yellow metal was harder than common brass, and brittle Both varieties contain a great quantity of yellow alloy, which seems to be in an amorphous state, showing a uniform, finely granular appearance, without any vestige of the beautiful crystallites, so characteristic for copper-zinc alloys, obtained by fusion. Further, a good deal of angular fragments of red copper, some of them cracked and doubled up, with yellow threads between the red lumps and strands, and finally some zinc, angular fragments and threads, trending outwards and uniting near the curved surface of the cylindrical specimens The metal is nearly, but not wholly compact There is much that gives evidence of a flow in the yellow alloy and in the zinc, but nothing pointing to a truly liquid state of the alloy or one of its components Regelation seems to be put aside, while there does not remain any doubt that zinc and copper have been intimately mixed and actually united by repeated filing and compression One may venture to say, that a more complete union of metallic powders by compression will lead to alloys of most remarkable properties, and may give some alloys that cannot be produced by fusion

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS —Our Earth—Night to Twilight, vol i G Ferguson (Unwin) —The Alternate Current Transformer, vol ii The Utilisation of Induced Currents Prof J A Fleming (*Electrician* Company).—Essai sur la Vie et la Mort A Sabatier (Paris Babé) —Chambers's Encyclopædia, vol ix (Chambers) —Iconographia Floræ Japonicæ, vol i Part 2 Dr R Yatabe (Tōkyō) —Thermodynamique à l'Usage des Ingénieurs A. Witz (Paris Gauthier Villars).—U S Relief Map (Washington) —Bees for Pleasure and Profit G G Samson (Lockwood) —Waterdale Researches, or Fresh Light on the Dynamic Action and Ponderosity of Matter 'Waterdale (Chapman and Hall) —Helen Keller Souvenir of the First Summer Meeting of the American Association to Promote the Teaching of Speech to the Deaf, second edition (Washington, Volta Bureau)

PAMPHLETS.—Descriptive List of the Fishes of Lorain County, Ohio L M McCormick (Oberlin) —Land Improvement in India Colonel A T Fraser (Bombay, Thacker) —Proposal for a National Photographic Record and Survey W J Harrison (Harrison)

SERIALS —Journal of the College of Science, Imperial University, Japan, vol. v, Part i (Tōkyō) —Journal of the Institution of Electrical Engineers, June (Spon) —Journal of the Polynesian Society, vol i No. i (Wellington N Z).—Proceedings of the Society for Psychical Research, June (Kegan Paul) —Deutsche Ueberseeische Meteorologische Beobachtungen, Heft 4 (Hamburg) —Journal and Proceedings of the Royal Society of New South Wales vol xxv 1891 (Kegan Paul) —Beiträge zur Biologie der Pflanzen, v Band 3 Heft (Williams and Norgate) —Bulletin from the Laboratories of Natural History of the State University of Iowa, vol ii No 2 (Iowa) —Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie, Sechzehnter Band 1 Heft, Fünfzehnter Band, 3 Heft (Williams and Norgate) —Encyklopædia der Naturwissenschaften Erste Abthg, 67 Liefg, Zweite Abthg, 69–70 Lief (Williams and Norgate)

CONTENTS.

THURSDAY, JULY 7, 1892

A SYSTEM OF MINERALOGY

The System of Mineralogy of James Dwight Dana, 1837–68 *Descriptive Mineralogy* Sixth Edition By Edward Salisbury Dana, Professor of Physics, and Curator of the Mineral Collection, Yale University Entirely re-written and much enlarged Pp lxiii and 1134 Illustrated with over 1400 Figures (New York and London Kegan Paul, Trench, Trubner, and Co, 1892)

IN the whole history of scientific literature it would be difficult to find a parallel to Dana's "System of Mineralogy," for there is probably no work which, like it, has maintained for more than half a century its position as the best and most complete work of reference on a branch of natural history In spite of the enormous additions to our knowledge of the chemical and physical properties of well known minerals, and of the discovery of innumerable new species and varieties, during that long period, the work has been carefully kept up to date, and so thorough and judicious have been the revisions to which successive editions have been subjected, that the book may at the present time fearlessly challenge comparison with the latest and most successful attempts to supply a comprehensive survey of mineralogical science

When the work first appeared, in 1837, its author made a determined attempt to grapple with the difficult problem of mineralogical nomenclature and classification, like many of his contemporaries, he was sanguine of being able to make the taxonomy of mineralogy correspond with that of the other natural-history sciences, and a so-called *natural* system of classification, based on that of Mohs, was adopted by him But on the appearance of the third edition in 1850 the futility of all such attempts was admitted, and a scheme of classification founded upon chemical composition was substituted, it is this system of classification which, with some modifications rendered necessary by the progress of discovery, is employed in the present edition

On reaching its fourth edition in 1854, the work had grown to such an extent that it became necessary to divide it into two volumes the first devoted to a general introduction to crystallography, with mineral physics and chemistry, and the second to descriptive mineralogy. The necessity for the re-issue of the first of these volumes has been obviated, however, by the publication in 1875 of the "Determinative Mineralogy" by the author's friend and fellow-worker, Prof Brush, and by the appearance, two years later, of the "Text-book of Mineralogy," in the preparation of which the author had the able co-operation of his son, Prof Edward Salisbury Dana. In this way the "System of Mineralogy" has now been limited to the descriptive portion of the original work, and only a few pages of introductory matter are given to explain the terminology, symbols, and abbreviations which it has been found necessary to employ A noteworthy change in the fifth edition, and one which has tended to greatly increase the value of the work for reference purposes, was the fuller recognition and description of varieties, and of the localities from which they have been obtained, the very thorough revision of the historical synonymy, which was undertaken for this fifth edition, also greatly enhanced the usefulness of the book These historical details and references, which have entailed a vast amount of bibliographical research, have been retained with but few modifications in the present edition

In the preface to this fifth edition, Prof Dana wrote in 1868 as follows.—

"In these and other ways the volume has unavoidably become enlarged Not a page, and scarcely a paragraph, of the preceding edition remains unaltered, and fully five-sixths of the volume have been printed from manuscript copy I may here add that, notwithstanding the impaired state of my health, this manuscript—the paragraphs on the pyrognostic characters excepted—was almost solely in the handwriting of the author, or in that of a copyist from it Neither the consultation of authorities, the drawing of conclusions, nor the putting of the results on paper, has been delegated to another And being now but half-way between the fifties and sixties, it is my hope that the future will afford another opportunity for similar work"

In writing these lines, Prof Dana could scarcely have foreseen that the issue of the sixth edition of the work would be delayed for 24 years During that period three appendices have been prepared by the author, and he has shown, in numerous books and original memoirs on various branches of geology and natural history, an unabated interest and zeal in scientific work But the very heavy task of incorporating the matter of the appendices into a new edition, and of revising and re-arranging the whole work, has had to be delegated by the author to his son, and certainly it could not have been placed in more competent hands Every mineralogist will rejoice that the familiar and excellent features of the original work have been carefully preserved The book, indeed, is so well known to all working geologists and mineralogists, that we cannot do better than to indicate the chief changes which have been found necessary in the present edition, in order to bring it up to date and maintain its high character

The work now contains more than one-half more matter than the fifth edition, and, to keep it down even to this limit, a very rigid system of abbreviation and condensation has had to be adopted, while the size of the page has been increased by one fifth The historical account of the species remains substantially the same as in the last edition, but names commonly employed in important languages, in addition to English, French, and German, have been given

In the chemical portion of the work very considerable changes have been introduced The difficult question of the classification of the silicates has received the fullest consideration, and the views of Rammelsberg, Tschermak, and other chemists on each species are clearly indicated It has no longer been found possible, however, to give a statement of all the analyses that have been made of a species The microscopic work of Lacroix and others has shown that many of these analyses are worthless, as the material operated upon has been a mixture and not a homogeneous substance In the present edition all trustworthy analyses of rare minerals have been given, and

in the case of common minerals, where the number of published analyses is very great, a judicious selection of the best and most recent analyses has been made

The statement of the optical constants and the physical characters of minerals has been treated in much the same fashion as the chemical data The best and most trustworthy determinations have been selected, while measurements of doubtful value have been omitted

It is on the crystallographic portion of the work, however, that Prof E S Dana has expended the greatest amount of labour We are informed in the preface that "an attempt has been made to trace back to the original observer the fundamental angles for each species, then the axes have been recalculated from them, and finally the important angles of all common forms have been calculated from these axes" The author is able to state that in every case this recalculation of the angles of all the forms of a mineral has been undertaken, and that no pains has been spared in the verification and correction of the results The crystal forms are indicated by letters, and the symbols employed are in the first instance those of Miller, and in the second instance the modified form of Naumann's symbols familiar to all who have used the earlier editions of the work The author gives it as his opinion that the former should eventually supplant the latter altogether In the hexagonal and rhombohedral system, however, the Bravais-Miller system is adopted in preference to that of Miller

With few exceptions, the figures of crystals (1400 in number) are new Many have been drawn from original data, and those taken from other works have been redrawn so as to secure uniformity of projection, the habits of each species and the types of twinning in crystals have been very fully illustrated

While the general account of the mode of occurrence and association of mineral species has been very carefully attended to, there has been no attempt to make this part of the work exhaustive, for to have done so would have greatly increased the bulk of the volume The account of American localities—which has always been an important feature of Dana's work, and has made it for North America what the treatises of Kokscharov and Zepharovitch are for the Russian and Austrian Empires respectively—has been greatly added to The works of Roth and Hintze, with the numerous books and memoirs devoted to the geology of particular regions, now supply all the information that is needed in respect to mineralogical distribution in other areas

We have tested the volume in many ways as to the completeness and recent nature of the information given with respect to particular species, and always with satisfactory results To pass such a voluminous mass of information through the press has required eighteen months of labour, and notices of important contributions to our knowledge that have appeared since the earlier pages of the book were printed off have been relegated to a supplement This supplement, which extends to 28 pages, also contains brief accounts of minerals of unknown composition, and of doubtful species having little or no claim to recognition

In conclusion, we must congratulate both the original author of the "System," and the writer of the volume in its present form, on the completion of their useful labours It is not too much to say that the publication of each successive edition of this work has constituted an epoch in the history of mineralogical science, and the present edition, coming from the hands of a new author, completely maintains the prestige of former ones

J W J

MODERN INFINITESIMAL CALCULUS

An Introduction to the Study of the Elements of the Differential and Integral Calculus From the German of the late Axel Harnack, Professor of Mathematics at the Polytechnicum, Dresden (London and Edinburgh Williams and Norgate, 1891)

MR G L CATHCART'S translation forms a handsome volume, and will prove acceptable to those engaged in mathematical teaching, as a storehouse of suggestive methods and ideas for analytical exegesis

But let us examine the work from the standpoint of the student approaching the subject of the Calculus for the first time, supposing this book to be put into his hands to acquire his first acquaintance with the method and reasoning

Until very recently the Classics, Greek and Latin, as taught at school, were looked upon chiefly as collections of grammatical examples, and the subject-matter was lost sight of in the careful parsing and analysis of the sentences Boys were taught on a system which implied that they were all, in their turn, to become schoolmasters and instructors, and the interests of the majority, who would profit intellectually from the literary study of the ancient masterpieces, were completely neglected

So, too, in Mathematics the ordinary text-books give an excellent schoolmaster's training in the subject, but the large and increasing class of students, brought into existence recently by the commercial developments of scientific application, who are required to put into immediate practice the theory which they find indispensable, cannot afford the time to be dragged the whole length of the quagmire of the Convergency of Series, of Inequalities, of Discontinuity, and of the so-called Failure of Taylor's Theorem These are the quagmires in which the mere mathematician delights to lose himself, and also to lure in others after him

To one who is already very familiar with the notation and operations of the Calculus the present treatise will prove, not repellent, but even fascinating to minds who pursue the subject for its purely analytical interest. Having been over the road before, they will be prepared to appreciate the strictly logical order in which the theorems are developed, starting in Chapter I with the fundamental conceptions of Rational Numbers, of their Addition, Subtraction, Multiplication, and Division—the subject of Arithmetic in short, and passing on in Chapter II to Radicals and Irrational Numbers in general The next three chapters treat of the Conceptions of Variable Quantities, of Functions of a Variable, their Geometric Representation and Continuity; and it is not till the sixth chapter that the Differential Coefficient is introduced and determined for the simplest functions

But the beginner, who has had the courage to read thus far, will wonder what on earth the subject is all

about, even when he has reached the end of Book I, which covers the ground of the subject usually called the Differential Calculus there are no illustrations, except for one or two meagre geometrical applications, for the mind to hold on by, no diagrams, and no examples to test the soundness of the student's knowledge

It is true that these collections of examples are decried in certain lofty quarters of the mathematical hierarchy, but the humbler priests of the science, who are in touch with the noviciate mind of human nature, know their practical value, and these collections of problems, formerly a feature of our text-books unknown abroad, are now being extensively copied and adopted in other countries "In scientiis ediscendis prosunt exempla magis quam præcepta" (Newton)

The Second Book considers Functions of Complex Numbers we make another fresh start with the operations of Arithmetic, as it is called here, not that any resemblance can be traced to what generally goes by that name In this book the questions of Convergency, of Single- and Multiple-valued Functions, as illustrated by a Riemann surface, and of their Zeros and Infinities, are gone into at great length, but at the same time the reader will have an impression that the information is given in a very condensed form, and that an attempt has been made to give a brief *résumé* of a subject which requires a large volume to itself

This Morbid Pathology of the Mathematical Function, as we may call it, requires a very clear, concise, and cosmopolitan tereminology, which, as Mr. Cathcart points out on p 148, it does not yet possess, it is unfortunate that the nomenclature has mostly been formed originally in the agglutinate German language, and in many cases is only very imperfectly translatable

This part of the subject, although principally known to us from the researches of later writers, such as Cauchy, Riemann, Dirichlet, and Weierstrass, owes very much to Gauss, but Gauss deserves to lose the credit of priority, from his baneful habit of bottling up his discoveries, after announcing that he had obtained the solution, so as to warn off all other investigators from his preserves of research

The Integral Calculus is developed in Book III, here also the treatment, though complete, is very condensed, and but few simple problems and applications are provided to show the use of the subject when the analysis is established

The author never employs the hyperbolic functions, although their use can be traced back to Newton ("Principia," Lib II, Prop ix), but in the reductions of the integral of $F(x, \sqrt{R})$ where R is the quadratic $a + 2bx + cx^2$, the use of $\sqrt{R}$ as the argument in conjunction with the circular and hyperbolic functions enables us to present the different results which arise in a more systematic manner than that employed in the present work. A very short sketch is also given of the method of reduction of the integrals when R is of the third or fourth degree; the elliptic integrals are now introduced, but no mention is made of the elliptic *functions*, introduced by Abel by the inversion of the elliptic *integrals*

The Fourth Book, which treats of the integrals of complex functions and of the general properties of analytic functions, is probably the sole presentation of this modern and difficult subject in our language To a mathematician of Mr Cathcart's development the treatment will appear very concise and elegant, but for our part we miss the footholds afforded by the physical applications of the general theorems of functions, say to Hydrodynamics, such as those recently published by Prof W Burnside in the Proceedings of the London Mathematical Society, on Riemann's Theory and on Automorphic Functions, determined from their discontinuities.

The book will recommend itself, as we said at the outset, to the advanced student, who pursues mathematical study as an end to itself, by reason of the strict logical order in which the subjects are presented, but is this strict logical order the most suitable arrangement for a beginner?

Herbert Spencer says that "in each branch of instruction we should proceed from the empirical to the rational" In the operatic version of "Manon" the events are presented in chronological order, but in the original "Histoire de Manon Lescaut" the story begins in the middle, so as to excite the reader's curiosity as to the preceding events which led up to the point at which the characters appear on the scene

According to Prof Harnack's preface, the present work may be considered the operatic version of his lectures, while the simple story would appear in the lectures delivered in the Dresden Polytechnicum to his technical students, who required a knowledge of Analysis chiefly as an instrument for the solution of mechanical problems

Mr Cathcart explains in his Translator's Note the desire he had to make these lectures accessible to the English reader, and records the regret he felt at the news of the death of Prof Harnack, while engaged on a revision of his notes for a new edition The thanks of the mathematical world are due to Mr Cathcart for the care and trouble he has taken in this valuable piece of work

A. G GREENHILL.

ALTERATIONS OF PERSONALITY

Les Altérations de la Personnalité. Par Alfred Binet. Bibliothèque Scientifique Internationale (Paris Ancienne Librairie Germer Baillière et Cie, 1892)

IN what is in ordinary parlance called somnambulism, or sleep-walking, the patient rises in the night, performs a number of seemingly intelligent actions directed to some special end, answers questions with regard to such actions with a variable amount of coherence, returns to bed, and generally, but not in all cases, wakes in the morning with no remembrance of that which he has done during the night. Such is somnambulism in its narrower sense. It exhibits the individual in an abnormal psychological condition, the actions performed in this abnormal condition being generally unconnected in memory with the normal sequence of events in waking life The word somnambulism is, however, now used in a wider and at the same time more technical sense, being applied to all cases where the individual, either spontaneously or through hypnotic suggestion, falls into an abnormal condition distinguishable from the normal condition of his or her waking life. It is with the alterations of personality exhibited during the state of somnambulism in this wider sense that M. Binet's volume chiefly deals.

The subject is one that is beset with peculiar difficulties, and one in which extreme caution is necessary in drawing anything like definite conclusions But it is one that is throwing, and is likely to throw, important side light on normal psychology, and one that may prove helpful in elucidating the difficult problem of the nature of the association of brain and consciousness It will only be possible in the space at our disposal to indicate the nature of some of the evidence M Binet adduces, and the interpretation suggested by this learned and lucid writer

The phenomena of so-called spontaneous somnambulism are somewhat as follows The patient is, we will say, a dull and melancholy young woman She falls into a deep and prolonged sleep, or suffers from an hysterical or convulsive crisis On waking from the sleep, or emerging from the crisis, she is in an altered condition, with little or no memory of her previous life, and no apparent knowledge of her friends and relations Her character is changed no longer dull and melancholy, she is bright and merry In this state she remains for a time, learning anew the ways of the world, and daily profiting by her fresh experiences Then she falls again into deep slumber, or other crisis, from which she emerges her old self once more, taking up her normal dull and melancholy life just where she left it She remembers nothing that happened in her abnormal or second state There is no continuity between the two Such alterations of personality may continue at varying intervals for many years

Somewhat similar are the phenomena observed in the somnambulism induced through hypnotic suggestion M Janet's subject, Léonie, is a serious and rather sad person, calm and slow, very mild with everyone, and extremely timid Hypnotized, she becomes a different being She keeps her eyes closed, but her other senses are abnormally acute She is gay, noisy, and restless, good-natured, but with a tendency to irony and sharp jesting In this condition she repudiates her former self "That good woman is not myself," she says, "she is too stupid!"

M Binet, summarizing the principal modifications of memory in hypnotic somnambulism, says that the subject during the normal condition, remembers nothing of the events which have taken place during somnambulism, but that, when hypnotized, he may remember not only the occurrences in former somnambulisms, but also those which belong to the normal state There is thus some continuity of the normal into the hypnotic personality, but none from the hypnotic to the normal "Le livre de la vie somnambulique se ferme au réveil, et la personne normale ne peut pas le lire"

But though there is no conscious memory in the waking state of what has occurred during somnambulism, it is said to be possible to unseal the register thereof through automatic writing A fact is told to the subject in the state of somnambulism under hypnosis, and the subject is then restored to the normal state. He has no recollection of the fact, and knows nothing about it But slip a pencil between his fingers, hiding the hand from his eyes by means of a screen, and he will write down the fact automatically (Gurney)

In cases of so-called "negative hallucination" or "systematic anæsthesia," the subject under hypnotic suggestion neglects and is apparently blind to certain objects For example, two out of a number of blank cards are marked with a cross, and the subject is made blind to these If she be given a dozen cards, and among them these two, and if she be asked to count the cards, she will neglect these two and reply that there are ten But if a pencil be slipped between her fingers, and she be asked in a low voice how many cards there are, she will reply, in automatic writing, *two* And if she be asked, in the same tone, why she said ten and neglected these two, she will write in reply that "she could not see them"

On the basis of such observations as are here briefly summarized, and others for a description of which we must refer our readers to the book itself, M Binet contends that, associated with the same physical individual, there may be two (or more) personalities, both of which are conscious They may be co-existent or successive Anæsthesia is the barrier which separates co-existent personalities amnesia the barrier which separates successive personalities "En un mot, il peut y avoir chez un même individu, pluralité de mémoires, pluralité de consciences, pluralité de personnalités, et chacune de ces mémoires, de ces consciences, de ces personnalités ne connaît que ce qui se passe sur son territoire" We do not propose to discuss this position Suffice it to say, that for ourselves we see no satisfactory evidence of the *co-existence* of two personalities *both of which are simultaneously conscious* Strange alterations and modifications of personality may occur under peculiar circumstances, but this is something very different from the supposed co-existence of two or more distinct consciousnesses

C LL M

OUR BOOK SHELF

Volcanoes Past and Present By Edward Hull, M A, LL D, F R S With Forty-one Illustrations and Four Plates of Rock-sections (London Walter Scott, 1892)

IN this new volume of the "Contemporary Science Series," Prof Hull has given a very readable account of the phenomena of volcanoes and earthquakes A short introduction to the subject of vulcanology is followed by a sketch of the active and extinct volcanoes of Europe, and this by an account of some of the "dormant or moribund volcanoes of other parts of the world" From this description of recent volcanoes, the author proceeds to the consideration of the Tertiary volcanic districts of the British Islands, and the pre-Tertiary volcanic rocks of our own and other countries The two concluding chapters of the book are devoted to a consideration of the remarkable eruption of Krakatão in 1883, and the great earthquakes which during the last few years have attracted so much attention, with a discussion of some of the volcanic and seismic problems suggested to the author by his review of the phenomena. These problems are classed by the author under the following heads — "The Ultimate Cause of Volcanic Action," "Lunar Volcanoes," and the question "Are we living in an Epoch of special Volcanic Activity?" An appendix gives "A Brief Account of the Principal Varieties of Volcanic Rocks"

In a little book of 270 pages it has of course been impossible for the author to do full justice to such a wide circle of topics, and it is sometimes difficult to detect the principle on which certain subjects have been included, and others rejected by him But the author may be fairly credited with having accomplished his main object, which he has defined as follows "To illustrate the most

recent conclusions regarding the phenomena and origin of volcanic action by the selection of examples drawn from districts where these phenomena have been most carefully observed and recorded under the light of modern geological science"

An admirable feature of the work is the recognition of the principle that vulcanological problems may often be better attacked by the study of ancient and greatly denuded volcanoes, rather than by the examination of those in actual activity, or of such as have recently become extinct

"*Encyclopédie scientifique des Aide-mémoire*" — *Résistance des matériaux* Par M Duquesnay
Étude expérimentale calorimétrique de la machine à vapeur Par V Dwelshauvers-Dery
Air comprimé ou raréfié Par Al Gouilly
(Paris Gauthier-Villars, Georges Masson)

THESE three little hand-books on their respective subjects are made by the separate publication of the respective articles of the "Encyclopédie scientifique", it is intended that each subject is to appear in a separate volume at a rate of publication of thirty to forty a year

There is no indication by numbering as to the order of appearance, so that probably these are the pioneer volumes

The first volume, "La résistance des matériaux," gives a very clear and concise account of the practical side of Elasticity, so far as required by the engineer in the design of beams, columns, bridges, and retaining walls

Prof Dwelshauvers-Dery is well known for his theoretical and experimental researches on the Steam Engine, and his treatise may be considered as the application of the empirical laws of saturated vapours to the theoretical determination of the useful effect obtainable in the different forms of steam engine, simple or compound, with an attempt at the evaluation of the loss due to conduction The results arrived at are checked by comparison with long-continued steam-engine trials carried out by Hirn, Donkin, Longridge, and the author himself

The third volume, on "Air comprimé," may be supposed to carry out the same development of abstract Thermo dynamics when the medium is supposed to behave as a perfect gas In this case the mathematical laws, developed at the outset, are capable of more ready and immediate application, and the second half of the book gives a detailed account of the employment of air as the medium for the transmission of energy in its various industrial applications—for instance, as laid on in Paris compressed in mains, or as employed when rarefied in the Westinghouse brake

A useful feature in these books is a page at the outset, in which the notation to be subsequently employed is carefully explained

The Mechanical Equivalent of Heat is taken as 425 kilogrammetres, presumably at Paris, the mean of Prof Rowland's experiments gives about 427 Baltimore kilogrammetres, or in absolute measure about 42 million ergs, or 4 2 joules

The "Encyclopédie" is to be divided in interest between the *section de l'Ingénieur* and the *section du Biologiste*, the volumes promised in the first section, as in course of preparation, will constitute a valuable technical working library G

Chambers's Encyclopædia New Edition Vol IX (London and Edinburgh W and R Chambers, 1892)

THE new edition of this admirable Encyclopædia is now approaching completion, and in the present volume there is certainly no falling-off in the ability with which the work has hitherto been written and edited On all important subjects represented by words between "Round" and "Swansea" there are articles summing up the latest results of research An excellent article on round towers, by Dr Joseph Anderson, is given on the first and second pages This is a model of what such a paper ought to be The author knows his subject thoroughly, and consequently understands where to draw the line between ascertained facts and the theories based upon them. Another well-arranged archæological contribution by Dr. Anderson is the paper on sculptured stones Dr John Murray writes with his usual lucidity on the sea and on sounding The task of expounding the facts and laws relating to sound and to the spectrum has been intrusted to Prof Knott, and the Rev E B Kirk contributes the articles on the sun and the stars Dr Buchan is the author of a clear and interesting paper on storms Other scientific articles which may be specially noted are those on the Silurian system, by Prof James Geikie, on the skull, by Dr D Hepburn, on the snail and the slug, by Mr T D A Cockerell, on snakes and spiders, by Mr J A Thomson, on the steam-engine, by Prof A B W Kennedy, and on the steam-hammer, by Prof T H Beare Among the geographical contributions are articles on Russia, by Prince Kropotkin, on Siam, by Mr J S Black, on South Australia, by Mr J Bonwick, and on Spain, by the Rev Wentworth Webster

A Guide to Electric Lighting By S R Bottone (Whittaker and Co, London, 1892)

IN this work the author gives a general idea of the various methods of electric lighting, without entering into any of those technicalities which tend to confuse rather than enlighten the ordinary reader Commencing with descriptions of the various batteries that are now employed, he discusses their particular advantages and disadvantages, adding also a table of their E M F, currents, and resistances

The second chapter, which is devoted to the production of currents by means of the dynamo, will enable the reader to form some idea as to the selection of one of these machines for a given purpose, and to understand its general principles Perhaps the chapter on electric lamps and accumulators will be found the most serviceable, for one is brought far more into contact with them than with dynamos themselves The information here will enable anyone to set up a small installation for himself, while a very useful table shows the dimensions, capacities, weights, &c, of accumulators suitable for such work

The remaining chapters deal with the descriptions of some of the smaller appliances necessary in connecting up the supplier of electricity, whether it be dynamo or accumulator, with motors or transformers, and last but not least with an excellent *résumé* of the cost of maintenance, showing the relative prices of gas and electricity as now regulated

The book contains numerous illustrations, and as a thoroughly practical and handy work should be widely read

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

"The Grammar of Science"

To the vast majority of readers, chapter ix of the "Grammar of Science" will probably seem to be simply a plea in favour of the doctrine of evolution in its purest form We were not called upon to express any opinion as to the merits of this doctrine, nor did we What struck us (and still strikes us) as fundamentally illogical, was the formulation of a theory, which, itself avowedly a mental product, proceeded to picture a universe devoid of sentient beings, or, in the phraseology of the "Grammar," a

conceptual world evolving the perceptive faculty which creates it An evolution theory which postulates spontaneous generation and human automatonism is natural to the materialist, and hence our contention that, in spite of the general character of the argument in the earlier chapters of the book, certain conclusions are distinctly materialistic

Again, we are not of those who would bind down all time to Newton's views on matter, force, and motion That never has been the position of those whom Prof Pearson delights in nicknaming the Edinburgh school Only we think a writer should be careful as to what he imputes to Newton Thomson and Tait say, "We cannot do better, at all events in commencing, than follow Newton somewhat closely" and unless they have misrepresented the teaching of the "Principia," an attack on their version surely amounts to an attack on Newton. Indeed, Prof. Pearson fully realizes this himself, when, on p 382, he accuses Newton of thinking of "force in the sense of mediæval metaphysics as a cause of change in motion" It was this statement we took exception to Similarly, we cannot but look upon Prof Pearson's obvious jeer at Maxwell's language as of the same gratuitous character

"Matter is, as it were, the plaything of force"—this evidently Prof Pearson regards as his trump card Now these words—and note the "as it were"—occur in the discussion of Newton's laws of motion, and are obviously suggested by Newton's own anthropomorphic language But they can give rise to no misapprehension in the mind of one who is reading Prof Tait's "Properties of Matter" for profit In the light of the introductory chapter there is really no room for other than wilful misrepresentation of Prof Tait's position Moreover, it is positively astonishing to find an author, who has no slender claims to the title of historian, confessing his ignorance of Prof Tait's lecture on "Force," delivered before the British Association in 1876, and published in NATURE, vol. xiv (see also "Recent Advances," third edition, and Maxwell's "Life," p 646) That lecture was, we think, the first popular exposition of the subjectivity of force The recognition of this truth was, of course, a natural consequence of the remarkable series of discoveries which brought home to the mind that energy was physically as objectively real as matter We certainly did not need to go all the way to Berlin to learn it C G K

On the Line Spectra of the Elements.

I OBSERVE from Prof Runge's last letter that on one point I was led into misinterpreting his meaning by his having used the letter j in his second formula on p 100 (NATURE of June 2) in a sense different from the only definition that had been given of that symbol, viz. the jot of time—the time that light takes to advance one tenth of a millimetre in the open æther The period of time represented by j is as determinate as a day or hour. With it, Prof Runge's equation represents one definite discontinuous motion along the sloping sides of the teeth of a particular saw, and this is what I understood by it I perceive now that he intended j to be interpreted in a new sense, and meant the equation to represent uniform motion in a straight line to an *indefinite* distance

If all that Prof Runge wishes to point out is that motion along an orbit that extends to infinity must be either wholly incapable of being represented by a Fourier's series, or at least must contain a component of that kind, this is both true and obvious, and the instance he gives (which is, in fact, uniform motion to an unlimited distance along a straight line) is a case in point But it should be added, no such component of the motion of an electric charge which does not yield to Fourier's theorem can produce any periodic disturbance in the æther - in other words, *it would not contribute anything to the spectrum* Accordingly, any such part of the motion—for instance, the advance, in common with the rest of the solar system, of the electrons within the molecules of a gas on the earth, at the rate of eight miles a second, towards the constellation Hercules, which is the precise kind of motion that Prof Runge adduces as an instance—has nothing whatever to do with the subject of my memoir, which is an investigation into the cause of double lines *in spectra* It should further be added that unlimited motions of any kind have nothing to do with motions going on *within molecules*, to the investigation of which chapter iv of my memoir is devoted, and that any discussion of them there would have been out of place

Hence, to represent as a defect which vitiates my reasoning, as Prof Runge does, that I have omitted in that chapter to refer to the motions which are not resolvable by Fourier's theorem, is, I submit, not legitimate criticism, especially as the matter, beside being irrelevant, is obvious, and I also submit that to say "A plausible suggestion about the movement of the molecules ought to explain more than one of the observed phenomena" (NATURE, April 28, p 607) is not criticism at all We must use the data furnished by our observation of nature to carry us as far as they will go in the interpretation of nature, and not refuse to employ them to that extent because they do not enable us to get further

G JOHNSTONE STONEY

9 Palmerston Park, Dublin, July 2

Range of the Sanderling in Winter

As my little contribution to the *Records of the Australian Museum* has been honoured by a notice in NATURE (*supra*, pp 177–78), I must ask leave to qualify two statements therein made Since I wrote it I have become aware that Dr Finsch had a specimen of the Sanderling (*Calidris arenaria*) brought to him at Bonham Island, one of the Marshall Group, which lies within the tropics (*Ibis*, 1880, p 331), and, after the publication of Mr Everett's list of the birds of Borneo in 1889, that gentleman announced the occurrence of this species at Baram, on the north-east coast of that island (*Ibis*, 1890, p 465) ALFRED NEWTON

Magdalene College, Cambridge, June 25

Immunity of the African Negro from Yellow Fever

DR CREIGHTON will find that on p 51 of a report dated 1890, "On the Etiology and Prevention of Yellow Fever," Dr George M Sternberg (Lieut -Colonel and Surgeon U S Army) makes the following statement —

"It has been asserted that the negro race has a congenital immunity from yellow fever, but this is a mistake The susceptibility of the negro is, however, much less than that of the white race Amongst those attacked the mortality, as a rule, is small"

He will also find the subject discussed on pp 166–67 of "A Contribution to the Natural History of Scarlatina," by Dr D Astley Gresswell (Clarendon Press, 1890) Dr Gresswell writes thus —

"The African negro of pure descent was supposed to be insusceptible to the virus of yellow fever and of malaria It is said, however, that when these affections are prevailing in a virulent form the negro does become infected and manifest such infection This would suggest that the almost complete immunity in the case of the negro has been acquired Moreover, the fact that negroes of pure descent are more likely to manifest the symptoms of yellow fever on exposure to the poison after they have passed some years or some generations in more temperate latitudes, in which the disease is not indigenous, suggests that in order to maintain this degree of immunity it is necessary that the negro should continue to live in localities in which the virus exists, in other words, that the individual or the race should be repeatedly subjected to the virus It may, in fact, be questioned how far, in regard to these diseases in man, susceptibility differs independently of protection acquired by previous subjection to the action of the virus or its products, though natural selection may (as certain facts indicate) have acted more directly. Indeed, it is quite possible that protection acquired by previous infection is much more frequently a cause for benignity or only partial susceptibility in the case of these and other infection-diseases than is generally allowed for"

I do not think I can with advantage add anything to these quotations YOUR REVIEWER.

A Solar Halo

IN connection with the heavy thunderstorms further south, possibly, there was here the most brilliant solar halo on the 29th which I have seen The wind was easterly all the time, causing sea-fog-like clouds in the morning, which dissipated by degrees about 10, but I did not notice the halo before 10 45, nor after 3 30 or 4 o'clock. It was certainly gone at 5.

Though a complete halo at 11, it was far intenser above and below, the north-west and south east octant especially By 1 o'clock this had shifted to the north-east and south-west octants.

Between 11 45 and 12 the south-east octant of the outer halo (red inside) was also visible.

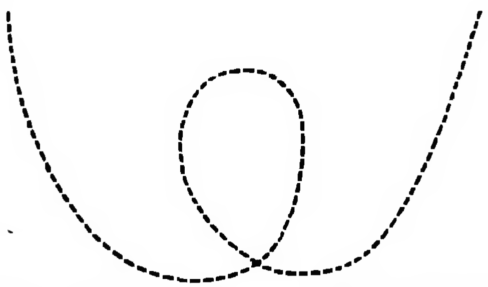
Until 1 o'clock the figure was practically circular, the inner space being remarkably free of colour, the blue of the sky assuming an ashy grey tint. By 2 the figure was elliptical, the long axis horizontal, and the halo *not complete*. The ellipticity increased as the sun sank. Hence the visible part was evidently formed of the *tangent arcs*. No doubt the intense brilliancy near noon was due to these arcs practically coinciding with the ordinary halo, because of the sun's great altitude.

J. EDMUND CLARK

4 Lorne Terrace, Edinburgh, June 30.

The Electric Current

DURING the thunderstorm last evening, in the middle of the brilliant flashes which illuminated the south eastern sky, I noticed the electric current assume the following remarkable form:—



Burlington Fine Arts Club, 17 Savile Row, W., June 29. EDWARD HAMILTON

Are the Solpugidæ Poisonous?

AT a recent meeting of the Linnean Society (June 2), I had the honour of exhibiting the jaws, claws, and hairs of a species of Galeodes from Tashkend, in order to show certain peculiarities, which perhaps throw light on the question as to whether these animals are poisonous or not.

Murray, in "Economic Entomology," says: "Their bite is said to be venomous, and even dangerous, but proof of this is wanting."

It is, further, always the natives in both the Old and New Worlds where this "spider" occurs who give it its bad reputation, and always the European immigrant or settler who either doubts or even positively denies it.

In spite of the well known fact of the persistence of groundless terrors in the minds of uncivilized peoples, I should still be inclined to think that, in a case of this kind, which is one of raw experience, the natives would probably be in the right.

Dufour, in his monograph of the Algerian species (*Mem. p. à l'Institut de France*, xvii.), after describing a serious case arising from a Galeodes bite, having failed to find any poison-glands or apparatus, leaves the mystery to be solved by others.

Croneberg (*Zool. Anzeiger*, 1879) claimed to have discovered the poison gland in a long coiled gland, which he says opens at the tip of a lancet-shaped process at the junction of the palp with its basal or maxillar portion. As far as I can make out, this gland is the homologue of the coxal gland of the other Arachnids. This would not preclude the possibility of its being a poison gland. On the face of it, however, I should not expect to find the opening of the poison gland in this comparatively awkward place. In a creature so armed for attack as Galeodes, one would expect the venom to take a more prominent place in the offensive armoury.

Examination, on immersion in clearing media, shows—

(1) That the tips of the jaws are not only traversed by a canal opening to the exterior, but are covered with multitudes of fine pores, which can be traced with a low power through the thick chitin.

(2) The claws are also open at the tip, while the shaft of the claw seems filled with a glandular mass of tissue provided with tracheæ. These claws are terrible weapons of offence; the articulating joint at the end enables them to anchor themselves in the body of the prey.

(3) Around these claws are sharp hairs, which appear, like the claws, to be open at their tips. It is obvious that the tighter the claws draw themselves into the flesh, the deeper would the pointed hairs at their base penetrate, and, if poisonous, increase the deadly nature of the attack.

(4) Leaving the spines on the limbs, and the long, thin apparently tactile hairs out of account, the hairs on the legs and back are, as a rule, forked at the tip, as has been already described by Dufour. Up to the fork they are hollow, like those round the claws. My suggestion is that these are like buttoned rapiers. They are harmless until the animal is seized. The fork prevents the hair from penetrating until the pressure is great enough to snap off the tip. Small mammals and birds would soon learn not to try to chew up or swallow a Galeodes. If this suggestion is correct, the action of the forked hairs may be compared with that of the stinging hairs of the common nettle.

(5) Here and there are long hollow hairs, with the tips swollen out into a thin bubble like expansion of the chitin. These hairs may be abnormal. I found five or six in all, and chiefly on the palp. They seem to indicate a tendency of fluid to flow down the hairs.

The openings at the tips of the claws are quite in keeping, morphologically, with those at the tips of the hairs. Claws are but highly developed hairs. The jaws, however, are modified joints of limbs. We have, therefore, to interpret the central canal (?) and the pores which open at and around their tips, as the canals which run through the cuticle into the hairs. We find that, as we recede from the tips of the jaws, the open pores cease, and the hairs commence, each with its central canal continued through the cuticle.

As to the nature of the poison which I suggest flows through these apertures, I am inclined to consider it, in the presumed absence of specialized glands, as a product of the hypodermal cells, perhaps even of those which secrete the hairs themselves. At the tips of the jaws, where the hairs have disappeared and only their pores remain, these cells could be specialized for this purpose alone. In the claws there seems to be a mass of cellular tissue, which would also be a derivative of the hypodermis, and may be solely taken up with the secretion of poison.

One other point remains to be mentioned, viz. the mechanism for the movement of the end joint of the claw. Articulated hairs are common among the Polychæte Annelids, but the exact mechanism is not visible. This large claw of Galeodes may explain these cases. We should naturally not expect a muscle fibre in a hair. The actual mechanism is very simple. Along one side of the claw the chitin splits, for, say, three-fourths of its proximal length, to form an inner and an outer layer. A very slight differentiation of the flexor muscles of the claw would allow of a few fibres being attached to the inner layer. A pull at the inner strip of chitin bends round the tip of the claw, invaginating a small portion of the outer layer, which thus forms a collar round the base of the joint or "nail" as some call it. The bending of the claw would almost necessarily compress its fluid contents, some of which might escape through the opening at its tip.

Until the question as to the poisonous nature of Galeodes has been *experimentally* settled, these observations seem to have some weight in the affirmative scale. HENRY BERNARD

Streatham.

Death from Paraffin, and Members of Parliament

NOTWITHSTANDING the enormous development which has taken place in recent years in gas and electricity, there can be no doubt that oil lamps light the homes of a larger number of persons *throughout the world* than any other illuminant. Even in the United Kingdom alone it has been estimated that over 10,000,000 lamps are in use. No wonder, then, that newspaper readers are every now and again startled by the recital of terrible accidents, too often resulting in agonizing death. Mr. Alfred Spencer, of the London County Council, stated at the inquest on the late Lord Romilly that he estimated that there were 300 deaths a year caused in this country by unsafe lamps. Mr. Shean, of the Fire Brigade Association, expressed the opinion that 10 per cent. of fires are caused by paraffin lamps; and Captain Shaw, the former Superintendent of the London Fire Brigade, reported 156 fires in one year caused by the upsetting of lamps in London. Will a friend to humanity in each constituency ask the candidates, whether Liberal or Conservative, to pledge themselves to support a short Act of Parliament compelling every lamp to have affixed to it an automatic extinguisher, as recommended in the reports of Sir Frederick Abel, Mr. Boverton Redwood, and Colonel Majendie, or must we wait until a Bishop or a Royal Princess is burnt to death? HUMANITY.

ON THE CAUSES OF THE DEFORMATION OF THE EARTH'S CRUST

Mountain-making.

BY eminent geologists it has been shown that the contraction hypothesis is not sufficient to account for the observed deformations of the earth's crust We are obliged to look for other causes of deformation

The form of a cosmic body must be irregular if the masses are unequally mixed Already in the liquid stage under this condition a geoid is formed The radius with dense material must be shorter, so much as to equilibrate the higher regions with less density

This cause of constant irregularity is not sufficient to explain the existing differences of level In fact, depressions and elevations are not the result of a constant equilibrium, they are not permanent Sedimentation and erosion disturb the mechanical and the thermal equilibrium and cause a continual deformation of our planet Another cause of deformation is found in the continual shifting of material Accumulation of eruptive material and of sediments (loading) on one side, and erosion (disburdening) on the other side, cause deformations of the earth's crust If the plasticity of the cosmic body is great, the surface of the burdened and disburdened regions has the tendency to remain nearly level—a quasi-hydrostatic (a "magmastatic") equilibrium will dominate

As the material of our earth is not very plastic, and as other causes of deformation have a contrary effect, it is natural that geological facts are not in accordance with this hypothesis

Contradictory to this hypothesis are the facts (1) that subsidence does not continue as long as sedimentation goes on, (2) that sinking often is considerable, though the loading is slight, (3) that in many cases enormous loading does not produce a depression of the earth's crust (volcanic chains growing up on a highland)

The Thermal Theory

The constant disturbance of thermal equilibrium is of the highest importance Sedimentation causes an ascending movement of the geo-isotherms expansion and general elevation If the dilatation is concentrated, there may result a fold-chain (Hall, Reade) The hypothesis is supported by the fact that the elevation and folding always drives up sediments, which were formed immediately before the orogonic movement The mountains grow up from a shallow sea, they are never generated in the middle of a continent, which might as well occur according to the contraction-hypothesis

Messrs Fisher, Hutton, and Reade have considered the thermal effect, and agree that it is sufficient to produce considerable deformations But to produce a mountain-chain of some 1000 m, we must suppose a concentration of the effect in one zone, as long as we, according to Mr Reade, consider only the effect of thermal expansion in the earth's crust

As physical geology considers the earth as a rigid body (the plasticity, according to Mr G Darwin, being that of steel) there is no reason why the thermal expansion ought not to proceed through the rigid magma to the region of constant temperature The increase of temperature being 3° C for 100 m, the temperature at the depth of 40 km = 1200° C, at 50 km = 1500° C After sedimentation of 10 km the base of the sediments is warmer by 300° The underlying masses are equally warmer by this quantity

The linear expansion of rocks per 100° C is nearly = 1 per mille, *i e* 1 metre per km In our case the expansion is = 3 m per km. Lateral expansion being impossible, it results in a vertical elevation of nearly 1 per cent The *crust* would be elevated through the full expansion by 500 metres

If we consider the thermal expansion proceeding to a depth of 500 or 1000 km through the rigid magma, we find that indeed highlands and chains of some 1000 m may be driven up, even if we do not suppose a concentration of the thermal effect on a restricted zone

Yet certain facts are not in accordance with the theory thus formulated (1) Elevation and mountain-making is not a slow and constant process, but it is executed in a short time (relatively) (2) Folding in some cases does not reach to a considerable depth, but we often meet undisturbed masses below the folded complex. These facts induce us to modify the hypothesis

Messrs Gilbert and Suess have shown that the movement of folding is horizontal and superficial, we may consequently ask whether folding may not be caused by a *gliding* movement (see my "Theoretical Geology")

If we deposit under water sediments of great plasticity, and if we incline afterwards the masses to the extent of 5° or 10°, there succeeds a gliding movement, especially if the sediments partly emerge from the water-level, and if occasional shaking (earthquakes) occurs

The gliding masses form a fold-chain The Silurian of Christiania is intensely folded, but it rests on an undisturbed base (Brogger) The folded Jurassic strata of the Weser chain likewise repose on an unfolded base In such cases it is impossible to derive folding from a general contraction, nor can we explain the quiet base by supposing a concentration of thermal expansion in certain districts The existence of a quiet base is explained only if we admit folding to be in such cases a gliding process

The fact that folding in nature is accompanied by emersion is in accordance with these views

Contradictory to this hypothesis seems the fact that the hypothetical land (from which the folded sediments were pushed towards the lowland) in the back of the chain is often wanting, and that in its place a (marine or a terrestrial) depression exists This objection disappears if we pursue the process, and we find that this seemingly contradictory fact indeed must result partial cooling causes local depression Erosion has the same effect If 1 km (vertical measure) of rock mass is denuded, the temperature of the new surface is lower by 30° C than it was at this point before erosion occurred This cooling propagates into depth, and the denuded land gets depressed

The highland, from which the sediments glide away, must sink down in course of time The Jura is pushed towards the French plain, in the back is situated the depression of Neuchatel Here, according to the deduction, existed a highland, which subsided in consequence of cooling Between the fold-chain and the depressed district are situated deep ruptures, along which earthquakes occur as long as the depression goes on

East of the Appalachian Mountains, as late as the end of the Palæozoic era, a highland was situated, wherefrom the detritus-masses were transported into the Appalachian sea Afterwards the Carboniferous emersion occurred (in consequence of thermal expansion) and the Palæozoic sediments were pushed towards the western lowland, here the Appalachian chain was generated Erosion and consequent cooling, instead of the old elevation, caused a depression in the eastern region, which got inundated by the ocean

In course of time the adjoining districts have changed parts In the lowland a chain is driven up and the old highland sinks down

Eruptive districts form depressions with growing accumulations The thermal effect in course of time leads to an opposite movement Material of 1000° C. flows through many fissures and covers the surface The eruptive region, in consequence, gets heated in a higher degree than by simple sedimentation The period of

depression in this case, too, in course of time, gives way to a contrary movement

It is obvious that elevation and subsidence, in volcanic as well as in sedimentary districts, must alternate, as we indeed observe Compression, metamorphism, and loading cause a negative movement in the sedimentary districts (geosyncline), warming causes elevation, erosion again creates subsidence These positive and negative factors at different times have different values, and partly compensate each other Therefore elevation and subsidence are often observed to alternate

The greatest contrasts must occur where a highland joins the sea, here sedimentation and erosion cause a considerable shifting of material, loading and unloading, as well as great thermal contrasts, dominate in these regions

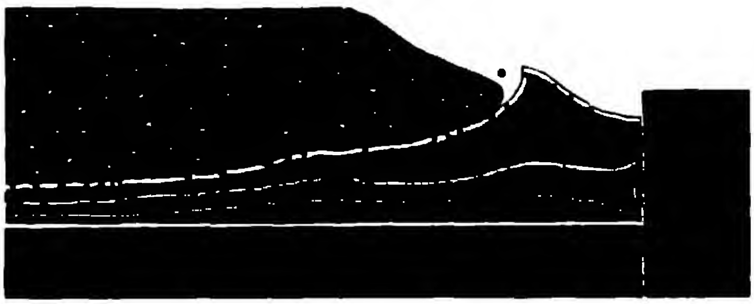


FIG 1

The positive and negative movements of the sea-level are not important; but the amplitude of deformation at the boundary between high land and sea is in some cases as great as 20,000 metres

The hydrosphere is relatively constant, whereas the crust executes oscillations of long duration and great amplitude

If we want to study in an experiment the formation and motion of a lava-stream, it cannot be our wish to observe the motions of an enormous quantity of a body as viscid and as hot as lava through long time, that would be mere observation, and not experiment In a real experiment we observe the motion of a small quantity of a less rigid material for some hours or days

If we observe in nature folded strata of hard sandstone and of soft shale or clay, we shall be satisfied to imitate the deformation of the latter masses, and instead of the hard sandstone, we will take substances as unplastic, but so brittle that they yield to the small forces employed in our experiment.

So we may produce on a small scale, with application of little force and in a short time, the same effect which we observe in nature on a large scale

If we succeed in producing experimentally the same phases of deformation, the same mechanical effect as in nature, if we see fold-chains and complicated eruptive massives growing up with their characteristic features, we shall be obliged to attribute to these experiments a high importance for mechanical geology

In my experiments I evaporated muddy material (clay, mud) or plaster of Paris, which consolidates slowly in consequence of an admixture of glue The strata were differently coloured some thin strata, consisting of plaster-powder, were brittle, and underwent ruptural deformation, whereas the other masses showed plastic deformation The whole system reposed on a base, which, according to the plasticity of the material, was inclined by 5° to 15°.

As soon as the inclination attained a certain limit, the whole complex begins to glide towards the lowland The sediments get folded to a considerable depth, faults occurred between districts of diverse motion The gliding deformation occurred rapidly whenever the base was shaken slightly (earthquakes) The experiment being finished, we let the masses consolidate, afterwards we may prepare profile-cuts, which may be executed with the saw, if we evaporated plaster

The cuts are instructive, if the strata are differently coloured

If we mark certain points in the originally level strata, or if we divide the whole system into cubes, we may study the locomotion and deformation of every point, line, square, or cube of our system, the vertical, as well as the horizontal component of displacement, may be observed and measured

The following experiments explain some points in this theoretical essay —

The plastic sediments are loaded by a mass, and get deformed in the manner illustrated by Fig 1 The black base and the black side-wall at the right hand (fault scarp) are rigid, the plastic strata are pushed up in form of a fold, the highest white stratum is rigid, and gets torn into clods

FIG 2

FIG 3

FIG 4

Figs. 2–4 show successive stages A delta, deposited

under water, gets elevated, it emerges, the masses are shaken slightly and glide over the inclined base Folding succeeds, as Figs 3 and 4 show

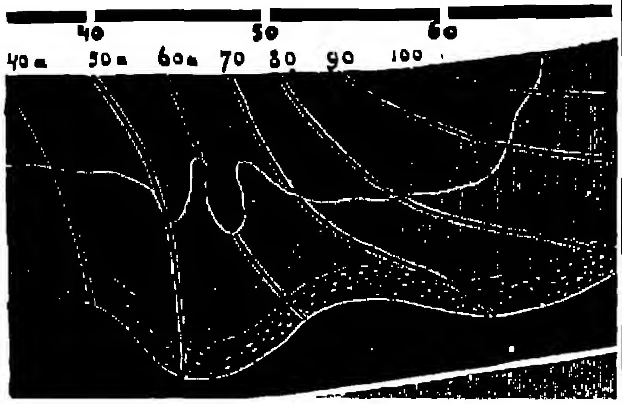


FIG 5

In Fig 5 the strata, gliding over the inclined plane to the left, were divided by vertical lines Distance of lines = 0 1 metre At the top of the figure the fixed scale is noted Point 40*a* of the strata originally lay directly below the scale-point 40, 60*a* was placed below 60, and so on

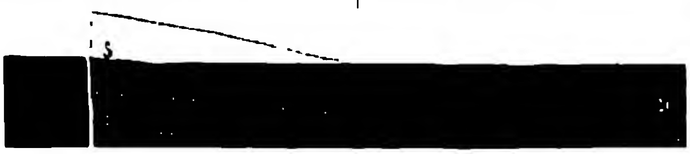


FIG 6

FIG 7

FIG 8 FIG 9

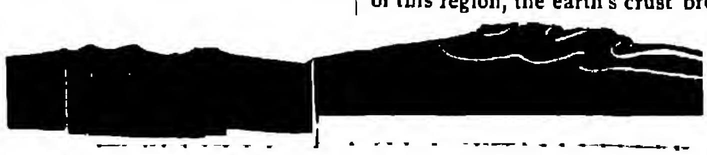


FIG 10

FIG 11

We see at once the amount of horizontal (gliding) movement The vertical lines are deformed in the direction of the motion. The parts near the base move little, the parts near the surface have a higher velocity, so that the vertical lines of division get curved The motion being intense in the highland (at the right hand), the vertical lines in this region are pushed over and assume a flat position

The surface of the gliding masses in this case remained level, as the material was very plastic, yet folding in the depth of the masses is remarkable We see that a fold chain may have a wide surface, the intensely folded regions get exposed only after an extensive erosion or abrasion occurred This experiment shows also how the motion and the amount of folding decrease in the direction towards the base

Figs. 6 and 7 illustrate my conception of the process of glide-folding as it occurs in nature The black parts form the solid basement, at S we observe a fault scarp (the coast of a continent) In the sea the sediments SX are deposited Warming of the newly-deposited masses, and of the lower parts of the earth's crust, in course of time elevates the sediments, as the dotted line in Fig 6 notes The sediments glide over the inclined plane towards the right, and form a fold-chain, O

The motion of a single point is noted in Fig 8 Point S first gets elevated (through thermal intumescence) to S′, and then it glides towards S″ In most cases the way described by a point is complicated, as Fig 9 illustrates Elevation having reached a certain degree, the masses glide a little, elevation continues, again gliding succeeds, and so on

The highland in the back of the fold chain (black mass at the left hand) gets eroded, cooling causes a subsidence of this region, the earth's crust breaks, and through the fissures and faults, in many cases, eruptive material escapes. A volcanic chain is built up in the back of the fold-chain (Fig. 10). In course of time the fold-chain

may be covered partly by the volcanic chain (Fig 11) Fig 12 (profile), and Fig 13 (surface of the same experiment) show that pulling (tearing) and pushing (folding) are *reciprocal processes* The strata, gliding away from the highland, are torn in this district, whereas compression and folding occur in the lowland

The surface of the strata (Fig 13) was divided into squares of different colour (like a chess-board), so that we may see and measure directly the direction and amount of pushing and pulling in both districts Black fissures occur at the left hand, grey folds at the right hand

FIG 12

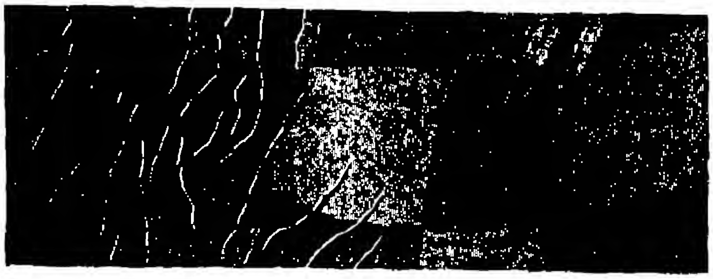


FIG 13

The base in this, as in the other cases, was rigid, there occurred *no compression in the depth*, yet folding succeeded in the gliding strata

Folding, according to my opinion, does not depend on a contraction of our planet, but is a simple gliding phenomenon.

E REYER

NOTES

AT the meeting of Section A of the British Association on Monday, August 8, there will be a discussion on the subject of a National Physical Laboratory The discussion will be opened by Prof Oliver J Lodge, F R S

THE Academy of Sciences at Berlin has conferred upon Lord Kelvin one of the first four Helmholtz gold medals

THE French Association for the Advancement of Science will hold its twenty-first meeting at Pau from September 15 to 22

THE Council of University College have accepted a tender for the erection of new technical laboratories for the practical teaching of mechanical and electrical engineering Care has been taken that the buildings shall accord with all the conditions of modern teaching, but of course it is necessary that provision shall also be made for an adequate supply of apparatus and plant The part of the proposed laboratory which is to be set apart for electrical engineering cannot be properly fitted up for a sum of less than £2010, and Prof Fleming has issued an appeal to all who may be able and willing to help him in obtaining this amount. In the course of his appeal he says "The Council do not at present see their way to incur this additional expenditure over and above the cost of the buildings, and yet it is absolutely essential to the completion of the project The Council have, therefore, by a minute of their proceedings of May 7, 1892, recommended this very essential part of the proposed work to the notice and liberality of those who may be disposed to help. Thus sanctioned and authorized by the Council, the Professor of Electrical Engineering begs permission to bring under your notice the necessity for a special Electrical Apparatus Fund, and desires to invite your aid in the formation of such a fund of £2010, to be entitled 'The University College Electrical Engineering Apparatus Fund'" Prof Fleming is anxious that the sum should, if possible, be obtained within the next six months Donations should be sent to the Secretary of University College, marked "Electrical Apparatus Fund"

THE services rendered by the late Sir William Macleay to the Linnean Society of New South Wales and to science in general are to be commemorated by the publication of a memorial volume This was decided recently at a general meeting of the New South Wales Linnean Society It is proposed that, in addition to a portrait and memoir of Sir William Macleay, the volume shall consist of original papers on those branches of science in the advancement of which he was especially interested —zoology, ethnology, botany, and geology Promises of papers have already been received from Sir F von Mueller, Prof Hutton, Prof J Parker, Prof Baldwin Spencer, and other leading Australian biologists It is intended that, as regards "style of get up and illustration," the volume shall be fully worthy of the occasion The expense is to be met by means of a public subscription Every ordinary member of the Society subscribing one guinea or upwards, and any non member subscribing two guineas or upwards, to the memorial will receive a copy of the volume At the meeting of the Society on May 25, the President announced that a number of subscriptions had been received in answer to a circular issued a few weeks previously It was necessary, however, he said, that a considerably larger sum should be collected before the Council would be in a position to proceed with the work

THE Governors of the Merchant Venturers' School, Bristol, have elected to the vacant Lectureship in Biology Mr G P Darnell-Smith, B Sc, assistant to Dr W Marcet at University College, London Mr Smith is a student of University College, and graduated with honours in botany and zoology in 1891

THE thunderstorms which we referred to in our last issue gave a very decided, but temporary, check to the temperature, the highest day readings falling about 20° after the storm, and the heavy rains which accompanied the disturbed weather have materially lessened the deficiency of rainfall, which has been so characteristic a feature for some months past By the end of last week the temperature had recovered, and the weather became very fine in the southern parts of the kingdom, the maxima reaching from 80° to 85° at some inland stations on Sunday, while conditions remained unsettled, with heavy rain, in the north and west, owing to a cyclonic area which passed along the Irish coast, and caused a thunderstorm on the east coast During the last day or two, depressions have passed to the northward of our islands, again causing unsettled weather, with rain in most parts, while the westerly winds have increased considerably in strength, reaching the force of a gale on our north-west coasts.

The *Weekly Weather Report* issued on the 2nd instant shows that the rainfall differed very considerably in various parts, in most of England, the north and west of Scotland, and in Ireland, the amount exceeded the mean The greatest deficiency on the amount due from the beginning of the year is over the midland, south, and south-west of England, and the west of Scotland, the amounts varying from about 3 to 7 inches. Bright sunshine exceeded the average amount for the week, except in the north western and south-western districts

THE Washington Weather Bureau has recently issued a report on its work for the last six months of the year 1891, dealing more with the scientific and practical work of the Department than with the administrative duties, which were referred to in a special report issued in October last (NATURE, vol xlv, p 86) Prof Harrington states that an endeavour has been made to improve the weather forecasts in every possible way, the time covered by the forecasts has been extended to thirty-six hours, and longer in some cases Every effort is made to distribute the information as widely as possible, and for this purpose the telephone is becoming more popular, and will possibly eventually supersede the telegraph Increased interest has of late been manifested in regard to meteorological education in the United States, and a list is given of the institutions which announce definite courses of instruction A very large accumulation of data is now in the possession of the Weather Bureau, a summary of these, under each element, is given in the report, and it is proposed to utilize the materials by special studies to be undertaken by the officers of the Bureau The study of terrestrial magnetism in connection with meteorology, with the object of discovering some physical relations connecting them, has from time to time been made by various persons, but, on the whole, it has not led to definite results Prof Harrington states, however, that the subject is now being specially investigated by Prof F H Bigelow, one of the meteorologists of the Bureau, and that such progress has been made as to render it quite certain that they are intimately associated By the method of analysis now being used by Prof Bigelow, which differs from that hitherto employed, it is stated that he has been able to disentangle several of the magnetic fields surrounding the earth, which are observed in the magnetic curves as an integrated effect

ACCORDING to the *Pioneer Mail*, the Port Officer of Mangalore reports that a native craft was overtaken by heavy weather and made for Mangalore, where there is a bad bar with about eight feet of water in it A tremendous sea was breaking over the bar, so, before crossing it, and while running in, the native skipper opened one oil cask, forming a part of the cargo, and scattered it all round in the sea plentifully, with the result that he took his craft across the bar safely, and so saved the vessel and the cargo The vessel's name was *Mahadeprasad*, and she was of 95 tons, bound from Cochin to Bombay This is said to be the first case on record of a native tindal who has successfully used the oil in troubled waters

MR H ROWLAND-BROWN, writing in the current number of the *Entomologist*, says that when sitting in the Temple Gardens on June 22 he saw a fine male *Colias edusa* fly across the lawn The excitement among the sparrows was "simply immense," but the butterfly "proved a match for his innumerable pursuers, and sailed calmly over the railings towards the City" The editor of the *Entomologist* adds a note to the effect that this species was seen in London in 1877, which is remembered as the great "*edusa* year"

A FACT noted in the current number of the *Zoologist* gives a very vivid idea of the depth of snow and drift in the north of Scotland last winter In the parish of Lairg, a month or two after the first thaw set in, two full grown stags were found dead in a hollow in a "burn" The first thing one of the keepers saw was a stag's antlers above the snow These he took for the branch of a tree, but on going near he found that a stag had been smothered by the drifting snow while standing on its feet A week or so afterwards, when more of the snow was melted, another stag was discovered This one had been smothered while lying down He was close to his comrade

THE Peabody Museum has issued, in its series of archæological and ethnological papers, an interesting report on pile-structures in Naaman's Creek, near Claymont, Delaware, by Dr H T Cresson These pile structures are believed to be remains of prehistoric fish-weirs

THE Chicago Exhibition will include what promises to be a very important department for the exhibition of objects relating to ethnology, archæology, history, and cartography A special bureau connected with the department will represent the history of the Latin-American Republics, and include all relics of the time of Columbus. There will also be a group of "isolated and collective exhibits" A full account of the plan of the department, and of the classification of the exhibits, has been prepared by Mr F W Putnam, chief of the department By means of special research in different parts of America, under Mr Putnam's direction, important scientific collections in the ethnological and archæological sections will be brought together It is hoped that every State Board and many historical and scientific Societies, as well as owners of private collections, will do what they can to contribute to the success of the department, so that it may present a full and effective illustration of the present status of American archæology and ethnology

MESSRS MITCHELL AND HUGHES have issued the Transactions of the County of Middlesex Natural History and Science Society for the sessions 1889-90 and 1890-91 The volume contains papers on rabies—its natural history and the means of extinguishing it, by Arthur Nicols, the best means of examining Rotifers under the microscope, by C Rousselet, the tubercle bacillus, by A W Williams, and "A Night among the Infinities," with a description of the instruments at Stanmore Observatory, by Sydney T Klein

THE July number of *Natural Science* opens with some "Notes and Comments," and contains articles on "The Story of Olenellus," by Prof G A J Cole, the physical features of the Norfolk Broads, by J W Gregory, the evolution of flat-fish, by Prof A Giard, is Stigmaria a root or a rhizome? by T Hick (with "A Reply," by Prof W C Williamson, F R S, and "A Rejoinder," by T Hick), agricultural museums, by J H Crawford, and amber and fossil plants, by A C Seward

A PAPER on three deep wells in Manitoba, by Mr J B Tyrrell, was lately submitted to the Royal Society of Canada, and has now been printed in the Transactions It contains a good deal of interesting and well arranged geological information.

MR D J MACGOWAN, writing in the *Shanghai Mercury*, gives an account of some remarkable statements made by a group of Chinese traders who lately undertook a mercantile exploration of the interior of Southern Formosa. They started from Lamalan, which Mr. Macgowan takes to be Chockeday of the charts, and in seven days reached their objective point, Hualin Stream They lodged in stone caverns, and the chattering of monkeys and the sounds of insects seemed to them "appalling and indescribable" The region was so "weird" that it reminded them of "legends of the kingdom of hobgoblins." Among the trees were some of "prodigious girth, forming a vast forest" These trees are said to measure more than ten outstretched arms A tree said to flourish in the same

forest is described as bearing "flowers, red and white, which are larger than a sieve, and of extraordinary fragrance" Mr. Macgowan adds —"Mr Taylor, while searching for orchids, heard of these majestic trees and huge flowers, which he inferred, from what natives said, were epiphyte orchids I am moved to make known this sylvan discovery in the hope that, pending the exploration of this *terra incognita* by our botanists, Dr Henry or Mr Ford, residents in Formosa, will take measures to provide those naturalists with specimens of flowers, seeds, leaves, and bark of the trees concerning which the Chinese have excited our curiosity"

IN a capital address on "tooth culture," delivered at the annual meeting of the Eastern Counties Branch of the British Dental Association, and printed in the current number of the *Lancet*, Sir James Crichton-Browne referred to a change which has taken place in bread, as one of the causes of the increase of dental caries So far as our own country is concerned, this is essentially an age of white bread and fine flour, and it is an age therefore in which we are no longer partaking, to anything like the same amount that our ancestors did, of the bran or husky parts of wheat, and so are deprived to a large degree of a chemical element which they contain—namely, fluorine The late Dr George Wilson showed that fluorine is more widely distributed in nature than was before his time supposed, but still, as he pointed out, it is but sparingly present where it does occur, and the only channels by which it can apparently find its way into the animal economy are through the siliceous stems of grasses and the outer husks of grain, in which it exists in comparative abundance Analysis has proved that the enamel of the teeth contains more fluorine, in the form of fluoride of calcium, than any other part of the body, and fluorine might, indeed, be regarded as the characteristic chemical constituent of this structure, the hardest of all animal tissue, and containing 95 5 per per cent of salts, against 72 per cent in the dentine. As this is so, it is clear that a supply of fluorine, while the development of the teeth is proceeding, is essential to the proper formation of the enamel, and that any deficiency in this respect must result in thin and inferior enamel Sir James Crichton-Browne thinks it well worthy of consideration whether the reintroduction into our diet of a supply of fluorine in some suitable natural form—and what form, he asks, can be more suitable than that in which it exists in the pellicles of our grain stuffs?—might not do something to fortify the teeth of the next generation

THE recent publication is announced of the first number of a new monthly journal under the title *Rivista di patologia vegetale* It is edited by Sigg A N and A Berlese, and published at Avellino, in Italy, and is to be devoted to the study of animal and vegetable parasites infesting cultivated plants, to the diseases which they cause, and the remedies employed to combat them

DR H C CHAPMAN contributes to the latest instalment of the Proceedings of the Academy of Natural Sciences, Philadelphia, a paper describing observations on the brain of the gorilla He says that while the fissures and convolutions are disposed in the brain of the gorilla in the same manner, generally speaking, as in that of man or of the chimpanzee or orang, it is nevertheless a low type of brain, being much less convoluted than the brain of man or of either of the two other anthropoids If it were permissible, in the absence of living links or sufficient fossil remains, to speculate upon the development of man and the anthropoids from lower forms of simian life, Dr Chapman thinks it might be inferred from the character of the brain that the gorilla had descended from some extinct *Cynocephalus*; the chimpanzee and orang from extinct macaque and gibbon like forms; and man from some generalized simian form combining in itself the characteristics of existing anthropoids

AT the annual meeting of the Department of Electricity of the Brooklyn Institute of Arts and Sciences on June 1, Prof E J Houston delivered a lecture on recent advances in the applications of electricity Turning for a moment from the past to the future, Prof Houston said it was related of Faraday that when asked his opinion of the future of the electric motor, he put up his cane and stopped it That was Faraday's opinion Prof Houston's view was more favourable The true efficiency of a triple expansion steam engine, he said, did not exceed 17 per cent as a maximum With the electric motor we could already get an efficiency of from 90 to 95 per cent, but it was to-day dependent on the steam engine A cheaper method would be devised for generating currents, and he believed there were now those living who would see the steam-engine relegated to the scrap heap Possibly the motor of the future would be operated by thermo-electricity Possibly a means would be devised of converting the latent energy of coal directly into potential electrical energy He believed in the successful solution of the problem of aerial navigation in the near future He was confident that ere long our present methods of electric illumination, in which 97 to 98 per cent of the energy was expended in useless heat rays, would be supplanted by one in which the order was reversed—in which 97 to 98 per cent would be converted into light, and but 2 to 3 into heat And finally, he believed the time was near at hand when electro therapeutists, instead of regarding the human body as a vehicle for electricity, would regard it as a source of electricity They would then make their diagnoses with the voltmeter, the ammeter, and the condenser, and the result would then be definite, instead of, as at present, "hit or miss"

THE *Mediterranean Naturalist* quotes a statement made by the late Rev H Seddall, who was many years a resident of Malta, as to a curious form of industry formerly practised by the Maltese "Five species of *Pinna*," wrote Mr Seddall, "are found in Malta, some of them common in the harbours within reach of a boat or a pole hook They project from the mud amongst the Zostera roots, to which they are attached by their silken cable Of this silk, which is of fine texture, but heavy, I have seen gloves made"

THE additions to the Zoological Society's Gardens during the past week include a Palm Squirrel (*Sciurus palmarum*) from India, presented by Miss Daisy Fox, a Common Roe (*Capreolus capraea* ♂), European, presented by Mr E J H Towers; a Tawny Owl (*Syrnium aluco*), European, presented by Mr Leigh Robinson, a Bronze Fruit Pigeon (*Carpophaga aenea*) from India, presented by Mr J L Shand, a Tuberculated Tortoise (*Homopus femoralis*), a Tent Tortoise (*Testudo tentoria*), two Fisk's Tortoises (*Testudo fiski*), a Robben Island Snake (*Coronella phocarum*) from South Africa, presented by the Rev G H R Fisk, C M Z S, two Green Lizards (*Lacerta viridis*), European, three Viperine Snakes (*Tropidonotus viperinus*) from North Africa, presented by the Rev F M Haines, a Common Chameleon (*Chamaeleon vulgaris*) from North Africa, presented by Mr Samuel L. Bensusan, a Water Viper (*Cenchris piscivora*) from North America, presented by Mr Ernest Brewerton; a —— Zorilla (*Zorilla typica*), a Grey Monitor (*Varanus griseus*) from Egypt, a Stanley Parrakeet (*Platycercus icterotis*) from Australia, deposited, two Asiatic Wild Asses (*Equus onager* ♂ ♀) from South-west Asia, received in exchange, four Wapiti Deer (*Cervus canadensis* ♂ ♀ ♀ ♀) born in the Gardens

OUR ASTRONOMICAL COLUMN

THE RED SPOT ON JUPITER—M J J Landerer, in *Bulletin Astronomique* (tome ix, June), gives the results of his measurements of the dimensions and Jovicentric latitude of the red spot on Jupiter. The method he adopted was to make use of the transit

of the satellite's shadows as they were projected on the extreme points of the two axes of the spot, the mean giving the position of the spot's centre. In the case of the third satellite, when its latitude was $-1° 45' 14''$, that of its shadow—reckoning from the bottom side of the spot—was $-30° 34' 36''$ The latitude of the shadow of the second satellite came out to be $-17° 48' 10''$, and after allowing for the fact that it was projected tangentially on the side of the spot and for the diffraction of the instrument, this value for the latitude of the north side of the spot became $-20° 56' 37''$ Taking the mean of the values obtained from both satellites, the latitude of the centre was $-25° 45' 36''$, and, with the polar semi-diameter as unity, the magnitude of the spot was 0 20297

The mean value of the latitude obtained from eleven observations by Denning, Green, Ricco, Williams, Keeler, and Terby was 21° 5 ± 2° 05, the major and minor axes of the spot being 0 555 and 0 188 respectively Using the micrometer, the latitude, according to Young, amounted to 40°, while Denning estimated that the major axis embraced an arc varying between 19° 3 and 37° 8

A MEAN TIME SUN-DIAL.—A very ingenious sun dial, capable of indicating mean time, has been recently invented by Major-General Oliver, the construction of the instrument being undertaken by Messrs Negretti and Zambra. In an ordinary sun-dial, the time is read off generally by the position of the centre of a shadow, cast by a straight-edged style, on a flat surface on which the hours are graduated The peculiarity of the present instrument is that the time is indicated by the position of the *edge* of a shadow cast by a "nine pin" shaped style, with regard to an equatorial circular line The style is fixed along the diameter of a semicircular arc, which is clamped by means of a screw to a firm stand to suit any latitude, at right angles to this arc, and also capable of adjustment, is another semicircle, graduated in five minute divisions Owing to the change of declination of the sun throughout the year, different *parts* of the shadow of the style are brought on to the hour circle in such a way that the difference between the time indicated (by the dial) and mean time, or the equation of time, is counterbalanced by the change in position of the shadow, due to the peculiar form of the style If we start, for instance, on December 24, the readings have to be taken from the shadow of the eastern edge of the lower part of the style in an upward direction, the bulging out of the style counteracting the increase and decrease of the equation of time (which is here positive) until June 14 is reached Owing to the thickness of the style's axis, a slight adjustment is here necessary when we pass to the other side of the style; this adjustment is facilitated by placing the twelve o'clock graduation to the western of two marks shown on the vertical circle This being done, the readings from the shadow, cast now by the western side of the upper protuberance, are taken until the other nodal point on June 14 is reached At this time also—in fact, four times a year—this slight alteration has to be made. From this latter date until December 24 is reached the same process is repeated, only the respective opposite sides of the style are used in the inverse order To obviate the necessity of having two styles, which, of course, would have to be the case if the greatest accuracy were desired, owing to the differences in the maximum values of the equation of time, one with a mean contour is given the error produced by this is practically very slight, amounting in time to about one-sixteenth of greatest value of the equation of time—a quantity scarcely appreciable, on account of the lack of sharpness of the edge of the shadow

COMET SWIFT (1892 MARCH 6) —*Edinburgh Circular* No 28 contains a continuation of the ephemeris of Comet Swift (March 6, 1892) for the month of July and part of August, from which we make the following extract —

Berlin Midnight

1892	R A h. m s	Decl ° '	log Δ.	log r	Br
July 7	0 52 36	+48 0 5			
8	53 33	12 6	0 2391	0 2552	0 17
9	54 28	24 5			
10	55 20	36 2			
11	56 10	47 7			
12	56 58	59 0	0 2427	0 2665	0 16
13	57 43	49 10 0			

The brightness at the time of discovery being taken as the unit of brightness, it will be seen that the comet is at present more than five times dimmer than it was in March In fact, it is rapidly becoming invisible, and will only be able to be observed with large instruments for another two months or so Its position on July 7 will lie to the very southern extremity of the constellation of Cassiopeia, forming nearly an equilateral triangle with ξ and π

STARS' PROPER MOTIONS —Mr J G Porter contributes to the *Astronomical Journal*, No 268, a catalogue of the proper motions of 301 stars, which amount to half a second or more in a year This list, as he informs us, is from a still more extensive catalogue which he hopes soon to publish, and the proper motions contained in it are rendered more trustworthy by the enlightenment of new observations The positions of the stars are all brought up to the epoch 1900 0

GEOGRAPHICAL NOTES

M CHARLES ALLUAUD describes his researches on the Island of Mahe, the largest of the Seychelles Group (see NATURE, p 162), in a letter to the Paris Geographical Society He has studied the fauna with some care, and remarks on the singular poverty of animal life compared with the great luxuriance of vegetation In Port Victoria, the chief settlement in Mahe, the only form of butcher meat obtainable is the flesh of the great turtle (*Chelone midas*) whose shell is valueless, the tortoise shell fisheries of the island depending on the *Chelone imbricata* M Alluaud hopes to bring back with him living specimens of the elephantine turtles of the Aldabra Islands, specimens of which have been transported to the Seychelles

THE expectation of an Antarctic expedition, on which valuable scientific observations might have been made, has proved illusory Captain Gray, of Peterhead, had organized a whaling voyage to the far south, and appealed to the public for funds to carry it out with some prospect of commercial success, but the response was so unsatisfactory that the enterprise has been abandoned From a scientific point of view, the advantages of Antarctic exploration are so great, and the probability of valuable practical results so apparent, that the apathy alike of the British and Australian Governments as well as of the general geographical public is incomprehensible The fact that no steamer has ever been despatched to the south of the Antarctic Circle with the object of attaining high latitudes says much for the prudence and little for the energy of present-day explorers.

A CHAIR of Colonial Geography is about to be established at the Sorbonne for the special study of the French colonies

THE discovery of America by Columbus is to be celebrated in Hamburg on October 11 and 12 by gatherings of delegates from the German Universities and Geographical Societies, by whom papers bearing on German enterprise in the sixteenth century will be read An exhibition of articles illustrating the early connection of Hamburg and America will also be held

THE Manchester Geographical Society has just published its *Journal* for July–September 1891, containing several interesting papers on India and a variety of short notices It is unfortunate that the small local encouragement given to this Society makes the earlier publication of its memoirs impossible Surely Manchester could afford and should endeavour to maintain a Geographical Society as prosperous financially as it is enterprising and persevering The contrast between the many provincial Geographical Societies in Germany and France with the three already established in England corresponds to the relative interest in geography as an aid to commerce on the Continent and in Great Britain

METALLIC CARBONYLS[1]

JUSTUS LIEBIG, perhaps the most prophetic mind among modern men of science, wrote in the year 1834 in the *Annalen der Pharmacie* "I have previously announced that carbonic oxide may be considered as a radical, of which carbonic acid and oxalic acid are the oxides, and phosgene gas is the chloride The further pursuit of this idea has led me to the most singular and the most remarkable results"

Liebig has not told us what these results were, and it has taken many years before the progress of chemical research has revealed to us what may at that early date have been before Liebig's vision. I will to-night bring before you some important

[1] Friday Evening Discourse delivered at the Royal Institution by Ludwig Mond, F R S, on June 3.

discoveries made only within the last few years by following up Liebig's idea

Carbonic oxide, composed of one atom of carbon and one atom of oxygen, is a colourless gas, without taste or smell, which I have here in this jar It burns with a blue flame When it acts as a radical combining with other bodies, we term it carbonyl, and its compounds with other elements or radicals are termed carbonyls

Liebig defined a radical as a compound having the characteristics of a simple body, which would combine with, replace, and be replaced by simple bodies In more modern times a radical has been defined as an unsatiated body I am of course speaking of chemical radicals If we look at it from the modern point of view, carbonyl should be the very model of a radical, because only half of the four valencies of the carbon atom are satiated, the other two remaining free Carbonic oxide should even be a most violent radical, because, amongst all organic radicals, it is the only one we know to exist in the atomic or free state All the other organic radicals, even such typical ones as cyanogen and acetylene, are known to us as molecules composed of two atoms of the radical, so that the cyanogen gas and acetylene gas we know should more properly be called di-cyanogen and di-acetylene, they consist of two atoms of the radical cyanogen or of the radical acetylene, the free valencies or combining powers of which satiate or neutralize each other On the other hand, carbonic oxide gas, as I stated before, makes the sole exception Its molecule contains only one atom of carbonyl moving about with its free valencies unfettered by a second atom For all that, carbonic oxide is by no means a violent body, but the very reverse, and instead of being ready to attack with its two free valencies anything coming in its way, until very recently we only knew it to interact and to combine with substances possessing themselves extreme attacking powers, such as chlorine and potassium Although Liebig had so long ago proclaimed it as a radical, the chemical world was startled when, two years ago, I announced in a paper I communicated to the Chemical Society in conjunction with Drs Langer and Quincke, that carbonic oxide combines at ordinary temperature with so inactive an element as nickel, and forms a well defined compound of very peculiar properties

The fact that carbonic oxide does not possess the chemical activity one would suppose in a radical composed of single atoms may, I believe, be explained by assuming that the two valencies of carbon which are not combined with oxygen do satiate or neutralize each other Everybody admits that the valencies of two different carbon atoms, which are all considered of equal value, can neutralize each other I see, therefore, no reason to question the possibility of two valencies of the same carbon atom neutralizing each other On this assumption carbonic oxide may be looked upon as a self satisfied body—one which keeps in check its free affinities within itself

You have here the typical carbon radicals containing one atom of that element, acetylene, methylene, methyl, cyanogen, and carbonyl In the second column you have these substances as they are known to us in the free state You see the carbonyl is the only one which exists in the free state as a single atom, while all the others only exist as molecules, composed of two atoms the free valencies of which neutralize each other The carbonyl I have represented in the last formula, with the two valencies not combined with oxygen neutralizing each other, so that in this way it also becomes a satiated body. I will try to make this still plainer to you by means of the models I have before me

The paper published by Liebig in 1834, from which I have already quoted, was entitled "On the Action of Carbonic Oxide on Potassium" In it Liebig fully described the preparation and properties of the first metallic carbonyl known—a compound of potassium and carbonic oxide Liebig obtained this compound by the direct action of carbonic oxide upon potassium at a temperature of 80° C, and proved it to be identical with a substance which had been previously obtained as a very disagreeable by product of the manufacture of potassium from potash and carbon by Brunner's method It forms a grey powder which is not volatile, and which on treatment with water yields a red solution, gradually turning yellow in contact with air, and from which on evaporation a yellow salt is obtained, called potassium croconate, on account of its colour. Liebig showed this salt to consist of two atoms of potassium, five of carbon, and five of oxygen, and not to contain any hydrogen, as had previously been supposed

Since the publication of Liebig's paper, potassium carbonyl has been studied by numerous investigators, amongst whom Sir Benjamin Brodie deserves particular mention, but it has been reserved to Nietzki and Benkiser to determine finally in the year 1885, by a series of brilliant investigations, its exact constitution, and its place in the edifice of chemistry They have proved that it has the formula $K_6C_6O_6$, that the six carbons in this compound are linked together in the form of a benzole ring, that, in fact, the compound is hexhydroxylbenzole, in which all the hydrogen is replaced by potassium By simple treatment with an acid it can be converted into the hexhydroxylbenzole, and from this substance it is possible to produce, by a series of reactions well known to organic chemists, the whole wide range of the benzole compounds. The body which Liebig obtained by the direct action of carbonic oxide on potassium has thus enabled us to prepare synthetically in a very simple way from purely inorganic substances—to wit, from potash and carbon, or if we like even from potash and iron—the whole series of those most important and interesting compounds called aromatic compounds, including all the coal-tar colours, which have furnished us with an undreamt-of variety of innumerable hues and shades of colour, as well as many new substances of great value to suffering humanity as medicines Surely a startling result, which alone would have fully justified Liebig's prediction of 1834!

Speaking of coal tar colours, everybody will be reminded of the great loss the scientific world has recently sustained by the death of August Wilhelm Hofmann, their first discoverer, Liebig's greatest pupil. Hofmann will ever be remembered in this Institution, where he so often delighted the audience by his lucid lectures, and in whose welfare he took the greatest interest, of which he gave us a fresh proof only last year, in the charming letter he wrote on the occasion of his election as an honorary member

Looking back upon the wonderful outcome of Liebig's idea I have referred to, it seems surprising indeed that others should not have followed up his work by attempting to obtain other metallic carbonyls

A very few experiments were made with other alkaline metals. sodium, otherwise resembling potassium so closely, has been shown not to combine with carbonic oxide, lithium and cæsium are stated to behave similarly to potassium But metals of other groups received little or no attention The very important *rôle* which carbonic oxide plays in the manufacture of iron did lead a number of metallurgists (among whom Sir Lowthian Bell and Dr Alder Wright are the most prominent) to study its action upon metallic iron and other heavy metals, including nickel and cobalt at high temperatures They proved that these metals have the property to split up carbonic oxide into carbon and carbonic acid at a low red heat, a result of great importance, which threw a new light upon the chemistry of the blast furnace. None of these investigators, however, turned their attention to obtaining compounds of these metals with carbonic oxide, and, owing to the high temperature and the other conditions under which they worked, the existence of such compounds could not come under their observation In order to obtain these compounds, very special conditions must be observed, which are fully described in the papers I have published during the last two years in conjunction with Dr Langer and Dr Quincke

The metals must be prepared with great care, so as to obtain them in an extremely fine state of division, and must be treated with carbonic oxide at a *low temperature* The best results are obtained when the oxalate of the metal is heated in a current of hydrogen at the lowest temperature at which its reduction to the metallic state is possible I have in the tube before me metallic nickel prepared in this way, and over which a slow current of carbonic oxide is now passing, the carbonic oxide before entering the tube burns, as you see, with a blue non luminous flame After passing over the nickel it burns with a highly luminous flame, which is due to the separation of metallic nickel from the nickel carbonyl formed in the tube, which is heated to incandescence in the flame (In passing the gas issuing from our tube through a glass tube heated to about 200°, we obtain a metallic mirror of pure nickel, because at this temperature the nickel carbonyl is again completely resolved into its components, nickel and carbonic oxide If we pass the gas through a freezing mixture, you will observe that a colourless liquid is condensed, of which I have a larger quantity standing in this tube This liquid formed is pure nickel carbonyl, and has the formula $Ni(CO)_4$

If cooled to $-25°$ C., it solidifies, forming needle-shaped

crystals The vapour of nickel carbonyl possesses a characteristic odour and is poisonous, but not more so than carbonic oxide gas Prof McKendrick has studied the physiological action of this liquid, and has found that, when injected subcutaneously in extremely small doses in rabbits, it produces an extraordinary reduction in temperature, in some cases as much as 12°

The liquid can be completely distilled without decomposition, but from its solution in liquids of a higher boiling point it cannot be obtained by rectification On heating such a solution the compound is decomposed, nickel being separated in the liquid, while carbonic oxide gas escapes I will try to demonstrate this by an experiment

We have here a solution of the substance in heavy petroleum oil, which you will, in a few minutes, see turns completely black on heating by the separation of nickel, while a gas escapes which is carbonic oxide

In a similar way, when the nickel carbonyl is attacked by oxidizing agents, such as nitric acid, chlorine, or bromine, it is readily broken up, nickel salts being formed, and carbonic oxide being liberated Sulphur acts in a similar way Metals, even potassium, alkalies, and acids, which have no oxidizing power, will not act upon the liquid at all, nor do the salts of other metals react upon it The substance behaves therefore, chemically, in an entirely different manner from potassium carbonyl, and does not lead, as the other does, by easy methods to complicated organic compounds It does not show any one of the reactions which are so characteristic for organic bodies containing carbonyl, such as the ketones and quinones, and we have not been able, in spite of very numerous experiments, either to substitute the carbonic oxide in this compound by other bivalent groups, or to introduce the carbonic oxide by means of this compound into organic substances

By exposing the liquid to atmospheric air, a precipitate of carbonate of nickel is slowly formed of varying composition, which is yellowish-white if perfectly dry air is used, and varies from a light green to a brownish colour if more or less moisture is present We have found all these precipitates to dissolve easily and completely in dilute acid, with evolution of carbonic acid, leaving ordinary nickel salts behind, and can therefore not agree with the view propounded by Prof Berthelot, in a communication to the French Academy of Sciences, that these precipitates contain a compound of nickel with carbon and oxygen, comparable to the so called oxides of organo metallic compounds In the same paper Prof Berthelot has described a beautiful reaction of nickel carbonyl with nitric oxide, which we will now show you You will notice the intense blue coloration which the liquid solution of nickel carbonyl in alcohol assumes by passing the nitric oxide through it Prof Berthelot has reserved to himself the study of this interesting body, but has so far not published anything further about it

The chemical properties of the compound I have just described to you are without parallel, we do not know a single substance of similar properties It became, therefore, of special interest to study the physical properties of the compound

Prof Quincke, of Heidelberg, has kindly determined its magnetic properties, and found that it possesses in a high degree the property discovered by Faraday, and called by him diamagnetism, which is the more remarkable, as all the other nickel compounds are paramagnetic He also found that it is an almost perfect non-conductor of electricity, in this respect differing from all other nickel compounds

The absorption spectrum, and also the flame spectrum, of our compound are at present under investigation by those indefatigable spectroscopists, Profs Dewar and Liveing, by whose kindness I am enabled to bring before you, in advance of a paper they are sending to the Royal Society, some of the interesting results they have obtained We have here a photograph of the absorption spectrum, obtained by means of a hollow prism through quartz plates filled with nickel carbonyl, through which the spark spectrum of iron is passed, which is photographed on the same plate You see that the whole of the ultra-violet rays of the iron spectrum have disappeared, being completely absorbed by the nickel carbonyl, which is thus quite opaque for all the rays beyond the wave length 3820 The spectrum of the highly luminous flame of nickel carbonyl, which I have shown you before, is quite continuous, but if the nickel carbonyl is diluted with hydrogen, and the mixture burnt by means of oxygen, the gases burn with a bright yellowish-green flame without visible smoke, and the spectrum of this flame shows in its visible part, on a background of a continuous spectrum, a large number of bands, brightest in the green, but extending on the red side beyond the red line of lithium, and on the violet side well into the blue These bands cannot be seen on the photograph which I will now show you, the visible part of the spectrum appearing continuous, but beyond the visible part the photograph shows a large number—over fifty—of well-defined lines in the ultra violet I will show you these lines in another photograph taken with greater dispersion, and on which has also been photographed the spark spectrum of nickel You will see that all these lines correspond absolutely to lines appertaining to the spark spectrum, in fact, the greater part of the lines in the spark spectrum are also shown in this flame spectrum We have here another and very striking example of the fact discovered on the same day by Profs Dewar and Liveing, and by Dr. Huggins, that the spectrum of luminous flames is not always continuous throughout its whole range, a fact which was at one time much debated and discussed

One of the most remarkable discoveries made within the precincts of this Institution by that illustrious man whose centenary we celebrated last year was that of the connection between magnetism and light, which manifests itself when a beam of polarized light is sent through a substance while it is subjected to a strong magnetic field, under whose influence the beam of light is rotated through a certain angle Dr W H. Perkin has prosecuted this discovery of Faraday's by a long series of most elaborate researches, and has established the fact that this power of magnetic rotation of various bodies has a definite relation to their chemical constitution, and enables us to gain a better insight into the structure of chemical compounds Dr. Perkin has been good enough to investigate the power of magnetic rotation of the nickel carbonyl, and has found it quite as unusual as its chemical properties, and to be, with the sole exception of phosphorus, greater than that of any other substance he has yet examined

The power of different bodies of refracting and dispersing a ray of light has been shown by the beautiful and elaborate researches undertaken many years ago by Dr Gladstone—who has given an account of them in this theatre in 1875, and who has since continued them with indefatigable zeal—to throw a considerable light upon the constitution of chemical compounds

I have investigated the refractive and dispersive powers of nickel carbonyl in Rome, in conjunction with Prof Nasini We found that the atomic refraction of nickel in the substance is nearly two and a half times as large as it is in any other nickel compound—a difference very much greater than had ever before been observed in the atomic refraction of any element To give you some idea how these figures are obtained, Mr Lennox will now throw on to the screen a beam of light through two superposed prisms, one filled with nickel carbonyl and the other with alcohol You will notice that the lines of the spectrum on the top are turned much further to the left, showing the nickel carbonyl to possess a much greater power of refraction than alcohol, and you will also notice that it is much wider than the bottom spectrum, which shows the greater dispersive power of the nickel carbonyl

It is now generally supposed that, if one element shows different atomic refractive powers in different compounds, it enters with a larger number of valencies into the compound which shows a higher refractive power In accordance with this view, the very much greater refractive power of the nickel in the carbonyl would find an explanation in assuming that this element, which in all its other known combinations is distinctly bivalent, exercises in the carbonyl the limit of its valency, viz. 8, assigned to it by Mendeleeff, who placed it in the eighth group in his Table of Elements This would mean that the one atom of nickel contained in the nickel carbonyl is combined directly with each of the four bivalent atoms of carbonyl, each of which would saturate two of the eight valencies of nickel, as is shown by this formula—

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          O
          C
          ‖
O C = Ni = C O
          ‖
          C
          O
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This view seems plausible, and in accordance with the chemical properties of the substance, and I should have no hesitation in accepting it if we had not, in the further pursuit of our work on metallic carbonyls, met with another substance—a liquid compound of iron with carbonic oxide—which in its properties bears so much resemblance to the nickel compound that one cannot assign to it a different constitution, whilst its composition makes the adoption of a similar structural formula next to impossible. It contains, for one equivalent of iron, five equivalents of carbonyl. To assign to it a similar constitution, one would, therefore, have to assume that iron did exercise ten valencies, or two more than any other known element, a view which very few chemists would be prepared to countenance. The atomic refraction of iron in this compound, which Dr. Gladstone has had the kindness to determine, is as unusual as that of the nickel in the nickel compound, and bears about the same ratio to the atomic refraction of iron in other compounds. We have, therefore, to find another explanation for the extraordinarily high atomic refraction of these metals in their compounds with carbon monoxide, which may possibly modify our present view on this subject. As to the structure of these compounds themselves, we are almost bound to assume that they contain the carbonyl atoms in the form of a chain.

The ferro-carbonyl is prepared in a similar manner to the nickel compound. The iron used is obtained by heating iron oxalate at the very lowest temperature possible. This carbonyl forms, however, with such very great difficulty, that we overlooked its existence for a long time, and great precautions have to be taken to obtain even a small quantity of it. It forms an amber-coloured liquid, of which I have a small quantity before me. It solidifies below -21° C. to a mass of needle shaped crystals. On heating the vapour to 180° C., it is completely decomposed into iron and carbonic oxide. The iron mirrors before me have been obtained in this way. Its chemical composition is $Fe(CO)_5$.

It is interesting that, within a short time after we had made known the existence of this body, Sir Henry Roscoe found it in carbonic oxide gas which had stood compressed in an iron cylinder for a considerable time, and expressed the opinion that the red deposit which sometimes forms in ordinary steatite gas burners is due to the presence of this substance in ordinary illuminating gas. Its presence in compressed gas used for lime lights has been noticed by Dr. Thorne, whose attention was called to the fact that this gas sometimes will not give a proper light because the incandescent lime becomes covered with oxide of iron.

M. Garnier, in a paper communicated to the French Academy of Sciences, supposes even that this gas is sometimes formed in large quantities in blast-furnaces when they are working too cold, and refers to some instances in which he found large deposits of oxide of iron in the tubes leading away the gas from these furnaces. I find it difficult to believe that the temperature of a blast-furnace could ever be sufficiently reduced as to give rise to the formation of this compound. On the other hand, it is highly probable that the formation of this compound of iron and carbonic oxide may play an important *rôle* in that mysterious process by which we are still making, and have been making for ages, the finest qualities of steel, called the cementation process.

The chemical behaviour of the substance towards acids and oxidizing agents is exactly the same as that of the nickel compound, but to alkalies it behaves differently. The liquid dissolves without evolution of gas. After a while a greenish precipitate is formed, which contains chiefly hydrated ferrous oxide, and the solution becomes brown. On exposure to the air, it takes up oxygen, the colour changes to a dark red, whilst hydrated ferric oxide separates out.

We have so far not been able to obtain from this solution any compound fit for analysis, and are still engaged upon unravelling the nature of the reaction that takes place, and of the compounds that are formed.

Although the solution resembles in appearance to some extent the solutions obtained by treating potassium carbonyl with water, it does not give any of the characteristic reactions of the latter.

When speaking of potassium carbonyl, I mentioned that, by its treatment with water, croconate of potassium was obtained, which has the formula $K_2C_5O_5$. We have transformed this by double decomposition into ferrous croconate (FeC_5O_5), a salt forming dark crystals of metallic lustre resembling iodine, which is not volatile, and dissolves readily in water, the solution giving all the well-known reactions of iron and of croconic acid. You will note how entirely different the properties of this substance are from those of iron carbonyl, which I have described to you, yet, on reference to its composition, you will find that it contains exactly the same number of atoms of iron, carbon, and oxygen as the latter. This is a very interesting case of isomerism, considering that both compounds contain only iron, carbon, and oxygen.

The difference in the properties of these two bodies becomes explainable by comparing the structural formula of the two substances.

I would now call your attention to the great difference in the constitution of the potassium carbonyl and that of the nickel and ferro carbonyl. In the former the metal potassium is combined with the oxygen in the carbonyl, in the latter the metals nickel and iron are combined with the carbon of carbonyl. In the first case we have a benzole ring with its three single and three double bonds, in the second a closed chain with only single bonds. It is evident that the chemical properties of these substances must be widely different.

The ferro-penta carbonyl remains perfectly unchanged in the dark, but if it is exposed to sunlight it is transformed into a solid body of remarkably fine appearance, of gold colour and lustre, as shown by the sample in this tube.

This solid body is not volatile, but on heating it in the absence of air, iron separates out and liquid ferro-carbonyl distils over. If, however, it is heated carefully in a current of carbonic oxide it is reconverted into the ferro penta carbonyl, and completely volatilized. We have so far found no solvent for this substance, so that we have no means as yet of obtaining it in a perfectly pure state. Several determinations of the iron in different samples of the substance have led to fairly concordant figures, which agree with the formula $Fe_2(CO)_7$, or di ferro-hepta-carbonyl.

The interesting properties of the substances described have naturally led us "to try," as Lord Kelvin once put it to me so prettily, "to give wings to other heavy metals." We have tried all the well known and a very large number of the rarer metals, but with the exception of nickel and iron we have so far been entirely unsuccessful. Even cobalt, which is so very like nickel, has not yielded the smallest trace of a carbonyl. This led me to study the question whether, by means of the action of carbonic oxide, the separation on a large scale of nickel from cobalt could not be effected, which has so far been a most complicated metallurgical operation, and subsequently I was led to investigate whether it would not be possible to use carbonic oxide to extract nickel industrially direct from its ores.

It had been established that pure nickel prepared with very great precautions in a glass tube, could be partly volatilized by carbonic oxide, and that from the gas thus obtained the nickel could be separated again by heating. The questions to be studied were, therefore, whether it would be possible to reduce the ores, on an industrial scale, under such conditions as to obtain the nickel in a sufficiently finely divided and active a state that the carbonic oxide would volatilize it, whether such action would be sufficiently rapid to allow of its industrial application, whether it would be sufficiently complete to remove all the nickel from the ore, and whether none of the other constituents of the ore would pass with the nickel and render it unfit for use, and further, whether the nickel could be completely separated out of the gas within practical limits, and whether the recovered carbonic oxide could be made use of over and over again.

For solving these problems within the limits of the resources of a laboratory, I have devised apparatus which consists of a cylinder divided into many compartments, through which the properly prepared ore is passed very slowly by means of stirrers attached to a shaft. On leaving the bottom of this cylinder, the ore passes through a transporting screw, and from this to an elevator, which returns it to the top of the cylinder, so that it passes many times through the cylinder, until all the nickel is volatilized. Into the bottom of this cylinder we pass carbonic oxide, which leaves it at the top charged with nickel carbonyl vapour, and passes through the conduits shown here into tubes set in a furnace and heated to 200°. Here the nickel separates out from the nickel carbonyl. The carbonic oxide is regenerated and taken back to the cylinder by means of a fan, so that the same gas is made to carry fresh quantities of nickel out of the ore in the cylinder, and to deposit it in these tubes an infinite number of times.

Upon these principles Dr. Langer has constructed a complete plant on a Liliputian scale, which has been at work in my laboratory for a considerable time, and a photograph of which we will now throw on to the screen. You see here the volatilising cylinder divided into numerous compartments, through which the ore is passing, and subjected to the action of carbonic oxide. At the bottom the ore is delivered into the transporting screw, passing through a furnace, and from this screw into an elevator, which returns the ore to the top of the cylinder, so that the ore constantly passes at a slow rate through the cylinder again and again, until the nickel it contains has been taken out. The carbonic oxide gas, prepared in any convenient manner, enters the bottom of the cylinder and comes out again at the top. It then passes through a filter to retain any dust it may carry away, and thence into a series of iron tubes built into a furnace, where they are heated to about 200° C. In these tubes the nickel carbonyl carried off by the carbonic oxide is completely decomposed, and the nickel deposited against the sides of the tubes is from time to time withdrawn and is thus obtained in the pieces of tubing and the plates which you see on the table.

The carbonic oxide regenerated in these tubes is passed through another filter, thence through a lime purifier, to absorb any carbonic acid which may have been formed through the action of the finely-divided nickel upon the carbonic oxide, and is then returned through a small fan into the bottom of the cylinder. The whole of this plant is automatically kept in motion by means of an electric motor, and the gearing which you see here.

By means of this apparatus we have succeeded in extracting the nickel from a great variety of ores, in a time varying, according to the nature of the ore, between a few hours and several days.

Before the end of this year this process is going to be established in Birmingham on a scale that will enable me to place its industrial capacity beyond a doubt, so that I feel justified in the expectation that in a few months nickel carbonyl, a substance quite unknown two years ago, and to-day still a great rarity, which has not yet passed out of the chemical laboratory, will be produced in very large quantities, and will play an important *rôle* in metallurgy.

The process possesses, besides its great simplicity, the additional advantage that it is possible to immediately obtain the nickel in any definite form. If we deposit it in tubes we obtain nickel tubes; if we deposit it in a globe we obtain a globe of nickel; if we deposit it in any heated mould we obtain copies of these moulds in pure, firmly coherent, metallic nickel. A deposit of nickel reproduces the most minute details of the surface of the moulds to fully the same extent as galvanic reproductions. All the very numerous objects now produced by galvanic deposition, of which Mr. Swan exhibited here such a large and beautiful variety a fortnight ago, can thus be produced by this process with the same perfection in pure metallic nickel. It is equally easy to nickel plate any surface which will withstand the temperature of 180° C. by heating it to that temperature and exposing it to the vapour, or even to a solution of nickel carbonyl, a process which may in many cases have advantages over electroplating. I have on the table before me specimens of nickel ores we have thus treated, of nickel tubes and plates we have obtained from these ores, and a few specimens of articles of pure nickel and articles plated with nickel which have been prepared in my laboratory. These will give you some idea of the prospects which the process I have described opens out to the metallurgist, upon whom, from day to day, greater demands are made to supply pure nickel in quantities. The most valuable properties of the alloy of nickel and iron called nickel steel, which promises to supply us with impenetrable ironclads, have made an abundant and cheap supply of this metal a question of national importance. The inspection of the few specimens of articles of pure nickel and of nickel-plated articles will, I hope, suffice to show you the great facilities the process offers for producing very fine copies, and for making articles of such forms as cannot be produced by hydraulic pressure, the only method hitherto available for manufacturing articles of pure nickel.

The first practical use of the process has been made by Prof. Ramsay, who, for the purposes of a chemical investigation, made this beautiful little apparatus of pure nickel all in one piece, which he has kindly lent for exhibition to-night.

I began my lecture by bringing under your notice an idea of Liebig's which he published fifty-eight years ago. I have shown you how he himself elaborated this idea, and how it developed, until within recent years it has led to results of the highest scientific importance and probably of great practical utility.

Had Liebig all these results before his "mind's eye" when he penned those prophetic words I have quoted? This is a question impossible to answer. Who will attempt to measure the range of vision of our great men, who from their lofty pinnacle see with eagle eye far into the Land of Science, and reveal to us wonderful sights which we can only realize after toiling slowly along the road they have indicated? Whether Liebig saw all these results or not, it is due to him and to men like him that science continues its marvellous advance, dispersing the darkness around us, and ever adding to the scope and exactness of our knowledge, that mighty power for promoting the progress and enhancing the happiness of humanity.

NORTH-WESTERN DISTRICT OF BRITISH GUIANA

AT the meeting of the Royal Geographical Society on Monday evening, Mr. Everard im Thurn described the general characteristics of the new district in the north-west of British Guiana in the settlement and administration of which he has been employed for the last nine years. The colony of British Guiana he described as formed of a low swampy coast strip, often below the level of the sea, densely covered with mangroves, and intersected by rivers bound together by interlacing channels. Farther inland the mangroves pass into forests of tropical trees, which, as the land rises more steeply, are reduced to strips along the rivers, and finally merge into dry grassy uplands known as savannahs. The north-western district of the colony is officially defined as the territory bounded on the north by the Atlantic Ocean and the mouth of the River Orinoco; on the south by the ridge of land between the sources of the Amakuru, Barima, and Waini Rivers, and their tributaries, and the sources of the tributaries of the Cuyuni River; on the east by a line extending from the Atlantic Ocean in a southerly direction to the said ridge of land; on the south and on the west, by the Amakuru River and the line known as Schomburgh's line.

Mr. im Thurn's first task was to explore his territory, and this he did mainly by boat along the rivers and their connecting channels, traversing country never before visited by white men. The nature of this mode of travelling was very vividly described. On ascending the Moruka, the country on each side of the river was seen to become gradually more and more open—the river at last often winding through open savannahs, and broadening out here and there into pools so thickly set with water-lilies that the boat was forced through with difficulty. The waterway after some time leaves the river and passes along a narrow itabbo, or artificial water path, which connects the Moruka with the Waini River. This connecting passage is about thirty miles long, and about ten miles is semi-artificial itabbo, made by the constant passage of the canoes of the Redmen through the swampy savannah, and very difficult to get through. Generally, it was hardly wider than the boat, and had many abrupt windings; the trees hung down so low over the water, that it was hard work either to force the boat under the low-lying branches, or to cut these away, and so make a passage. On either side of the channel the ground is so swampy as rarely to allow foothold of even a few inches in extent. The light hardly penetrates through the dense roof of leaves; and in the gloom under the roof only a few aroids, ferns, lilies, and orchids, and great masses of a palm previously undescribed could be described.

The itabbo passed, the boat turned suddenly into the Barabara River itself, at first narrow, but soon widening and winding on its course through dense and unbroken bush, chiefly composed of the graceful, swaying manicole palms (*Euterpe edulis*). Very abundant, perched high up and low down among this dense bush, were great quantities of an orchid with stems eight and nine feet long, loaded with its countless butterfly-like yellow flowers (*Oncidium altissimum*). After a few miles the Barabara River led into the Biara, a river of much the same character, which, though naturally larger than the Barabara, was still so small as hardly to deserve more than the local name of creek. And, again, in a few miles the Biara carried the boat into the Baramanni River, which is about 100 or 150 yards wide, and very deep. This is, in fact, not a river at all, but a very elongated lake or lagoon, of perhaps twenty miles in length, the lower end

opening into the Waini, while the upper end discharges part of its surplus water into the sea. Anything more maze like than the itabbo between the Waini and Barima Rivers it is impossible to imagine.

On the Aruka, a large tributary of the Barima, the curious Arawack game of the Macquari whip is played, the essential feature of which is a testing of endurance by means of alternately giving and receiving severe cuts with a somewhat severe whip. This extraordinary performance, accompanied with much drinking and with invariable good humour, is carried on for some days in accordance with a fixed ritual, the blows, which are received by the players on the calves of their legs, being so severe as to draw much blood. The river, too, must at one time have been the site of a Redskin civilization far superior to, and very different from, any known previously of the early inhabitants of Guiana; for there are on it considerable deposits of pottery ornamented with incised patterns, and even very abundantly with grotesque figures of men and animals in very high relief. To estimate the significance of this latter fact, it must be remembered that none of the known early inhabitants of Guiana have advanced in the important primitive art of pottery beyond the stage of making vessels of two or three definite and very simple shapes, which are almost invariably entirely without ornament, or are at best, in a very few cases, ornamented with a simple pattern painted on the flat surface.

The Warrau Redmen inhabiting a neighbouring region have recourse to a picturesque game in order to decide disputes amicably. For this purpose, on an appointed day both parties come together on some open space, such as this sand-bank, each man or boy provided with a large shield made of the leaf stalks of the aeta palm (*Mauritia flexuosa*). After much shouting and dancing in two opposed lines, the shields of the one party are pushed against those of the other, and by this means the members of each party endeavoured by sheer strength to overthrow, or at least to force back from their position, the members of the other party; and the right in the matter in dispute is considered to lie with whichever party proves itself the stronger in this contest. The game is peculiar to the swamp Warraus, who live in the swamps of the mouths of the Orinoco, and live here chiefly on the aeta palm, not cultivating any food-stuff, but eating the fruit of this palm and the pith of its stem, not making any fermented drink, as other Redmen do, but drinking only water and the sap of this same palm, building their houses, not as Humboldt thought, actually *in* these palms, but yet entirely, floor, posts, and roof, *of* the various parts of this palm.

The physical features of the north-western district are like, yet in some respects different from, those of the rest of the colony. The watershed from which the main rivers, the Waini, Barama, Barima, and the Amakuru, run down to the sea, is here nearer to the coast-line than it is further south. Two more important consequences arise from this. The bare dry savannah of the interior of other parts of the colony is here unrepresented, the whole district being practically within the forest belt. And the rivers are both shorter and deeper, though their mouths are very wide. Moreover, these rivers are curiously connected both by a remarkably elaborate network, probably hardly paralleled in any other part of the world, of natural and semi natural water channels—such as those described—and by an almost equally elaborate network of Redmen's paths through the forest.

The inhabitants of this district were, ten years ago, Redmen, and Redmen only. Their distribution is interesting when taken in connection with the distribution of their kind throughout the colony. The Redmen of Guiana consist of many small tribes, the best known of which are the Arawacks and the so called Caribs—true Caribs they are preferably called. These two last named tribes owe the fact that they are the best known to the circumstance that they shared between them the West Indian Islands south of Jamaica at the time of their discovery by Columbus; and they are the last remnants of those people who were the victims of that brutal policy of extermination by cruelty followed by the Spanish conquerors of the New World. The north-western district is some 9500 square miles in extent, and rises gradually from the sea to the range of somewhat higher land, which is represented, with some exaggeration, on most existing maps as the Sierra Imataca range of mountains, but which, within the limits of British Guiana, never attains a general level of more than 300 or 400 feet. The lower or alluvial part of this country consists of some of the richest soil in the world. Parts which have since been taken in and drained now yield crops of tropical produce of simply amazing abundance. As an illustration, a garden which hardly two and a half years ago was cleared and drained already has in it avenues of trees (*Casuarina*) of over 40 feet high, which were then planted. On the other hand, the higher part of the new district is being fast overrun by very successful gold-diggers.

For geographical reasons the most convenient centre from which to administer the district was at the point at which the Morawhanna leaves the Barima. This is near the centre of the waterway which traverses the northern part of the colony from the sugar fields about the mouth of the Essequibo to its northern limits on the Orinoco, by which, in the absence of roads, all traffic from the Orinoco to the older established parts of the colony must necessarily pass. Here, therefore, the central station, with the Government Agency, the police barracks, the hospital, and the other buildings, public and private, which go to make up the chief township, have been placed, and are fast being added to. A large station, with the other necessary accommodation, was also placed at the northern end of the waterway, on the mouth of the Amakuru; and other stations have been placed at intervals along the whole line.

SCIENTIFIC SERIALS

THE *American Meteorological Journal* for May contains a paper read by Prof. W. M. Davis, before the New England Meteorological Society, entitled "Meteorology in the Schools." It points out the best plan to be adopted by a teacher to give his pupils a sound knowledge of the subject, and it will be found full of interest for many who may have made considerable progress in the study of meteorology. The complete solution of weather changes is far beyond the meteorology of the day, but the paper will teach the student to recognize the great difficulties attendant upon successful weather-predictions, and to discriminate between these and the predictions of those who pretend to outline the course of meteorological events for months ahead.—Thunderstorms in New England during the year 1886, by R. De C. Ward. The observation of thunderstorms was taken as a special subject of investigation by the New England Meteorological Society in the years 1885–87, and this paper is a preliminary report on the investigation, to be eventually published by the Harvard College. The storms were most frequent between May and August, and between 5h. and 7h. p.m. The average rate of movement throughout the year was 35 miles an hour. The influence of the tides on the direction of the storms is said to be brought out in several reports.—The storm of March 1–4, 1892, by J. Warren Smith. This storm was so severe in the New England States, and the snowfall and drift so heavy, as to cause in many places the cessation of all outside business; trains were blocked, and much damage done to shipping from the violence of the wind.

THE *American Meteorological Journal* for June contains the following original articles:—Flood-stage river predictions, by Prof. T. Russell. The paper gives some account of the methods by which the rules for river-stage predictions are derived. A river stage is the vertical height of the water surface above the plane of low water, observed with a gauge. There are about 150 gauge stations maintained at various points in the United States. The predictions are mainly based upon observation of the stages and rises at certain points of a stream, and upon a consideration of what has occurred in previous cases, from which data factors are calculated. As a rule, rainfall observations are of little use in such predictions.—The first scientific balloon voyage, translated by R. De C. Ward, from an article by Dr. Hellmann. (See NATURE, vol. xlv. p. 471.)—Snow-storms at Chicago, by A. B. Crane. The writer has tabulated the records relating to the subject from 1879–90, and has discussed them with reference to the meteorological conditions prior to the storm. The heaviest storms occurred in January, the average temperature being 21°.4. He found that before the storms the temperature nearly always rises, and that it rarely falls for twenty four hours previously.—The eye of the storm, by S. M. Ballou. This name is given to the calm area in the centre of a cyclone, where clear sky is generally visible. The author quotes accounts by various observers, and a review of the different explanations of the phenomenon.—Shall we erect lightning rods?, by A. McAdie. The question being whether it is

cheaper to insure buildings than to incur the expense of erecting lightning rods, the author quotes a number of authorities in support of the advisability of putting up rods, and gives rules to be observed in doing so

Bulletin of the New York Mathematical Society, vol 1, Nos 8 and 9 (New York, 1892)—The illustrious German mathematician, Leopold Kronecker, died recently at Berlin (December 29, 1891) No 8 (pp 173–84) opens with a most interesting article, by H B Fine, entitled "Kronecker and his Arithmetical Theory of the Algebraic Equation" This is biographical and analytical A short note, by Prof Cajori, follows, on the "Multiplication of Series" The concluding note is by Dr Macfarlane, "On Exact Analysis as the Basis of Language" This is a brief abstract of a paper read before the Society (March 5, 1892)—No 9 gives an account of a recent paper in the *Mathematische Annalen* (vol xxxviii), by M Hilbert, under the head "Topology of Algebraic Curves" The writer, L S Hulburt, recasts the theory, with the view of making the theory more intelligible, and corrects some slight inaccuracies Dr Merriman abstracts a paper (read before the Society) on "Final Formulas for the Algebraic Solution of Quartic Equations" This number closes with a full account of Poincaré's "Mécanique Céleste," by E W Brown The usual short notes and list of new publications are given at the end of each number

Memoirs of the Mathematical Section of the Odessa University, vol xiii—On the theory of linear differential equations, by M Rudzky—The mechanics of a system subject to similar changes, by D Seiliger, part iii The paper is followed by a description of an apparatus, the "homoyograph," three spots of which always take such positions as to make similar triangles—Experimental researches into the compressibility of glass and mercury, by G De-Metz The absolute compressibility of mercury has been determined on the two methods of Regnault and Jamin, as also on a third method which results from the equations of Lamé in his "Leçons sur l'Elasticité," and the seventh memoir of Regnault The results arrived at in these very elaborate researches are very near to those arrived at by Amagat—Volume xii of the same periodical consists of a work by J Timtchenko, on the foundations of the theory of analytical functions The aim of the author is to contribute towards the elaboration of a *general* theory of functions which would include Weierstrass's theory as well The first part, now published, contains the historical review of the development of the theory

Bulletin de la Société des Naturalistes de Moscou, 1891, Nos 2 and 3—The Specton clays and their equivalents, by A Pavloff and G W Lamplugh—Contributions to the study of molecular forces in chemically simple bodies, on the ground of thermodynamics, by J Weinberg—Studies on the development of Amphipodes, part v, by Madame Catherine Wagner (in French, with two plates) The development of the embryo of the *Melita palmata* is apparently quite similar to that of *Gammarus* and *Caprella* in its earlier stages, but the microscopic observation of cuttings through the embryo discloses several interesting peculiarities, which are described and illustrated—What is the Hipparion?, by Marie Pavloff (in French) being an answer to critical remarks, by M Trouessart, in *Annuaire Géologique Universel*, tome vi, relative to Marie Pavloff's work on the evolution of Ungulates—On a new apparatus for determining the moment of inertia of a body, by N. Joukovsky (in French)—On *Pteromonas alata*, Cohn, by M Golenkin (in German)—The present state of our knowledge of the contents of the cells of the Phycochromaceæ, by Valerian Deinega (in German) The author has come to no definite results as to the nucleus in the Phycochromaceæ, especially in the thread like species, new colouring methods ought to be discovered

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 2—"Supplementary Report on Explorations of Erect Trees containing Animal Remains in the Coal-formation of Nova Scotia" By Sir J William Dawson, F R S

To the memoir which I had the honour to present to the Royal Society on this subject in 1882[1] I appended a note from Dr Scudder, of Cambridge, U S, so well known for his researches in fossil Insects and Arachnidans, in which he gave a preliminary account of the remains of Arthropods in my collections which I had submitted to him He has only in the present year completed his examination of these remains, most of which are fragmentary, and much damaged by unequal pressure The result has been embodied in a Report on Canadian Fossil Insects, now in course of publication by the Geological Survey of Canada

In this Report he will describe from the contents of the Sigillarian stumps extracted by me, with the aid of the grant of this Society, three new species of Myriapoda, making, with the five previously known from these remarkable repositories, eight in all, belonging to two families, Archiulidæ and Euphoberidæ, and to three genera, *Archiulus*, *Xylobius*, and *Amynilyspes* The three new species are *Archiulus euphoberioides*, Sc, *A Lyelli*, Sc, and *Amynilyspes* (sp) The remains of Scorpions he refers to three species, *Mazonia acadica*, Sc, *Mazonia* (sp), and a third represented only by small fragments The characters of the species referred to *Mazonia* he considers as tending to establish the generic distinctness of *Mazonia* from *Eoscorpius* Dr Scudder also notices the fragment of an insect's head containing part of a facetted eye, mentioned in my memoir, and considers it probably a portion of a Cockroach

Much credit is due to Dr Scudder for the care and skill with which he has worked up the mostly small and obscure fragments which I was able to submit to him, and which are probably little more than *débris* of the food of the Amphibians living for a time in these hollow stumps, and devouring such smaller animals as were so unfortunate as to be imprisoned with them In this connection the suggestion of Dr Scudder is worthy of attention, that the scaly armour of the smaller Microsaurians may have been intended to defend them against the active and venomous Scorpions which were their contemporaries, and some of which were sufficiently large to be formidable antagonists to the smaller land Vertebrates of the period.

The report of Dr Scudder will complete the account of the land animals of the erect Sigillariæ of the South Joggins, unless by new falls of the cliff fresh trees should be exposed From 1851, when the first remains were obtained from these singular repositories by the late Sir Charles Lyell and the writer, up to the present time, they have afforded the remains of twelve species of Amphibians, three land Snails, eight Millipedes, three Scorpions, and an Insect

The type specimens of these animals have been placed in the Peter Redpath Museum of McGill University, and such duplicates as are available will be sent to the British Museum and that of the Geological Survey of Canada

June 16—"On the Estimation of Uric Acid in Urine." By F Gowland Hopkins

The process described depends upon the complete insolubility of ammonium urate in saturated solutions of ammonium chloride The pure chloride is powdered, and added to the sample to complete saturation After two hours' standing, the whole of the uric acid separates as biurate of ammonium The urate is then decomposed with hydrochloric acid, and the liberated uric acid determined by any approved method In contrast to the well-known Fokker-Salkowski process the separation is rapid and complete

The author has experimented with permanganate solutions for the titration of the separated uric acid, and finds that accurate results may be obtained by their employment For this purpose the uric acid is dissolved in 100 cc of water, with a minimum of Na_2CO_3, 20 cc. of strong H_2SO_4 being then added, and the solution immediately titrated with one-twentieth normal permanganate of potassium The addition of 20 per cent H_2SO_4 to the previously cooled solution of sodium urate yields just such a temperature (about 60°C) as is requisite for a determinate reaction 1 cc of the permanganate solution is equal to 0 00375 grm uric acid

Physical Society, June 24.—Prof A W. Rücker, F R S, in the chair—The following communications were made—On breath figures, by Mr W B Croft. After mentioning the observations of early experimenters on the subject, the author described a method which he found to give the best results A coin is placed on a glass plate for insulation, another glass plate, which is to receive the impression, is well polished and laid on

[1] Phil Trans., 1882, p. 621

the coin, whilst a second coin is placed above the first. The coins are put in connection with the poles of an electrical machine, giving one inch sparks for two minutes When the coins are removed and the glass breathed on, clear frosted pictures of the coins are seen on the glass The microscope shows that moisture is deposited on the whole surface, the size of the minute water granulation increasing as the part of the picture is darker in shade The thickness of the glass seemed to make no difference to the result, and several plates and coins might be piled up alternately If carefully protected, time appears to have little effect on the figures, but they can be removed by rubbing whilst the glass is moist Failures and their causes were discussed, and the more complex phenomena produced by strong discharges described. It was also pointed out that breath figures could be produced by laying a coin on a freshly split surface of mica, and that a coin laid on glass for some time leaves its traces Perfect reproductions of printed matter have been obtained by placing a paper printed on one side only between two sheets of glass for ten hours Some substances, such as silk in contact with glass, give white figures, whilst wool, cotton, &c, give black ones Various analogous effects are noticed in the paper, and the several views put forward in explanation of the phenomena examined —A communication on the same subject, from the Rev F J Smith, was read by Prof Perry He had investigated some of the effects, and succeeded in photographing the impressions, prints from which were shown He had also examined the influence of various gases on the results, and found that oxygen gave the best figures In a vacuum no figures could be obtained The effect of temperature had also been tested Prof S P. Thompson said details of early researches were given in *Poggendorff's Annalen* for 1842 It was there pointed out that better results were obtained by putting a spark gap between the coin and the machine Since the effects did not depend on the way in which the sparks passed, he thought it was probable that electrical oscillations were involved He himself had worked at the subject in 1881, and recently repeated some of the experiments Figures could be produced on almost any polished surface, he got the best results by using a small induction coil giving 3 mm spark, for about five seconds In 1881 he accidentally noticed that photographs could be got on ebonite Hot coins put on uncleaned glass gave good breath figures. A member said that instead of breathing on the plates, he and Mr Garrett had sifted finely powdered red lead on them, to get the figures They had also fixed the figures by etching with hydrofluoric acid Mr Croft exhibited some figures he obtained two years ago, which were still quite distinct —On the measurement of the internal resistance of cells, by Mr E. Wythe Smith After referring to the methods hitherto used, the author described a modification of Mance's test which he had recently devised One pole of the battery to be tested is connected to the similar poles of two other batteries, each battery has a separate circuit, through which currents are allowed to pass Selecting a point A at the opposite pole of the battery to be tested, points B and C in the circuits of the auxiliary batteries are found, whose potentials are equal to that of A The resistances between each pair of points AB, AC, BC, are then measured by a Wheatstone's bridge Calling these resistances R_1, R_2, and R_3 respectively, it is shown that the internal resistance required is given by the formula $b = x + \frac{x^2}{r} + \frac{x^3}{r^2} + \&c.$, where $x = \frac{R_1 + R_2 - R_3}{2}$, and r is the external resistance of the circuit containing the battery tested For an accumulator discharging, $b = x$ to within about 2 per cent Prof Perry inquired how far the results obtained agreed with those got by the older methods, and whether they depended on the time the keys were kept down In the old methods it was assumed that an instantaneous rise in P D occurred on breaking the circuit This might or might not be true He was inclined to regard the P D and current as functions, both of resistance and time The behaviour of cells seemed to indicate the existence of something like capacity, or rather, capacities and resistances in series. Prof Ayrton said the paper was of great interest, for it made possible what could not be done before, viz to find the resistance of a cell without appreciably altering the current through it. Although the new method required more cells, this was not prohibitive, for the result sought was of considerable scientific importance. The same method was applicable for finding the resistance of dynamo-armatures when working, a quantity which had hitherto been unattainable by direct measurement Mr Lane Fox said the perplexing changes in the P D of secondary cells were to be accounted for by changes in the electrolyte, which occurred in the pores of the plates He could detect no flaw in the reasoning given in the paper Dr Sumpner remarked that the method was a valuable one, for it depended on bridge tests which could be made with considerable accuracy On the other hand, it was a false zero method, and therefore liable to errors arising from changes of this zero Prof Ayrton pointed out that these errors could be eliminated by reversing the bridge battery Mr Rimington said a though the testing currents were small they might affect the E M F, and thus introduce an error in b This might be tested by using alternate currents and a telephone In reply to Prof Perry, Mr Smith said the results agreed with those obtained by the older methods to within the limits of accuracy obtainable by the latter methods, this might amount to something like 15 per cent —On the relation of the dimensions of physical quantities to directions in space, by Mr W Williams In February 1889, Prof Rucker recalled attention to the fact that, in the ordinary dimensional formulæ for electrical quantities, the dimensions of μ (permeability) and k (specific inductive capacity) are suppressed In the discussion on that paper Prof S P Thompson pointed out that lengths should be considered as having direction as well as magnitude, for, if so regarded, difficulties arising from different units, such as *couple* and *work*, having the same dimensions, would be avoided Developing this idea, the author takes three mutually perpendicular lines, along which lengths are measured Calling unit lengths along these lines X, Y, and Z respectively, the various dynamical units, such as velocity, acceleration, force, work, &c, are expressed in terms of M, T, X, Y, and Z The formulæ then denote the directional as well as the numerical relations between the units, and the dimensional formulæ are therefore regarded as the symbolical expressions of the physical nature of the quantities, so far as they depend on lengths, mass, and time In this system areas and volumes are represented by products of different vector lengths instead of by powers of a single length, and angles and angular displacements by quotients of rectangular vectors, instead of being pure numbers For physical purposes pure numbers may be defined as ratios of concretes of the same kind similarly directed (if directed at all) A plane angle has dimensions $X^{-1}Y$, X being in the direction of the radius, and Y that of the arc, whilst solid angles have dimensions YZX^{-2}, and radii of curvature Y^2X^{-1} It is also shown that π is a concrete quantity of the dimensions either of plane or of solid angle This is of considerable importance in connection with the radial and circuital fluxes in the electromagnetic field In deducing the dimensional formulæ for electrical and magnetic units, the rational and simplified relations given by Mr Oliver Heaviside in the *Electrician* of October 16 and 30, 1891, are used Instantaneous axes are taken at any point of an isotropic medium (the ether) such that X coincides with the electrical displacements, Y with that of the magnetic displacement, and Z with the intersection of the two equipotential surfaces at that point Starting with the relation μH = energy per unit volume, the formulæ for the various quantities in terms of μ are obtained. These simplify down to those of the ordinary electro-magnetic system by putting $\mu = 1$ and suppressing the distinction between X, Y, and Z Similarly, commencing with kE^2 = energy per unit volume, formulæ in terms of k are obtained, which, when simplified as above, give those of the ordinary electrostatic system Examples of the consistent way in which the results work out are given in the paper, and the whole subject is discussed in detail, both by Cartesian and vectorial methods The formulæ in terms of μ and k are used to trace out and examine the various analogies between electro magnetism and dynamics, thereby obtaining a connected dynamical theory of electromagnetism Inquiry is then made as to what dimensions of μ and k in terms of M, T, X, Y, Z, render the interpretation of electrical and magnetic units simple, natural, and intelligible as a whole The conditions imposed (for reasons stated in the paper) are, first, that the dimensions of μ and k satisfy the relation $[\mu k] = Z^2T^{-2}$, second, that the powers of the fundamental units in the dimensional formulæ shall not be higher or lower than those found in the formulæ of the ordinary dynamical quantities, and, third, that quantities which are scalar or directed must also be scalar or directed when their dimensions are expressed abso-

lutely Subject to these conditions, it is shown that the possible dimensional values of μ and k are eight in number Of these only two lead to intelligible results These are—

$$(1)\ \mu = M(XYZ)^{-1} \text{ and } k = M^{-1}XYZ^{-1}T^2$$

and

$$(2)\ \mu = M^{-1}XYZ^{-1}T^2 \text{ and } k = M(XYZ)^{-1}$$

According to (1), μ is the density of the medium, electrical energy is potential, and magnetic energy kinetic By (2), k is the density of the medium, electrical energy is kinetic, and magnetic energy potential Full interpretations of the dimensional formulæ of all the electro-magnetic quantities, as obtained in accordance with the above conditions, are given in the paper Prof S P Thompson said the paper was a very important one, and thought the idea of finding dimensions for μ and k which would rationalize the ordinary dimensional formulæ a great step The use of vectors was a valuable feature, whilst the employment of X, Y, and Z instead of L removed many difficulties connected with dimensional formulæ Other difficulties might be cleared up by paying attention to the signs of the vector products and quotients, and to the order in which the symbols were written Another important matter was the use of Mr Heaviside's "rational units,' a system which merited serious attention In conclusion, Prof Thompson expressed a hope that, in accordance with the resolution of the Electrical Congress at Frankfort, both permeability and specific inductive capacity should be designated by Greek symbols Prof O Henrici expressed his admiration of the way in which the subject had been treated in the paper He had long held that clear ideas of physical quantities were best got by vectorial methods He also congratulated the author on his treatment of plane and solid angles as concrete quantities In a communication addressed to the Secretaries, Prof O J Lodge remarked that physicists in England were more or less familiar with the advantages of retaining μ and k in dimensional expressions before Prof Rucker's paper of February 1889 brought the matter closely home to students The system of mechanical dimensions suggested for electrical quantities in an Appendix to "Modern Views of Electricity" was not put forth as the only one possible, but as one having certain probabilities of truth in its favour Prof Rücker said that, although Mr Williams and himself had talked over certain minor points in the paper, the main ideas brought forward were quite original, having been fully developed by Mr Williams before he mentioned the subject to him (Prof Rücker) —A paper on molecular forces, by Mr W Sutherland, communicated by Prof Carey Foster, was taken as read The Chairman announced that both this paper and that of Mr Williams would be printed in the *Philosophical Magazine* during the long vacation, so that they could be fully discussed early next session

Linnean Society, June 16 —Prof Stewart, President, in the chair —Mr F Enock exhibited some specimens of the Mustard Beetle, and gave an account of its recent depredations as observed by himself So numerous was it that in walking down a single row of mustard, a distance of sixty-five yards, he had captured with a butterfly net upwards of 15,000, as he subsequently ascertained by counting a portion and weighing the remainder. The crop of mustard thus affected he regarded as destroyed —Mr R I Pocock exhibited and made some remarks upon a species of Peripatus (*P juliformis*) from St Vincent, of which five specimens had been collected by Mr H H Smith for the Committee investigating the fauna and flora of the Lesser Antilles. The species was originally described so long ago as 1826, by the Rev L Guilding (*Zoological Journal*, vol ii), but from that time until the present no additional specimens had been procured there As Guilding's types had been lost, and his descriptions are wanting in detail, this rediscovery was of considerable interest —Mr George Murray exhibited and described the type of a new order of Algæ, to which the name *Splachnidium rugosum* was given —A paper was read by Prof. J R. Henderson, entitled "Contributions to Indian Carcinology," and embodied an account of several little-known Crustaceans, and descriptions of some new species.—Mr. H B Guppy read a paper on "The Thames as an Agent in Plant Dispersal," in which several interesting facts were brought out, the observations being illustrated by specimens collected by the author, and a useful record given of the effects of exposure to sea-water, and of freezing, upon the germinating power of seeds —Prof F. Oliver gave an abstract of observations made by Miss M F Ewart, on some abnormal developments of the flowers of *Cypripedium*, illustrated by effective diagrams in coloured chalk —Mr R I Pocock contributed some "Supplementary Notes on the Fauna of the Mergui Archipelago," the result of his examination of some fresh material which had lately come to hand —The evening was brought to a close by an exhibition by Mr Carruthers, with the aid of the oxy hydrogen lantern, of some beautiful slides of sections of fossil plants A second series, zoological, exhibited by the President, included several minute organisms of extreme interest —This meeting brought the session of 1891–92 to a close

Anthropological Institute, June 21 —Edward B Tylor, F R S, President, in the chair —Dr R Wallaschek read a paper entitled "An Ethnological Inquiry into the Basis of our Musical System" In the course of the paper he pointed out that harmony is not a modern European invention, but known to many savage tribes, and even to the Hottentots and Bushmen A regular bass accompaniment (to distinguish it from songs in harmonious intervals) is far more seldom to be met with, as the extreme simplicity of primitive songs does not admit of much variety in accompaniment On the other hand, some savage tribes (Hottentots, Malays, Negroes) show an astonishingly great talent in accompanying European tunes by ear Both keys, the major as well as the minor, occur in the songs of primitive races. Minor chords also occur occasionally There is no internal connection between a peculiar key and a peculiar mood or disposition of mind The diatonic scale does not seem to be a more recent invention than the pentatonic The most ancient diatonic division is to be met with in instruments (pipes, flutes) of the Stone period This early occurrence seems to be due to the fact that the diatonic scale is the most natural for the player's fingers, while it is at the same time the most effective The diatonic system is neither an "artistic invention," nor a "scientific discovery," nor is it "natural" for the voice or the ear, nor based upon the laws and conditions of sounds, but it is the most natural for the hand, and the most practical for playing instruments —Prof Basil Hall Chamberlain then read a paper on some minor Japanese religious practices After mentioning various miscellaneous usages and superstitions, the author treated chiefly of Japanese pilgrims and their ways, illustrating his remarks by an exhibition of a large collection of charms, sacred pictures, pilgrims' dresses, &c brought together partly by himself, partly by Mr Lafcadio Hearn The collection included articles from the Shinto shrines of Ise and Izumo, from the "Thirty-three Holy Places" of Central Japan, from the "Eighty eight Holy Places" of the island of Shikoku, from the temple of Asakusa in Tokyo, &c The most curious was a sacred fire-drill from the great Shinto shrine of Izumo This, together with a few of the other articles, has been presented by Prof Chamberlain to the Pitt Rivers Museum at Oxford Another feature of the paper was the translation given of a Buddhist legend explaining the origin of the pilgrimage to the "Thirty three Holy Places," and of some of the hymns intoned by the pilgrims

Geological Society, June 22 —W H Hudleston, F R S, President, in the chair —The following communications were read —Contribution to a knowledge of the Saurischia of Europe and Africa, by Prof H G Seeley, F R S. The Saurischia are defined as terrestial unguiculate Ornithomorpha, with pubic bones directed downward, inward, and forward to meet in a ventral union The forms of the pelvic bones vary with the length of the limbs, the acetabulum becoming perforate, the ilium more extended, the pubis and ischium more slender, and the sacrum narrower as the limb-bones elongate The order is regarded as including the Cetiosauria, Megalosauria, and Aristosuchia or Compsognatha The Cetiosaurian pelvis has been figured in the *Quart Journ Geol Soc*, and a restoration is now given of the pelvis in *Megalosaurus*, *Streptospondylus*, and *Compsognathus* The characters of the skull are evidenced by description of the hinder part of the skull in *Megalosaurus* found at Kirklington, and preserved in the Oxford University Museum In form and proportions it closely resembles *Ceratosaurus*, and the corresponding region of the head in Jurassic Ornithosauria. The brain cavity and cranial nerves are described, and contrasted with those of *Ceratosaurus* The skull in Cetiosauria, known from the American type *Diplodocus*, is identified in the European genus *Belodon*, which is regarded as a primitive Cetiosaurian. Part 2 discusses the pelvis of *Belodon*, restored from specimens in the British Museum, and regarded as Cetiosaurian. A restoration of the shoulder-girdle is made, and found to resemble that in Ichthyosaura, Anomodonts, and Dinosauria. The vertebræ in form and articulation of the ribs

are Saurischian, the capitular and tubercular facets being vertical in the dorsal region, and not horizontal as in Crocodiles. The humerus shows some characters in common with that of *Stereorachis dominans*, in the epicondylar groove. In general character the limb-bones are more crocodilian than the axial skeleton. The interclavicle is described and regarded as a family characteristic of the Belodontidæ. In the third part an account is given of *Staganolepis*, which is regarded as showing a similar relation with the Megalosauria, to that of *Belodon* with the Cetiosauria. This interpretation is based chiefly upon the identification of the pubic bone in *Staganolepis*, which has the proximal end notched as in *Zanclodon* and *Streptospondylus*, and the inner ridge at the proximal end is developed into an internal plate. A note follows on the pelvis of *Aetosaurus*, which is also referred to the Saurischia on evidence of its pelvic characters, approximating to the Cetiosaurian sub order. Part 4 treats of *Zanclodon*, which is regarded as closely allied to *Massospondylus*, *Euskelesaurus*, and *Streptospondylus*. It is founded chiefly on specimens in the Royal Museum at Stuttgart, and in the University Museum at Tübingen. The latter are regarded as possibly referable to *Teratosaurus*, but are mentioned as *Zanclodon Quenstedti*. The pelvis is described and restored. *Zanclodon* has the cervical vertebræ relatively long, as compared with *Megalosaurus*, and small as compared with the dorsal vertebræ, which have the same Teleosauroid mode of union with the neural arch as is seen in *Streptospondylus* and *Massospondylus*. The sternum, of Pleininger, is the right and left pubic bones, but there is much the same difference in the proximal articular ends of those bones in the fossils at Stuttgart and Tubingen, as distinguishes corresponding parts of the pubes in *Megalosaurus* and *Streptospondylus*. The ilium is more like that of *Palæosaurus* and *Dimodosaurus*. The limb bones and digits are most like those of *Dimodosaurus*, but the teeth resemble *Palæosaurus*, *Euskelesaurus*, *Megalosaurus*, and *Streptospondylus*. Part 5 discusses *Thecodontosaurus* and *Palæosaurus* upon evidence from the Dolomitic Conglomerate in the Bristol Museum. An attempt is made to separate the remains into those referable to *Thecodontosaurus* and those belonging to *Palæosaurus*. The latter is represented by dorsal and caudal vertebræ, a scapular arch, humerus, ulna (?), metacarpals, ilium, femur, tibia, fibula, metatarsals, and phalanges. These portions of the skeleton are described. There is throughout a strong resemblance to *Zanclodon* and other Triassic types. A new type of ilium, and the humerus originally figured, are referred to *Thecodontosaurus*. Part 6 gives an account of the South African genus *Massospondylus*. It is based partly upon the collection from Beaucherf, in the Museum of the Royal College of Surgeons, referred to *M carinatus*, and partly upon a collection from the Telle River, obtained by Mr Alfred Brown of Aliwal North, referred to *M Browni*. The former is represented by cervical, dorsal, sacral, and caudal vertebræ, ilium, ischium, and pubis, femur, tibia, humerus, metatarsals, and phalanges. The latter is known from cervical, dorsal, and caudal vertebræ, femur, metatarsals, and bones of the digits. The affinities with *Zanclodon* are, in some parts of the skeleton, stronger than with *Euskelesaurus*. Part 7 gives an account of *Euskelesaurus Browni*, partly based upon materials obtained by Mr Alfred Brown from Barnard's Spruit, Aliwal North, and partly on specimens collected by the author, with Dr W G Atherstone, Mr T Bain, and Mr Alfred Brown, at the Kraal River. The former series comprises the maxillary bone and teeth, vertebræ, pubis, femur, tibia and fibula, phalanges, chevron bone and rib. The latter includes a cervical vertebra and rib, and lower jaw. The teeth are stronger than those of *Teratosaurus*, or any known Megalosaurian. The anterior part of the head was compressed from side to side, and the head in size and form like *Megalosaurus*, so far as preserved. The pubis is twisted as in *Staganolepis* and *Massospondylus*, with a notch instead of a foramen at the proximal end, as in those genera; and it expands distally after the pattern of *Zanclodon*. The chevron bones are exceptionally long, and the tail appears to have been greatly elongated. The femur is intermediate between *Megalosaurus* and *Palæosaurus*, but most resembles *Zanclodon* and *Massospondylus*. The tibia in its proximal end resembles many Triassic genera, and in its distal end is well distinguished from *Massospondylus* by its mode of union with the astragalus. The claw-phalanges are convexly rounded, being wider than is usual in Megalosauroids. The lower jaw from the Kraai River gives the characters of the articular bone, and the articulation, as well as of the dentary region and teeth. The cervical vertebra is imperfect, but is remarkable for the shortness of the centrum, being shorter than in *Megalosaurus*. In Part 8 an account is given of *Hortalotarsus skirtopodus* from Barkly East, preserved in the Albany Museum. It is a Euskelesaurian, and exhibits the tibia and fibula, and tarsus. There is a separate ossification for the intermedium, which does not form an ascending process; and the astragalus is distinct from the calcaneum. The metatarsals are elongated, and the phalanges somewhat similar to those of *Dimodosaurus*. Part 9, in conclusion, briefly examines the relations of the Saurischian types with each other, and indicates ways in which they approximate towards the Ornithosauria. It is urged that the Ornithosauria are as closely related to the Saurischia as are the Aves to the Ornithischia, and that both divisions of the Saurischia approximate in *Staganolepis* and *Belodon*. Finally, a tabular statement is given of the distribution in space and time of the 25 Old World genera which are regarded as probably well established. Eight of these are referred to the Cetiosauria, thirteen to the Megalosauria, and four to the Aristosuchia or Compsognatha.—Mesosauria from South Africa, by Prof H G. Seeley, F R S.—On a new Reptile from Welte Vreden, *Eunotosaurus africanus* (Seeley), by Prof H. G Seeley, F R S. The President observed that there could be no question as to the great value of these papers, the first of which especially was the outcome of years of experience and study on the part of the author. It was only right to remark that the paper on Saurischia was received by the officers of the Society early in *April*. Since that date Prof Marsh, in his notes on Triassic Dinosauria (which did not appear till *May* 24), had published, as regards *Zanclodon*, conclusions similar to those at which the author (Prof Seeley) had already arrived. Mr E T Newton also spoke. Prof Seeley drew attention to a photograph of *Hortalotarsus*, a reproduction of a sketch made at Barkly East, before the original specimen had been destroyed in the process of blasting the rock.—The dioritic picrite of White Hause and Great Cockup, by J Postlethwaite.—On the structure of the American Pteraspidian, *Palæaspis* (Claypole), with remarks on the family, by Prof E W Claypole.—Contributions to the geology of the Wengen and St Cassian strata in Southern Tyrol, by Maria M Ogilvie, B Sc. (Communicated by Prof C Lapworth, F R S.)—Notes on some new and little-known species of Carboniferous *Murchisonia*, by Miss Jane Donald (Communicated by J G Goodchild.)—Notes from a geological survey in Nicaragua, by J Crawford, State Geologist to the Nicaraguan Government. (Communicated by Prof J Prestwich, F R S.)—Microzoa from the phosphatic chalk of Taplow, by F Chapman. (Communicated by Prof T. Rupert Jones, F R S.)—On the basalts and andesites of Devonshire, known as felspathic traps, by Bernard Hobson.—Notes on recent borings for salt and coal in the Tees salt district, by Thomas Tate.

MELBOURNE

Royal Society of Victoria, March 12.—Annual Meeting.—The following officers were elected for the year:—President: Prof. Kernot. Vice-Presidents: Messrs E. J White, H K. Rusden. Hon Treasurer: Mr C R Blackett. Hon. Librarian: Dr Dendy. Hon Secretaries: Prof. Spencer, Mr A Sutherland.—The following paper was read:—Preliminary notice of Victorian earthworms: Part 2, the genus Perichæta, by Prof Spencer. The author described 18 species collected in Victoria, of which 16 are new.

May 13.—The following papers were read:—On confocal quadrics of moments of inertia pertaining to all planes in space, and loci and envelopes of straight lines whose moments of inertia are of constant magnitude, by Martin Gardiner.—Further notes on the oviparity of the larger Victorian Peripatus, generally known as *P. leuckartii*, by Dr Dendy. In this paper the author replied to some remarkable strictures recently passed upon his work by Mr J J Fletcher in the Proceedings of the Sydney Linnean Society. He showed that at the time of writing his first paper on this subject nothing was known as to the method of reproduction of *P. leuckartii*, Mr Fletcher's brief footnote to the effect that one specimen dissected was found to be pregnant not of necessity implying the presence of developed embryos within the egg-case. The Victorian specimens, containing in their uterus large eggs, might with equal truth be de-

scribed as pregnant Dr Dendy brought forward evidence proving conclusively that in the eggs investigated by him development had gone on normally outside of the body for a period exceeding eight months, one of them at the close of this time containing a perfect young form with even the pigment developed Since the publication of his first paper, but not prior to this, Mr Fletcher had shown that the New South Wales *Peripatus leuckartii* was undoubtedly viviparous, and Dr Dendy suggested that if, as seems most probable, the Victorian species is oviparous, then his original idea of its being a distinct species from the New South Wales form may probably be correct

Paris

Academy of Sciences, June 27.—On the local disturbances produced underneath a heavy load uniformly distributed along a straight line perpendicular to the two edges, on the upper surface of a rectangular beam of indefinite length laid down on a horizontal surface, or on two transverse supports equidistant from the load, by M J Boussinesq.—Contribution to the study of the function of camphoric acid, by M A Haller.—On the presence and the nature of the phylacogenic substance in the ordinary liquid cultivations of *Bacillus anthracis*, by M Arloing. The liquid was carefully siphoned off from a large cultivation of the bacillus which had been allowed to stand for a considerable time. The usual porcelain filters were not employed, as they are apt to intercept most of the prophylactic substances. A liquid perfectly free from the anthrax bacillus having thus been obtained, two solutions in glycerine were prepared, the one containing the substances soluble in alcohol, the other those precipitated by alcohol. Of six lambs, two received subcutaneous injections of the former, two of the latter solution, and the rest of neither. Eight days afterwards all six were inoculated with a very virulent dose of the bacillus. The only survivors were those inoculated with the matter soluble in alcohol, thus proving that the prophylactic substance belongs to this group.—On the determination of the angle of polarization of Venus, by M. J J Landerer. By almost daily observations, extending from April 29 to June 8, the angle of polarization of Venus was found to vary between 45° 17 and 27° 51, using an instrument of 135 mm aperture, to which a Cornu photo-polarimeter was adapted. The author concludes that the light from the crescent of Venus is not polarized, and hence that almost the entire visible surface of the planet is constituted by a thick layer of clouds. At the poles, however, permanent spots are observable, which are due to part of the solid surface protruding beyond the cloudy mass.—On the variations in temperature of water suddenly compressed to 500 atmospheres between 0° and 10°, by M Paul Galopin. An account of the first of a series of experiments to be made in M Raoul Pictet's laboratory to determine the heat produced by the adiabatic compression of a large number of liquids between − 200° and + 200°, under sudden variations of pressure amounting to 1000 atmospheres. The apparatus consists of a steel cylinder provided with a thermometer 1 m long, capable of measuring 0°.01. Pressure is applied by means of a Cailletet pump, and the whole apparatus is immersed in a large calorimeter with quadruple envelopes. The results obtained, which vary from 0°.20 at 0°.4 to 0°.59 at 10°, show that the increase of pressure lowers the temperature of maximum density of water for that particular pressure, and that under high pressures it corresponds nearly to the freezing-point.—Measurement of the dielectric constant by electro magnetic oscillations, by M A Perot. This measurement is based on the law formulated by Blondlot, according to which the period of the resonators is proportional to the square root of their capacities. The value obtained for essence of terebenthine was 2.25, that for ice between 60 and 71, in confirmation of previous results.—On the conductivity of a gas inclosed between a cold metal and an incandescent body, by M Edouard Branly.—On the physiological effects of alternating currents with sinusoidal variations: process of administering them in electro-therapeutics, by M A d'Arsonval. The law indicated by the results of the experiments is that the intensity of the motor or the sensory reaction is proportional to the variation of potential at the point excited. Although oscillations of great frequency seem to have but faint physiological effects, a careful analysis shows that the absorption of oxygen and the elimination of carbonic acid in the lungs is greatly augmented.—On aluminium, by M. Balland. A series of experiments to prove that aluminium is well-suited for domestic utensils, being not more attacked by air, water, wine, coffee, milk, butter, &c., than other metals used for such purposes.—Action of chlorine on the alcohols of the fatty series, by M A Brochet.—On asboline (pyrocatechine and homopyrocatechine), by MM Béhal and Desvignes.—On the vegetable cholesterines, by M Gérard.—Researches on the adulteration of the essence of sandalwood, by M E Mesnard.—On two specimens of the waters of the Arctic seas, by M J Thoulet.—New remarks on "pœcilogony," by M Alfred Giard.—On a sporozoarian parasite of the muscles of the Decapod Crustaceans, by MM F Henneguy and P Thélohan.—The first phases in the development of certain nematoid worms, by M Léon Jammes.—A contribution to the history of ambergris, by M S. Jourdain.—On the *brunissure*, a disease of the vine caused by the *Plasmodiophora Vitis*, by MM P Viala and C Sauvageau.—On the secretion of oxygen in the natatory vessel of the fishes, by M Chr Bohr.—Physiological action of mountain climates, by M Viault. The effects of a high elevation, though powerfully beneficent for dyspeptics, neurasthenics, and tuberculous patients, must be long continued to be permanent. The effects are due to an increase in the number of blood corpuscles and in the respiratory power of the blood.—Permanent abolition of the chromogenic function of the *Bacillus pyocyaneus*, by MM Charrin and Phisalix.

CONTENTS.

THURSDAY, JULY 14, 1892.

A TREATISE ON ZOOLOGY

Outlines of Zoology By J Arthur Thomson, M A, Lecturer on Zoology in the School of Medicine, Edinburgh (Edinburgh and London · Young J Pentland, 1892)

GENERAL—The above-named volume of 604 pages small octavo, the latest of Pentland's "Students' Manuals," is divided into twenty-five chapters, with an introduction and a well-constructed index By way of illustration, there are interleaved two-and-thirty sheets of diagrammatic sketches It is difficult to find upon these any dozen figures which adequately represent anything in nature, and the majority of the "diagrams" are the rudest of rude sketch maps Archetypes are well to the fore with their misrepresentations and evil influences, and such illustrations as those of the "unsegmented worm," the "spinal canal" figure of Plate 22, and others akin to them, are meaningless atrocities, conveying absolutely no idea to the mind The Peripatus series are very suggestive, they are three in number—namely, one (bad) depicting the whole animal, another (worse) of a nephridium, and a third (unfounded) representing a conventional branched tube, spiral lining and all (*sic*) To be brief, the illustrations are mostly bad, and might well be dispensed with Of those copied from well-known figures, many are spoilt in the copying, while the remainder are such as might have been produced in the greatest haste by a person accustomed to reading about, but not to handling, objects of the class delineated

The book itself is written in a clear and intelligible style, and its author has been at immense pains in producing it He deals with many difficult topics, especially when they do not involve minute structural detail, with conspicuous success He is in some parts racy, in others flippant, *pace* the remark (p 264) that "even a wooden leg may crumble before" the jaws of the termite, and he occasionally shows himself to be alive to difficulties of the passing moment—for example, that of the histogenesis of the nerve fibre Some sections of the work are deplorably meagre, *e g* those devoted to the Ganoids, Tunicata, Rotifera, and Sponges, and especially to the Brachiopods and Polyzoa, which (following Lang) the author ranks with the Sipunculids and Phoronis as the "Prosopygii" Classifications such as that given of the Chelonia, and the adoption of the absolutely groundless term "Ornithosauria" as the ordinal name for the Pterodactyles, are bad examples of their kind. Akin to the occasional flippancy already alluded to are the descriptions of the embryonic membranes as "birth-robes," of the crystalline lens and the liver as "moored" to adjacent structures, and of the viscera as "swathed" in the mesentery All science worthy the name must be now technical, whether set forth in the pages of a monograph or of a text-book, and when recognized terms are in daily use they should be employed Personal names are occasionally mentioned, and it is a curious detail that, with one or two exceptions, those of workers in the Edinburgh School are alone qualified We strongly deprecate the mention of individuals in an elementary text-book, as unnecessary and liable to abuse; but, in having adopted the course alluded to, the author displays a becoming respect for his seniors, such as we could wish were more general nowadays His book is written for Edinburgh students, but we nevertheless note the absence of all reference to certain organisms in vogue among them—to wit, *Trochosphæra*, a knowledge of the development of which was demanded in a recent syllabus issued by authority

The book, however, while lacking in much that is of primary importance, contains a bulk of excellent material It is wonderfully free of really gross errors, and we therefore willingly recommend it on its general merits as a useful work of reference, believing that the author will strengthen its weaknesses as opportunity occurs

The assertion that *Limnocodium* was "found in a tank at Kew" will probably whet the appetite of that establishment, and statements like that of the brain being "but an anterior expansion of the medullary canal," while self-explanatory, afford at least a relief to the reviewer

Analytical—The author tells us in his preface that his book is "intended to serve as a manual which students of zoology may use in the lecture-room, museum, and laboratory", and, in accordance with this, he subdivides most of the chapters each into three sections, dealing respectively with what we presume he would consider a lecture equivalent, with the more didactic consideration of type-structure, and with facts usually embodying the principles of classification A very ambitious scheme this, and it will be convenient to deal with each of the three departments separately

First, as to the use of the book in the laboratory The author here deals with familiar types, and supplements these here and there by the addition of wisely chosen species His descriptions are, however, at most points insufficient and far too general, the one detailed account being made to do duty in the case of the Simple Ascidian (p 358) for three distinct genera This is not as it should be The method of laboratory instruction in zoology employed in this country, with its rigid adherence to the type-system, is, in the long run, but that of teaching the alphabet whereby the student shall read, and, even were this not so, the laboratory training is one in discipline and observation, wherefore it is of the highest importance that any notes which shall be given the beginner for his guidance in it, shall be rigidly confined to actual statements of observed fact The author partially disarms criticism under this head by remarking that his book is intended (preface) "as an accompaniment to several well-known works," which he cites (p 88), and among which he enumerates leading laboratory treatises Unfortunately, however, the plan of construction of those works does away with the necessity for his own as an adjunct to their utility. And we have therefore but to deplore the incorporation of generalities and ambiguities, in a portion of the author's treatise where they are calculated to encourage a general looseness, and to nullify much of the good intended by the founders of the system which he has adopted

On passing to the two remaining departments of the book, we express ourselves at a loss to appreciate the utility of a text-book in the lecture-room. Much that

passes current for scientific lecturing nowadays is mere parrot work, and lecturing which is confined to mere text-book recapitulation (such as could alone justify the author's intention that his book should be used in the lecture-room) is no lecturing at all, but rather a poor form of dictation work. We deem it the highest aim of a scientific lecturer to teach his hearers, by example, how best to extend, systematize, and apply their knowledge of crude facts previously acquired in the laboratory He should in all cases work out from these and lead up to generalizations, and, to the end in view, he should be up to date in his reading, and, above all, cautious in his selection of approved topics Given this line of action, the competent teacher could not fail to present his facts in a manner in which they could not be found in any text-book. The author of the work before us has clearly realized this position, and much of his book which we presume he would regard as the equivalent of lecture material, fulfils our ideal. We note, however, a too frequent want of judgment, and a too general desire to present theories before facts By way of example, the inter-relationships of the Echinodermata are summarily dismissed in some ten or a dozen lines, in a manner as "cocksure" as it is certainly erroneous, and the beginner is told (p 377) that the ribs of Vertebrates "perhaps bear the same relation to the vertebræ that the visceral arches do to the skull," before he either knows sufficiently what constitutes a rib, or at all appreciates the difficulties in the way of homologizing the ribs of the leading classes of Vertebrata And here and there the author goes out of his way to raise difficulties at the outset (*e g* the opening sentence in the book, and the second sentence of p 121), when dealing with terms having a definitely accepted meaning, while, in ushering in the Mollusca with a reference (p 299) to "a diagrammatic summary of the chief anatomical characters" and a "schematic Archi-mollusk—a reconstruction of a possible ancestor," he proceeds along a line subversive of all good discipline established either on precedent or sound sense There is here evidence of a topsyturveydom in method, which could only be productive of disastrous results.

Concerning the more strictly text-book portion of the volume, we confess to a similar attitude of mixed judgment There is in it much that is admirable and beneficial, and not a little that is crooked and injurious The gastræa theory is swallowed outright, mention of equally plausible alternative ones being confined (p 62) to five none too fortunate lines The description of the scapula (p 472) as "a membrane bone," of the cranial nerves of vertebrates (p 381) as ten in number, like the assertions (p 444) that "it is very difficult to distinguish Amphibians from Fishes," that (p 33) Volvox "is a hollow sphere of epithelium," that the skate's egg-purse is (p 425) "composed of a horny substance allied to that of hair and hoof", like definitions such as that of *Balanoglossus* and *Cephalodiscus* (p 348) as "surviving incipient Vertebrates" (of course with a "notochord"), of *Lepidosiren* (p 428) as "only a species of *Protopterus*," simply will not do; while arrangements such as those of the Mammalia (p 7) and Vermes (p. 149) are hardly in keeping with modern conceptions

Retrospective.—On retrospective examination of the book before us, we seek in vain for evidence of that impress of the author's individuality as an actual worker which has so often "made" the zoological text-book of the past The author has been too content to abstract all in his way Obsolete classifications are placed side by side with others as audacious as they are premature, and rival theories are alike abstracted for what they may be worth When, however, the author's method leads to the citing (p 86) of Kropotkin as an authority on evolution, to the placing side by side, as alternative interpretations of the phenomena of Nature, those generalized statements of facts which constitute the "laws" of Darwin, and the flighty fantasies shot at a venture by certain younger "law-makers" (some of whom are sufficiently candid to admit that they are generalizing without facts), willing to risk all if, perchance, a frivolous public will but proclaim them philosophers, the experienced naturalist, in whose hand the judgment lies, steps in and demands a reconsideration In a word, the author has insufficiently exercised his judgment in selection of material To the teacher of science the duty of showing his scholars, by inference, what to neglect is, perhaps, of paramount importance to that of indicating upon what they are to rely The author of the volume under review would, however, leave the discretion in the hands of the student, he writes rather as the amateur, to whom everything is equally important, and in thus acting he fails to recognize one of the highest functions of his office, to the utter confusion, if not the ruin, of his followers. In our opinion, his book, although in many respects admirable, falls short in each of its great departments which we have signalized. It will be largely used, and we wish it an ultimate success It nevertheless contains the framework of a really serviceable text-book, and if the author will elaborate this, using a fitting exercise of judgment, and either eliminating the illustrations altogether or replacing them in others better and more numerous, he ought to produce a work of more than passing value, and he would sufficiently justify the great pains at which he has placed himself In its present form the book is calculated to encourage a love of premature generalization, and anyone adopting its methods would teach fantasies before facts The mental attitude which it typifies is one apt to create a bias, under which the student would suffer in his after work, as is indeed exemplified by the author himself in his treatment (pp 178–79) of the reproductive organs of the worm To encourage this is but to foster a growing evil. The didactic method of instruction in zoology now in vogue will unmistakably prevail in the future, but, unless its dryness be salted with work akin to the good old-fashioned field work, to the discouragement of the more modern and pedantic phylum-mongering and striving after impossibilities, better, by far, the *régime* of the past

G. B H

WATTS' "DICTIONARY OF CHEMISTRY"

Watts' Dictionary of Chemistry Vol III By Forster Morley and M. M Pattison Muir (London Longmans, 1892)

THE third of the four volumes of this excellent work has just appeared, and in value and interest this one does not stand behind the two previous volumes

Amongst the articles written by eminent specialists, one, the most important, is that contributed by Prof J J Thomson, of Cambridge, on the theories of the molecular structure of bodies It is from the interpretation of chemical phenomena, by the help of exact physical research, that we may most hopefully look for insight into the true explanation of these phenomena And although the theory of the molecular constitution of matter now universally held has been adopted as regards chemical change ever since the publication of Dalton's new system of chemistry in 1808, the crucial proof of its necessity has only recently been given Prof Thomson briefly but clearly explains the historical development of this proof The first attempt was made by Cauchy, founded on the dispersion which light experiences when it passes through transparent bodies But this attempt was an incomplete one, and a less ambiguous proof was given by Osborne Reynolds in 1879, based upon the thermal effusion of gases Lord Kelvin, Loschmidt, and others have gone still further, not only proving that matter possesses structure, but giving limits below which the "coarse grainedness" of matter cannot lie These conclusions are founded upon considerations of several distinct sets of phenomena, viz surface-tension, the difference of potential which occurs when two metals are placed in metallic connection, the amount of polarization at the surface of an electrode and of an electrolyte, and the viscosity, the diffusion, and the conductivity for heat, of gases The discussion of the methods by which the limit is reached in the case of surface tension is next clearly given, and the result arrived at that a thickness of 10^{-8} cm must be comparable with the range of molecular action of the water molecules The results of the well-known researches of Quincke on silver films and on capillary elevation, as summarized in a lecture delivered before the Chemical Society of London by Prof Rucker in 1888, are then explained, and the limits of molecular action deduced from these experiments Having given an idea of the coarse-grainedness of matter, Thomson proceeds to consider the various theories of that structure, and gives an account of the most important of these by Lord Kelvin and Lindemann The evidence of molecular structure afforded by the spectra of bodies, that concerning the arrangement of the atoms in the molecule on the supposition that the atoms are vortex-rings, and the electrical theory of molecular structure, first brought forward by Helmholtz in his Faraday Lecture, are all clearly discussed, and the author's own researches on the conduction of electricity by gases, which bear out the results of this latter theory, are adverted to The whole article, which only extends over seven pages, forms an admirable exposition of a most important, if a somewhat difficult, subject, and shows what chemistry gains from the work of mathematical physicists

Another short but excellent article is that by Mr Shenstone, on ozone, including, as it does, the most recent work on the subject, as well as a *résumé* of the older and better known results The question as to the relation existing between the quantity of ozone produced and the potential difference between the discharging surfaces, does not appear to have as yet been settled, though Berthelot finds that an increase of potential produces an increased yield of ozone Nor has the exact influence of temperature and pressure been properly made out, though it appears that at a pressure of about 50 mm. ozone is alternately produced and destroyed These facts point to the conclusion that, although much labour has already been spent upon the investigation of ozone, much yet remains to be accomplished before our knowledge of "modified oxygen" is anything like complete

Of the recent progress made in our general chemical conceptions, none are of greater, if any are of as great, importance as the foundation of the periodic law by Mendeleeff in 1869 A Dictionary which failed to give an account, not only of the nature of this law, but also of its rise and development, would indeed be incomplete Mr. Douglas Carnegie's article, however, does justice to his subject, and I am glad to see he has not ignored the extensions made by my lamented pupil and friend, Carnelly, which are truly said to be as much in advance of the earlier views of Dumas and Gladstone as the periodic law is in advance of the earlier disconnected schemes of classification And I agree with the writer in his remarks that if these extensions must be regarded as bold speculations, they indicate the direction in which investigations on the *rationale* of the periodic law, and o the nature of the elements, will probably have to be prosecuted before we can hope to arrive at any explanation of the law, or of the nature of the chemical elements themselves

The article on "Metals (rare)" is, of course, contributed by Mr Crookes It contains an account of the contributor's own researches on the splitting up of the rare earth metals Many of the metals described in our treatises, and in the Dictionary itself, are probably mixtures Some years ago I proved that an element termed philippium was in reality a mixture of two others, viz terbium and yttrium, and Mr Crookes's researches have since confirmed my results It is, however, quite true, as Crookes observes, that until we know what terbium and yttrium themselves are, we have not got to the bottom of the question And from his own work it does not appear very likely that the chemists of this generation will bottom this subject, for the more Mr Crookes works on the separation of these bodies the more complex does the question of identification appear to become Those who wish to form an idea of the character of work of this kind will do well to study the article

A notable characteristic of this Dictionary is the summation of the properties of the different allied groups of chemical elements Thus in this volume we find an excellent article by one of the editors, Mr. Pattison Muir, on the nitrogen group of elements The relationships between the corresponding compounds of two different members are clearly set forth in tabular form, and thus the reader is able at a glance to compare the analogies and differences which these compounds exhibit both in composition and properties

Prof Armstrong's article on isomerism bears out the author's reputation for clear statement and complete knowledge of his subject He fully discusses its historical development, strengthening his statements by valuable quotations from the writings of chemists of eminence, and brings the matter up to the latest views

of chemists such as Van't Hoff, Victor Meyer, Wislicenus, and others, who have recently contributed to our knowledge of isomeric bodies.

For the rest, which indeed forms the bulk of the volume, I must content myself with saying that the numerous articles descriptive of organic compounds ranging from indin on p. 1 to phenyl-tetrazole carboxylic acid on p. 858 (not to mention the inorganic compounds) are mainly contributed by Dr. H. Forster Morley, one of the editors. How far these hundreds of compounds are adequately described, or what mistakes of omission or commission the descriptions may contain, or how many printers' errors exist, must be left to be determined, if determined at all, by someone with more leisure, and, may I add, with more taste for that sort of work than I possess. But I may conclude by saying that, knowing the accuracy and care which uniformly characterize Dr. Morley's work, I do not think that any adverse critic, if such there should be, of this great addition to our chemical literature, will find it a very happy hunting-ground, for, as far as I am able to judge, the work has been carefully and accurately done.

H. E. Roscoe.

THE ENGLISH SLOJD

Manual Instruction, Wood-work, the English Sloyd. By S. Barter. With 302 Illustrations. Preface by George Ricks, B.Sc. Lond. (London: Whittaker and Co., 1892.)

It is to be regretted that the author of this very excellent and practical work should not have stated on the title-page what it really is, *i.e.* a book simply teaching carpentry, including directions for a limited amount of technical or mechanical drawing, and not have termed it "Wood-work," since by this term much is understood which is not given in his pages. Neither is there any occasion for the word which he gives in one place as *Sloyd* and in others as *Slojd*, it being sufficiently misused already in Swedish by being confined to common incised carving and small carpenter's work, when it is properly applicable to all kinds of technical art. Since Mr. Barter has had the intelligence and boldness to declare that whatever can be done with the barbarous "*Slojd*" knife can be better done with the chisel, it is to be regretted that, as he is with his English common-sense altogether out of and beyond *Slojd*, he did not let the Swedish system alone altogether. There was no occasion for him to mention it or its palpable defects, to which he might have added the preposterous arrogance of its claims to be the incarnation of all that is needed to train the hand and eye to industrial art. However, since he who is fitter to be the leader humbly assumes the name, and follows the lead as an English *Slojder*, we, of course, cannot complain, since it is to his own disadvantage that he assumes a title which detracts seriously from the merits of the treatise. He gives a very good introduction on drawing, which has, however, the serious defect of being beyond the capacity of mere boys, who, while at carpenters' work, certainly cannot be expected to devote hours to learning the meaning and application of "orthographic projection," "the assumption of the existence of parallel horizontal rays of light which project the elevation on a vertical surface," "isometric axes," and "therefore as AC is to CH $\sqrt{3}$ $\sqrt{2}$, but CH = A'K, which is," *et cetera*—all of which, with the diagrams, contrasts strangely with the pictures of the ten-year-old chubby youngsters who are represented as merrily sawing and planing in the frontispiece. It is true that there are little boys who can master Euclid, or its equivalents; but an experience of years in teaching qualifies us to state that a much more simply written chapter than this, or one within the ready comprehension of "boys," would have been better adapted to the book. The forty-two pages devoted to timber are thoroughly scientific, practical, and admirable. Yet as boys seldom have any great choice of wood, and have little to do with teak, ebony, and lignum vitæ, much of the space might have been better devoted to some kind of wood-work not touched on in this book. Materials and tools are well described. We observe that in his illustrations of nails Mr. Barter makes no mention of the very best of all—the triangular, which goes home as straight as a screw, and holds like one.

"Bench-work" is the best portion of the book, being thorough, comprehensive, and manifestly written by a master of the subject. It is not beyond the comprehension of an intelligent boy who will devote to it serious attention; therefore, for such as are somewhat advanced, it may be warmly commended, for the simple reason that intelligent minds pay most serious attention to, and remember best, what costs them some trouble. The author is evidently a very practical, serious, and earnest mechanic, who, understanding his business perfectly, describes everything as he would teach it to a class of young men who had been a while in workshops. But with his "orthographic projections" as with his whole style, he is—not invariably, nor even generally, but very often—too hard for urchins; and, in fact, the juvenile who is depicted on p. 175 as boring a hole has appropriately the pensive air of one who is very much bored himself—probably by some difficulty in the text. Yet all of this does not detract from the fact that the work is an admirable one, that it is the best of its kind, and perfectly adapted to the use of teachers establishing classes, who are, after all, the only persons who really need or read such works, as pupils seldom look at anything of the kind unless required to. But though it is very seldom done, it would have good results if pupils in technical schools should be made to read more, and secondly, if the teacher should carefully explain to them the text.

An excellent feature in the bench work is that the author, giving the names of a majority of such objects as an amateur may expect to make, describes in detail, with excellent and abundant illustrations, how to make them. He might in some cases have gone a little further in his work. Thus it never appears to have occurred to him that parquetry, or inlaid work, can be made save by sawing out pieces of wood in their natural colours. But a large portion of French and Italian work is made by using wood which is artificially coloured, and we should not have expected this to be passed over by a writer who had the intelligence to remark that "Colour, which plays so prominent a part in design, is entirely overlooked in the Slöjd system," which it certainly is, and with it much

more that is indispensable to teaching the minor arts as a system even to the youngest children Nor does Mr Barter mention the so-called Venetian *intarsiatura*, in which the pattern, drawn on one piece of wood, is cut half through the panel, the line being then filled with coloured mastic, and the pattern dyed But such sins of omission are trifling, though in a book which proclaims on its title that it is devoted to wood-work we should have expected something more than carpentry, and at least a full description of Slöjd carving? And having pointed out, as in conscience bound, every defect, we feel it to be a duty to congratulate the publishers of this remarkably handsome, well-bound, and useful work on having done their best, and on having issued a manual which deserves a place in every industrial school

But there is a word to be said as regards the preface and a portion of the introduction It is perfectly true that manual instruction for children develops their intellects, and fits them for life far more than ordinary school studies usually do But it is not true that this training should consist, as Messrs Ricks and Barter virtually declare, of nothing but Slojd, be it Swedish or English, or of carpenters' work Such training should be for girls as well as boys, and it should be based on design and drawing, taught simultaneously in the simplest and easiest freehand, after which the pupils may take up not merely carpentry, or even Slöjd—which is nothing effectively but a minor branch of wood-carving—but also wood-carving itself, and many other arts, all of which come as one and promptly to the pupil who can design, and, when occasion favours, also can model a little But to expect that carpentry alone, without a trace of art, is all that is needed to inspire the creative faculty is a great mistake, and what is worse is that, despite thousands of living examples of the superiority of the more artistic method for children, the British—like the American—public persists in believing that all that is needed is to teach "our boys" how to make benches and boxes

OUR BOOK SHELF

Thermodynamische Studien Von J Willard Gibbs, übersetzt von W Ostwald (Leipzig Engelmann, 1892)

THIS is a German translation of three of Prof Gibbs's Thermodynamic Papers These were published during the years 1873-8, in the Transactions of the Connecticut Academy (vols ii and iii), and one reason which prompted Prof Ostwald to undertake the translation of them was their inaccessibility to the general scientific public Their importance is sufficiently attested by the fact that part of the ground covered by Prof Gibbs has been gone over again by later writers who deemed they were themselves pioneers

"Graphical Methods in the Thermodynamics of Fluids" is the title of the first paper It gives for the first time a general account of the comparative advantages of using various pairs of the five fundamental thermodynamic quantities for graphical representation. The entropy-temperature and entropy-volume diagrams are discussed in considerable detail The second paper contains the description of the volume-energy-entropy surface, which generally goes by the name of Gibbs's thermodynamic surface. Its contents are familiar to all who have studied Maxwell's "Theory of Heat"

The third paper, "On the Equilibrium of Heterogeneous Substances," fills five-sixths (344 pages) of the whole book, and is, out of question, by far the weightiest contribution which Prof Gibbs has made to the development of thermodynamic methods To him must be given the credit of first formulating the energy-entropy criterion of equilibrium and stability, and developing it in a form applicable to the complicated problems of dissociation To give anything like a complete idea of the contents of this paper, with its discussion of critical points, capillarity, growth of crystals, electromotive force, &c, would mean the reproduction of Prof Gibbs's own very full synopsis, which in the German translation forms the greater part of the table of contents of the book. It will suffice to notice the general theory of the voltaic cell, with which the paper ends Here distinctly for the first time is it pointed out that the electromotive force of the cell depends on other factors than the variations of its energy Von Helmholtz's theory, which differs from that given by Prof Gibbs only in the greater fulness of detail, was not published till 1882

Prof Ostwald tells us that he had the benefit of the author's revision With the exception of a few obvious corrections the original papers are most faithfully reproduced, even to certain footnotes which in these days have no particular value In the circumstances a little license might well have been taken, and a slavish adherence to the original text departed from For example, it is surely most desirable to use the word *isenergic* for lines of equal energy, and not the inappropriate term *isodynamic* which Prof Gibbs made use of in his paper of 1873 Again, we question the right of any writer on thermodynamics to use the word *reversible* in other than Carnot's sense. Such double meanings tend to produce confusion, in spite of elaborate footnotes

These blemishes apart, however, there is no doubt that Prof Ostwald deserves great credit for his labour of love in preparing this translation He has made it possible for the many, who know of Prof Gibbs's work only at second hand, to acquaint themselves with the original papers, and we feel confident that the book will find its place on the shelves of all who desire a really complete library of thermodynamic literature

Elements of Physic By C E Fessenden (London: Macmillan and Co, 1892)

THE subject matter of this book is arranged in four chapters—Matter and its Properties, Kinematics, Dynamics (including statics, hydrostatics, and pneumatics), and Heat It thus forms an excellent introduction to a more extended study of physical science The treatment of the subject is based largely on simple experiments to be performed by the student himself, whose reasoning powers the author seeks to draw out as far as possible by suggestive questions interspersed through the text The following example will give a good idea of the style of treatment —

"All experience teaches that *no two portions of matter can occupy the same space at the same time*. This property which matter possesses of excluding other matter from its own space, is called *impenetrability* It is peculiar to matter, nothing else possesses it These facts being known, let us proceed to put certain interrogations to nature. Is air matter? Is a vessel full of air a vessel full of nothing? Is it 'empty'? *Can matter exist in an invisible state?*

"*Experiment* 1—Float a cork on a surface of water, cover it with a tumbler, or tall glass jar, and thrust the glass vessel, mouth downward, into the water . State *how* the experiment answers each of the above questions and what evidence it furnishes that air is matter, or, at least, that air is like matter

"*Experiment* 2—Hold a test tube for a minute over the

mouth of a bottle containing ammonia water. Hold another tube over a bottle containing hydrochloric acid. The tubes become filled with gases that rise from the bottles, yet nothing can be seen in either tube. Place the mouth of the first tube over the mouth of the second, and invert. Do you see any evidence of the presence of matter? Was this matter in the tubes before they were brought together? If not, from what was it formed? Which of the proposed questions does this experiment answer? How does the experiment answer it?"

In many cases the questions asked are beyond the powers of the average beginner to answer, but this is not a serious objection if the book is used, as seems to be intended, for class instruction in schools. For such use it is admirably well adapted. Numerous questions and examples are scattered throughout the text; in the sections of kinematics and dynamics geometrical treatment alone is adopted, the student being supposed to be acquainted with Euclid but not with trigonometry.

The style is concise, but clear and accurate, and as the book has not been written with the view of preparing the student for any special examination it is refreshingly free from any tendency towards cram. H. H. H.

Recette, Conservation, et Travail des Bois. Par M. Alheilig. (Paris: Gauthier-Villars et Fils, 1892.)

THIS little book belongs to the useful series entitled "Encyclopédie Scientifique des Aide-Mémoire." The author presents a remarkably clear summary of the principal facts relating to wood, regarded from an industrial point of view. Although iron and steel have to so large an extent taken the place of wood in various great constructions, wood is still, of course, needed in vast quantities, and instruction in the proper way of dealing with it for industrial purposes must always form an important department of technical education. M. Alheilig has supplied a good text-book, the most valuable characteristic of which is that its practical details rest on a sound basis of scientific principle. He is especially successful in the chapters on the tools and machinery used in the working of wood.

Country Thoughts for Town Readers. By K. B. Baghot de la Bere. (London: Simpkin, Marshall, and Co., 1892.)

THE greater part of this book consists of imaginary conversations between a Canon and "a city lawyer," who spends two days with him in the country. The Canon lectures his friend with an air of authority and patronage which would not be particularly agreeable to ordinary mortals. The city lawyer, however, is never tired of thanking the great man for the knowledge he communicates. The Canon's information is made up chiefly of scraps of scientific commonplace, which, if they can be of no particular service to any class of readers, are at least harmless.

A Synoptical Geography of the World. (London: Blackie and Son.)

NO effort has been made by the compiler of this handbook to present geography in an attractive form. The volume consists of a number of bald statements which, as here given, could neither excite interest nor form any real addition to knowledge. It is not intended, however, that the book shall be used apart from other means of instruction. It is meant to be taken "in conjunction with a fuller text-book or the teacher's lectures." Used in this way it may be of some service to students in the revision of their work before examination. A good many maps have been specially engraved to accompany the text.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

An Acoustic Method whereby the Depth of Water in a River may be measured at a Distance.

ABOUT two years ago, I wished to know from time to time the rate at which a river was rising after a fall of rain. The river was at a considerable distance from the spot where its height was to be known. By means of the combination of two organ pipes, and a telephonic circuit, described in the following lines, I have been able to make the required measurement within rather close limits. At the river station, an organ pipe was fixed vertically in an inverted position, so that the water in the river acted as a stopper to the pipe, and the rise or fall of the water determined the note it gave, when blown by a small bellows driven by a very small water wheel. A microphone was attached to the upper end of the organ pipe; this was in circuit with a wire leading to a town station at some distance; at the town station there was an exactly similar organ pipe, which could be lowered into a vessel full of water while it was sounding. By means of the telephone the note given by the pipe at the river was clearly heard at the town station; then the organ pipe at this station was lowered or raised by hand until it gave the same note. The lengths of the organ pipes under water at the two stations were then equal, so that the height of the water in the distant river was known.

The determination can be made in less than a minute by any one who can recognize the agreement of two similar notes. The arrangement when first tested was so placed that the height of water at two places near together might be easily compared. I found that a lad with an average ear for musical sounds was able to get the two heights to agree within one eighth of an inch of each other, while a person with an educated ear adjusted the instrument immediately to almost exact agreement. The total height to be measured was 17 inches. A difference of temperature at the two stations would make a small difference in the observed heights. For example, taking a note caused by 250 vibrations per second, a difference of 10° C. between the temperatures of the two stations (one not likely to occur) would make a difference of about 0.02 feet in the height, a quantity of no moment in such a class of measurements. The organ pipes were of square section, and made of metal to resist the action of the water.

FREDERICK J. SMITH.

Trinity College, Oxford, June 28.

Waterspouts in East Yorkshire.

ON June 9, 1888, a waterspout was seen traversing the Yorkshire wolds in the neighbourhood of Langtoft, which finally spent its fury on the north-eastern side of a large basin-like range of valleys, where a steep declivity barred its further progress. A single cutting or trench was made in a slight hollow of the hill, and in this three large holes were scooped out of the chalk, which was here composed of much rubble, about seven feet in diameter and depth.

On July 3 of the present year, another waterspout has been developed, and has again expended its energy on the same hill as the previous one in 1888, a few yards only further south of the former site, and, taking a trifle more easterly course, has cut three parallel ditches or elongated pits in the solid chalk, two of them twenty to thirty yards in length, and seven to ten feet deep in the deepest portions, scattering the whole of the expelled rock, amounting to many tons, to the foot of the hill.

Serious floods were consequent, and the village of Langtoft, which is situated lower down the valley, was terribly inundated with a volume of water seven to ten feet in height, an immense amount of damage being done, including the total demolition of two cottages and a workshop. Fortunately no lives were lost beyond several pigs, sheep, and a few hundred fowls.

Driffield, July 9. J. LOVEL.

On the Line Spectra of the Elements

PROF STONEY seems to agree with me that I have given an obvious example of a motion for which the theorems in chapter iv of his memoir do not hold good. Theorem B, page 591, runs thus: "Any motion of a point in space may be regarded as the co-existence and superposition of one *definite* set of partials which are the pendulous elliptic motions determined as above, &c." It is indeed obvious that a uniform motion in a straight line cannot be regarded in this manner, not even approximately for any length of time, if the set of partials are required to be *definite*. I might have given an example of a limited motion, *e.g.* $x = \sin t^2$, which equally contradicts the theorem, but I thought a more obvious example would convince Prof. Stoney more easily. I think, indeed, that the reasoning in chapter iv of his memoir is erroneous. But I do not say that therefore Prof. Stoney's views on the cause of the line-spectra are wrong. They may be right, although the argument in chapter iv is not. Why this criticism is not legitimate I do not see. For no slight alterations or additions would set those theorems right, as there is a palpable mathematical error at the bottom of it.

Technische Hochschule, Hanover, July 9. C. RUNGE.

The Grammar of Science

THE exposition of the Newtonian laws as given by Thomson and Tait has unfortunately been taken as the basis for the treatment of the laws of motion by all elementary text-book writers in the English tongue since the publication of the great "Treatise on Natural Philosophy." When that exposition is attacked we are told that Newton introduced a qualifying context which has been omitted from the exposition. In other words the current statement of elementary dynamical principles is thrown overboard in favour of Newton pure and simple. On the other hand when Prof. Tait uses an expression which is totally opposed to that principle of the "subjectivity of force" which C. G. K. claims that Prof. Tait was the first, or among the first, to propound, we are told that this expression was obviously suggested by "Newton's own anthropomorphic language." C. G. K., I take it, admits that the Newtonian Laws of Motion are illogical and unphilosophical when stated by Thomson and Tait without Newton's modifying context. I propose therefore to shortly publish a criticism of the laws of motion as accompanied by that context of Newton's which does not appear in Prof. Tait's text-books. I trust C. G. K. will not then turn round on me and say, "Oh, yes, but this has nothing to do with Prof. Tait, it is Newton's own anthropomorphic language."

Lastly, as to the origin of the doctrine of the "subjectivity of force," which to my mind is just as much or as little valid as the "subjectivity of matter," I would remind C. G. K. that the first two parts of Kirchhoff's "Mechanik" were published in 1874, and were then only the publication of lectures of an earlier date. Philosophers before Kirchhoff taught the doctrine of subjectivity, but he, and not the author of the "Dynamics of a Particle," was the physicist who first helped many of us out of the mental obscurity as to dynamical principles produced by our study of the expositions of the laws of motion due to the Edinburgh school. KARL PEARSON.

"Are the Solpugidæ Poisonous?"

IN reference to this question, propounded by Mr. Bernard in your last issue, I should be inclined to answer in the negative. I captured several specimens of *Solpuga chelicornis* in the Transvaal, and on one occasion witnessed a persistent attack made on this "spider" by a bird which appeared to be the Cape wagtail (*Motacilla capensis*). Had the *Solpuga* possessed poisonous qualities the attack would probably not have been made.

The specimens taken by myself exhibited no signs of pugnacity, but always sought refuge in headlong flight to the nearest cover. W. L. DISTANT.

Russell Hill, Purley, Surrey, July 8.

Hairlessness of Terminal Phalanges in Primates.

I OBSERVE that, in your report of the proceedings of the Zoological Society, you allude to my paper on "a seemingly new diagnostic feature of the order Primates," viz. that the terminal phalanges are destitute of hair.

Since the paper was read I have found that this feature is not of ordinal value. But it is of sufficiently general occurrence to merit inquiry touching its distribution in different species.

Therefore I have withdrawn publication of the paper for the present. GEORGE J. ROMANES.

Oxford, July 1.

Mental Arithmetic

REFERRING to the articles on "Mental Arithmetic" in NATURE, vol. xlv. p. 78 and 198, I beg to state that there also exists a very clearly written little text-book on arithmetic founded entirely on the principles mentioned by Mr. Clive Cuthbertstone. The title is "Neuer Unterricht in der Schnell-rechen-Kunst," by C. Jul. Giesing, Editor, Carl Schmidt, in Doebeln (Saxony). Price 1 mark 80 pf. G. DAEHNE.

Dresden-Blasewitz, "Isis," July 9.

Jackals

THE incident of the jackals entering Howrah brings to my memory that this winter jackals entered the suburban town of Bournabal, in the Smyrna district of Western Asia Minor. This last winter being severe, it was noticed in the papers that rabies had extended to wolves and jackals, and to this circumstance was attributed their entering the villages and attacking people, and also their attacking the domestic animals.

HYDE CLARKE.

WEIGHT

THE following remarks are presented with the object of reducing the increasing gap which is growing between the treatment of the fundamental ideas of Dynamics, as taught in our academical text-books from the standpoint of verbal abstraction, and the ideas and language of those who have to deal with the actual phenomena of Nature as a reality.

1. According to the precise legal definitions of all our successive Acts of Parliament on "Weights and Measures," the *weight* of a body is the quantity of matter in the body, as measured out by the operation of weighing it in the scales of a correct balance.

The body to be weighed is placed in one of the scales, and is equilibrated by standard lumps of metal, stamped as pound weights, or kilogramme weights, or hundred weights, or ton weights, and the sum of these weights is called the *weight* of the body.

In the words of the Act of Parliament, 18 and 19 Victoria, c. 72, July 30, 1855, the British pound weight is defined as a weight of platinum, marked P. S., 1844, 1 lb., deposited in the Office of the Exchequer; and the Act goes on to say that this lump of metal "shall be the legal and genuine standard measure of weight, and shall be and be denominated the Imperial Standard Avoirdupois Pound, and shall be deemed to be the only standard of weight from which all other weights and all other measures having reference to weight shall be derived, computed, and ascertained, and one equal seven thousandth part of such pound avoirdupois shall be a grain, and five thousand seven hundred and sixty such grains shall be and be deemed a pound troy."

In defining the unit of length, the standard yard, the temperature must be defined, 62° F. in the Act of Parliament; but in defining the pound weight, there is in the Act no mention of temperature, height of barometer, height above sea-level, latitude, longitude, date and time of day, establishment of the port, &c., or of any other cause tending to alter the local value of g.

Details of the temperature and density of the air are only required when defining the volume of the gallon of 10 lbs. of water, or when making accurate copies of the standard platinum pound weight in some other metal—brass or iron, for instance—when a correction for the buoyancy of the air must be made; and it is to cover

this detail that the words *in vacuo* have been added in the most recent Acts of Parliament on "Weights and Measures" (41 and 42 Victoria, 1878).

2. We now pass on to the investigation of the motion set up in a body of given weight due to the action of specified forces; we use the word *weight* advisedly, so as to agree with the terminology of the Acts of Parliament

As the field of force in which we live is that due to the attraction of the Earth, it was natural to begin by taking the attraction of the Earth on our standard weight as the unit of force, and we find that in all Statical problems of architecture and engineering the unit of force employed is the force with which a pound weight, or a kilogramme weight, or a ton weight, is attracted by the Earth

The engineer calls these forces the force of a pound, of a kilogramme, or of a ton, he does not add the word weight, reserving the word *weight* to denote the quantity of matter in the body which is acted upon, in accordance with the language of the Act of Parliament on "Weights and Measures"

In the Dynamics of bodies on the surface of the Earth, the same gravitational unit of force is universally employed in practice, and now, to take a familiar problem, we may investigate the motion of a train, weighing W tons, on a straight level railway, pulled by an engine exerting a tractive force of P tons, by the bite of the driving wheels on the rails

Neglecting passive resistances, and the *rotary inertia* of the wheels, the train will acquire from rest a velocity v feet per second in s feet, given by

$$Ps = \frac{Wv^2}{2g} \text{ (foot-tons)}$$

The velocity growing uniformly, the average velocity will be half the final velocity v, so that if the train takes t seconds to go the first s feet,

$$s/t = \tfrac{1}{2}v,$$

and

$$Pt = \frac{Wv}{g} \text{ (second-tons)}$$

The word *second-tons* has been formed by analogy with the word *foot-tons*, to express the product of a force of P tons and t seconds, the time it acts, just as foot-tons expresses the product of a force of P tons and s feet, the distance through which it acts

While Ps, the *work* in foot-tons done by the force P tons acting through s feet, has a mechanical equivalent, $\frac{Wv^2}{2g}$, called the *kinetic energy* of the train in foot-tons, so Pt, which we may call the *impulse* in second-tons of the force P tons acting for t seconds, has a mechanical equivalent $\frac{Wv}{g}$, the *momentum* communicated to the train in second-tons

We merely state these theorems, with the addition of the proposed new name of *second-tons*, as these theorems are found in all dynamical treatises, being direct corollaries of Newton's Second Law of Motion

We have measured W and P in tons, as would be natural in any railway-train problem, but the same equations of course hold when W and P are given in cwt, pounds, kilogrammes, or grammes, and then impulse or momentum will be given in second-cwt, second-pounds, second-kilogrammes or second-grammes, while work or kinetic energy will be given in foot-cwt, foot-pounds, or metre-kilogrammes, or centimetre-grammes, on changing to the metre or centimetre as metric unit of length, and changing at the same time the numerical measure of g.

3 The presence of g in the denominator of W in the dynamical equations will be remarked, and this constitutes a difficulty to the student, which our teachers of Dynamics have done their best to obscure

The quantity g makes its appearance, not because W/g is an invariable quantity, as is generally taught, but because the unit of force in which P is measured is variable, being proportional to the local value of g

With a foot and second as units of length and time, we may take the value of g at the equator as 32, increasing gradually to about one-289th part more, or about $\frac{1}{3}$ per cent greater at the poles, in consequence of the Earth's rotation

The force of a pound, meaning thereby the force with which the Earth appears to attract a pound weight, is thence about $\frac{1}{3}$ per cent greater at the poles than at the equator, and this does not allow for the increase in g due to the ellipticity, which by Clairaut's theorem would make the total increase about $\frac{1}{2}$ per cent

But to say that a body has gained in weight one-289th part, or $\frac{1}{3}$ per cent, in going from the equator to the pole is absurd and misleading, for if we carry our standard weights and scales with us, we shall find that the body weighs exactly the same

When the theorist tells us that a body gains or loses one-289th part of its weight in being taken from the equator to the pole, or back again, he means that the indications on a spring balance, graduated in latitude 45° by attaching standard weights, will be about $\frac{1}{6}$ per cent in error at the equator and at the poles

But such a spring balance would be illegal if used according to its graduations in any other latitude than the one in which it was constructed, and the user would lose in all cases, he would lose at the equator by selling $\frac{1}{6}$ per cent too much by weight, and he would lose at the poles the fines incurred from the Inspector of Weights and Measures, who would test his spring balance by attaching standard weights, composed of lumps of metal

The spring balance graduated in latitude 45°, and employed alternately at the equator and the pole, is equivalent to a beam balance, of which the beam stretches over a quadrant of the meridian of the Earth from the equator to the pole, with a fulcrum in latitude 45°, but such an abnormal balance is not contemplated in the Act

4. If we could transport ourselves to the surface of the Moon, Sun, or any planet, with our weights and scales, Newton's Law of Universal Gravitation teaches us that we should still find the body of exactly the same weight in the balance, the attraction of the Moon, Sun, or planets on the body and on the weights being still equal

The magnitudes of these equal attractions would, however, have changed, since the attraction is proportional to the local value of g, on the surface of the Moon it is calculated that g is about 5 4, on the surface of the Sun it is about 30 times the value on the surface of the earth, while on Jupiter it is calculated that g is about 71

These values of g are inferred from observation of the diameter of the celestial body, and from its weight, measured in terms of the weight of the Earth, or using the Earth as the standard weight, and calculated by Kepler's Third Law from the period and distance of a satellite, compared with the period and distance of our satellite, the Moon

The weight of the Earth itself is inferred from the Cavendish Experiment, in which the attraction of gravitation between two given weights is measured

According to Newton's Law of Universal Gravitation, the attraction between two spherical bodies, arranged in spherical strata, the Sun and Earth for instance, weighing S and E g (grammes) when their centres are a cm apart, will be proportional to S Ea^{-2}; with C.G.S units, this attraction may be expressed as CSEa^{-2} dynes, and then C is called the *constant of gravitation*; and the Cavendish experiment is devised for the purpose of measuring C.

Denoting by g the acceleration of gravity (in C G S.

spouds), then on the surface of the Earth we may take, in round numbers,

$$g = CE/R^2, \text{ or } CE = gR^2,$$

R denoting the radius of the Earth in cm, taken as $10^9 \div \frac{1}{2}\pi$, the quadrant being 10^9 cm

With mean density ρ, the weight of the Earth, E, in g, is given by

$$E = \tfrac{4}{3}\pi\rho R^3,$$

so that

$$\tfrac{4}{3}\pi RC\rho = g,$$

or

$$C\rho = \tfrac{3}{8}g \times 10^{-9},$$

so that ρ is known from C, and *vice versâ*

For instance, with $\rho = 5\ 5$, and $g = 981$,

$$C = 10^{-8} \times 6\ 688$$

We are awaiting with great interest the quantitative results of Mr C V Boys, with his improved form of apparatus; but meanwhile we may take a mean density of 5 5, the mean of Cornu's and Poynting's results, which is about half the density of lead It is very extraordinary that this should agree so exactly with Newton's conjecture, *Principia*, lib iii, prop x —"Unde cum terra communis suprema quasi duplo gravior sit quam aqua, et paulo inferius in fodinis quasi triplo vel quadruplo aut etiam quintuplo gravior reperiatur verisimile est quod copia materiæ totius in Terra quasi quintuplo vel sextuplo major sit quam si tota ex aqua constaret, præsertim cum Terram quasi quintuplo densiorem esse quam Jovem jam ante ostensum sit"

5 A short numerical calculation will now give us the *weight* of the Earth (Hamilton, "Lectures on Quaternions"), also of the Moon, Sun, &c

We assume that the Earth is a sphere, whose girth is 40,000 kilometres, so that R, the radius of the Earth, is $10^7 - \frac{1}{2}\pi$ m (metres), and the volume, V, is $\frac{4}{3}\pi R^3 m^3$, while the weight, E, is ρV t (metric tonnes of 1000 kg, or 2205 lbs), where $\rho = 5\ 5$

Four-figure logarithms will suffice for our calculations, and now

$$\begin{aligned}
\log 10^7 &= 7\ 000 \\
\log \tfrac{1}{2}\pi &= 1961 \\
\log R &= 6\ 8039, \quad R = 10^0 \times 6\ 366\ \text{m}, \\
\log R^3 &= 20\ 4117 \\
\log \tfrac{4}{3}\pi &= 6221 \\
\log V &= 21\ 0338, \quad V = 10^{21} \times 1\ 081\ \text{m}^3, \\
\log \rho &= 7404 \\
\log E &= 21\ 7742, \quad E = 10^{21} \times 5\ 946\ \text{t},
\end{aligned}$$

or 6×10^{21} metric tonnes in round numbers

The weight of the Moon, M, generally taken as one-80th of the Earth, will be $10^{19} \times 7\ 432$ t

To determine S, the weight of the Sun, we employ Kepler's Third Law, which gives

$$\frac{S + E + M}{E + M} = \frac{n^2a^3}{n'^2a'^3},$$

where n, n' denote the mean motions of the Sun and Moon, and a, a' their mean distances from the Earth

Since M is insignificant compared with E, and E compared with S, we may write this

$$\frac{S}{E} = \frac{n^2a^3}{n'^2a'^3},$$

where $n'/n = 13$, the number of lunations in a year, and $a/a' = 390$, the ratio of the mean distances of the Sun and the Moon, this being the ratio of 57′ to 8″ 8, the inverse ratio of the parallaxes

Now

$$\begin{aligned}
\log a/a' &= 2\ 5911 \\
\log (a/a')^3 &= 7\ 7733 \\
\log (n'/n)^2 &= 2\ 2279 \\
\log S/E &= 5\ 5454, \quad S/E = 351{,}100,
\end{aligned}$$

so that the weight of the Sun is about 350,000 times the weight of the Earth, or about 2×10^{27} t, or 2×10^{33}g.

To determine the value of G the acceleration of gravity on the surface of the Sun, compared with g, the value on the surface of the Earth, we have

$$\frac{G}{g} = \frac{S}{E}\left(\frac{\text{diameter of earth}}{\text{diameter of sun}}\right)^2 = \frac{S}{E}\left(\frac{8\ 8}{960}\right)^2,$$

since the apparent semi-diameter of the Sun as seen from the Earth is about 960″, while the apparent semi-diameter of the Earth as seen from the Sun, in other words the solar parallax, is taken as 8″ 8

Now

$$\begin{aligned}
\log 960 &= 2\ 9823 \\
\log 8\ 8 &= 9445 \\
\log (960 - 8\ 8) &= 2\ 0378 \\
\log (960 - 8\ 8)^2 &= 4\ 0756 \\
\log S/E &= 5\ 5454 \\
\log G/g &= 1\ 4698, \quad G/g = 29\ 49
\end{aligned}$$

6 According to Newton's Law of Universal Gravitation, the operation of weighing out the quantity W in the balance gives the same result wherever the operation is carried out in the universe, assuming that the balance and the body to be weighed are of ordinary moderate dimensions

It is otherwise with the quantity denoted by P, because the magnitude of the gravitation unit of force varies, being proportional to the local value of g

Suppose we write the first two equations

$$Pgs = \tfrac{1}{2}Wv^2, \quad Pgt = Wv,$$

and now put $Pg = Q$, this is equivalent to taking a new unit of force, $1/g$th part of the former unit; this is an invariable unit

Now our dynamical equations become

$$Qs = \tfrac{1}{2}Wv^2, \quad Qt = Wv,$$

from which g has disappeared

The first suggestion of the change to this new absolute unit of force is due to Gauss, who found the necessity of it when comparing records of the Earth's magnetic force, made at different parts of the Earth's surface, and all expressed in the local gravitation unit

It is curious that this suggestion of an absolute unit of force, the same for all the universe, did not originate with the astronomers, but Astronomy remains mere Kinematics until an accurate determination of the Gravitation Constant has been made

On the F P S (British foot-pound-second) system, this absolute unit of force is called the *poundal*, a name due to Prof James Thomson, so that

$$Qs = \tfrac{1}{2}Wv^2 \text{ (foot-poundals)}, \quad Qt = Wv \text{ (second-poundals)}$$

On the C G S (Metric centimetre-gramme second) system, this absolute unit of force is called the *dyne*, the centimetre-dyne of work being called the *erg*, and the second dyne of impulse being called the *bole*, and now

$$Qs = \tfrac{1}{2}Wv^2 \text{ (ergs)}, \quad Qt = Wv \text{ (boles)}$$

These absolute units are always employed in the statement of dynamical results in Electricity and Astronomy, where cosmopolitan interests are considered

7 The disappearance of g from the dynamical equations is such a comfort to the algebraist, that he now makes a new start *ab initio* in dynamics, and gives a new definition of the absolute unit of force

He defines the *poundal* as the force which, acting on a pound weight, makes the velocity grow one foot per second every second, and he defines the *dyne* as the force which, acting on a gramme weight, makes the velocity grow one centimetre per second every second, and now if W lbs or g is acted upon by a force of Q poundals or dynes, the acceleration a is given by

$$a = Q/W \text{ (*celoes* or *spouds*)},$$

and

$$Q = Wa,$$

leading to the original equations

$$Qs = \tfrac{1}{2}Wv^2 \text{ (foot poundals or ergs)},$$
$$Qt = Wv \text{ (second-poundals or boles)}$$

These definitions of the absolute unit of force are very elegant and useful so long as we confine ourselves to calculations on paper, but they will not satisfy legal requirements There is no apparatus in existence which will measure a *poundal* or *dyne* from these academic definitions within, say, 10 per cent For accurate definition we must return to the old gravitation measure, and define the *poundal* or *dyne* as one gth part of the force with which the Earth attracts a pound weight or a gramme weight, the value of g (in celoes or spouds) being determined by pendulum observations, and now the standard weight and the value of g are capable of measurement to within, say, one-100th per cent, an accuracy sufficient to prevent litigation

In the recent report of the Committee on Electrical Standards we find the *ohm* defined as the equivalent of a velocity of ten million metres (one quadrant of the Earth) per second, to satisfy theoretical requirements, but as this definition would be useless for commercial purposes, Dr Hopkinson insisted that it was essential that an alternate definition should be given, legalizing certain bars of metal as standard ohms

In converting absolute and gravitation measure, we must notice that there are, strictly speaking, three different g's in existence (1) the g of pure gravity of a body falling freely, (2) the g determined by a plumb-line, or by a Foucault pendulum of which the plane of oscillation is free to rotate, (3) the g determined by a pendulum oscillating in a fixed vertical plane, about a fixed axis, this is the legal g, so to speak, although practically undistinguishable from the g given in (2)

Sir W Thomson's Standard Electrical Balance Instruments are graduated in gravitation measure, so that, if calibrated at Glasgow, they are one-25th per cent in error in London, and about one-7th per cent in error at the equator, and a corresponding correction must be made

An absolute Spring Balance instrument would possess a spurious absoluteness, in consequence of the deterioration of temper of the spring, and of its variation of strength with the temperature, as experienced in the Indicator

8 There is no advantage or gain of simplicity by the use of absolute units in dynamical questions concerning motion which is due to the gravitational field of force, the only change being the removal of g from the denominator on the right hand side of our dynamical equations to the numerator on the left-hand side

For this reason engineers and practical men invariably employ the gravitation unit of force in the dynamical questions which concern them, measuring, for instance, their forces in pounds, pressures in pounds per square foot or square inch, while at the same time measuring the quantity of matter in the moving parts by pound weights

The absolute unit of force has only recently made its way into dynamical treatment, principally in consequence of the development of Electricity Previously the gravitation unit was universally employed, with the consequence that W in the equations of motion always appeared qualified by a denominator g, in the form W/g

9 Noticing that W never appeared alone, but always as $\frac{W}{g}$ (for instance, that if a celoes is the acceleration which a force of P pounds causes in a weight of W lbs, then

$$P = \frac{W}{g}a, \text{ or } a = \frac{P}{\frac{W}{g}}),$$

early writers on Dynamics were unfortunately tempted to make an abbreviation in writing and printing, by replacing $\frac{W}{g}$ by a single letter M, so that the dynamical equations could be printed

$$P = Ma \text{ (pounds)},$$
$$Ps = \tfrac{1}{2}Mv^2 \text{ (foot pounds)},$$
$$Pt = Mv \text{ (second-pounds)},$$

each occupying one line of print

This quantity M was variously called the *mass* of the body—a quantity *sui generis*—the *massiveness* of the body, the *inertia*, or the *invariable quantity of matter* in the body

But if M denotes the invariable quantity of matter, we have this awkwardness, that M, the invariable quantity, is measured in terms of a variable unit, g pounds, while the force P, which varies with g, is always measured by means of a definite lump of metal, the pound weight

This awkwardness is rectified if we change the unit of force, and measure P in absolute units, poundals, and M in lbs, but now M becomes the same as W, formerly, and its introduction only causes confusion, because M is still taken by most writers on Dynamics as defined by

$$M = \frac{W}{g},$$

thus making $W = Mg$, the source of all the confusion in our dynamical equations

If weight W is measured in pounds, as the Act of Parliament directs, and if the unit of mass is one pound, so that M is also measured in pounds, then, if W and M refer to the same body, W = M, and not Mg

If $W = Mg$, and W is measured in lbs, then M is measured in units of g lbs, a variable unit, unsuitable for a cosmopolitan question

But if $W = Mg$, and M is measured in pounds, then weight W is measured in units of one gth part of a pound, or *poundals*, which is illegal according to the Act on Weights and Measures, c 19, 41 and 42 Victoria "Any person who sells by any denomination of weight or measure other than one of the imperial weights or measures, or some multiple or part thereof, shall be liable to a fine not exceeding forty shillings for each such sale"

10 The theoretical writer overrides these difficulties by giving a new definition of Weight, not contemplated or mentioned in the Act of Parliament

"The weight of a body is the force with which it is attracted by the Earth"

Let us examine this definition closely

In the first place, it does not appear to contemplate the use of the word *weight*, except in reference to bodies on or near the surface of the Earth

According to this definition, what is the weight of the Moon, or of a body on the Moon? Must the Moon be brought up to the surface of the Earth in fragments, or must the weight be estimated at the present distance of the Moon?

What, again, is the weight of the Sun, or of a body on the Sun? and what is the weight of the Earth itself?

And what does Sir Robert Ball mean when he writes that "the weight of Algol is about double the weight of the Sun"?

Considering, however, merely bodies of moderate size on the surface of the Earth, the attraction of pure gravity of the Earth is only to be found in a body falling freely; the tension of a thread by which a body is supported is influenced by the rotation of the Earth

Again, the local value of g is, theoretically speaking, influenced by the position of the Moon and Sun; it is true that the influence is insensible on the plumb-line, although manifest on such a gigantic scale in its tide-producing effects.

Suppose, then, we employ the gravitation unit of force in the theorist's definition of the weight of a body. The

definition now becomes an inexact truism asserting that the Earth attracts W lbs with a force of W pounds, and inexact, because it neglects the discount in g due to the rotation of the Earth, and to say that "the weight of a body is the force with which it is attracted by the Earth" conveys no additional information

Having introduced the word *mass*, primarily as a mere abbreviation in printing, and having subsequently changed the unit of mass so as to make the mass the same as the weight, the theorist is now trying to dislodge the word *weight* from its primary meaning, which it has possessed for thousands of years, as meaning the quantity of matter in a body, and is trying to degrade it into a subsidiary position, to express a mere secondary idea, the attraction of gravity, and that only on the surface of the earth, and even then not clearly defined

We might as well define the pound sterling by its purchasing power in any locality, instead of by its proper definition as a certain quantity of gold

11 So long as the gravitation unit of force alone was employed, the same number, which expressed the number of the weights which equilibrate the body, also expressed the number of pounds of force with which the Earth appeared to attract the body, and it is only in this sense that the weight of a body is "the force with which it is attracted by the Earth", it is essential that the unit of force should be the gravitation unit, when this definition is employed

We say, for instance, in Hydrostatics, that a ship is buoyed up by the water with a force equal to the weight of the displaced water, which is also equal to the weight of the ship, when in equilibrium

Again, the head of water which will produce a pressure of 150 lbs on the sq inch, is always

$$150 \times 144 \div 62.5 = 345.6 \text{ feet},$$

whatever the local value of g, the numerical measure is always the same, although the amount may differ in consequence of the variation of g and the unit of force A boiler tested to 150 lbs on the square inch is tried one 25th per cent more severely in Glasgow than in London This variation, at most ½ per cent, is not likely to lead to litigation—*De minimis non curat lex*

There is no particular harm in the use of the word *mass*, provided it is always measured in the standard units of weight, there is this drawback, that there is no verb to "mass", we can say that the body weighs W lbs, but we cannot say it "masses" M lbs

Again, the Acts of Parliament do not regulate "Masses and Measures," but "Weights and Measures," "Poids et Mesures," "Maasse und Gewichte," "De Ponderibus et Mensuris"

The French language possesses the two words *Poids* and *Pesanteur*, both of which we translate by Weight

Poids may be translated *mass*, or quantity of matter, *copia materiæ*, but that does not justify the degradation of *weight* down to the meaning of *pesanteur*, and that merely the *pesanteur* on the surface of the Earth, having already invented *mass*, the theorist must invent a new word to translate *pesanteur*, the word *heft* has been suggested, but the word *weight* must be left alone, to do double duty occasionally.

A libellous story of the Hudson Bay Company says that in their former dealings with the Red Indians, the weight of the factor's fist was always one pound, a good illustration of weight as meaning both *poids* and *pesanteur* to ignorant minds

An amusing instance of the confusion of using *weight* in the double sense of *poids* and *pesanteur*, when not restricted to the provincial gravitation unit of the surface of the Earth, on which the human race is imprisoned, occurred in a lecture last year on Popular Astronomy To illustrate the fact that g on the surface of the Sun is about 30 times greater than it is here (§ 5), the lecturer said, "An ordinary middle-aged man of this audience, if transported to the surface of the Sun, would *weigh about two tons*, but his reflections on this difficulty would be cut short by the immediate prospect of being converted into *two tons of fuel*"

12 Maxwell unfortunately lent his powerful aid to the attempt to degrade the word *weight* to mean merely *pesanteur*

In a review of Whewell's "Writings and Correspondence," edited by Todhunter, Maxwell writes that—

"Finding the word weight employed in ordinary language to denote the quantity of matter in a body, though in scientific language it denotes the tendency of that body to move downwards, and at the same time supposing that the word mass in its scientific sense was not sufficiently established to be used without danger in ordinary language, Dr Whewell endeavoured to make the word weight carry the meaning of the word mass Thus he tells us that—the weight of the whole compound must be equal to the weight of the separate elements"

"It is evident that what Dr Whewell should have said was—the mass of the whole compound must be equal to the sum of the masses of the separate elements"

But Whewell was quite right, because, at the time he wrote, mass was merely the printer's abbreviation for

$$\frac{W}{g}$$

"We are reminded by Mr Todhunter that the method of comparing quantities by weighing them is not strictly correct" (Compare this statement of Todhunter with that of Dr Harkness in his article on "The Art of Weighing and Measuring," NATURE, August 15, 1889, p 381, where it is pointed out that weighings can be carried out to within one 10-millionth part)

Again, in Maxwell's "Theory of Heat" (p 85), we read "In a rude age, before the invention of means for overcoming friction, the weight of bodies formed the chief obstacle to setting them in motion It was only after some progress had been made in the art of throwing missiles, and in the use of wheel-carriages and floating vessels, that men's minds became practically impressed with the idea of mass as distinguished from weight Accordingly, while almost all the metaphysicians who discussed the qualities of matter, assigned a prominent place to *weight* among the primary qualities, few or none of them perceived that the sole unalterable property of matter is its *mass*"

The question in dispute resolves itself, then, merely into a difference of terminology, and the metaphysicians are using the language universally employed up to the middle of this century, and are justified on all sides in their usuage Maxwell might as well have criticized the traditional names which astronomers employ for the heavenly bodies

Maxwell would even have edited the authorized and revised version of the New Testament, in ὡσεὶ λίτρας ἑκατόν—translated "about an hundred pound *weight*"—(John xix. 39), he proposed the omission of *weight*, probably inserted in the version to make a distinction from pounds *sterling*

This addition of the word weight is common elsewhere, thus, "His Majesty's Warrant, August 19, 1683, to cause 3 barrels of fine pistol powder, 3 cwt weight of pistol bullets, and 3 cwt weight of match to be delivered to John Leake, Master Gunner, for the use of the 3 troops of Granadiers, &c" ("Notes on the Early History of the Royal Regiment of Artillery," by Colonel Cleaveland)

Dr. Lodge says that the term hundredweight bears marks of confusion on its surface, and had better be avoided, what does he say to this use of hundredweight weights, not intended to mean pull of gravity?

This Warrant is dated four years before the first edition of the "Principia," in which the downward tendency of a

weight was first clearly demonstrated as due to the attraction of the Earth, although mere surmises had been propounded by early astronomers, and in "Troilus and Cressida" we have—"As the very centre of the earth, drawing all things to it"

But Acts of Parliament on "Weights and Measures" were extant hundreds of years before the first appearance of the "Principia", and when the standard pound weight was defined in these Acts, it was the lump of metal preserved at the Exchequer that was described, and not the pressure on the bottom of the box in which it was kept

13 Formerly, the words *vis inertiæ*, or *inertia*, were used instead of the modern word *mass* (often used in ordinary language as the equivalent of *bulk*) But it is useful to notice that inertia is not always the same thing as weight or mass, or even proportional to them

Thus the inertia of a body is increased by the presence of the surrounding medium, the inertia of a sphere moving in a frictionless incompressible liquid is increased by half the weight of the liquid displaced, and of a cylinder moving perpendicular to the axis by the weight displaced, while an elongated projectile requires rotation about an axis for stability of flight, in consequence of its inertia being different for different directions of motion

The inertia of a pendulum, or of the train in § 2, is increased to an appreciable extent by the presence of the surrounding air

Again, the inertia of a rolling hoop is twice its weight, of a cylinder is half again as great, of a billiard ball is 40 per cent greater, and the inertia of a bicycle, or of the train we have considered in § 2, when the *rotary inertia* of the wheels is taken into account, must be increased by a fraction of the weight of the wheels and axles equal to k^2/a^2, where a is the radius of a pair of wheels, and k the radius of gyration of the wheels and axle about the axis of rotation

For the same reason the centre of inertia does not always coincide with the centre of gravity, or centre of mass The buffers of a railway carriage should be at the height of the centre of inertia, and this is easily seen to be at a height

$$h \Big/ \left(1 + \frac{w k}{W a}\right)$$

above the axles, w denoting the weight of the wheels, W of the body of the carriage, and h the height of its centre of gravity above the axles

The recommendations of the A I G T, in their "Syllabus of Elementary Dynamics," will only serve to widen the increasing gulf between theoretical treatises and the Applied Mechanics which engineers use, unless the Committee of the A I G T will set to work to invent a totally new word, such as *heft*, to express the pull of gravity on a given weight, as an equivalent of the French word *pesanteur*, it is hopeless to attempt to degrade the, old word *weight* into the subsidiary secondary meaning so long as in commerce, and in the Acts of Parliament, *weight* invariably means quantity of matter, *copia materiæ*

A G GREENHILL

APHANAPTERYX AND OTHER REMAINS IN THE CHATHAM ISLANDS

IN a former letter I sent you some account of the finding of the *Aphanapteryx* in the Chatham Islands I have now gone more carefully over the bones I collected there, and some additional notes may not be without interest I find that, of the heads I have obtained, a number are much larger than that of *Aphanapteryx broeckei* (Schlegel), and are therefore rightly assigned, I think, to a distinct species The tarso-metatarsus, as figured by M. Milne-Edwards, however, may, I think, prove to belong not to *Aphanapteryx*, or at any rate not to a species with so robust a tibia I found several tarso-metatarsi in near relation to the tibiæ and femora, and heads of *A hawkinsi*, and they are all without exception much shorter and stouter bones in proportion to the tibiæ and femora Out of the same strata which contained *Aphanapteryx*, I obtained a number of the bones of the skeleton of a *Fulica* very nearly related to *F newtoni* Like the *Aphanapteryx* bones, they vary very much in size, some being equal, others much larger than those of *F newtoni* So much so that I am inclined to recognize them as different species, or at least different races The larger species I have named *F chathamensis* The portions I have had before me are the pelvis, the femur, the tibia, and metatarsus I have portions of a large ralline skull, which may be that of this *Fulica*, but it is rather too imperfect to enable me to speak more confidently at present The tarso-metatarsi of this bird agree much more closely with the tarso metatarsus assigned in M Milne-Edwards's plate to *Aphanapteryx* Of the *Aphanapteryx* I possess the complete cranium, femur, tibia, metatarsus, humerus, and pelvis Among the other interesting specimens so far identified, are the humeri and pelvis of a species of Crow half as large again as *C corax* They agree closely with those of a true *Corvus* I have designated it as *Corvus moriorum*, as I found some of these bones among the remains scattered round a very ancient Moriori cooking-place, which had become uncovered by the wind in the strata in which *Aphanapteryx* occurs Indeed, in this kitchen-midden I gathered portions of the *Aphanapteryx*, of a large swan, of several species of ducks, and of a *Carpophaga* indistinguishable from the species now living on the islands —a species (*Carpophaga chathamica* mihi[1]) new to science. I may say that it is easily distinguished from *C novæ-zealandiæ* by the breast-shield in both sexes being altogether duller than, and not extending so far ventrally as, in the latter The head, neck, and breast are of the same colour—a dull green, with purple and green metallic reflections when viewed with the bird between the light and the eye It is, however, most markedly distinguished by the pale lavender colour of the external border of the wings, the much paler colour of the lower back and rump, and by the black on the under surface of the tail feathers being prominent on all the rectrices except on the anterior portions of the outer tail feather on each side, and passing under the tail coverts in a broad wedge Mr Travers relates that he was informed by one of the early settlers on Pitt Island that he remembered the first appearance of the pigeon in the islands This statement cannot well be accepted in face of the presence of the bird's bones in a midden so ancient as that I have referred to above. In the *Aphanapteryx* beds, I obtained also the portions of a skull of a species of *Columbidæ*, apparently of a *Columba*, of which I can say little till I am in possession of more material I have obtained also bones of the small hawk (*Harpa*), showing that it existed on the islands, whereas it is now unknown there, although *Circus gouldi* is not uncommon

At about 3 feet below the floor of a small cave, which the weathering limestone has deposited, I obtained portions of a pigmy Weka (*Ocydromus pygmæus*), and also the limb bones of a rat If they have been gradually covered to this depth by the fall of particles from the roof, as there seems no reason to doubt, their age must be very great, but whether that would take us back to a date antecedent to the arrival of the Morioris in the Chatham Islands is a more difficult question to answer with our present data

So far, the birds of whose presence in the Chatham Islands till now we have had no knowlege, are: *Harpa ? ferox*, *Nestor meridionalis* and *? N notabilis*, *Corvus*

[1 ? *Carpophaga chathamensis* of Rothschild, P.Z.S. 1891, p. 312, pl. xxviii. —ED]

moriorum, *Ocydromus pygmæus*, *Fulica newtoni*, *F chathamensis*, *Aphanapteryx hawkinsi*, *Ap* ? spp , *Chenopis sumnerensis*, *Carpophaga chathamica*, *Columba* sp

HENRY O FORBES

Canterbury Museum, April 2

ADMIRAL MOUCHEZ

WE have already referred to the loss which French science has recently sustained in the sudden death of the director of the Paris Observatory, at the age of 71 It falls to the lot of few sailors in any country to take so large a share in scientific progress as did Admiral Mouchez, or to combine great administrative capacity with thorough knowledge and power of initiation

His love for astronomy and geodesy first made itself felt when he was at the Collège Louis le Grand Appointed to the navy in 1843, he was captain of a frigate in 1861, but three years before this he had communicated to the Academy of Sciences observations of the partial eclipse of the sun seen by him at Buenos Ayres on September 7, 1858 He was then in that locality constructing the hydrographical map of the eastern coast of South America A year or two later he presented to the Academy a map of Paraguay, and he was presented as a candidate for filling the seat vacated by the untimely death of Bravais in 1863 But he was outvoted, and he continued his hydrographical work He published a description of the coast of Brazil, and he observed an annular eclipse of the sun (on October 30, 1864) at San Catharina, Brazil

When in 1872 expeditions were being organized by all countries to observe the transit of Venus in 1874, Mouchez was placed in command of the party which was destined for the island of Saint Paul The climatic conditions of this island—either the winds are very violent, or the heaven is nearly always overcast—did not seem to favour the observers The head of the expedition had the greatest difficulty in reaching his post, and it was in the middle of a violent storm that he had to approach the large volcano which was to be his station

The evening of the day before the transit the rain fell in torrents, but the next day, at the moment wished for, by quite a fortunate chance, the storm cleared in consequence of a change of wind, and the veil of mist which covered the sky suddenly vanished, the observation was thus made under most favourable conditions Mouchez was able to recognize the atmosphere of Venus very distinct from that of the Sun at the moment of contact

The astronomical expedition which he commanded was composed of naturalists as well as astronomers, it has furnished science with interesting accounts of the geology, zoology, and botany of the islands of St Paul and Amsterdam its neighbour.

On Mouchez's return to France he was promoted Commander of the Legion of Honour at the same time that he was nominated a member of the Academy of Sciences in the place of the astronomer Mathieu In October 1875, at the annual public séance of the five academies, he gave an account of his expedition to the island St Paul.

In 1878 he obtained from the French Admiralty the funds required for establishing at Montsouris, with the same instruments used by him at St. Paul, a school of astronomy for the use of marine officers and masters This school is in full prosperity, and every year about a dozen men are trained in conducting astronomical and magnetical observations.

When Le Verrier died, on September 13, 1877, Mouchez, then commander, was appointed to the directorship of the National Observatory, and nearly simultaneously with this Commander Mouchez received the rank of Rear Admiral. He was put on the Reserve List in 1880

Admiral Mouchez showed himself, at the Observatory, an active administrator He brought about many marked improvements in the different branches of the establishment He suggested the establishment of a practical school of astronomy, which has been worked for eight years consecutively, and has furnished all the French observatories with a remarkable supply of young astronomers Thirty have passed through the two years' course

Admiral Mouchez always encouraged useful researches, and the magnificent work undertaken with so much success by the brothers Henry in celestial photography, and the development of the *equatorial coudé*, under the fostering care of M Loewy, must be specially mentioned here

But by far the most important result of this kind which we owe to the Admiral's clear foresight and power of dealing with men is to be found in the Chart of the Heavens, which will remain as one of the memorable works of the science of the nineteenth century It was on the proposal of the director of the observatory that the Academy of Sciences convoked foreign astronomers to take part in the Congress which, on three different occasions, assembled with so much success at the Paris Observatory

This vast undertaking would have been impossible without the genius of the French nation and without such a man as Mouchez It is essentially an international work which England should have started, but alas! in such matters our science is scarcely national, it is parochial, and so it must remain until the relations between science and the Government are changed

Admiral Mouchez was a very zealous promoter of colonial observatories He travelled to Algiers in order to preside over the inauguration of the large establishment erected by M Trépied This very year, having travelled to Tunis to recruit his failing health, he had taken steps for creating an astronomical station in the town of Zaghouan, and he was advocating the building of observatories at Tahiti and Tananarivo at the time of his death

There are few astronomers who will not feel the death of Admiral Mouchez as the loss of a dear friend, and one in whom loyalty, honesty, and simplicity of character were so blended that the great services rendered by the savant were almost forgotten in the esteem felt for the man

NOTES

M HECKEL, the President of the Botanical Section of the French Association for the Advancement of Science, proposes, as special subjects for discussion at the approaching meeting of the Association, to be held at Pau, the flora of the Alps and of the Pyrenees, and a comparison between them, and the best means of arranging and preserving botanical collections.

PROF T H HUXLEY has been elected President, and Sir Henry Roscoe and the Master of University College, Oxford, two of the Vice-Presidents, of the Association for Promoting a Teaching University for London Motions on the whole favourable to the plans of the Association have been carried by the Senate of the University of London and the Council of University College.

PROF. RAMSAY, in his report as Dean of the Faculty of Science in University College, London, has to record many changes during the past session Reference is, of course, made to the retirement of Prof. Croom Robertson from the Chair of Philosophy, and to the appointment of Dr James Sully as his successor. Prof. Ramsay's predecessor as Dean, Prof Lankester, expressed to him his regret that he had not taken steps to ascertain the number of original investigations carried

out during the time of his Deanship, and it occurred to Prof Ramsay that no more fitting task could devolve on the Dean than to chronicle how far the progress of science is due to those, students and teachers, who work in University College His colleagues have responded to his inquiries, and he has thus been able to lay before the Council a list of publications amounting in all to 84 separate memoirs or books They contain accounts of researches in which professors, assistants, students, former students who are still at work in the College have taken part, and Prof Ramsay maintains that in this, as well as in the routine of teaching, the College fulfils the duties of a true University The record, he contends, equals, if it does not surpass, that of any University in the kingdom

SINCE Saturday last Mount Etna has been in a state of eruption, and many severe shocks of earthquake have been felt in the surrounding country From midnight till six o'clock on Saturday evening there were eleven distinct shocks About noon on Saturday a great fissure opened on the summit of the mountain, from which lava began to issue with great rapidity During the following night the eruption assumed alarming proportions, and huge quantities of lava streamed down the sides of the mountain This rapidly flowed in two streams—one going in the direction of Nicolosi and the other towards Belpasso There was a severe earthquake shock in the immediate vicinity of the volcano on Saturday night On Sunday the people of Nicolosi assembled for mass outside the cathedral, and remained kneeling in the open air, being afraid to enter owing to the continued shocks of earthquake At five o'clock in the evening the shocks continued, and very loud subterranean rumblings were heard, giving the impression of a terrible storm Twelve houses and a portion of a church were destroyed. The eruption continued very active On Monday it was stated that the rumblings had grown less frequent, and there were indications that the eruptions from the newly-formed fissure were about to cease The principal crater, however, showed signs of renewed activity On Tuesday the following telegram was despatched from Catania through Reuter's agency —"The eruption of Mount Etna is again rapidly increasing in volume and intensity Five craters at different points on the mountain are showing great activity Loud explosions occur continually, and this morning there was a strong shock of earthquake Giarre, on the coast to the north of Catania, has been reduced to ruins, and the whole country round has suffered severely, A number of engineers who have been sent to the points immediately threatened express fears that the wells will blow up on contact with the lava There is no panic, and in the circumstances the people maintain a fairly calm demeanour"

A TERRIBLE disaster has happened in the neighbourhood of the sulphur springs of St Gervais, a little way off the road from Geneva to Chamonix According to a Reuter's telegram, despatched from Bonneville, Haute Savoie, on July 12, the calamity was due to the fact that the lower end of the glacier of Blonnay became detached from Mont Blanc and fell into the torrent beneath It carried away with it the little village of the same name The masses of ice and the wreck of the village formed a dam which held up the waters for some time, until they suddenly broke through the obstruction and burst like a cataract into the mountain stream, known as the Bon Nant, which flows by St. Gervais les Bains. These thermal springs, the medicinal virtues of which attract many visitors to the hotel during the year, rise in the wooded ravine of Montjoie, through which the Bon Nant or "Good Stream" passes on its way down to meet the river Arve The gorge in which the Etablissement des Bains, erected at an altitude of 2066 feet above the level of the sea, stands, or rather stood, is narrow, and the hotel consisted of five separate buildings joined together by walls of stone roughly hewn from the mountain side At a quarter past two on Tuesday morning or thereabouts, the people in the hotel were awakened by a terrific noise of rushing water, and the crashing of rocks one against the other. Then a furious gust of wind drove through the gorge The next moment a torrent of water, carrying with it fragments of rock, trees, and debris of all descriptions, hurled itself upon the hotel Of the five buildings, three were utterly destroyed, another was nearly so, while the fifth remained almost unhurt, owing its safety to its position, which was high above the course of the Bon Nant Passing down the valley, the torrent struck the village of Le Fayet, which was almost entirely demolished The wreckage of the houses was swept down the stream for miles into the river Arve, on the surface of which corpses and débris of all kinds were seen floating all day on Tuesday According to the latest calculations on Tuesday evening, there were no fewer than 200 victims, more than half of whom were staying at the bathing establishment of St Gervais

THE following are among the Civil List pensions granted during the year ended June 20 —to Mrs Caroline Emma Carpenter, £100, in consideration of the services rendered by her late husband, Dr Philip Herbert Carpenter, F R S, to science, and of the sad circumstances in which she was left by his death, to Mr Thomas Woodhouse Levin, £50, in consideration of the services he has rendered to education and philosophy and mental science, of his blindness, and of his inadequate means of support, to Dr George Gore, F R S, £150, in consideration of his services to chemical and physical science, to Mr Henry Dunning Macleod, M A, £100, in consideration of his labours as a writer upon economical subjects, to Mr Henry Bradley, £150, in consideration of his labours in connection with the "New English Dictionary", to Miss Letitia Marian Cole, £30, Miss Henrietta Lindsay Cole, £30, and Miss Rose Owen Cole, £30, in recognition of the services rendered by the late Sir Henry Cole to the cause of artistic and scientific education, and to Mrs Jeanie Gwynne Bettany, £50, in consideration of the services rendered to the spread of scientific knowledge by the numerous writings of her husband, the late Mr G T Bettany, M A

MR THOMAS HANBURY has presented to the Botanical Institute at Genoa the very rich collection of vascular plants made by the late Prof Willkomm, of Prague It comprises as many as 14,472 species, the greater number being European or from the adjacent districts of Asia and Africa It is especially rich in plants of the Spanish Peninsula, and includes most of Willkomm's original type-specimens

THE Society of Natural History of St Petersburg has despatched Dr. K N Denkenbach on a mission to explore the flora of the Black Sea

THE death is announced of Prof Giovanni Flechia, Vice President of the Reale Accademia delle Scienze of Turin.

THE series of fifteen water-colour paintings of the volcanic district in New Zealand, which were lent by Miss Constance F. Gordon Cumming to the Indian and Colonial Exhibition, are now lent to "The Castle" at Nottingham, where they will be shown for some little time They were in the Indian and Colonial Exhibition at the time of the great eruption of Mount Tarawera, which destroyed the beautiful Terraces

THE weather during the past week has been changeable, with frequent rain, more particularly in the north and west, 1·7 inch was measured on the west coast of Ireland on the morning of the 12th instant At the time of our last issue a deep depression lay over the north of Scotland, the barometer being below 29 inches, while a moderate westerly gale was blowing in the

Channel, with a high sea, and other depressions have subsequently travelled to the northward of our islands The weather, however, remained fair, but cloudy, in the southern parts of the kingdom, and fog prevailed on the north east coast on Monday The distribution of barometrical pressure has, for the most part, been favourable to westerly winds, the high barometer being situated over the north of France A change, however, set in on Monday, accompanied by strong easterly winds and a falling barometer, the highest readings having shifted northward, with their centre situated to the eastward of our islands These conditions were followed by fresh disturbances, accompanied by rainy and unsettled weather Temperature has been lower than of late, although but little below the average, the highest day readings have seldom reached 70° The *Weekly Weather Report* issued on the 9th showed that, for that week, bright sunshine continued fairly prevalent over the eastern and southern districts, and that there was a considerable excess of rainfall in Ireland and the northern and western parts of Scotland

THE United States Weather Bureau has just published Bulletin No 1, containing some interesting notes on the climate and meteorology of Death Valley, California This valley lies between lats. 35° 40′ and 36° 35′ N and longs 116° 15′ and 117° 5′ W, and owes its name to the fate of a party of immigrants, who, about 1850, perished from thirst The principal feature of interest about the place is that, although situated about 200 miles from the sea, it is said to lie 100 feet or more below the sea level, as determined from barometrical observations. The observations now published were commenced by the Geological Survey and the Signal Service, and were continued by the Weather Bureau during five months from May to September, 1891, and we believe these are the only regular observations, with trustworthy instruments, that have been made there The principal meteorological features are the excessive heat and dryness, the temperature rises occasionally to 122° in the shade, and rarely falls during the hot season below 70° It is said that the thermometer has sometimes reached 130°, and once even 137°. The diurnal range of the barometer is characteristic of the form found in continental valleys, being of the purest single maximum type, and has the largest amplitude known The rainfall was extremely light, and was always either a slight sprinkle or a thunderstorm The total fall for the five months was only 1 4 inches It showed a distinct diurnal frequency, nearly all the hours of rain being during the night Sand storms were also observed on several occasions

THE Deutsche Seewarte has just issued Part IV of their meteorological observations made at distant stations The observations are made three times daily, and monthly means are added in the form agreed upon for international meteorological publications. These observations are especially valuable both on account of the remoteness of the places and of the details which are given about the stations and the instruments used This volume contains observations made (1) at six stations in Labrador for 1887, (2) at Walfisch Bay for 1889, (3) in the Cameroon estuary, from April 1889 to June 1890, (4) at Bismarckburg, Togoland, West Africa, from June 1889 to May 1890, (5) at Chemulpo, Korea, from July 1888 to December 1889, (6) at Mohammera, mouth of the Euphrates, from June to August 1885, and (7) at Bushire, from September 1885 to March 1886 In some cases the introductory text contains general remarks relating to the tides and prominent features of the climate

IN February 1888, Dr E Etienne was sent to Banana by the Congo Free State to direct the sanitary service, and he made regular meteorological observations there, six times daily from December 1, 1889, to May 16, 1891, which have now been published by the State The range of temperature during the year 1890 presented great regularity, the absolute maximum, 93° 6, occurred in March, and the minimum, 61° 9, in July, the lowest maximum was 73° 9 in July, and the highest minimum, 79° 2, in April The greatest monthly variability (the difference of the monthly mean from one month to another) was 5° 0 between May and June The winds are very uniform a land breeze from south east to south at sunrise, then calm till about 11h a m, a sea-breeze from south west till about 7h p m, and a second calm about 10h p m The rainy season of 1889–90 numbered fifty days, with a mean daily fall of 0 49 inch The most remarkable fall was 1 2 inch in 45 minutes The rainy season of 1890–91 differed considerably from the former, the number of wet days was only 29, with a mean daily fall of 0 52 inch, the total amount being about five-eighths of that in the previous year In addition to the above there is a very small amount of rain in the dry season

THAT iron is always present in small quantities in chlorophyll has been asserted over and over again in botanical text-books Dr H Molisch, who has recently investigated the subject of the presence of iron in plants, disputes this, and asserts that he has never found a trace of iron in the ash of chlorophyll He states that iron occurs in plants in two forms—in that of ordinary iron-salts, and in the "masked" condition, in which it is so closely combined with organic substances that the ordinary reagents fail to detect it In this form iron occurs both in the cell-wall and in the cell contents, but it does not enter into living protoplasm

IN one of the alcoves of the Museum of the Academy of Natural Sciences, Philadelphia, there are various fossil bones of extinct animals belonging to the Pleistocene period, and along with them a human bone These "finds" were presented to the Academy in 1846 by Dr. Dickeson, who discovered them in a single deposit at the foot of the bluff in the vicinity of Natchez, Mississippi Specimens—one from the human bone, the other from one of the bones of a Mylodon—have been submitted for analysis to Prof F. W Clarke, chemist of the U S Geological Survey, and the result is reported by Dr Thomas Wilson, of the Smithsonian Institution, in the current number of the *American Naturalist* The human bone is in a higher state of fossilization than the Mylodon It has less lime and more silica. In their other chemical constituents they are without any great difference. Of lime the bone of the Mylodon has 30 48 per cent., while that of man has but 25 88 per cent Of silica the Mylodon has 3 71 per cent, while man has 22 59 per cent Dr Wilson refers to the ordinary uncertainty of this test when applied to specimens from different localities and subjected to different conditions, but points out that in the present case no such differences exist The bones were all encased in the same stratum of blue clay, and were subjected practically to the same conditions and surroundings

MR A J. COOK, of the Agricultural College, Michigan, has been making experiments to determine how much honey is needed to enable bees to secrete one pound of wax, and he has found that the amount is eleven pounds of honey This is less than the amount given by Huber, and more than that stated by Viallon and Hasty An account of the experiments and of many other interesting facts relating to apiculture will be found in a report included in Bulletin 26 of the U S Department of Agriculture.

AN interesting memoir of John Hancock, with portrait, opens the latest instalment (vol. xi. Part 1) of the Natural History Transactions of Northumberland, Durham, and Newcastle-

upon-Tyne The writer, Dr. Embleton, gives an excellent account of Hancock's masterly power of mounting animals He notes also Hancock's remarkably intimate knowledge of the characters and habits of birds "He could describe and imitate their motions and sounds so vividly, by feature, voice, and posture, as to be most instructive and at the same time amusing, whilst he convinced his auditors of the naturalness of his pantomime"

A PAPER on the Tertiary Rhynchophora of North America, by Mr. Samuel H Scudder, has been reprinted from the Proceedings of the Boston Society of Natural History (Vol 25) The assortment of the mass of Tertiary insects from American western deposits, upon which Mr Scudder has been engaged for many years, has brought to light an unexpectedly large number of Rhynchophora, about eight hundred and fifty specimens having passed through Mr Scudder's hands, of these, however, fully a hundred have proved too imperfect for present use or until other specimens in better condition may show what they are Seven hundred and fifty-three specimens have served as the basis of a Monograph now being printed More than half (431) of these specimens come from the single locality of Florissant, Colo, and excepting a single specimen from Fossil, Wyo, and another from Scarboro', Ontario, the others are divided between three localities not widely removed the crest of the Roan Mountains in western Colorado, the buttes on either side of the lower White River near the Colorado-Utah boundary, and the immediate vicinity of Green River City, Wyoming One hundred and ninety three species are determined, divided among ninety five genera, thirty-six tribes or sub families, and six families, by which it will be seen at once that the fauna is a very varied one It is richer than that of Europe, where there have been described (or merely indicated) only one hundred and fifty species, of which nine come from the Pleistocene The older Tertiary rocks of America, therefore, are found to have already yielded nearly twenty eight per cent more forms than the corresponding European rocks Although it is evident to any student of fossil insects that even in Tertiary deposits we possess but a mere fragment of the vast host which must have been entombed in the rocks, Mr Scudder contends that we have already discovered such a variety and abundance of forms as to make it clear that there has been but little important change in the insect fauna of the world since the beginning of the Tertiary epoch

IN a paper on artesian water in New South Wales, printed in the current number of the Journal and Proceedings of the Royal Society of that colony, Prof Edgeworth David says that water rises to the surface in many parts of the east central portions of Australia from mud or mound springs These occur chiefly in strata of Cretaceous age The most remarkable groups are perhaps those on the Lower Flinders, which have been described by Mr E Palmer in the Proceedings of the Royal Society of Queensland The springs erupt thin mud and hot water intermittently, and thus gradually build up around their orifices mounds of mud of a rudely crateriform shape At Mount Browne, on the Lower Flinders, several feet above the general level of the plain, is a mud spring mound covered with gigantic tea trees (*Melaleuca leucodendron*), among the matted roots of which the hot water steams in clear shining crystal pools At the top of the mound is a large basin of hot water, stated to be fathomless The roots and branches of the tea-trees lying in this water become coated with a soft green vegetable substance, with air bubbles clinging to them Innumerable small bubbles of carbon-dioxide are continually rising to the surface of the basin. The water is too hot for the hand to bear for any length of time, but when cooled it is good for use and always bright and clear, and free from any taste, while that in the adjoining cold springs is extremely disagreeable The temperature of the water in two of these hot springs at Mount Browne is 120° F No change has been observed in the hot springs as regards level or temperature since 1865, when a cattle station was settled there

AMONG the curiosities in the mines and mining building at the Chicago Exhibition will be a solid gold brick, weighing 500 pounds, and worth 150,000 dollars It will be exhibited by a mine owner at Helena, Mon

DR C F MACDONALD, who has been present at the seven executions by electricity in New York State, has submitted to the State authorities a report, in which he contends that experience has thoroughly justified the abolition of hanging When the new method is used, death, he maintains, occurs before any sensation of pain or shock can be conveyed to the brain of the condemned Dr. MacDonald's conclusions are endorsed by a hundred physicians who have acted as witnesses at different executions

THE raisin industry is being gradually developed in Victoria, and promises shortly to be sufficient to supply the requirements of the colony So says Mr J Knight, who writes on the subject in the new Bulletin of the Victoria Department of Agriculture Extensive planting, he says, is going on in various parts of the colony, from the extreme west at Mildura along to the east as far as Wangaratta, the largest plantation being in the well-known Goulburn Valley In this locality not only has the manufacture of raisins received attention during the last six years, but the products of the currant vine also are now being placed on the market

THE second volume of the *Photographic Annual* has been issued It includes a vast number of advertisements, but contains also some able articles, among which we may especially note Mr Albert Taylor's general view of the progress of astronomical photography during 1891

IN 1891 wide-spread alarm was caused in America by the presence of several species of destructive locusts in different parts of the country, particularly in the Western States. A general summary of these incursions was given in Mr. C. V. Riley's annual report for 1891, and now a Bulletin has been issued by the U S Department of Agriculture giving the detailed reports of the agents who carefully examined the invaded districts

A CATALOGUE of the marine shells of Australia and Tasmania, compiled by John Brazier, F L S, is being printed by order of the trustees of the Australian Museum, Sydney The first part, dealing with Cephalopoda, has been issued The task cannot be accomplished very quickly, as it entails the examination of many thousands of specimens, both dry and in spirits The catalogue will include not only the species represented in the general Museum collection, but also those in the Hargreave's collection presented to the trustees by the late Mr Thomas Walker, and those recently purchased from Mr Brazier

MR R. ETHERIDGE, JUN, gives, in the latest instalment of the Transactions of the Royal Society of Victoria, an interesting account of a fine specimen of an unusually large species of the genus Belonostomus, obtained in 1889 by Mr George Sweet, of Brunswick, Melbourne, in the Rolling Downs formation (Cretaceous) of Central Queensland The fossil exhibits a long, slender fish, with deep, narrow ganoid scales and feeble fins, bent upon itself at about the middle point, and wanting the greater part of the head Species that are apparently allied have been recorded from the Upper Cretaceous of Western Europe, India, and Brazil, and Mr. Etheridge notes that the

present discovery is of great interest as extending still further the ascertained geographical range of the genus during Cretaceous times.

THE very extensive alterations in botanical nomenclature proposed in Kuntze's "Revisio Generum" has prompted a proposal, emanating from the four eminent German botanists, Ascherson, Engler, Schumann, and Urban, with the assent of a number of their colleagues, for a revision of De Candolle's "Lois de Nomenclature Botanique." The essential points of the propositions are that the starting point for the priority of genera, as well as of species, shall be the year 1753, the date of the publication of Linnæus's "Species Plantarum"; that "nomina nuda" and "semi-nuda," *i.e.* names without a diagnosis, or with only a very imperfect diagnosis, shall be rejected, as well as figures without a diagnosis; that no generic name shall be rejected because of its similarity to another generic name, even if it differ only in the last syllable, but that, if the difference be in spelling only, the later name must be rejected; that the names of certain large and universally known genera be retained, even though they would have to be rejected by the strict rules of priority. English botanists are invited to signify their assent or otherwise to these propositions.

AT the meeting of the Linnean Society of New South Wales, on May 25, Mr. Pedley exhibited a very fine and perfect saw, about 5 feet long, of the saw fish *Pristis zysron*, Bleeker. The fish, without the saw, was about 19 feet long, and was captured in a net at Evans River, N.S.W. The number of pairs of rostral teeth for this species is usually given as from 26-32; the specimen exhibited had only 25 pairs, all in place. At the same meeting, Mr. Hedley exhibited, on behalf of Mr. Rainbow, a spider of the family *Epeiridæ*. This rare and remarkable insect furnishes an addition to the fauna of Australia, and it is supposed that a new genus may be required for its reception.

MR. W. A. ROGERS, writing to *Science* from Colby University, Waterville, Me., confirms testimony given by Mr. Kunz as to the fact that the hardness of diamonds is not perceptibly reduced by cutting and polishing. In the earlier years of Mr. Rogers's experience in ruling upon glass he was accustomed to select a gem with a smoothly-glazed surface, and, the stone being split in a cleavage plane inclined at a rather sharp angle to the natural face selected, this split face was ground and polished. In this way he was able to obtain at several points short knife-edges, which gave superb results in ruling. It was soon found, however, that after ruling several thousand rather heavy lines the diamond was liable to lose its sharp cutting-edge, and this experience became so frequent that he was compelled to resort to the method now employed, that of grinding and polishing both faces to a knife edge. He has one ruling diamond prepared in this way, which has been in constant use for four years, and its capacity for good work has not yet been reduced in the slightest degree. A diamond prepared by Mr. Max Levy, of Philadelphia, has given even better results, and so far it shows no evidence of wear.

THE *Bulletin de la Société des Naturalistes de Moscou* (1891, Nos. 2 and 3) contains a very interesting paper, in French, by Prof. A. Pavloff and Mr. G. W. Lamplugh, on the Speeton clays and their equivalents. These clays, which have long occupied the attention of geologists, have acquired of late a new interest owing to close resemblance between their fauna and that of similar deposits in other countries, even as far distant as Russia. The work consists of three parts: the first part, devoted to the description of the Speeton clays and their Lincolnshire equivalents, has been written by Mr. Lamplugh, and will, no doubt, be published in English as well. The second part, by Prof. Pavloff, is devoted to the description of the Cephalopods found in these clays, the Speeton forms being compared with those of other countries, and especially those of Russia. A table giving the succession of the subdivisions of the Jurassic and Cretaceous deposits, with their leading fossils, in the two Russian localities where they are best represented (Moscow and the lower Volga), is given by the author, and it differs from a previous table by the introduction of a new series, named Petchorian, which, although it has the thickness of but a few inches, has nevertheless a very peculiar fauna, of a well determined character. However, for the present it is not possible to classify it either under the Jurassic or the Cretaceous formation. The table is followed by a detailed description of twenty-five species of Belemnites, of which eight are new, the chief interest of this description being in the attempt to give in each case the genealogical relations of closely allied species, and in a special chapter devoted to the geological history of Belemnites generally and the descent of various species supposed to have originated from the *Belemnites tripartitus* of the middle Jurassic and Lias epoch. In a subsequent paper, which will contain the third part of the work—namely, a comparison of the Speeton clays with those of other localities—the author proposes to describe in the same way the Speeton Ammonites, which are even more interesting than the Belemnites; and he hopes to be able then to give a more positive answer as to where the separation must be taken between the Jurassic and the Cretaceous deposits of the Speeton clays and analogous deposits.

MR. MATTHIAS DUNN writes to us from Mevagissey, Cornwall, that the fishing boat *Mispah* landed a large shark there lately which had got entangled in her mackerel nets. Its length was 11 feet 2 inches, and in its stomach were two considerable-sized congers. The creature proved to be Couch's Porbeagle Shark, or *Lamna cornubica* of Cuvier.

THE additions to the Zoological Society's Gardens during the past week include a Tiger (*Felis tigris* ♂ jr.) from Amoy, China, presented by Mr. Robert Bruce; two Mountain Ka-kas (*Nestor notabilis*) from New Zealand, presented by the Earl of Onslow, K.C.M.G.; a Chilian Sea Eagle (*Geranoaëtus melanoleucus*) from Chili, presented by Mr. Edward Jewell; a Broad-fronted Crocodile (*Crocodilus frontatus*) from West Africa, presented by Mr. G. T. Carter; a Common Boa (*Boa constrictor*) from South America, presented by Mr. A. E. Oakes; a Macaque Monkey (*Macacus cynomolgus* ♀) from India; a Kinkajou (*Cercoleptes caudivolvulus*) from Demerara, deposited; a Hippopotamus (*Hippopotamus amphibius* ♂) bred in Antwerp; sixteen Common Boas (*Boa constrictor*) from South America, purchased; an Indian Muntjac (*Cervulus muntjac* ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN

LUNAR PHOTOGRAPHY.—Dr. L. Weinek, of the Prague Observatory, has been the recipient of several photographs of the moon from Prof. Holden for the purpose of making enlargements from them. The photographs were obtained with the large equatorial of the Observatory at Mount Hamilton, and an illustration of one of the enlargements is given in *L'Astronomie* for July. The photograph is of the large crater Petavius, 157 kilometres in length. With M. Weinek's apparatus the photograph was enlarged twenty times, giving a lunar image of nearly three metres in diameter. At first sight the photograph looks as if the enlargement had been carried a little too far, but when held at arm's length the effect is very fine. The most striking features noticeable are the narrow river-like lines, which are numerous and very alike in appearance. Whether these are really photographic or not of course we cannot say, as we have not seen the original negatives, but they seem to be rather too

distinct and natural to be taken for any impression other than photographic What these rivers, if we may use such a term, are composed of is at present a subject of mere conjecture, but the day is not far off when a very careful systematic study will have to be undertaken to settle some of the questions that have been recently raised in respect to our satellite's surface.

COMET SWIFT (1892 MARCH 6) —The ephemeris of this comet for the ensuing week, taken from the *Edinburgh Circular*, No 28, is as follows :—

Berlin Midnight

1892	R A. h. m s	Decl ° '	log Δ	log r	Br
July 14	0 58 26	+49 20 8			
15	59 6	49 31 4			
16	0 59 44	49 41 8	0 2459	0 2776	0 15
17	1 0 19	49 51 9			
18	0 52	50 1 8			
19	1 22	50 11 5			
20	1 49	50 21 0	0 2488	0 2884	0 14

Brightness at time of discovery taken as unity The comet ies in the southern extremity of the constellation of Cassiopeia

OPPOSITION OF MARS —All observatories which have the necessary equipment are especially invited by the United States Naval Observatory to join with them in making observations of the coming opposition of Mars Observations should commence on June 20 to September 23, this period being divided into three parts, the comparison stars for the first section being O A S 20970, η Capricorni, 27 Capricorni, ϕ Capricorni, Lacaille 8851, 41 Capricorni, D M - 20°, 6923, Lalande 42700 It may be mentioned that observations made in accordance with the special circular which the U S Observatory has issued will be reduced by them

SUN-SPOTS —*Himmel und Erde* for July contains two very good photographs of the sun at the time of the great spot in the month of February They were photographed by Dr Lohse, at the Astrophysical Observatory at Potsdam One was taken on February 13 at 10h , and shows the large group near central transit with a smaller group on the limb , while in the other, the large group is nearer the western limb A small disc represents the relative size of the earth for comparison

REMARKABLE PROMINENCES —The sun's atmosphere this year has been subject to many violent disturbances, indicated to us by the presence of spots, prominences, &c The spots, with special reference to the February group, have already received much attention, but not so with the prominences From a set of forty observations of the latter made between March 1 and May 31, 1892, by M Trouvelot, 23 of these, as he says, belonged to the most interesting type, *i e* , eruptive On April 6, 1892, there appeared an arched like prominence on the sun's limb, extending through 12°, the length of its base being 144,932 and its height 92,664 kilometres , to give an idea of the size of this arch, it may be stated that as many as 22 globes the size of our earth might have simultaneously passed under it At 10h 54m , on the 8th of the same month, a huge column of light, in shape rather like a candle flame, rose to a height of 115,830, extending, in a little over half-an-hour, to 169,884 kilometres A prominence of far greater length, occupying 34° of the solar limb, but of much less height than those mentioned above, was visible on April 15 Its base covered 410,632 kilometres, thus exceeding ten times the circumference of our earth

GEOGRAPHICAL NOTES.

AT the last meeting of the Council of the Royal Geographical Society for the present session, it was unanimously agreed to admit women as Fellows on the same terms as men. There is nothing in the society's charter to limit the membership to men, and the proposal of admitting ladies has been made several times, and on the last occasion—two years ago—was nearly carried As there will not be another meeting of the society until the opening of next session, the election of the first lady F R G S cannot take place until November

THE Annual Congress of the French Geographical Societies meets this year at Lille in the first week of August, for the consideration of questions relating mainly to France and its colonies The French Association for the Advancement of Science will hold its meeting at Pau, as we have already announced, in the third week of September Its Geographical Section will be presided over by M E Anthoine, head of the French Map Department and of Graphic Statistics under the Minister of the Interior In all departments of geography there is a remarkable revival of interest among Frenchmen at the present time, although the narrow or national aspect of the subject predominates over the wider or cosmopolitan

A CURIOUS account of the piratical Tugere tribe of New Guinea has been published in most of the continental geographical journals on the authority of "an English medical missionary, Dr Montague," who was picked up by a Dutch war-vessel near the boundary of Dutch and British New Guinea. This gentleman told a remarkable narrative of his capture and imprisonment by the Tugere, but as no English missionary of his name is known to be in New Guinea, nor has any mission station been recently raided by the Tugere, there is no doubt that some mistake has been made It is impossible that so serious an incident as the imprisonment of an English missionary could be unknown in this country, and unless strong evidence were forthcoming, it is difficult to believe that such a thoroughly piratical people as the Tugere could show the diligence in agriculture and the relatively high civilization with which the story credits them.

M F A MARTEL continues his researches into the subterranean geography of France In March last he descended the "unfathomable" Creux Percé on the plateau of Langres, proving it to be only 180 feet deep It is a hollow in Jurassic limestone, and, although open to daylight, forms a natural ice house, having a temperature of 28°F when the external air was at 58° In June he examined the still more remarkable Creux de Souci in the department of the Puy de Dôme It proved to be a rounded cavity in recent basalt, 115 feet deep, having the appearance of being formed by a great gas bubble A stagnant pool occupied the bottom of the pit, and above it the air was so much impregnated with carbonic acid that a candle would not burn In this instance also the temperature fell as the distance from the surface increased, that of the external air being 51°, of the air at the bottom of the shaft 34°, and the water itself 34° 3 The Paris Society of Commercial Geography recently awarded a medal to M Martel on account of the practical value of his researches in leading to the regulation of the underground drainage of Greece

EASTER ISLAND

THE prehistoric remains of Easter Island make it for archæologists one of the most interesting islands in the Pacific They will therefore read with interest an elaborate paper in the Report of the U S National Museum for 1888–89, which has just been issued The paper is entitled "Te Pito Te Henua, or Easter Island," and is by William J Thomson, Paymaster, U S Navy It records the results of researches made by Mr Thomson during a visit paid to Easter Island by the American vessel, the *Mohican*, towards the end of 1886 The *Mohican* anchored in the Bay of Hanga Roa on the morning of December 18, 1886, and remained till the evening of the last day of the year, when she sailed for Valparaiso Mr Thomson and some of his comrades, interested in the relics of a past phase of life in the island, made the most of the short time at their disposal, and his essay will certainly rank among the most important contributions which have been made to our knowledge of the subject with which it deals

He begins with a general account of Easter Island, and in this part of his work has succeeded in presenting compactly and clearly much valuable information Of the geological features of the island he says that they are "replete with interest." The formation is purely volcanic, and embraces every variety pertaining to that structure The tufaceous lavas form the most prominent element in the physiognomy of the island. To them, with the action of the trade-winds and heavy rains, is due the fact that Easter Island is surrounded by precipitous cliffs, rising in some cases to a thousand feet in height The formation is extremely friable, and by the action of the elements enormous masses are continually disappearing beneath the waves that beat on the unprotected shore Both on the coast-line and in the interior there are many natural caves Some of these are of undoubted antiquity, and bear evidence of having been used by early inhabitants as dwellings and burial-places. It is reported

that small images, inscribed tablets, and other objects of interest have been hidden away in such caves and lost through land slides

The climate is not unlike that of Madeira, with one wet and one dry season Yams, potatoes, and taro are cultivated, the young plants being protected from the fierce heat of the sun by a mulching of dried grass gathered from the uncultivated ground Bananas are grown, and so is sugar-cane, but the natives do not extract the juice for the purpose of making sugar. A wild gourd is common, and constituted the only water-jar and domestic utensil known to the islanders Mr Thomson saw no flowering plants indigenous to the soil, but ferns of many varieties are common, and grow in profusion in the craters of the volcanoes Except in a few exposed places, the slopes of the hills and the valleys are covered with a perennial grass resembling the Jamaica grass (*Paspalum*) This natural growth supplies ample pasturage for cattle and sheep

The only quadrupeds peculiar to the island are several varieties of rodents Fish abounds in the surrounding sea, and has always been the principal means of support for the islanders Turtles are also plentiful, and are highly esteemed The turtle occupies a prominent place in tradition, and is frequently represented in the hieroglyphics It appears also on sculptured rocks

According to the traditions of the natives, the island was discovered by King Hotu-Matua, who came from the land in the direction of the rising sun, with two large double canoes and three hundred chosen followers Mr Thomson thinks there may have been more than one migration of people to the island, and that their traditions may have been mingled together, but there can, he believes, be no reasonable doubt about the progenitors of the present islanders being of the Malayo-Polynesian stock. The people were shockingly treated by some of the early voyagers, and in 1863 the majority of the able-bodied men were kidnapped by Peruvians, who carried them away to work in the guano deposits of the Chincha Islands and the plantations in Peru Just before the arrival of the *Mohican* a complete census of the population had been taken by Mr Salmon, who found that the total number of natives was 155 The children are not much darker than Europeans, but the skin assumes a brown hue as they grow up and are exposed to the sun and trade-winds The eyes are dark brown, bright, and full, with black brows and lashes not very heavy The countenance is usually open, modest, and pleasing In disposition the natives are cheerful and contented They all profess Christianity, but there are now no missionaries among them, and they display a tendency to return to the old Pagan ideas Tattooing is no longer practised, but every islander advanced in life is ornamented in all parts of the body

At one time the island must have been densely populated, and the surviving monuments show that the inhabitants had attained to a higher civilization than that of other Polynesians The ancient stone houses at Orongo were thoroughly explored by Mr Thomson and his party These curious dwellings seem to have been built for the accommodation of the natives while the festival of the "sea-birds' eggs" was being celebrated During the winter months the island is visited by great numbers of sea-birds, most of which build their nests among the ledges and cliffs of the inaccessible rocks Some, however, choose two islets lying a few hundred yards from the south west point of Easter Island, and the natives are believed to have selected Orongo as a convenient spot for watching for the coming of the birds The fortunate person who obtained possession of the first egg, and returned with it unbroken to the expectant crowd, became entitled to certain privileges and rights during the following year Near Orongo are the most important sculptured rocks in the island They are covered with carvings intended to represent human faces, birds, fishes, and mythical animals, all very much defaced by the time and the elements The most common figure is a mythical animal, half human in form, with bowed back and long claw-like legs and arms According to the natives, this symbol represented "Meke-Meke," the great Spirit of the sea

On the high bluff west of Kotatake Mountain the party discovered the ruins of a settlement extending more than a mile along the coast-line and inland to the base of the hill These remains bear unmistakable evidences of being the oldest habitations on the island. The houses are elliptical in shape, with doorways facing the sea, and were built of uncut stone Some of the walls are standing, but the majority are scattered about in confusion Each dwelling was provided with a small cave or niche at the rear end, built of loose lava stones, which was in a number of instances covered by an arch supported by a fairly shaped key-stone The recesses were "undoubtedly designed to contain the household gods"

Mr Thomson has, of course, much to say about the stone images with the idea of which Easter Island is intimately associated in the minds of all who have devoted any attention to its antiquities Every image in the island was counted, and the list shows a total of 555 images Mr Thomson says.—

"Of this number forty are standing inside of the crater, and nearly as many more on the outside of Rana Roraka, at the foot of the slope where they were placed as finished and ready for removal to the different platforms for which they were designed, some finished statues lie scattered over the plains as though they were being dragged toward a particular locality but were suddenly abandoned The large majority of the images, however, are lying near platforms all around the coast, all more or less mutilated, and some reduced to a mere shapeless fragment Not one stands in its original position upon a platform The largest image is in one of the workshops in an unfinished state, and measures 70 feet in length, the smallest was found in one of the caves, and is a little short of three feet in length One of the largest images that has been in position lies near the platform which it ornamented, near Ovahe, it is 32 feet long, and weighs 50 tons •

"Images representing females were found One at Anakena is called 'Viri viri Moai-a Taka,' and is apparently as perfect as the day it was finished, another, on the plain west of Rana Roraka is called 'Moai Putu,' and is in a fair state of preservation The natives have names for every one of the images The designation of images and platforms as obtained from the guides during the exploration was afterwards checked off in company with other individuals without confusion in the record The course gray trachytic lava of which the images were made is found only in the vicinity of Rana Roraka, and was selected because the conglomerate character of the material made it easily worked with the rude stone implements that constituted the only tools possessed by the natives The disintegration of the material when exposed to the action of the elements is about equivalent to that of sandstone under similar conditions, and admits of an estimate in regard to the probable age The traditions in regard to the images are numerous, but relate principally to impossible occurrences, such as being endowed with power to walk about in the darkness, assisting certain clans by subtle means in contests, and delivering oracular judgments The legends state that a son of King Mahuta Ariiki, named Tro Kaiho, designed the first image, but it is difficult to arrive at an estimation of the period The journals of the early navigators throw but little light upon the subject The workshops must have been in operation at the time of Captain Cook's visit, but unfortunately his exploration of the island was not directed towards the crater of Rana Roraka

"Although the images range in size from the colossus of 70 feet down to the pigmy of 3 feet, they are clearly all of the same type and general characteristics The head is long, the eyes close under the heavy brows, the nose long, low-bridged, and expanded at the nostrils, the upper lip short and the lips pouting The aspect is slightly upwards, and the expression is firm and profoundly solemn Careful investigation failed to detect the slightest evidence that the sockets had ever been fitted with artificial eyes, made of bone and obsidian, such as are placed in the wooden images

"The head was in all cases cut flat on top, to accommodate the red tufa crowns with which they were ornamented, but the images standing outside of the crater had flatter heads and bodies than those found around the coast The images represent the human body only from the head to the hips, where it is cut squarely off to afford a good polygon of support when standing The artists seem to have exhausted their talents in executing the features, very little work being done below the shoulders, and the arms being merely cut in low relief The ears are only rectangular projections, but the lobes are represented longer in the older statues than in those of more recent date

"The images were designed as effigies of distinguished persons, and intended as monuments to perpetuate their memory They were never regarded as idols, and were not venerated or worshipped in any manner The natives had their tutelary genii, gods, and goddesses, but they were represented by small wooden or stone idols, which bore no relation to the images that ornamented the burial platforms The image makers were a privileged class, and the profession descended from father to son

Some of the natives still claim a descent from the image-makers, and refer to their ancestors with as much pride as to the royal family.

"The work of carving the image into shape, and detaching it from the rock of which it was a part, did not consume a great deal of time, but the chief difficulty was, in the absence of mechanical contrivances, to launch it safely down the slope of the mountain and transport it to a distant point. It was lowered to the plain by a system of chocks and wedges, and the rest was a dead drag accomplished by main strength. A roadway was constructed, over which the images were dragged by means of ropes made of indigenous hemp, and sea weed and grass made excellent lubricants. The platforms were all built with sloping terraces in the rear, and up this incline a temporary road way was constructed of a suitable height, upon which the statue could be rolled until the base was over its proper resting place. The earth was then dug away to allow the image to settle down into position, the ropes being used to steady it in the meantime."

Interesting as these monuments are, they are less remarkable than the incised tablets which show that the Easter Islanders had worked out for themselves a kind of writing. The following account of the tablets is given by Mr. Thomson. Their existence "was not known until the missionaries settled upon the island. Numerous specimens were found in the possession of the natives but no especial attention appears to have been directed towards them. Several persons, belonging to vessels that were wrecked at Easter Island, report having seen such tablets, but the natives could not be induced to part with them. The three hundred islanders who emigrated to Tahiti had in their possession a number of tablets; they created some attention on account of the remarkable skill with which the figures were executed, but they were highly prized by the owners, and no effort was made to secure them because their real value was not discovered. The Chilian corvette *O'Higgins* visited Easter Island in January 1870, and Captain Gana secured three tablets, two of which are on deposit in the National Museum at Santiago de Chili, and the third was sent to France, but does not appear to have reached its destination. Paper impressions and casts were taken from the Chilian tablets for the various Museums of Europe. Those sent to the English Ethnological Society created some interest after a time, but others sent to Berlin were regarded as stamps for marking native cloth (*Mittheilungen*, July 1871). Seven of these tablets are now in the possession of Tepano Janssen, Bishop of Axieri, all in excellent state of preservation.

"While the *Mohican* was at Tahiti, the Bishop kindly permitted us to examine these tablets and take photographs of them. These tablets were obtained from the missionaries who had been stationed on Easter Island, and they ranged in size from 5½ inches in length by 4 inches broad, to 5½ feet in length and 7 inches wide. Diligent search was made for specimens of these tablets during our visit to Easter Island. At first the natives denied having any, but Mr. Salmon knew of the existence of two, and these were finally purchased after a great deal of trouble and at considerable expense. The tablets obtained are in a fair state of preservation. The large one is a piece of driftwood that from its peculiar shape is supposed to have been used as a portion of a canoe. The other is made of the toromiro wood indigenous to the island. In explanation of the disappearance of these tablets, the natives stated that the missionaries had ordered all that could be found to be burned, with a view to destroying the ancient records, and getting rid of everything that would have a tendency to attach them to their heathenism, and prevent their thorough conversion to Christianity. The loss to the science of philology by this destruction of valuable relics is too great to be estimated. The native traditions in regard to the incised tablets simply assert that Hotu-Matua, the first king, possessed the knowledge of this written language, and brought with him to the island sixty-seven tablets containing allegories, traditions, genealogical tables, and proverbs relating to the land from which he had migrated. A knowledge of the written characters was confined to the royal family, the chiefs of the six districts into which the island was divided, sons of those chiefs, and certain priests or teachers, but the people were assembled at Anekena Bay once each year to hear all of the tablets read. The feast of the tablets was regarded as their most important *fête* day, and not even war was allowed to interfere with it.

"The combination of circumstances that caused the sudden arrest of image-making, and resulted in the abandonment of all such work on the island, never to be again revived, may have had its effect upon the art of writing. The tablets that have been found in the best stage of preservation would correspond very nearly with the age of the unfinished images in the workshops. The ability to read the characters may have continued until 1864, when the Peruvian slavers captured a large number of the inhabitants, and among those kidnapped were all of the officials and persons in authority. After this outrage, the traditions, &c., embraced by the tablets, seem to have been repeated on particular occasions, but the value of the characters was not understood, and was lost to the natives.

"A casual glance at the Easter Island tablets is sufficient to note the fact that they differ materially from other kyriologic writings. The pictorial symbols are engraved in regular lines on depressed channels separated by slight ridges intended to protect the hieroglyphics from injury by rubbing. In some cases the characters are smaller, and the tablets contain a greater number of lines, but in all cases the hieroglyphics are incised, and cover both sides as well as the bevelled edges and hollows of the board upon which they are engraved. The symbols on each line are alternately reversed; those on the first stand upright, and those on the next line are upside down, and so on by regular alternation.

"This unique plan makes it necessary for the reader to turn the tablet and change its position at the end of every line; by this means the characters will be found to follow in regular procession. The reading should commence at the lower left hand corner, on the particular side that will bring the figures erect, and followed as the characters face in the procession, turning the tablet at the end of each line, as indicated. Arriving at the top of the first face, the reading is continued over the edge to the nearest line, at the top of the other side, and the descent continues in the same manner until the end is reached. The Boustrophedon method is supposed to have been adopted in order to avoid the possibility of missing a line of hieroglyphics."

A man called Ure Vaeiko, one of the patriarchs of the island, professed to have been under instructions in the art of hieroglyphic reading at the time of the Peruvian visit, and claimed to understand most of the characters. The photographs of the tablets owned by the Bishop were submitted to this old man, who related with fluency and without hesitation the legend which he declared to be appropriate to each. "The story of all the tablets of which we had knowledge," says Mr. Thomson, "was finally obtained, the words of the native being written down by Mr. Salmon as they were uttered, and afterwards translated into English."

Ure Vaeiko's tales, with the translations, are printed in Mr. Thomson's paper; and, as they are manifestly not the reciter's own invention, they have a certain interest for students of anthropology. But whether they represent the meaning of the inscriptions on the mysterious tablets is another question. It is noteworthy that, although Ure Vaeiko's fluent interpretation of the tablets was not interrupted, "it became evident that he was not actually reading the characters." "It was noticed that the shifting of the position did not accord with the number of the symbols on the lines, and afterwards, when the photograph of another tablet was substituted, the same story was continued without the change being discovered." These facts raise a doubt as to the trustworthiness of his pretensions to knowledge. However, Mr. Thomson does not seem to have yet presented a full account of the work accomplished in connection with this curious problem. "Results of an extremely interesting nature," he says, "are barely outlined at present, and not in shape to be presented herewith. It is not considered expedient to attempt an explanation of the symbols until the subject can be treated exhaustively."

It remains for us only to say that the paper is richly illustrated, and accompanied by a map of Easter Island.

EMBRYOGENY OF GNETUM.

THE remarkable observations of Treub on the mode of fertilization in the *Casuarinaceæ*,[1] have been followed by some almost equally interesting, by Herr Karsten, on the formation of the embryo in *Gnetum*. The following is a summary of the more important points, as described in the *Botanische Zeitung*.

The inner integument of the ovule develops into a long tube leading to the apex of the nucellus, and projecting far beyond

[1] See NATURE, vol. xlv. p. 548.

the other two integuments, it forms, at its apex, a drop of sweet fluid which captures the pollen-grains carried by the wind or possibly by insects. The outermost very thick integument becomes fleshy and bright-coloured, and is attractive to herbivorous animals In the division of the cells of the nucellus at an early stage there is no evident predestination of one, as there is in most Angiosperms, as the mother-cell of the embryo sac In *Gnetum Gnemon* and *neglectum* there are usually two, three, or even more embryo-sacs which appear equally capable of further development, while in *G edule*, and allied forms, the author found only one In the division of the contents of the embryo sac no differentiation of a female apparatus takes place in any of the species examined, no corpuscles or special ovum-cells are formed, and no antipodals, but the protoplasm of the embryo-sac divides into a parietal layer of primordial cells, which appear to be altogether equivalent, and which represent so many ovum cells capable of fertilization

As the pollen tube lengthens, its nucleus gives off a smaller vegetative nucleus, probably soon after the entrance of the tube into the tissue of the nucellus The two nuclei remain very near one another, the vegetative nucleus or prothallium cell remains unchanged, while the generative nucleus increases greatly in size and divides into two In *G edule* the apex of the pollen tube has now entered the apex of the embryo-sac, while in *G neglectum* it appears to make a curve to avoid the apex of the sac, and becomes closely applied to its lower portion After the pollen-tube has entered the embryo-sac its vegetative nucleus disappears, while each of the two generative nuclei surrounds itself with a membrane of protoplasm, and the nucleus of each of these generative cells divides into four or eight The actual coalescence of the male and female nuclei was not observed, but a number of small nuclei were detected in the male generative cells, in addition to its four (or eight) comparatively large male nuclei, which the author regards as the nuclei of the primordial ovum-cells which have wandered into the male generative cells, and the coalescence must take place within the male generative cell After the entrance of the pollen tube, the parietal layer of protoplasm of the embryo sac, in which the female primordial cells are imbedded, breaks up into an endosperm tissue

The author regards *Gnetum* as representing a higher type of the order *Gnetaceæ* than the other genera, *Welwitschia* and *Ephedra*, the fact that no endosperm is formed before fertilization indicating an advance on other Gymnosperms The presence of a large number of embryo sacs, and the absence in them of antipodals, may indicate some analogy with *Casuarina* The processes described above finally negative, in the opinion of the author, the theory that the antipodals are a survival of the female prothallium of Vascular Cryptogams, they appear, rather, to be a degenerate and functionless female sexual apparatus According to this view, there are, in the embryo sac of Angiosperms, two female sexual apparatuses of similar origin, the vegetative nuclei of which coalesce in each, but one of the two apparatuses is altogether abortive Both the antipodals and the egg-apparatus or embryonic vesicles consist of an archegone reduced to a single cell A. W. B

INTERNATIONAL CONGRESS OF EXPERIMENTAL PSYCHOLOGY

THE second session of the above Congress will be held in London on Monday, August 1, 1892, and the three following days, under the presidency of Prof H Sidgwick The Congress will assemble in the rooms of University College, Gower Street (kindly lent for the purpose), from 10 to 1 and from 2 to 4.30 The following papers have been arranged for —

Dr ALEXANDER BAIN	"The Respective Spheres and the Mutual Aids of Introspection and Experiment in Psychology"
Prof M. BALDWIN	"Suggestion and Will."
Prof. BEAUNIS	"Psychological Questioning" (Des questionnaires psychologiques)
Dr. BÉRILLON	"The Applications of Hypnotic Suggestion to Education"
Prof. BERNHEIM	"The Psychical Character of Hysterical Amblyopia".
M. BINET	"The Psychology of Insects."
Prof. DELBŒUF	"The Appreciation of Time by Somnambulists"
Dr DONALDSON	"Laura Bridgman"
Dr VAN EEDEN	"Principles of Psycho-Therapeutics"
Prof EBBINGHAUS	"Theory of Colour perception"
Dr GOLDSCHEIDER	"Investigations into the Muscular Sense of the Blind"
Prof STANLEY HALL	"Recent Researches in the Psychology of the Skin"
Prof HENSCHEN	"The Visual Centre in the Cortex of the Calcarine Fissure"
Prof HEYMANS	"Inhibition of Presentations"
Prof V HORSLEY	"The Degree of Localization of Movements and Correlative Sensations"
Prof PIERRE JANET	"Loss of Volitional Power (l'aboulie)"
Prof N LANGE	"A Law of Perception"
Prof LIÉGEOIS	"The Female Poisoner of Ain-Fezza"
Prof LEHMANN	"Experimental Inquiry into the relation of Respiration to Attention"
Dr. LIGHTNER-WITMER	"The Direct and Associative Factors in Judgments of Æsthetic Proportion"
Prof LOMBROSO	"The Sensibility of Women, Normal, Insane, and Criminal"
Dr MENDELSSOHN	"Investigations into the Parallel Law of Fechner."
Prof LLOYD MORGAN	"The Limits of Animal Intelligence"
Prof G E MULLER	"The Experimental Investigation of Memory"
Prof MUNSTERBERG	"The Psycho Physical Basis of the Feelings"
Mr F W H MYERS	"The Experimental Induction of Hallucinations"
Dr. W R NEWBOLD	"The Characteristics and Conditions of the Simplest Forms of Belief"
Prof PREYER	"The Origin of Numbers"
Prof RIBOT	"General Ideas"
Prof RICHET	"The Future of Psychology"
Prof SCHAFER	"The Anatomical and Physiological Relations of the Frontal Lobes"
Mrs SIDGWICK	"Experiments in Thought-Transference"
Dr E B TITCHENER	"Binocular After-images"
Prof TSCHISCH	"Relation of Reaction time to the Breadth of Perception"
Dr VERRIEST	"The Physiological Basis of Rhythmic Speech"
Dr WALLER	"On the Functional Attributes of the Cerebral Cortex"

The Meetings of the Congress will be General and Sectional It is provisionally arranged that the General Meetings will be held on Monday or Thursday, and on the afternoons of Tuesday and Wednesday, and that the Sectional Meetings will be held on Tuesday and Wednesday Mornings, and if necessary on Thursday Morning There will be two Sections at least · Section A, Neurology and Psychophysics, and Section B, Hypnotism and Cognate Questions Under Section A will fall, for example, the papers of M Binet, Profs Henschen, Horsley, Schafer, Waller, &c, under Section B will fall the papers of Dr Bérillon, Profs Bernheim, Delbœuf, Liégeois, Dr Van Eeden, Mr F. W H Myers, and Mrs Sidgwick

Reports will be given in by Profs Sidgwick and James and M. Marillier of the results of the census of hallucinations which it was decided to carry out at the first Session of the Congress (Paris, 1889).

A Committee of Reception has been formed, which includes, among others, the following names:—Dr. A. Bain, Dr D. Ferrier, Mr F Galton, Dr. Shadworth Hodgson, Prof. V. Horsley, Dr. Hughlings Jackson, Dr Charles Mercier, Prof. Croom Robertson, Dr. G J. Romanes, Mr. Herbert Spencer, Mr. G. F Stout, Dr. J. Ward, and Dr. de Watteville.

The fee for attendance at the Congress is ten shillings, which

will entitle to a printed report of the proceedings Any intending members who have not yet paid the fee are requested to send it to Prof Sully

During the Congress letters may be addressed to Members at the Council Room, University College, Gower Street, London, W C, where each Member is requested to inscribe his name, on his first attendance at the Congress

F W H Myers,
Leckhampton House, Cambridge

James Sully,
East Heath Road, Hampstead, London, N W

SCIENTIFIC SERIALS

The current number of the *Royal Agricultural Society's Journal* is, perhaps, of more than usual interest The first article is on Vermin of the Farm, by J E Harting, and is followed by an editorial note on the same subject The plague of "mice" on the hill pastures of Scotland this spring gives a special interest to these articles It appears that the Scotch plague is caused not by mice, but by fieldvoles (*Arvicola agrestis*), and the destruction they have wrought in the hill pastures of Scotland arises from the fondness of these voles for the delicate white stems of the hillside herbage Judging from the reports of similar plagues in previous years it would appear that the natural enemies of the vole—the short-eared owl and the kestrel hawk—are far more efficacious remedies than any artificial means yet devised for the destruction of the voles, hence a paper on Wild Birds in relation to Agriculture, by Earl Cathcart, is very opportune, protesting as it does against the careless destruction of such birds as the owl, the hawk, and the rook The Journal also contains a second paper by Mr Dan Pidgeon on the Evolution of Agricultural Implements A suggestive paper by Mr William E Bear on Desirable Agricultural Experiments advocates extensive experiments to test the economy of nitrogenous manuring by means of leguminous crops Other papers in this number are Contagious Footrot in Sheep, by Prof G T Brown, Variations of the Four course System, by Gilbert Murray, and the Trial of Ploughs at Warwick, by F S Courtenay

SOCIETIES AND ACADEMIES

Oxford University Junior Scientific Club, May 27 —The biennial conversazione of the Club was held in the University Museum, when an address inaugural to the recently founded "Robert Boyle lectures of the O U J S C" was delivered by Prof Sir Henry W Acland, Bart, K C B, F R S, on Robert Boyle, his life, work, and influence on science A very interesting series of exhibits was shown by the various departments of the Museum and by the University Observatory, illustrating recent progress in their particular branches of science Of special interest were the exhibits by the Rev F J Smith on shadow and objective spark photography, illustrated by pictures of objects in rapid motion; by Mr Cecil Carus Wilson, of natural and artificial musical sands, by the University Observers, of a series of splendid photographs illustrating recent improvements in astronomical and spectral photography, by the National Telephone Company, of telephonic apparatus, by Dr Hunt, of preparations and cultivations illustrating the methods of isolation and identification of bacteria, by Mr B V Darbishire, of a series of lantern views in the Caucasus and in the British East Africa Company's territory, the slides for which were kindly lent by the Royal Geographical Society The Club is much indebted to the Royal Society, the Pharmaceutical Society, the Right Hon the Earl of Cork and Orrery, Prof Wyndham R Dunstan, Prof Odling, and other gentlemen for the loan of oil paintings, engravings, and relics of Robert Boyle and his contemporary men of science in Oxford

June 3 —The President, Mr W Ramsden, in the chair —The following papers were read —The sub salts of the alkali metals, by Mr W Pullinger —The action of silicon-tetrachloride on benzene, by Mr C H H Walker —Marriages of consanguinity, by Mr H. Anglin Whitelocke.—A new and improved form of rotatory hypsometer, by Mr. S A Sworn (Balliol) Mr C J Romanes was elected an honorary member of the Club

June 14 —The President, Mr W Ramsden, in the chair —The following papers were read —The action of iodine on a mixture of sulphites and thiosulphates, by Mr H A Colefax —On marine nests, by Mr W B Benham

Edinburgh

Royal Society, June 20 —Dr Traquair exhibited some remains of animals occurring in volcanic tuff at Teneriffe —Dr Hunter Stewart read a paper on the variations in the amount of carbonic acid gas in the ground air —Dr Buchan discussed the diurnal variations of barometric readings in the polar regions during summer From observations made in the summer of 1876 and the two succeeding summers, in the central part of the North Atlantic, between 62° and 80° north latitude, he showed that only one maximum and one minimum occur during the day Observations made by the *Challenger* staff in high antarctic latitudes during summer give the same result A single maximum and a single minimum are also found in the interior parts of the polar continents, but these occur at different times of the day from the ocean maximum and minimum Superposition of the two sets of variations gives a variation like that ordinarily observed

July 4 —The Hon Lord Maclaren, Vice President, in the chair —Dr A W Hughes read a paper on the rotatory movements of the human vertebral column Among other results he points out that while the lumbar vertebræ cannot rotate much about a vertical axis, the dorsal vertebræ are capable of considerable rotation—the total rotation of this part of the vertebral column being 45° or more—and the cervical vertebræ are still more free—the total amount being at least 90° —Mr R Kidston discussed the genus *Lepidophloios*, Sternb —Prof C G Knott and Mr A Shand communicated some further notes on the volume effects of magnetization Five iron tubes, with bores varying from 16 0 to 3 5 mm diameter, but otherwise identical in form and substance, were subjected to a series of magnetizing forces In low fields the thinner-walled tubes experienced the greater dilatations of internal volume, but in high fields the narrower bored tubes showed much the greater dilatations For example, in field 1400 the dilatations of the tubes in order, beginning with the one of widest bore and thinnest wall, were +4, −3, −20, −53, and −129—each being multiplied by 10^{-7} With the two tubes of widest bore, the change of volume had reached its limit at this high field, the substance being practically saturated, but with the tubes of narrowest bore there was no evidence of a limit being reached, the innermost layers of iron being evidently far from practical saturation Some interesting illustrations of magnetic after effect were also described —Dr A B Griffiths submitted a paper on the blood of the invertebrata.—Prof Tait communicated the second part of a paper on the laws of motion If we assume the principles of inertia of matter and conservation of energy (the energy of a self contained system consisting of the kinetic energy of all its parts supposed to be moving with the speed of its centre of inertia, the kinetic energy of relative motion of its parts, and the potential energy of its parts), the fact that we cannot attach any definite meaning to the principle of conservation, except when the motion of the system is Galilei wise, leads at once to the first and third laws of motion, since the centre of inertia moves uniformly in a straight line, and the second law becomes merely a definition of the word "force" as used in the first law, and as used instead of "action" and "reaction" in one interpretation of the third

Paris

Academy of Sciences, July 4.—M. d'Abbadie in the chair —On local disturbances produced underneath a heavy load uniformly distributed along a straight line normal to the two edges, on the upper surface of a rectangular beam; experimental verifications, by M J Boussinesq —Resemblances in the march of evolution on the old continent and the new, by M. Albert Gaudry —Experimental researches on falling bodies and the resistance of air to their motion: experiments performed at the Eiffel Tower, by MM L. Cailletet and E Colardeau Metallic spheres were let fall from the second platform of the Eiffel

Tower, and their exact time of describing certain distances was measured to a hundredth of a second by means of an electric chronograph The body was fixed to a very light thread wound round a set of inverted cones, each of which held 20m of thread The latter passed from one cone to another through two fine springs in contact, which contact was broken by the string pulling through, thus producing a mark on the chronograph The retardation produced by the string was independently determined and found to be less than 0 001 per cent The following laws were verified · that the resistance of the air is proportional to the area of the resisting surface, and that it is independent of the form of the surface That it is also proportional to the square of the velocity was not found to be strictly true, since the resistance increased rather more rapidly The amount of fall after which the velocity of the weights employed became uniform ranged from 60m to 100m Contribution to the study of the function of camphoric acid, by M A Haller —A new contribution to the history of morbid associations, anthrax and paludism, by M Verneuil —Fixation of ammoniacal nitrogen on straw, by M de Vogüé —On the nature of the rotation of the knife-edge of a pendulum on its plane of suspension, by M G Defforges This rotation is not a simple rolling, as was assumed by Euler and Laplace, but is compounded with a sliding motion, whose existence can be proved by means of interference fringes The sliding is proportional to the amplitude and up to six or seven kgr to the weight —On the influence of the place of the external thermometer in observations of zenith distances, by M Périgaud In calculating the error due to refraction by Arago's method, the density of the layer of air in the neighbourhood of the objective is measured by a thermometer placed outside the room, near the north side of the observatory It was sought to fulfil the conditions of the problem more rigidly by suspending a thermometer quite close to the objective The zenith-distances, calculated on the basis of its indications, showed a difference of 0 2 to 0 8 from those obtained by Arago's method, which made the zenith distances too large. The writer's method has been adopted at the great transit instrument of the Paris Observatory —On the primary forms of linear differential equations of the second order, by M Ludwig Schlesinger —On the precise determination of the critical density, by M E Mathias This determination is aided by the law of the rectilineal diameter, according to which in the curve of temperatures and densities the locus of the midpoints of the chords parallel to the axis of the ordinates is a straight line This law, recently confirmed by Young's experiments, implies that the critical density is equal to the ordinate of the diameter which corresponds to the critical temperature Calculated according to this law, the critical densities of methyl, ethyl, and propyl alcohol are found to be the same —Influence of the mass of the liquid in the phenomena of heating, by W A Witz.—Measurement of the dielectric constant by electromagnetic oscillations, by M A Pérot By the method described, the constant K was determined for glass, and found to range from 2 71 if charged for $72 6 \times 10^{-10}$ sec to 5 727 if charged for $453 7 \times 10^{-10}$ sec —On the composition of water and Gay Lussac's law of volumes, by M A Leduc The writer's researches on the densities of gases have led him to adopt the value 23 24 for the percentage of oxygen in the air The density of oxygen was determined by a modification of Dumas's process, in which the hydrogen was absorbed by finely-laminated electrolytic copper The atomic weight deduced was 15 88, while the mean of the best values for the density is 15 90 This shows that Gay Lussac's law of volumes is only approximate —On the nitrogen salts of platinum, by M M Vèzes.—Researches on the sodic pyrogallols, by M de Forcrand —On acetono-resorcine, by M H. Causse —Utilization of roasted iron pyrites for the manufacture of iron salts, by MM A and P Buisine.—On the alterations of ferruginous waters, by M. F. Parmentier —Reproduction of pure potassic nepheline, by M André Duboin.—On the passage of dissolved substances through mineral filters and capillary tubes, by M C. Chabrié —On hæmocyanine, by M Léon Frédéricq —On the physiological determinism in the metamorphosis of the silk-worm, by M E. Bataillon.—On a new *Temnocephala*, a parasite of *Astacoides madagascariensis*, by M A Vayssière —Earthworms and tuberculosis, by MM Lortet and Despeignes. Proving that worms can bring the bacillus to the surface, preserving all its virulent properties.—On the Californian disease, a disease of the vine caused by *Plasmodiophora californica*, by MM P Viala and C Sauvageau —An essay on vegetable statics, by M Augustin Letellier —On the cavern called the Creux de Souci (Puy-de-Dome), by MM E Martel, A. Delebecque, and G Gaupillat —On the lakes of the central plateau of France, by MM A Delebecque and E Ritter

BERLIN

Physical Society, June 3 —Prof Schwalbe, President, in the chair —Dr Gross continued his remarks on the subject of entropy —Dr Wien gave an account of experiments on the measurement of high temperatures, made in conjunction with Dr Holborn, with a view to testing Le Chatelier's platinum and rhodium thermo elements They were first compared with an air-thermometer The latter consisted of a glazed porcelain tube containing slightly rarefied air, the temperature being recorded by a manometer The thermo-element was introduced into the cavity of the air thermometer, and the readings of the respective instruments were compared between $-80°$ and $+1500°$ Below 500° the thermo element was not very sensitive, and is hence of use only for high temperatures Alloys of platinum with 9, 10, 11, 20 and 40 per cent of rhodium were tried It was found that the E M F increased with the increased percentage of rhodium, but that the most suitable alloy was that containing 10 per cent of rhodium as recommended by Le Chatelier The above experiments necessitated the determination of the co-efficient of linear expansion of Berlin porcelain This was found to be 000004 In some final experiments the melting point of gold was determined to be 1073° and 1067°, of silver 972° and 968°, and of copper 1082°

June 17 —Prof Kundt, President, in the chair —Prof Vogel exhibited a remarkably fine series of coloured prints of oil paintings, &c, prepared in accordance with his method by Messrs Vogel and Ulrich The method consists in first taking a red, a yellow, and a blue negative of the object on plates specially sensitized for colours The three negatives are then printed on to one and the same paper by means of complementarily coloured rollers or stones In order to obtain the colours exactly complementary to those of the negatives, the colours used for printing were either the coloured sensitizers themselves or some substance whose equivalence to these had been determined spectroscopically The application of the physical principles involved in the above yielded an approximate reproduction of the natural colours which was surprisingly complete, and will become more so as more and more coloured substances are discovered suitable as sensitizers —Prof Koenig described his new spectrophotometer Its chief improvement consists in the introduction of Lummer and Brodhun's glass-cube, which is, however, so modified as to admit of the measurement of the relative intensities of the parallel rays falling into it

Physiological Society, June 24.—Prof du Bois Raymond, President, in the chair —Prof Kossel communicated the results of some experiments made by Dr Monti on the absorption of oxygen by the tissues after death, using for this purpose their reducing action on photographic plates. The suprarenals, spleen, and thymus reduced most actively, while brain-substances produced but little effect Dr Lilienfeld had investigated the distribution of phosphorus in various tissues by means of micro-chemical reactions with ammonium molybdate and pyrogallol The presence of phosphorus was usually strongly marked in the nuclei as compared with the cell substance, except in the case of the cerebral ganglia, in which the reverse was frequently observed. Prof Gad drew attention to a phenomenon, brought to his notice by Prof Litten, which may be observed during normal human respiration, and consists in the downward passage of an obvious wave over the wall of the thorax at each inspiration and the upward passage of a similar wave at each expiration.

AMSTERDAM

Royal Academy of Sciences, June 25 —Prof. van der Waals in the chair —Prof. T Forster spoke (1) On the action of heat upon tuberculous matter According to former investigations by "pasteurizing" (*i e*, warming liquids to a temperature of 60 to 80° C for a short time and cooling them immediately), bacteria of Asiatic cholera and typhoid-fever are killed at about

60° From a hygienic point of view it is of still more importance to discover what is the lowest temperature at which the bacilli of tuberculosis are destroyed It is established that tuberculosis is produced by the consumption of milk secreted by tuberculous cows. Meat also, coming from tuberculous cattle, sometimes contains infectious matter By boiling heat, indeed, the bacilli of tuberculosis are killed But if meat is prepared in the usual manner, even small pieces of it are not warmed thoroughly at 100° C, milk, on the other hand changes in taste if boiled, so that most people do not like boiled milk By a series of experiments, recently made, Prof Forster has settled that the bacilli of tuberculosis are destroyed by a temperature of 60° C acting during one hour, and by the action during six hours of a temperature of 55° C Higher temperatures than 60°, for instance, 80, 90 or 95° C, destroy the infectious matter in milk from tuberculous cows if they act during *ten* minutes, "pasteurizing," however, at 80° during *one* minute does not hurt the bacilli of tuberculosis (2) On the development of bacteria at a temperature of melting ice He had formerly demonstrated cultivations of bacteria, which produce light of phosphorescence The same kind of bacteria are also able to develop and to multiply at a temperature of 0° C He found that bacteria which have this peculiar quality, so interesting from a biological point of view, not only live in the sea, but are met with in brackish and fresh water, upon victuals, manures, etc, etc This agrees with the fact that victuals, kept for some days in an ice chamber, gradually assume a disagreeable smell and taste, and that meat can be preserved from putrefaction for days but not for weeks If foods are to be preserved at a low temperature for a long time, beside cold a second agent is necessary—dryness In the cooling rooms of the most modern establishments (slaughterhouses, stores, etc, etc) no use is made of ice, which after melting moistens the atmosphere and the objects in the ice-chambers, but arrangements are made by which the atmosphere is cooled to a low temperature and at the same time kept perfectly dry —M Beyerinck spoke of the culture of organisms of nitrification on agar agar and on gelatine First it was stated, in accordance with the discovery of Warington and Winogradsky, that nitrification consists in two processes—the formation of nitrous acid from the ammonsalt by a specific bacterium and the oxidation of the nitrite into nitrate by another and independent species of bacterium Secondly, that both these processes occur *only* when soluble organic matter is reduced to a minimum such as has been proved by the classic researches of Winogradsky and the Franklands Even 0 1 per cent. of calcium acetate retards nitrification strongly Thirdly, it was found that organic matter in the solid state does not in the least interrupt or retard nitrification Therefore an attempt was made—and successfully—to cultivate the nitrous and nitric bacteria on agar-agar, fully extracted with distilled water and afterwards boiled with the inorganic salts needed for nitrification If with these salts some pure precipitated carbonate of lime was added to the agar it was possible to obtain a "chalk agar plate," whereon the nitrous bacteria of the soil, after their growth into colonies, could directly be numbered For this purpose the chalk-agar is poured into a glass box, and some soil suspended in sterilised water brought on the surface of the solidified plate After three to four weeks the colonies become visible as the centres of clear, transparent, perfectly circular diffusion figures, formed by the solution of the carbonate of lime in the nitrous acid, the very soluble calcium-nitrite diffusing in all directions in the agar plate. In this way it was found, for example, that out of c.a. 10 millogrammes soil taken from under a sod of white clover in a garden at Delft, thirty colonies of the nitrous bacterium could be cultivated The species is the same as that described as the European form by Winogradsky, growing, as well as zooglœa, quite free, and possessing the form of a small, moveable mikrokok with one cilium Gelatine, prepared with the same precautions as the agar, can also be used, but therein the production of nitrous acid soon ceases The nitrous bacterium does not liquefy the gelatine Though it does not grow or oxidize when organic matter is present, it does not lose these powers by this contact, as shown when brought anew under adequate conditions. The nitric bacterium was also isolated on fully extracted agar, to which 0·1 per cent. potassium-nitrite and some phosphate was added. The colonies are very small and coloured light yellow They consist of very small non-moving mikrokoks or short ellipsoids. They lose their power of oxidizing nitrites by the contact of soluble organic matter, without thereby losing their power of growth The nitric bacterium does not oxidize ammonsalts. It is also without action on potassium rhodanate and hydrochloric-hydroxylamine It therefore does not seem to produce free acid such as the nitrous bacterium A simple method for the formation of sterile plates of silica, with and without carbonate, was also described Many preparations were demonstrated

BOOKS AND SERIALS RECEIVED

BOOKS —Grasses C H Jones (S P C K.) —A Synoptical Geography of the World (Blackie) —London Matriculation Directory, No. xii, June 1892 (Clive) —The Case against Bimetallism R Giffen (Bell).—The Birds of Devon W S M D'Urban and Rev M A. Mathew (Porter).—Universal Atlas Part 16 (Cassell) —Photography Annual, 1892 (Iliffe) — Muséum d Histoire Naturelle des Pays Bas, tome xi Cat Systématique des Mammifères F A Jentink (Leide, Brill) —The Applications of Elliptic Functions A G Greenhill (Macmillan and Co) —Sunshine A Johnson (Macmillan and Co) —Theory of Numbers, Part 1 G B Mathews (Bell) —Alcohol and Public Health Dr J J Ridge (Lewis).—Murray s Hand book, Norway 8th edition (Murray)

SERIALS —Transactions of the County of Middlesex Natural History and Scientific Society, Sessions 1889-90, 1890, and 1891 (London).—Natural Science, No 5 (Macmillan and Co) —L'Anthropologie, 1892, tome 3, No 3 (Paris Masson) —Bulletin de l Académie Royale des Sciences de Belgique, No 5 (Bruxelles) —Journal of the Royal Agricultural Society of England, 3rd series, vol 3, Part 2, No x (Murray) —Department of Agriculture, Victoria, Bulletin No 14 (Melbourne) —The Asclepiad, No 34, vol ix (Longmans) —Mind, July (Williams and Norgate) —Journal of Anatomy and Physiology, July (Williams and Norgate) —Archives des Sciences Biologiques publiées par l'Institut Impérial de Médecine Expérimentale à St Pétersbourg, tome 1, No 3 (St Petersburg) —Geological Magazine, July (K Paul) —Annals of Scottish Natural History, No. 3 (Edinburgh, Douglas) —Medical Magazine, vol 1, No 1 (Southwood).—Journal of the Royal Statistical Society, June (Stanford).—Journal of the Chemical Society, July (Gurney and Jackson).—Quarterly Journal of Microscopical Science, No 132 (Churchill)

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THURSDAY, JULY 21, 1892

DR. MIVART'S ESSAYS

Essays and Criticisms By St. George Mivart, F R S (London Osgood, M'Ilvaine, and Co, 1892)

DR MIVART has collected in two portly volumes a number of essays and critical reviews which he has from time to time contributed to current monthly or quarterly literature The ground covered is tolerably extensive, from "Jacobinism" and "The French Revolution" to "Weismann's Theories" and "Eimer on Growth and Inheritance," from "Austrian Monasteries" and "The Greyfriars" to "Herbert Spencer" and "Hermann Lotze" We have read the whole, or almost the whole, with interest, and not without admiration of the author's wide knowledge, his earnest purpose, and his power of clear exposition Here, however, we are chiefly concerned with those essays which deal with scientific problems They are well worthy of reperusal in their present collected form, and that chiefly because Dr Mivart holds definite and in some respects peculiar views on evolution, because he has the advantage of some training in philosophy, because he is a learned and acute critic, and because he has pre eminently the courage of his convictions

It is scarcely necessary to remind the readers of NATURE that Dr Mivart is one of those who hold that natural selection has played a quite subordinate part in the evolution of organisms He believes that the concurrence of certain external exciting causes acts in such a manner on internal predisposing tendencies as to determine by direct modification the evolution of new specific forms Furthermore he affirms that, beyond the domains of merely physical science (which, though much, is not everything), reason demands a non-mechanical conception—namely, the conception of an immanent active principle or soul in everything which lives And he contends that between the self-conscious reason of man and the mere sensuous feeling of the higher brutes, there is a great and impassable gulf fixed These are among the more important positions which the author of these "Essays and Criticisms" assumes in the field of biological speculation And to these may, perhaps, be added his condemnation of the doctrine of the relativity of knowledge, and his belief in common-sense realism, apparently on the assumption that the external reality of the objective world (as opposed to its *phenomenal* existence) is directly apprehended by the intellect, though it cannot be reached through sensuous feeling

On all these matters Dr Mivart has much that is interesting to say, and says it in an interesting manner It would manifestly be impossible here to discuss so wide a range of problems We therefore propose to select one matter—that of the relation of human reason to brute intelligence—on which to offer a few remarks.

In the essay entitled "A Limit to Evolution," the author seeks to establish the impossibility of mental evolution as applied to man. He insists, and rightly insists, that the great difference between man and the lower animals lies not in his bodily but in his mental constitution ; and he contends, again in our opinion with perfect justice, that in order to examine this question we must begin by looking a little carefully into our own minds, and by examining our own acts and mental nature. As the result of this examination he finds that our psychical operations fall into two classes, on the one hand, there are feeling (sensitivity), imagination and sensuous memory, sensuous emotion, sense-perception, and sensuous inference, on the other hand, there are intellectual perception, ideation and conception, abstract ideas, and moral and æsthetic concepts "The contrast, the difference of *kind*," he says, "which exists between this *intellectual conception* and the various forms of *feeling* is very great" We thus possess a dual psychical nature, on the one side sensuous, on the other side intellectual The sense-perceptions of the one and the abstract ideas of the other "belong to utterly different categories, and a nature which has this power of abstraction is separated from any nature which has *not* that power, by a gulf which is an impassable *limit to evolution*, because feeling and intellect are both thus different in nature, and progress and develop along different and more or less diverging roads" But the psychical powers of brutes are limited to sense-perception, and give no evidence of the possession of the higher faculty of ideation and conception Therefore the passage from the so-called mind of the brute to the conceptual mind of man is not only impossible but inconceivable

Such in brief is Dr Mivart's line of argument. Now, we hold that the distinction between the higher self-conscious, reflective, and conceptual powers of man, and his lower sensuous, non-reflective, and perceptual mental activities is a valid and valuable one, and one which is too often lost sight of And we hold, further, that our author is right, in the main if not entirely, in denying to brutes the higher powers of conceptual thought Again, we agree with Dr Mivart in regarding the progress and development of sense-perception and abstract thought as more or less divergent Where we part company with him is in the assumption, for such it appears to us, that these divergent lines of development cannot have a common origin In all that he has written on the subject we fail to find any adequate justification for this dogmatic assertion so often and so confidently reiterated The distinction between mere sense-perception and reflective thought is frequently drawn with admirable lucidity and clearness, but the impossibility of their having a common psychical root is merely asserted with a few rhetorical flourishes We venture to question the assertion. Dr Mivart is not, be it noted, content to assume the modest but perfectly legitimate scientific position that no one has yet succeeded in showing the early stages of the divergence, the tentative beginnings of the reflective process, the gradual focussing of the mental eye upon the processes of consciousness He does not take his stand on a "not proven," but on a somewhat dogmatic "impossible"—not merely an "impossible" to this or that or the other factor in evolution from the nature of the factor, but broadly and generally an Impossible that is as worthy of a big initial letter as the Unknowable itself!

We cannot take leave of Dr. Mivart's volumes without again calling attention to the fact that they are full of matter interesting to the student of evolution. His scientific conclusions are not altogether those to which

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we have ourselves been led, though there are not a few matters on which we have the pleasure of agreeing with him, his psychological and philosophical views are not in all respects those which we have reached, though here again we are on many not unimportant questions on his side, but we believe him to be an honest and fearless inquirer after that Truth which stands on the title-page of a work to which, perhaps, for some of our readers, these volumes of essays may form a suitable introduction

C. LL. M.

PHYSICAL OPTICS

A Treatise on Physical Optics By A. B. Basset, M.A., F.R.S. (Cambridge: Deighton, Bell, and Co., 1892.)

A NEW treatise on the higher branches of physical optics must be welcome to all who are interested in the subject Mr Basset explains in the preface the scope and aim of his book, and it is needless to say that he performs the task he has set himself with ability and success If, nevertheless, we close the book with a feeling of disappointment, it is because we could have wished that the author had been more ambitious, and attempted to give us a little more than a compilation of the standard papers on the subject There is one sentence in the preface which, though it evidently does not express what the author meant to say, yet may serve as a peg whereon to hang the only criticism which can fairly be raised against Mr Basset's treatment of his subject "I have a profound distrust," says the author, "of vague and obscure arguments based upon general reasoning instead of upon rigorous mathematical analysis" Now, if we are to have vague and obscure arguments, it does not seem to matter much whether they are founded upon general reasoning or upon mathematical analysis, however rigorous that may be In a subject which is in a state of growth, it may be possible to hide, but it is impossible to avoid, all obscurity and vagueness, and original work ever consists in the attempt to overcome such obscurities By purposely excluding everything that is vague from a physical treatise, we destroy all possibility of making the work useful in stimulating further research There are two ways of dealing with difficulties we may try to overcome them, or we may run away from them Mr Basset chooses the latter course, and though some of us might have wished him to be a little more venturesome, we gratefully accept what he has given us, and the above remarks only apply to certain parts of the book. After an introductory chapter, Mr Basset treats of the interference of light He follows the time-honoured custom of taking Fresnel's mirrors and the biprism as the simplest case of interference The effects which are observed are seriously modified, however, by so-called diffraction effects, and we might perhaps have expected a book of this kind to have entered a little more fully into the subject That the author avoids all reference to experimental details is a distinct advantage, and renders his book more lucid and valuable for reference It is much to be wished the author's plan could be more generally followed, and that all lengthy discussions of instrumental details could be kept out of theoretical treatises, and relegated to separate books.

The diffraction of light is fully discussed in chapters iv, v, and xiii Mr Basset has followed safe guides in the treatment of his subject, and it is perhaps this part of the book which will be specially valuable to the teacher and student

It is well that the phenomena of double refraction should be first approached without more allusion to the difficult subject of the constitution of the ether than is absolutely necessary, and this is perhaps most easily done by following, as Mr Basset does, the historical method, and starting from Fresnel's deductions

The colours of crystalline plates are, of course, treated in an important chapter, and it is worthy of note that Mr Basset does not introduce the somewhat misleading distinction between the effects produced by parallel and by convergent or divergent beams In the usual polariscopes a number of parallel beams pass through the crystalline plate in different directions If the optical arrangement between the plate and the eye is such that these various beams enter the eye, we get the phenomena which are often called interference effects in divergent light, while if those beams only which make a small angle with each other are allowed to pass the pupil, we get the uniform tint described as the effect of parallel light Both kinds of effects might also be produced if instead of parallel beams we had a number of pencils diverging from points in a plane close to the crystalline plate In either case the eye is supposed to focus for an infinite distance, and the different appearance is only one of degree, depending on the extent of the angle between the different rays passing through the crystal and into the eye

Mr Basset enters fully into the consequences of the various hypotheses which have been made as regards the differences of density or elasticity of the ether in different media The investigations referred to by him are, of course, of the utmost importance, but it should have been pointed out that as regards application to optics they are wanting in reality We know enough now to be able to say that the medium does not behave like an elastic body, and in some form or other the electro-magnetic theory must be considered as established It seems idle, therefore, to discuss whether the hypothesis of Green or of Neumann is most contradicted by experiment It would have been perhaps worth while to bring out more clearly the fact that *no* elastic theory of the ether has yet been found satisfactory, and that if the electro-magnetic theory had not come to help us we should be in a very serious difficulty

It is true, of course, that we are at present unable, and probably always shall remain unable, to discard the elastic theories, because the study of transverse vibrations can only be satisfactorily carried out with the help of examples in which we understand to some extent the mechanism by which the vibrations are propagated But unless a writer chooses to follow a purely historical treatment, it would seem to be more satisfactory to separate completely the mathematical study of vibrations from the subject of optics Treated purely as elastic vibrations we may usefully discuss what would happen at the boundary between two media having different elasticities or densities,

and such a discussion, though independent of optics, would be certain to have important applications in it, because its results would often still apply when translated into language of the electro-magnetic theory The mathematical investigation of vibrations might be made more clear and definite when it is freed from the necessity of adapting itself to experimental verification

Chapter xviii is a useful one, dealing with "theories based on the mutual reaction between ether and matter," but we might have wished for a more satisfactory introduction to the electro magnetic theory that is given in the last two chapters The way in which the subject is approached may illustrate some of the remarks made in the beginning of this review There is no doubt a very serious difficulty in explaining the fundamental notions underlying the theory, and Mr Basset, instead of making an attempt to help the student over the difficulty, suddenly plunges into a series of equations, referring us to Maxwell's book for an explanation even of his symbols

We have perhaps given an inadequate idea of the contents of Mr Basset's book, which no doubt lends itself to criticism from the physicist's point of view, but which nevertheless fills a gap and possesses merits which will render it of great value to the student of optics

ARTHUR SCHUSTER

THE APODIDÆ

The Apodidæ a Morphological Study By H M Bernard, M A Cantab (London Macmillan, 1892)

THE title of this little book is misleading It is not a treatise on the Apodidæ, but a statement of the author's speculations on the relations of the Phyllopodous Crustacea and Branchiate Arachnida to the Chætopod Worms The new observations recorded are few, and the most important, that as to the presumed hermaphroditism of *Apus cancriformis*, quite insufficiently set forth, and, so far as can be judged from the author's meagre statement, erroneous

Mr Bernard appears to be completely misinformed as to current views on the relationships of Apus to other Crustacea, and of that group, through it, to the parapodiate worms Apparently he addresses himself to a lay audience, and poses, to start with, as the discoverer of a new and unsuspected agreement between the lower Crustacea and the Chætopoda This may serve to excite the interest of uninstructed readers, but the zoologist knows that such pretensions are due either to defective acquaintance with the subject or to a want of candour on Mr Bernard's part The arguments by which Mr Bernard endeavours to support his thesis are, many of them, those which have been effectively used by his predecessors in the same cause, others are new and remarkable only for their arbitrary character and the evidence which they give of the author's boldness in writing a book on a morphological problem. Mr Bernard draws attention to the absence of developed articulations in the limbs of Apus as giving them a resemblance to the parapodia of Chætopoda He states that this absence "has already been pointed out by Lankester and others, but its true significance does not seem to have been noticed." This is an incorrect allusion to my essays on the appendages and nervous system of Apus (*Q. J Micr Sci*, 1881), and on Limulus an Arachnid (*ibid*), which is the more to be regretted since they appear to have furnished Mr Bernard with such of his theories as well as his facts as will bear examination At p 368, *loc cit*, my statement runs—

"I have long been of the opinion which Prof Claus appears to hold, that the appendages of the Arthropoda are homologous (or, to use a more distinctive term, 'homogenous') with the appendages of the Chætopoda, and on this account I consider it a proper step in classification to associate the Chætopoda with the Arthropoda and Rotifera in one large phylum—the Appendiculata"

Yet Mr Bernard comes forward to tell us that he now for the first time draws attention to the true significance of the absence of articulations in the limbs of Apus, although (as he admits) this condition was especially noted and very carefully described eleven years ago by me in the same essay in which the above paragraph as to the relationship of Arthropoda and Chætopoda occurs This is a sample of Mr Bernard's method of claiming novelty for what he has to say when dealing with old materials Frequently he asserts in strong language novel propositions which are purely speculative and of the truth of which no evidence is adduced There is in no part of this little book any evidence that the author has made use of living or of well-preserved material, or has had any special opportunities of studying the genera and species of Apodidæ, nor does it appear that he has any experience as a zoologist which might give some weight to his fanciful conceptions On the contrary, these crude speculations and dogmatic assertions are his first original contributions to zoological literature I regret to be obliged to say that in my opinion (which I am called upon to express candidly in these pages) "The Apodidæ" is not a book which can be recommended either as a repository of fact or as a model of the method in which a morphological problem should be attacked

E RAY LANKESTER

OUR BOOK SHELF.

Anatomy, Physiology, Morphology, and Development of the Blow-fly (Calliphora erythrocephala) Part III By B Thompson Lowne, F R C S., F L S (London R H Porter, 1892)

WE have before us another section of Mr Lowne's work, which has grown upon the author's hands, and will form two volumes instead of the one originally intended. Part iii is occupied with the internal anatomy of the imago, embryonic development, histology, and the development of the imago On each of these heads a great amount of information is supplied, and the author's statements are illustrated by many figures As to the puzzling question of the way in which the alimentary canal of the blow-fly is developed, Mr Lowne holds an opinion which is probably shared with no second person What Voeltzkow and Graber take to be the proctodæum, and what Korschelt and Heider believe to be the amniotic cavity, Mr. Lowne calls archenteron He is content, as he tells us in his preface, to await the verdict of posterity on such conclusions as this We are content to wait too The subject is too difficult for full consideration in this place, and it would be unfair to express a strong opinion without ample discussion of the evidence It is not unfair, we think, to characterize many of Mr Lowne's

morphological speculations as simple mistakes To compare an insect-embryo and its membranes with a Lamellibranch or an Ascidian in the extempore manner assumed so lightly by Mr. Lowne (p 244) is not creditable He tells us that he has no facts to guide him except the similarity of the form and disposition of the parts Any reader who is not able to judge for himself should be very much on his guard when our author mentions Vertebrates or Ascidians, or indeed any other animals outside the class of Insects.

It is painful to speak with any disrespect of an author so laborious and so independent as Mr Lowne But these good qualities do not suffice to make a really good book Advice will probably be thrown away, but we will offer one hint in the most friendly way If Mr Lowne before going to press would get his sheets revised by any cautious and well-informed zoologist, he would be saved from making statements which seriously impair his work.

L C M

A Mendip Valley its Inhabitants and Surroundings By Theodore Compton With Original Illustrations by Edward Theodore Compton (London Edward Stanford, 1891)

THIS is an enlarged and revised edition of the well-known "Winscombe Sketches," and will be cordially welcomed by readers who can appreciate the presentation of natural facts in a poetic spirit The author has spent the greater part of "thirty-three years of rural life" in the valley about which he writes, and every aspect of it he knows and loves He tells much that is interesting, not only about the valley itself, but about the people who inhabit it, and about its archæological remains, its wild beasts, past and present, its birds, fish, reptiles, butterflies, and flowers The style is simple and clear, and a certain charm is added to the writer's descriptions by the quaint reflections with which many of them are associated An excellent chapter on the geological history of the Mendips is contributed by Prof Lloyd Morgan The illustrations are daintily conceived and executed, and harmonize well with the general tone of the text

Key to Elementary Dynamics By S L Loney, M A (Cambridge University Press, 1892)

THOSE who are using the author's Elementary Treatise, whether they be teachers or students, will find this key very useful The solutions to the examples are here worked out in full, so that even one who is going through the subject by himself will learn much in the nature of attacking problems by direct methods The author's treatise is now so widely used that this key will come as a great boon to many

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

The Lightning Spectrum

DURING the brilliant display of lightning on the evening of June 28, I took the opportunity of making some observations of the spectrum The way in which the spectrum varied was very remarkable, some of the flashes giving apparently perfectly continuous spectra, while others gave a spectrum of bright lines, as already recorded by Kundt and others The continuous spectrum appeared to be associated with the flashes of longest duration, which were accompanied by very little thunder, and the bright line spectrum with the more instantaneous flashes Using a Liveing direct-vision spectroscope with a very accurate scale, I succeeded in measuring the positions of six lines in the green, all of which no doubt have been *observed* before, but in two cases at least the *positions* have not been previously measured The wave lengths of the lines observed were as follows—those determined by Vogel, Schuster, and Colonel John Herschel, being added for comparison —

	Schuster	Vogel	Herschel	Remarks
(1) 5002	—	5002	5009	Brightest line
(2) 5168	5160	—	—	Rather dim
—	5182	5184	—	—
(3) 5350	5334	5341	—	Fairly bright
(4) 5430	—	—	—	Rather dim
(5) 5515	—	—	—	Fairly bright
—	5592	—	—	—
(6) 5675	—	—	—	Fairly bright

Other lines were seen both in the red and blue, but time did not permit any accurate determinations of their positions.

The lines (1) and (6) are undoubtedly the two brightest double lines of the air spectrum which occur in this region, but in the case of the other lines the coincidences are not so definite The proximity of the line 5168 to the brightest carbon fluting (λ 5165) would suggest that it has its origin in the carbonic acid gas, which is always present in the atmosphere The remaining lines do not appear to coincide with air lines, and their origins for the present are undetermined A FOWLER

Royal College of Science, South Kensington

On the Line Spectra of the Elements

PROF RUNGE has not improved the position he has taken up by the new instance of a motion which he brings forward in last week's NATURE The instance he gave in his preceding letter is a motion which, as I pointed out, could not take place within molecules The motion he now gives is one which cannot even exist anywhere in nature It would require a supply of power (energy per unit of time) increasing *ad infinitum* The first instance he gave belongs to inapplicable kinematics, his new one to impossible dynamics Neither has anything to do with the subject of my memoir

He quotes the enunciation of a theorem from chapter iv of my paper, but does not quote the sentence introducing that theorem, which would have made it plain that the motions spoken of in it are *motions which can take place within molecules and which can produce an undulation in the ether*, not the motions of a mere mathematical exercise irrespective of whether they are real or imaginary The introductory sentence (p 588) is in the following words —"The motions of the electrons, the electric charges in the molecules, which are what excite the ethereal undulation, may be motions that are not confined to one plane Accordingly *to study them* we must investigate what theorem corresponds to Fourier's theorem when the motion takes place along a line of double curvature" And then follows the demonstration and the enunciation quoted by Prof. Runge In the foregoing words, in the introductory paragraphs of chapter iv of my memoir, and in other passages scattered up and down through that chapter, I made it abundantly clear, as I thought, that I was dealing throughout *with a real physical problem of nature*, not engaging in mere mathematical exercises that travel into the infinite and impossible I now see that I ought to have made more explicit statements upon this point for readers who would judge of each sentence apart from its context

In order that a motion, $x=f(t)$, may be susceptible of treatment by Fourier's theorem, the following are conditions that must be fulfilled —

1° The motion must be recurrent, or capable of being approximated to by recurrent motions

2° The quantity represented by x must not become infinite.

3° The quantity represented by t must not retreat

I have been familiar with these limitations since I was a student, more than forty years ago. *They are known to all students* I therefore thought it superfluous, and still think it ought to have been superfluous, to state them in my memoir I thought it also irrelevant, *since none of the limitations could occur in the motions I was investigating*, and I wished to shorten my memoir by excluding all irrelevant matter. Prof Runge, however, objects that I have not treated of violations of the first

two of these conditions He has not yet said that I ought also to have discussed the impossible dynamics in which the third condition would be violated

This, however, was not his original position He began (see his original article, NATURE, April 28, p 607) by supposing that a motion from which light emanated cannot, if non periodic, be investigated by Fourier's theorem ; and he stated that in consequence of this he could not understand the decomposition of the motion of an electron within a molecule into a series of superposed elliptic motions In NATURE for May 12, p 29, and for June 9, p 126, I demonstrated in two different ways that his supposition was a mistake The other objection made in his original article, viz that "a plausible suggestion about the movement of the molecules ought to explain more," is also a mistake These are the two condemnations passed on my paper in his original article Both these have been met And the issues he has since raised are, I again submit, not *legitimate* criticism of a physical inquiry To make them legitimate he would need to produce an instance of a motion *of the kind with which my paper deals* (*i e* a motion that can produce a spectrum) and which at the same time is not amenable to the method of analysis given in chapter iv. of my memoir This he cannot do, for there are no such motions In fact, the analysis effected by the spectroscope is *identical* with a part of that made by Fourier's theorem when applied in the way that I there point out The spectroscope gives the periodic times in the different partials, the sum of the squares of their principal axes, and in some cases their forms , but it does not give the phases of the motions in them or the planes in which they lie Prof Runge almost admits that his criticisms do not succeed in impugning the value of my memoir as a contribution towards our knowledge of nature, for in his last letter he says, "I do not say, therefore, that Prof Stoney's views on the cause of the line-spectra are wrong " This is very different from what he said in April G JOHNSTONE STONEY

9, Palmerston Park, Dublin,
July 17

"The Grammar of Science"

MAY I, through your columns, point out to Prof Pearson what seems to me a serious "antinomy," to use his own phrase, in his "Grammar of Science " The foundation of the whole book is the proposition that since we cannot directly apprehend anything but sense impressions, therefore the things we commonly speak of as objective, or external to ourselves, and their variations, are nothing but groups of sense-impressions and sequences of such groups But Prof Pearson admits the existence of other consciousnesses than his own, not only by implication in addressing his book to them, but explicitly in many passages He says (p 59) "Another man's consciousness, however, can never, it is said, be directly perceived by sense-impression , I can only *infer* its existence from the apparent similarity of our nervous systems, from observing the same hesitation in his case as in my own between sense impression and exertion, and from the similarity between his activities and my own "

With respect to the argument from the "similarity of our nervous systems," I may point out, *en passant*, that however many other people's nervous systems Prof Pearson may have dissected, he has certainly never dissected his own, and that therefore this argument, which is several times repeated in the book, is worthless , all Prof Pearson has to go upon is the external similarity of other people's bodies and activities to his own But he maintains that our bodies and their activities are nothing but groups and sequences of sense impressions Consequently, if other consciousnesses are similar to his own, some of his groups of sense-impressions possess private consciousnesses, which themselves receive sense-impressions, among which, for example, are to be found Prof Pearson himself ! Thus Prof Pearson's consciousness contains a number of parts, each of which contains, amongst other things, Prof. Pearson and his consciousness ! Of course it would be impossible thus to refute a consistent idealist, who maintained that not only external things but all other consciousnesses were unreal and existed only in his imagination ; but to recognize the reality of other consciousnesses is to recognize the reality of the means by which we become aware of them, which, as Prof. Pearson explicitly states, is the external aspect of men's bodies.

It is not difficult to find the way out of this difficulty. It is that, though we do not *know*, *i e* directly apprehend, anything about the external world but sense-impressions, yet in order to explain those impressions we frame the hypotheses of external, objective reality, and of the "ejective" reality of other consciousnesses, and since these hypotheses are successful in explaining most of our sense-impressions, we have come to believe that they are true. Indeed, I cannot seriously doubt that Prof Pearson himself believes in them as much as anyone else Only, if he were to acknowledge it explicitly, he would have to rewrite almost every page of "The Grammar of Science "

EDWARD T DIXON.

12 Barkston Mansions, South Kensington,
July 14

PROF KARL PEARSON'S "Grammar" merits more justice than it has received from "C G K" It is a remarkable book which I have read with much interest. He tells us (p 15) that "the unity of science consists alone in its method, not in its material," and therefore the method employed in this work on science acquires a special interest

There are two points in respect to which his method seems to me to call for a few remarks—remarks which cannot be unwelcome, since his motto is "La critique est la vie de la science "

The first point concerns his own position and that of certain persons he freely criticizes The Professor has scant patience with metaphysics, and says not a few hard things of those tiresome people the metaphysicians , and yet his own book is really a metaphysical treatise and he turns out himself to be an unconscious metaphysician *malgré lui* This fact can hardly surprise anyone who has mastered what is really the scientific A B C , but in the present instance it is peculiarly amusing. For he, with great *naiveté*, ridicules Prof Tait for being in the very same case He is styled (p 296) "the unconscious metaphysician, who groups sense impressions and supposes them to flow as properties from something beyond the sphere of perception" , and we are further told that "the unconscious metaphysics of Prof Tait occur on nearly every page of his treatment of the fundamental concepts of physical science "

The second point which seems to require notice is the way in which his method plays "fast and loose" both with the system he upholds and the system he most opposes.

He is an idealist of a kind Again and again we are told that scientific laws are but descriptions of our feelings in conceptual shorthand He speaks (p 129) of "the whole of *ordered* nature" being "seen as the product of one mind—the only mind with which we are acquainted," and he tells us plainly (p 130) that "the mind is absolutely confined within its nerve-exchange , beyond the walls of sense-impression it can logically infer nothing " It would be easy to multiply such quotations

Now, of course the idealist can logically make use of ordinary language in describing co existences and successions between his feelings The Professor's distinctions (p 114) between "physical and metaphysical supersensuousness" have been duly noted, as also his disclaimer (p 57) of giving any real explanation of the physical side of thought Nevertheless, none of these considerations appear to me to justify his dogmatic mode of speaking of things of which the senses can take no cognizance

If he knows nothing but his own feelings, he cannot reasonably speak of their mode of formation, or of the manner in which one group of feelings acts upon another Yet, referring to a sensory nerve, he writes (p 51) "The *manner* [the italics are mine] in which this nerve conveys its message is, without doubt, physical," and (p. 81) "Beyond the brain terminals of the sensory nerves we cannot get." Stars are for him but "groups of feelings," and yet he writes about them as follows "Among the myriad planetary systems we see on a clear night, there surely *must be* myriad planets which have reached our own stage of development, and teem, or have teemed, with human life" (p 179).

Speaking of waves (p. 305) he tells us, "The wave *forms* for us a group of sense impressions." But the wave is, for him, *itself* a group of self-impressions and so is a particle of protoplasm Nevertheless he speaks (p. 413) of the probability that long stages of development preceded its existence, and "of the millions of years, with complex and varying conditions of temperature," needed in order "to pass from the chemical *substance* of life to that complex *structure* which may have been the first

stage of organic being" He also declares (p 425) the belief that "the evolution of organic nature is at the basis of human history is the *unswerving belief* of the present writer"

My present object is not to object to any of these statements, but simply to call attention to the complete accord which exists between the Professor's language and that of realism, or any of the materialists whose sayings he sometimes deprecates, and to note the practical outcome of such teaching as that of his metaphysical "Grammar"

Its Idealism is an Idealism of parade, to be brought out occasionally, above all to confound some rash or inexperienced advocate of Intellectualism and Common sense But ordinarily and habitually it most certainly is, as "C G K" affirms (NATURE, July 7, p. 222), "distinctly materialistic" This teaching is an excellent example of that "intellectual thimble-rigging"—I use the illustration as an apt one, but in no invidious sense—to which I have elsewhere (see *On Truth*, p 135) called attention in greater detail

In conclusion I would ask how Prof Pearson's metaphysical system can be necessary or even useful for the progress of science?

What does it matter for science, provided we are all agreed about those things whereof the senses can take cognizance, whether or not we are convinced that something extended exists objectively? The Professor affirms (p 215) that the man of science "refuses to project his conceptions, atom and ether, into the real world of perceptions until he has perceived them there" We are then so far agreed We both welcome ether units, prime atoms, chemical atoms, molecules, molecular motion, ether rings, ether squirts, &c, as admirably useful working hypotheses, but not as things to be yet regarded as objective realities If I am right, the utility for science of much of the Grammar is not easily to be recognized But it has a very distinct metaphysical utility for the opponents of the system Prof Pearson favours, and will no doubt meet with grateful recognition at the hands of some of them ST GEORGE MIVART

Hurstcote, July 10

A "Viper" Bite

As cases of poisoning from the bite of venomous reptiles are happily rare in this country, it may prove interesting to some of your readers if I relate my experience on this matter

About a month ago I caught two snakes at Bickleigh, near Plymouth, and whilst examining one it "bit" or rather struck me on the lower part of the right thumb I immediately sucked the puncture (it could not be called a wound) which bled a little, and tried to make light of the matter A livid patch soon formed round the point, and the hand and arm commenced to swell In a quarter of an hour I was unable to hold anything, and almost in a fainting condition The first symptom (apart from the swelling) was a peculiar taste and a sensation of swelling in the teeth, then the tongue commenced to swell and became so large that I could hardly move it, my eyes seemed ready to start from their sockets

In half an hour a terrible vomiting commenced, preceded by excruciating pains in the stomach and heart, and continued with the pains altogether for nine hours, every drop of liquid being ejected almost as soon as swallowed, there was also violent purging and complete suppression of urine

There was practically no pain in the arm, altogether the painful symptoms lasted for about nine hours.

I did not lose consciousness at any time The arm continued to swell for two days, and then it was nearly as large as my leg After this the swelling subsided, but the arm did not return to its normal size until twelve days after the accident After the swelling had gone I suffered very much from rheumatical pains, and in fact do so now, and the digestion was also very much impaired The viper is a male, a little more than two feet long, and about one inch in diameter at the largest part Colour, a dull yellowish brown on the upper side, with a zigzag black line running down the whole length On the under side it is nearly black except at head, where it is pale yellow I have kept the reptile now for nearly five weeks, and although well supplied with small frogs, &c., it has not eaten anything, and seems as lively as ever

Cases of this kind, where the sufferer is able to record the symptoms, being rather unusual, is my excuse for occupying the space of NATURE

Plymouth W A RUDGE

THE EDINBURGH MEETING OF THE BRITISH ASSOCIATION

THE Association has already met three times in Edinburgh, in 1834, in 1850, and in 1871 With the success of the 1871 meeting fresh in the memories of many citizens, the Town Council and other public bodies have entered cordially into the local arrangements for the meeting The local committee formed some twelve months ago and its sub-committees have been actively at work, and everything is now practically ready for the reception of the Association

The number of members of the Association who have indicated their intention of being present, and of new members who have already joined, are such as to show that the meeting will be an exceptionally large one More than fifty distinguished foreigners have accepted the invitation of the local committee to attend the meeting

Reception and Section Rooms—The reception rooms are in Parliament-square, adjacent to St Giles' Cathedral and the City Chambers The Parliament Hall, the various court rooms, the rooms of the Society of Advocates, and the new library and hall of the Solicitors before the Supreme Courts have been placed at the disposal of the committee, and have been so appropriated as to constitute an ideal suite of reception rooms, including secretaries' and treasurer's offices, post, telegraph, and telephone office, ticket office, enquiry office, reading room, writing room, ladies' boudoir, smoke room, and refreshment buffet Many of the rooms lend themselves to decoration, and the arrangements are as excellent in taste as in convenience The Section Rooms are all in the University buildings, Sections A, E, F and G in the old buildings, and B, C, D and H in the new buildings These buildings are about two minutes' walk from one another, and about four from the reception rooms The section rooms are all well adapted for the purposes of the meetings, and in connection with each there is ample accommodation for committee meetings, while provision has been made for the occasional subdivision of some of the sections In the new University buildings a room has been set apart for a temporary museum, in which objects of interest, which are brought under the notice of any of the sections, may be afterwards placed so as to be more easily inspected than is possible during the meeting of the section It is expected that this will prove a valued addition to the convenience of the meeting

While light refreshments may be had at the buffet in the reception rooms, the principal luncheon room will be found in the Students' Union Club, situated between the new and old University buildings In the club there will also be a ladies' room, smoking-room, billiard-room, &c

Lectures and Entertainments—The programme for the evenings will follow the usual lines —On Wednesday Sir Archibald Geikie will assume the presidency and deliver an address, on Thursday, the Lord Provost, Magistrates and Town Council invite members and Associates to a *conversazione* in the Museum of Science and Art, the Lord Provost will receive and welcome guests to the City On Friday, Prof Milnes Marshall will lecture on "Pedigrees", on Saturday, Prof Vernon Boys will lecture to artizans on "The Photography of Flying Bullets", on Monday, Prof Ewing will lecture on "Magnetic Induction," and on Tuesday there will be a *conversazione* in the Music Hall on the invitation of the local committee

Military bands will play in the Princes Street Gardens every afternoon during the meeting, and there will be organ recitals in the "Reid" music class-room Afternoon entertainments will be given by the Royal Scottish Geographical Society, the Rector and Masters of the Edinburgh Academy, and by others

Arrangements have also been made to form parties to visit Edinburgh Castle, Holyrood Palace, and Arthur's Seat; these visits will be in the afternoon

Excursions.—The committee have prepared a long list of excursions. Among those for Saturday afternoon are geological excursions to North Berwick and Tantallon, and to the Pentland Hills; a botanical excursion to Gullane; a dredging excursion on the Firth of Forth; and excursions to such places of interest as the Land of Scott, the Fairfield Shipbuilding Works and Glasgow, the Pumpherston Oil Works, Dundee and the Firth of Tay, Stirling, Rosslyn, Dalmeny and the Forth Bridge, Newbattle Abbey, and Dalkeith Palace.

On Thursday, occasion is taken to visit places of interest further afield. St. Andrews, Dunkeld, Scone and Murthly (arboricultural), Croy (archæological), Dobbs Linn Moffat (geological), Moorfoot Waterworks, Hamilton Palace, Drumlanrig, Yarrow, Crieff, the Trossachs, Loch Lomond, the Firth of Clyde, are all brought within the limit of a one-day excursion.

Many of the more important manufacturing and other works in the city and neighbourhood are to be open to members, who will thus have ample opportunity of becoming acquainted with the trade of the district. Visits to the paper works at Penicuik or Currie, to the printing-ink works at Granton, and to the gunpowder mills at Roslin, will form pleasant short afternoon excursions. The printing offices of Edinburgh are of great interest, and many of them have made arrangements for the reception of visitors. Breweries, distilleries, biscuit factories, and hydraulic engineering works have all their special developments here, and are well worthy of visits.

Hospitality and Lodgings.—Perhaps the greatest difficulty that the local committee has had to face has been the date fixed for the visit of the Association. August is *the* holiday month in Edinburgh, and under ordinary circumstances the residential parts of the town are during that month entirely in the hands of the police. For many of the citizens, indeed, holidays are possible only in August. It has therefore been matter of congratulation to the committee dealing with this part of the work to find that many people intend to remain in town during the meeting of the Association and that they have been informed of a large number of offers of hospitality having been sent to visitors.

The hotel accommodation in Edinburgh is considerable, but the strain upon it in August is great. The local committee have secured for members of the Association a considerable number of rooms in hotels, and these are being rapidly allotted on application. Visitors who intend to live in hotels during the meeting will do well to make their arrangements early.

With regard to lodgings, probably no town is so well off as Edinburgh, and fortunately during August many of the best rooms are vacant. A register of lodgings has been opened at the local offices, and the secretaries are prepared to give assistance to visitors desiring to secure apartments. A provisional list of hotels and lodgings has been prepared and may be had on application. The principal clubs have offered to admit visiting members of the Association as honorary members during the meeting, subject to such conditions as are required by the constitution of the club.

Publications.—The programme of local arrangements will contain a hotel map of Edinburgh, a large scale map of central Edinburgh, including all the buildings used in connection with the meeting of the Association, and a general map of Edinburgh and Leith, on which all the works open to visitors are specially marked.

The "Excursions Handbook," published by the committee, gives details of the various transit arrangements and general sketches of the routes to be taken. It also indicates the nature of the interest attached to each excursion. The handbook will be illustrated by a special map of the South of Scotland and by section maps on a larger scale showing details of excursions.

F. GRANT OGILVIE.

THE ORIGIN OF LAND ANIMALS: A BIOLOGICAL RESEARCH.[1]

THIS remarkable and very unequal work, many-sided and heterogeneous, is worthy of careful consideration. It is not wanting in imagination, more or less disciplined, and it is loaded with information from the works of contemporary naturalists, now for the first time brought together in a single volume. One great merit it has of regarding plants and animals, not merely as forms of life, but as living forms: the machinery is exhibited to us in motion.

The title of the work scarcely conveys an adequate idea of its comprehensiveness; it might just as well have been styled "The Evolution of the Living World [for plants are not excluded from its universal purview], and the way it has been brought about."

The leading idea appears to be that a change from marine to terrestrial habitat has taken place much earlier in the history of the higher forms of life than is generally supposed, that the land from the early beginnings of geologic time has been peopled both with animals and plants, and has, more than the sea, been the great arena of progressive change. At the outset, the shore, where sea and land and air all meet and commingle, was the birthplace of life, and from it living forms have continually wandered in all directions—to the open ocean and the abyssal depths, to rivers, marshes, and dry land. From the Algæ, which are almost the only marine plants, the vegetable kingdom was derived. That this is characteristically terrestrial is due to the fact that vegetable protoplasm is less adaptive than animal. "Plants as land proprietors are the true conservatives;" hence, once on land, always on land. The terrestrial character of plants offers a suggestive hint as to the place of development of the greater part of the animal kingdom: it also has been on land, but with more numerous offshoots to the sea. In terrestrial plants such as Myxomycetes—"the true Bathybius"—are the roots of the animal world; or if this claim be not admitted, and to Bacteria be assigned this place, a terrestrial origin remains unimpugned, since these organisms are predominantly inhabitants of the land.

The migration of marine animals may be direct, but more usually it is by successive stages, first through fresh water—"the great highway to land life"—then to damp places, and finally to the dry land itself, which, however, at the time of migration may have been subjected to a damper and warmer climate than at present prevails. With change of medium progressive modification has been associated, for existence in the air makes three great demands on the organism, it must protect itself against being dried up, acquire new modes of respiration, and more substantial organs of support.

Many animals, ennobled by their response to these demands, have returned to the sea, and exercise dominion over it, undergoing, of course, fresh modifications, particularly of the respiratory organs; while others have retained possession of the terrestrial domain, adapting themselves to minor changes of habitat and climate. Thus far more groups of land-animals are derived from a terrestrial ancestry than we imagine, and the next-of-kin of orders now characteristically marine are less frequently than we suppose to be found in the sea, but must be sought for on the land. The whale and sea-turtle, land crabs and climbing fish, so far from being rare and exceptional cases, are instructive examples of great migratory movements and associated anatomical change.

The hypothesis not only supplies a needed stimulus, powerful enough to account for the evolution of the organic world, but at the same time it explains the futility of our search in marine strata for connecting links between lead-

1 "Die Entstehung der Landtiere: ein Biologischer Versuch." Von Dr. Heinrich Simroth, Privat-docent an der Universität, Leipzig. Pp. 492, with 234 Illustrations in the Text. (1891.)

ing types of life, since the most critical steps in evolution have been taken on the land, and terrestrial fossils are of the rarest occurrence

In illustration we may select the author's treatment of the Arthropoda, which have their origin in some ancient Annelid, probably a marine Polychæte, and not an Oligochæte, since no Arthropod possesses the red blood which the Oligochæta have acquired as an adaptation to land life

The absence of cilia and a thoroughgoing chitinization, which are the most striking peculiarity of the Arthropoda, are a direct adaptation to land life, the chitinous envelope furnishing on the one hand protection against desiccation, and on the other organs of support, whilst its extensive development necessarily involves the disappearance of cilia, and the development of fresh contrivances for respiration

Another important character common to the Arthropoda is the transverse striation of the muscle fibre, but transverse striation is generally admitted to be correlated with excessive functional activity, from which, according to the author, it results Encase an animal in chitin, and its movements will, from the mechanical conditions of the case, be "acrobatic,"—to move at all it must move strenuously, by this excessive exercise transverse striation will develope in all the voluntary muscles, and "by correlation" in those of the alimentary canal as well So much is the author impressed by the cogency of this reasoning that he regards the striation of the musculature as a direct indication of the terrestrial origin of the animal possessing it, and ventures to apply this formula to Sagitta, the direct development of which he gives as an additional argument for its descent from some terrestrial species

The parapodia of the Annelida naturally gave rise to the appendages of the Arthropods, and it was while these were still short, scarcely-jointed stumps that the Trilobites branched off in one direction, converting all their parapodia into legs, and the Scorpions and Merostomes, which discarded their abdominal appendages, in another The Crustacea, retaining like the Trilobites all their appendages, branched off at about the same level, and their connection with the Arachnida is confirmed by Jaworowski's recent observation of the exopodital and endopodital splitting of the appendages in Tarentula. A confirmation of the terrestrial habitat

FIG 1—Pedipalp of an embryo of *Trochosa singoriensis*, *en*, endopodite, *ex* exopodite, *h*, hairs (after Jaworowski)

of the primitive Crustacea is suggested by the fact that the most archaic existing forms are the Branchiopoda, which still live in fresh-water and salt marshes, can survive drying up, and indeed seem to require it for the production of sexual eggs The remarkable diversity of the respiratory organs in the Crustacea is another important piece of evidence, since it points to their having been acquired as secondary adaptations

Of Arachnoid forms, some entered the sea, probably the majority of the Merostomata and the Xiphosura, but Limulus still gives evidence of its original home, since it comes to the shore for begetting, and lays its eggs at the highest tide-mark

No doubt the notion that the immediate ancestors of Limulus were land animals will excite scorn in prejudiced minds, but it is one that Balfour long ago suggested (the author does not seem to be aware of this), led to it probably by his recognition of the close relationship between Limulus and the Arachnoids on the one hand, and the Arachnoids and Insects on the other—the latter connection lately so much strengthened by Jaworowski's remarkable discovery of rudimentary antennæ in Tarentula In

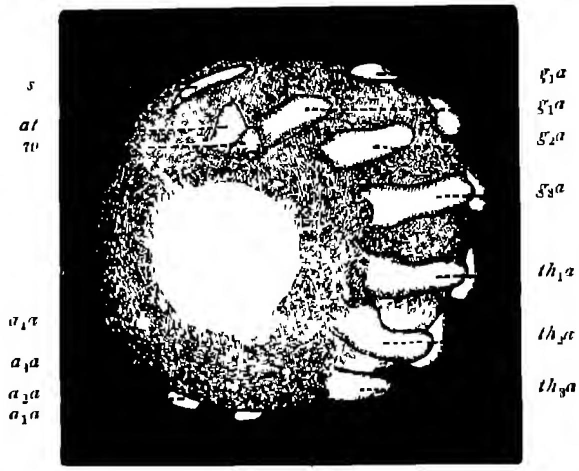

FIG 2

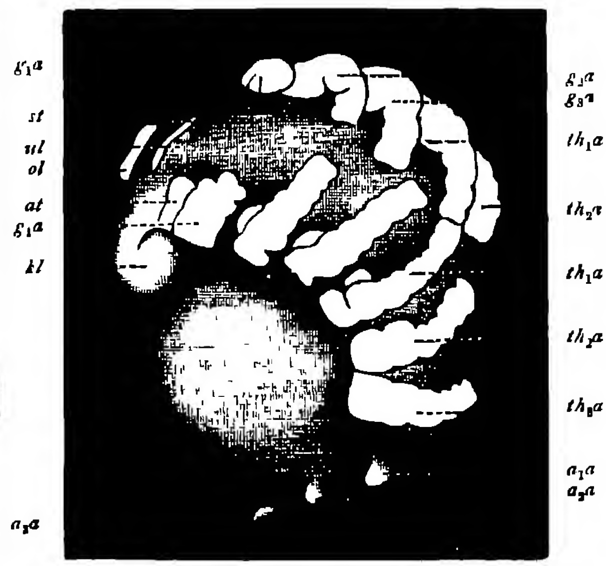

FIG 3

this direction may be looked for a reconciliation of the views of Lankester and Lang

The mild surprise with which we learn that Trilobites and Crustacea were originally denizens of the land has scarcely given place to conviction before we encounter the chapter on fishes We shall be prepared to find that these can claim terrestrial ancestry too. The earliest fossil vertebrates of which we know anything are the Placoderms, these were dwellers in the Old Red Sandstone lakes, and, as our author remarks, "from fresh water to the land is only a step" That the Placoderms were

well able to take this step is proved by the character of their pectoral limbs, which, unlike the fins of fish, are provided with a transverse joint in the middle—"an elbow joint", and this, while clearly helpful in walking, would not be well fitted for swimming No doubt the animal was also a swimmer, the dorsal fin shows so much, but it was also a walker, travelling over hard, uneven ground, indeed, to this habit is attributable the turning up of the tail-fin (!), which formed the third point of support A

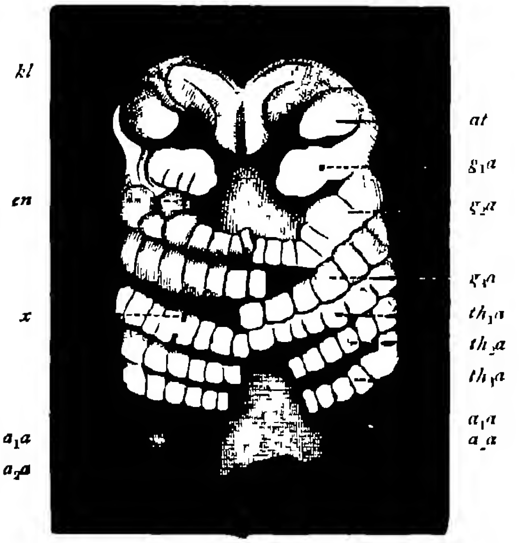

FIG 4

FIGS 2 to 4 —Embryos of *Trochosa singoriensis* Fig 2 on the 13th day Figs 3 and 4 on the 19th day, Fig 4, the anterior end seen *en face* *st*, stomatodæum, *kl*, frontal lobes *ol* upper and *ul*, lower lip, *at*, antennae *w*, wall-like thickening of marginal groove g_1a, chelicerae, g_2a, pedipalp g_3a, 1st pair of limbs th_1a–th_4a, thoracic appendages (2nd to 4th pairs of limbs), a_1a–a_4a, abdominal appendages *x*, a deep constriction, *en*, rudiment of endopodite (after Jaworowski)

drawing, subscribed "original," representing Pterichthys "as it might have moved," is so full of unconscious humour that we are tempted to reproduce it From such amphibious primitive vertebrates the fish branched off in one direction and descended to the sea—the swimming-bladder represents the original lung, in another direction proceeded the Stegocephala, the ancestors of reptiles, birds, and mammals Primarily the Vertebrata are derived from Annelids, but the claim put forward for the Placo-

FIG 5 —*Pterichthys*, as it might have moved (Original)

derms is more in harmony with Patten's view, connecting them with the Arachnoids, for the grave difficulties which beset this view, however, let Smith Woodward's trenchant criticisms be considered

The main line of argument is followed into a number of collateral branches, all elaborately discussed There is a powerful chapter on the strand fauna, in which are arrayed the great host of marine animals, including fishes, which temporarily leave the sea to breathe the air This is regarded as a fact of profound significance, indicating a general tendency of the strand fauna to come on shore

Recent investigations by Zacharias, Nusbaum, Chun, and others are made good use of in discussing the distribution of fresh-water fauna Aerial transport, particularly by birds, is accepted as accounting for most of the facts The survival of the transported forms is insured by the chitinous investment either of the animals themselves or more usually of their eggs It is pointed out that most pelagic fresh-water species are provided with means of attachment such are the spines of pelagic species of Daphnia, the abdominal processes of Bythotrephus, and the singular antennæ of Bosmina Copepods which lay eggs which sink to the bottom are restricted in distribution, those which carry them about in egg-sacs are world-wide

An attempt is made to prove that fresh water opposes some obstacle to the secretion of carbonate of lime, and though a comparison of the thickness of marine and fresh-water shells is far from bearing this out, yet some interesting results are elicited; as, for instance, the suggestion that the chitinous bristles of the young of *Paludina vivipara* are probably the last traces of originally calcareous spines

In illustration of the various stages of land life, the Testacillidæ are cited as an interesting example of adaptation to a terricolous existence *Daudebardia*, one of the family, begins life as a form precisely like a *Hyalina*, but with growth passes through the successive stages shewn in the figure (fig 6) till it becomes the worm-like adult

A good deal of space is naturally devoted to the subject of encystment, which is regarded as a protection against desiccation In the course of this discussion an earlier origin is attributed to the Heliozoa than to the

FIG 6 —*Daudebardia* in different stages of growth, on the right, youngest, on the left, oldest stages The buccal mass is shaded. (Original)

Radiolaria, since they do not possess the central capsule of the latter, which are consistently regarded as the marine descendants of an ancient fresh water group related to Heliozoa The suggestion is added that the withdrawal of plasma in the Radiolaria into the central capsule as a preliminary to spore formation is not really with a view to this event, but a reminiscence of encystment, which occurred in ancestral fresh-water forms Bald suggestions such as this, and another which occurs in the work, to the effect that chlorophyll first acquired its fluorescence as the primæval sky cleared of clouds and permitted an extension of the solar light towards the violet end of the spectrum, should, from motives of prudence, have been omitted A total *bouleversement* of accepted views on main lines of descent is sufficient for a great work without the added irritation of superfluous conjectures Summer and winter eggs belong more or less to the question of encystment, and the author regards winter eggs as "an adaptation to small pools, and threatened destruction by drying up" This, like the statement that the chitinous shells of the eggs of pelagic Crustaceans were acquired as a protection against desiccation during their aerial flight, might have been expected from an ultra-Darwinian, but in an author who wishes to explain evolution by physical causes, and not by chance, it is less pardonable "An adaptation to threatened drying up" is an expression which would please the metaphysicians, who have lately been contending that an effect may precede its cause.

The bibliography at the end of the work will be found most useful, especially to Englishmen, who will find in it a guide to a great deal of interesting German literature, but it is without form, and this to a great extent is true of

the work itself There are citations to the number of 423, and more, not numbered, yet, although we have a long discussion on the relationship of Limulus to Scorpion, Lankester's work is not mentioned, with chapters on fresh-water faunas, no allusion to "The Origin of Fresh-water Faunas," by Sollas, W Marshall, a German author, is set forward in the text as an authority on pelagic and coast faunas, and Moseley overlooked, titles are sometimes given without place or date of publication, a defect which becomes serious when periodical literature is referred to without mention of volume The illustrations are numerous and excellent

The author has produced a fresh and promising thought, but one cannot help regretting that he did not wait—like, say, Darwin—till it was full time for bringing forth W J SOLLAS

THE PHOTOGRAPHIC MAP OF THE HEAVENS[1]

THE first number of the second volume of papers published under the auspices of the Permanent Committee charged with the execution of the photographic map of the sky has made its appearance at a sad moment in the history of the undertaking For simultaneously with its appearance is announced the death of him who, more than any other man, has contributed to its success, and brought it within the range of practical science Admiral Mouchez has known how to secure not only the active co-operation of many astronomers, but also how to make them zealous in the great work, the arrangement of the details of which has occupied the last years of his life He has awakened enthusiasm for the success of his scheme, and smoothed many difficulties which might have hindered its progress, and probably few undertakings of equal magnitude and equal importance, breaking new ground in many directions, have been got under way with less friction and fewer disappointments We may well hope that the same sauvity and diplomacy which has characterized the conduct of the late Director of the Paris Observatory will be found in the counsels of his successor, and that a work begun in so much hope will be carried to a successful issue

The papers in the volume before us can be brought roughly under two heads, both, notwithstanding the lapse of time from the inception of the scheme, betokening an initial stage in the preparation One of the topics under discussion has for its aim the selection of a method which shall secure on the photographic plates, destined ultimately to furnish a catalogue, the impression of stars of the eleventh magnitude with certainty and uniformity, the other, a means of deriving the co ordinates of the star images so impressed with the greatest facility and sufficient accuracy

To deal with the second of these proposals first, we may remind our readers that whatever method of measuring the positions of stars on a plate may be adopted, the resulting co-ordinates must be purely differential, and probably referred to the axes of the réseau impressed upon the plate as a latent image, and developed under the same conditions as the stars themselves To pass to the determination of R A and declination, a great deal of information, entirely independent of photography, will have to be made available The readiest means of effecting this last step in the reduction, as it appeared to a committee of experts appointed to consider this question, was to determine by meridian instruments the absolute co-ordinates of six stars on each plate It is needless to comment upon the magnitude of the labour thus undertaken, or at least contemplated This preliminary work would demand a catalogue of some sixty or seventy thousand stars, most of them below the ninth magnitude and not found in existing catalogues In order to give to each determination the necessary accuracy, it is desirable that each star should be observed twice in both elements and at two observatories When we remember the length of time that the re-observation of Argelander's zones has consumed, and is still incomplete, we can form some estimate of the time that must inevitably elapse before the results of the photographic catalogue can be made available for astronomical purposes

In presence of these difficulties, and many more which occur to the practical astronomer, we must be very grateful to M Loewy for elaborating a scheme which, if it be found practicable, will materially shorten the time necessary for the production of the catalogue M Loewy proposes to avail himself of the fact that the plates are taken in two series, in such a manner that each corner of a plate in one series will form the centre of four other plates in the second series. When, therefore, the astronomer has determined the rectilinear co-ordinates of the stars on *one* plate relatively to the central lines of the réseau, each of these stars will belong in common to the plate considered, and to one of the four plates of the second series, partially covering the first M Loewy's scheme consists in making the stars on the four plates thus connected available for the reduction of the first And, on paper at least, it is not difficult to extend the scheme still further, and to make the plates contiguous to these four contribute to the reduction of the original plate by means of an extended triangulation In this way a plate would not be considered as an isolated fact, but a considerable area, of 36, 64, 100 or more square degrees could be woven into a harmonious scheme of reduction And such a plan possesses this very obvious advantage, that on even a lesser area, as of 36 square degrees, we may well expect to meet a sufficient number of bright stars whose places are already so well determined that the reduction of the plates could go on immediately without waiting for the observations of the stars on the meridian And independently of this evident advantage, it seems highly probable that two of the elements of reduction, viz the orientation of the plate, and the value of the scale, will be determined more accurately, if the stars which are used for the derivation of these corrections are separated by a considerable distance, that is greater than a single negative would permit

M Loewy considers the various sources of errors and their necessary correction with all the detail required to submit the plan to practical application, and this is precisely the test that is needed This appears to be also the opinion of Dr Gill, expressed in a very cautious approval of M Loewy's scheme, and he further quotes a remark of Prof Auwers, which contains a very salutary caution That astronomer points out that the reduction of the catalogue plates will be most accurately effected from the position of *faint* stars, rather than from bright ones In that case since our present most accurate catalogues do not give the positions of the fainter stars, those catalogues will still need to be supplemented by many meridian observations Dr Sande Bakhuyzen, however, expresses the opinion that the zones of the *Astronomische Gesellschaft* will, when completed, furnish the necessary data for all reductions, or, at most, require additional observations in some portions of the sky, which he is able to point out from a careful examination of the number of the stars contained in these zones.

The second topic which has received much consideration in this volume is, as before mentioned, the adoption of a method to secure the registration of stars of the eleventh magnitude It will be remembered that the International Congress of 1891 proposed to place in front of the object glass of the telescope, screens of fine metallic gauze, identical in manufacture, and of such construction that the amount of light impeded should be equivalent to two magnitudes the coefficient 2 512 being employed as

[1] "Bulletin du Comité International Permanent," tome ii, premier fascicule.

the ratio to express the relative brilliancy between two consecutive magnitudes A committee was appointed to carry this plan into execution, but the report which this Committee has issued is unfavourable to the adoption of the method The signatures of the Astronomer Royal, Prof. Pritchard, and the brothers Henry, are attached to this report, but M Vogel, the remaining member of the Committee, has not found the reasons assigned by his colleagues sufficient to warrant the rejection of the scheme, and consequently his name does not appear The President of the Permanent Committee thus sums up the case against the proposal Light in traversing a metallic screen of bright threads and very narrow mesh, seems to experience, besides the ordinary effects of diffraction, certain modifications, whose cause is not yet explained, and which the Congress could not foresee when they framed the recommendation This peculiar behaviour of the light demands further study, and renders the application of this means very difficult, if not useless, for the purpose for which it was proposed, since the discrepancies of the results obtained are greater than the error that an experienced astronomer would make in estimating stars of the eleventh magnitude

The experiments on which this conclusion is founded are set out in considerable detail, and a careful study of these experiments ought to convince an unprejudiced critic that the committee was justified in advising the rejection of the screens as an adequate and efficient means of deciding upon stars of the eleventh magnitude It should be stated that the gauze screens, identical in character, were furnished by Prof Vogel, and though there is no mention of the experiments or processes which induced the Potsdam astronomers to select a screen of this particular obstructive power, it is to be presumed that in his photographic telescope they stopped the amount of light proposed by the Congress It is not the least curious feature in the discussion (controversy would be far too strong a word to describe the courteous paragraphs in which the various astronomers set forth their reasons for dissent from the able physicist), that Prof Vogel takes no part in it nor vouchsafes any information as to the principles by which he was guided in the selection, but leaves the onus of rejection entirely to his colleagues, who are thus placed at a disadvantage

Prof Pritchard, whose photometric researches permit him to speak with authority, has stated concisely the result of his experience He found that on the ordinary astronomical telescope, achromatised presumably for D, the amount of light obstructed was equivalent to 2 4 mag, and on the photographic telescope, with a minimum focal length for G, the amount of light lost was not less than 2 8 mag The Astronomer-Royal reports that the action of the screen on the Greenwich telescope is to stop 2 5 mag This result was deduced by comparing the seventh and ninth magnitude stars of Argelander Some further comparisons of the obstructed and unobstructed light of stars of the ninth and eleventh magnitude photometrically examined by Prof Pritchard with the wedge photometer confirmed this result, and further proved that the scale of Pritchard and Argelander was in very satisfactory and close agreement It will be necessary to return to this point M Henry at Paris offers results in close accordance with those of the two English astronomers just quoted He finds that the screen proposed by M Vogel as effective in his instrument stops between 2 5 and 2 7 mag on the Paris telescope, and this effect is still further confirmed by some observations by M Trépied, while M Rayet at Bordeaux finds 2 7 mag represents the effective action of the screen Very different is the experience of M Donner, of Helsingfors. His method of estimating the loss of light is different from that employed in the other cases, and is perhaps not without objection, but the result which he derives from his observations is that the light of a star in passing through the screen loses only 1 6 mag

It is now necessary to describe very briefly the methods employed in the various observatories which have led to these discordant results, the more so as one eminent authority, Dr Dunér, of Lund, who apparently holds a brief for Prof Vogel, has taken exception to the results deduced Leaving on one side the experiments conducted by MM Henry and Trépied on artificial stars, and against which Dr Dunér urges no objection further than that they are founded on artificial stars, we find that one principle pervades the examination conducted at Greenwich, Paris, Bordeaux, and Algiers The several astronomers have determined what length of time is necessary to produce a blackened star disc of the same diameter from the same star with and without the screen In this way it has been found necessary to expose for ten or eleven times as long with the screen before the object glass as without, and from this fact it has been inferred that the loss of light occasioned by the screen amounts to 2 5 or 2 6 mag It is urged that if only two magnitudes were lost by obstruction, the necessary exposure would have been $(2\ 512)^2 = 6\ 3$, that required by the unobstructed object glass Dr Dunér remarks on this that those who have condemned the employment of the screens on these grounds have argued in a vicious circle, and to be logically correct it would be necessary to show that the intensity varies as the time of exposure or

$$it = \text{const.}$$

Against the accuracy of this law Dr Dunér urges that reports of the observers themselves show three distinct proofs In the first place (1) Dr Donner states that only 0 58 mag is gained by successively multiplying the length of exposure by 2 5, (2) that the Astronomer Royal proves that a gain of 1 7 or 1 85 mag is secured by multiplying the length of exposure by 6 25, and (3) that MM Henry have found that to obtain similar discs from stars of the 9 3 and 11 3 mag the exposure has to be increased from 28sec to 240sec. (1 8 6) These three experiments give instead of 2 512 respectively,

$$3\ 28,\ 2\ 69,\ 2\ 93$$

results apparently incompatible with the formula

$$it \quad \text{const}$$

MM Trépied and Henry reply at length and effectively to these strictures They do not regard 2 69 and 2 93 as differing so greatly from 2 512 but that the discrepancy may be fully explained by inaccuracy and paucity of observations The Helsingfors result (3 28) they refuse to accept as unequivocal evidence in the face of established facts The method of Dr Donner consisted in comparing photographs of the Pleiades, taken with and without the screen, with the map of M Wolf, and marking the number and magnitude of the stars which have black or grey images This method, as already hinted, does not seem to be entirely free from objection Admitting that the comparison of the images was made, as we are sure it was, with all the care possible, there is still room for the varying exercise of individual judgment as to what constitutes a black and what a grey image, and the final result is likely to be less exact than a process based upon rigorous measurement

The method employed by Prof Pritchard is, perhaps, as free as any from objection or misinterpretation He exposed the plate for *equal times* with and without the screen, and then measured the diameters of the resulting star discs If two discs, produced, one with, and one without the screen, were found equal in diameter, then the effect of the screen is equivalent in photographic action to the original difference of magnitude between the two stars This difference of magnitude was determined by the wedge photometer, and the only exception

that can be taken to this determination is that the scale of the wedge photometer may not be accurately applicable But here we have the distinct assertion of the Astronomer Royal, reiterated again by M Trépied, that the Pritchard Argelander scales are in very satisfactory accord This circumstance is the more gratifying for two reasons First, because it is distinctly stipulated in resolution 19 (1889), "Chaque observateur devra s'attacher à obtenir sur ses clichés destinés au catalogue la grandeur 11 0 déterminée aussi exactement que possible *au moyen de l'échelle d'Argelander*" The maintenance, therefore, of the scale of Argelander becomes of paramount importance, and this one could scarcely hope to effect by means of the gauze screens The second satisfactory point is, that Prof Pritchard is endeavouring to secure uniformity in the photographed stars by distributing among the participating observatories small charts of particular regions of the sky on which are marked stars of the 9th and 11th magnitudes approximately Naturally in the determination of the magnitudes of the stars on these charts, the scale of Argelander will be perpetuated, and inasmuch as the testimony of several astronomers is distinctly in favour of making use of these typical areas, it seems very probable that Argelander magnitudes will be prolonged in the catalogue work down to the faintest stars impressed

NOTES

THE summer meeting of the Institution of Mechanical Engineers will be held in Portsmouth, and will begin on Tuesday, July 26 The following papers have been offered for reading and discussion, not necessarily in the order here given —On shipbuilding in Portsmouth dockyard, by Mr William H White, F R S , on the applications of electricity in the Royal dockyards and navy, by Mr Henry E Deadman , description of the lifting and hauling appliances in Portsmouth dockyard, by Mr. John T Corner, R N , description of the new Royal pier at Southampton, by Mr James Lemon , description of the Portsmouth sewage outfall works, by Sir Frederick Bramwell, F R S , Past-President , description of the new floating bridge between Portsmouth and Gosport, by Mr H Graham Harris; description of the Southampton sewage precipitation works and refuse destructor, by Mr William B G Bennett , description of the experimental apparatus and shaping machine for ship models at the Admiralty experiment works, Haslar, by Mr R Edmund Froude , description of the pumping engines and water softening machinery at the Southampton water works, by Mr William Matthews

THE half yearly general meeting of the Scottish Meteorological Society was held at Edinburgh on Monday, July 18 The council of the society submitted its report , and Dr Buchan read a paper on variation in the annual rainfall in Scotland since 1800

THE Museums Association held its annual meeting in Manchester, at the Owens College, on July 5, 6, and 7, under the presidency of Prof Boyd Dawkins, whose address we print elsewhere Among those present at the meeting were Dr Ward, Principal of Owens College, Prof Flower, Prof Miall, the Rev Canon Hicks, Prof Milnes Marshall, the Rev. H. H Higgins, and Prof Weiss Mr J Willis Clark, the retiring president, was unfortunately prevented from attending The following papers were read and discussed —On the arrangement of botanical museums, by Prof. F E Weiss —On the cultivation of special features in museums, by the Rev H H Higgins —Local museums of art and history, by the Rev Canon Hicks —On the Manchester Art Museum, by Mr. T C Horsfall —On the preparation of picture catalogues, by Mr Butler Wood —On the colouring of the background of museum cases, by Mr Edgar R Waite.—On the best means of preserving vegetable structures, and on a collection illustrating the life-histories of the British Lepidoptera, by Mr J. W Carr —On the exclusion of dust, by Mr T Pridgin Teale , and library and museum legislation, by Mr E Howarth. Mr Pacy and Mr Ogle, who had been deputed by the Libraries' Association to attend the meeting, took part in the discussion of the last paper A Committee of the Museums' Association was appointed to confer with the Libraries' Association on the possibility of taking steps to improve library and museum legislation Most of the members of the Museums' Association who took part in the discussion were of opinion that the restrictions at present placed upon the action of Town Councils with regard to libraries and museums were unnecessary and obsolete The meeting was a very successful one, thanks to the energy and good management of Mr W E Hoyle and Prof Milnes Marshall The reception accorded to the Association by the authorities of the Owens College was of the most cordial nature, and the Association is indebted to Dr Ward and several of his colleagues for much kindness It was agreed to hold the next annual meeting in London under the presidency of Prof Flower

MR WILLIAM E PLUMMER has been appointed by the Mersey Docks and Harbour Board, director of the Liverpool Observatory, in the room of Mr J. Hartnup, deceased Hitherto this Observatory has done little more than regulate chronometers required for the port of Liverpool, but we understand that the Observatory will now be reorganized and made to play a more active part in observational astronomy, and one worthier of the equipment of the Observatory and the generous support the board accord to it.

DR W H INCE, Ph D (Wurzburg), Demonstrator of Chemistry in University College, Liverpool, has been appointed Demonstrator of Physics and Chemistry in the Medical School of St Thomas's Hospital

MR A H. LEAHY, M A , Fellow of Pembroke College, Cambridge, has been elected to the Professorship of Mathematics at Firth College, Sheffield Mr Leahy is a Mathematical Lecturer and Junior Bursar of his College, and is the author of several important papers on mathematical physics

MR R ELLIOT STEEL, Senior Science Master of the Bradford Grammar School, has been appointed by the Technical Instruction Committee of the Corporation of Plymouth to the Head Mastership of the Science Department of their new technical schools, Plymouth

THE Master and Wardens of the Drapers' Company of the City of London recently gave £3000 towards the erection of the new technical schools attached to the Nottingham University College, and have now given a further sum of £1000 towards their equipment

"COOK'S TOURS" are well known all over the civilized world, and vast numbers of Englishmen have been indebted to them for some of the brightest and pleasantest experiences of their lives. Everyone, therefore, was sorry to hear of the death of Mr Thomas Cook, the founder of the system. He died at Leicester on Monday in his eighty fourth year Mr Cook was a man of immense energy, and may almost be said to have had a touch of genius At all events he had a very remarkable faculty for organization, and did much to foster among the British public a just appreciation of the advantages to be derived from foreign travel. Last year the jubilee of his firm was celebrated

THE volcanic forces of Mount Etna have continued in a state of violent activity On the afternoon of July 14 it was stated,

a Reuter's telegram from Catania, that there were then eighteen openings in the mountain, of which nine were active "The lava," said the writer, "is flowing in the direction of Nicolosi at the rate of 50 yards an hour. It has already passed the deposit of lava formed by the eruption of 1886 The flow towards Pedara is less rapid Every hour the devastation increases, and the alarm of the inhabitants grows in proportion Their terror is not lessened by the explosions and rumblings proceeding from the volcano" On July 15 a Reuter's telegram from Catania stated that the eruption was that day more formidable than ever "The main crater is extending in size, and the showers of stones and masses of molten matter are continually increasing in volume, some of the projectiles being carried to a height of 1000 feet Meanwhile, two fresh cones, 800 feet in height, have been formed, and from these streams of lava are constantly flowing in the direction of Nicolosi, from which they are now only about two miles distant No immediate danger threatens the inhabitants of the village, but the destruction caused to the surrounding country goes on increasing" On July 16 and 17 telegrams to a like effect were despatched On the latter date, indeed, it was stated that the eruption had been less active on the previous night, and the reports of the internal explosions less frequent and not so loud, but the volcano continued to throw up enormous blocks of incandescent rock together with clouds of steam The lava stream had reached the village of Venatura, where it had destroyed several houses, besides doing enormous damage to the adjacent chestnut woods On the 18th it was announced from Catania that during the previous night loud rumblings had continued, and that the discharge from the craters of Mount Etna had increased in violence, stones and ashes being projected to a height of over 1200 feet In the morning the subterranean noises were less frequent and not so loud At Patagonia, besides the volcanic explosions proceeding from Mount Etna, subterranean rumblings had been heard, while in the neighbouring naphtha lake, and the fountains of Vachella, gaseous eruptions had occurred On the 19th, although the smoke proceeding from the craters was less dense, the eruption continued with renewed violence The subterranean rumblings were more frequent and of longer duration, but not so loud as during the previous days

ON July 15 it was announced from Naples that Mount Vesuvius had become active, and that lava in large quantities was pouring down the part of the mountain called the Atrio del Cavallo

DURING the latter part of last week the weather over these islands was much disturbed by the influence of a deep depression which lay over the Baltic The temperature was below 60° in the northern and below 70° in the southern parts of the kingdom, and the rainfall exceeded an inch in the south of Ireland At the close of the week another depression appeared over the Bay of Biscay, and spread over our southern districts, accompanied by rain, while owing to the northerly winds the temperature continued very low, the maxima scarcely exceeding 60° in any part. In London on Sunday it did not exceed 55°, which, with about one exception, is the lowest daily maximum in July during the last half-century During Monday night a deep depression advanced over Scotland from the northward, and travelled south-eastwards, accompanied by heavy rain, while on Tuesday increasing winds or gales were experienced on all our coasts, the wind direction varying from N E to N W and W. According to the *Weekly Weather Report* the rainfall for the week ending the 16th instant was considerably less than the mean in all the northern districts, while over the eastern, central, and southern parts of the kingdom there was a considerable excess, the amount being in many cases more than double the mean for the week Temperature was below the mean in all districts excepting the Channel Islands, in the eastern and central parts of England the deficiency for the week amounted to from four to six degrees.

LAST week two despatches were received at the Colonial Office from Mr Jerningham, Acting Governor of Mauritius, relative to the recent hurricane there Mr Jerningham states that the lives lost through the disaster were 1230, and the number of wounded still living 3167 Over sixty two churches and chapels had been damaged or wrecked, and there had been a partial and enforced cessation of the celebration of Divine service throughout the island The number of public buildings injured was 123, and the damage done to Government property was estimated at 286,807 rupees The injury to the railways would cost about 55,435 rupees to make good All the telegraph wires throughout the island were destroyed About 16,976 houses and huts had been destroyed or damaged, exclusive of those in Port Louis, and about 170 sugar factories had been wrecked or injured The task of repairing these disasters was one of great magnitude, and wholly beyond the unaided power of the colony A later despatch states that in Port Louis 1453 houses, churches, and public buildings, representing a value of nearly five million rupees, had been wholly or partially destroyed

THE *Kew Bulletin* for May and June contains several contributions which will be of great interest to botanists and to various classes connected with the industrial applications of botany One of these contributions is a valuable report (with a plate) by Mr George Massee on a disease that has attacked vanilla plants in Seychelles In the same number are printed the second of the Decades Kewenses Plantarum Novarum in Herbario Horti Regii conservatarum, and the second decade of new orchids An excellent illustration of the way in which the authorities at Kew seek to promote industry is afforded by a correspondence on Sansevieria fibre from Somali-land The increased attention devoted to the production of white rope fibres in the Western tropics appears to have had a stimulating effect in the East Indies, and now the production of fibre from *Agave vivipara* in Bombay and Manila is followed by a fibre obtained from Somali-land from a singular species of Sansevieria This fibre was first received in this country as an "Aloe" fibre It was soon noticed, however, that it possessed characteristics differing from all ordinary "Aloe" fibre, and a request was made to the Foreign Office that Colonel Stace should be invited to obtain for the Royal Gardens a small sample of the fibre, a large leaf from the plant yielding it, and, if possible, a few small plants for growing in the Kew collection In due time the specimens arrived in excellent order, and it was found that the fibre is one of the many so-called Bow string Hemps, and probably yielded by *Sansevieria Ehrenbergii*, a plant first collected by Dr Schweinfurth Little or nothing was known of it until it was described by Mr J J Baker, F R S, in the Journal of the Linnean Society, vol xiv, p 549 Its locality is there stated as "between Athara and the Red Sea." The plant is described in a letter to the Foreign Office, written by Mr. D Morris, as a very interesting one, and he adds that its existence as a source of a valuable supply of fibre will be sure to awaken attention among commercial men in Great Britain Messrs. Ide and Christie, writing to Mr. Morris, speak of the fibre as an excellent one of fair length and with plenty of "life" "In character," they say, "it strongly resembles the best Sisal hemp, with which we should have classed it but for your statement that it is derived from Sansevieria With the exception of its colour, its preparation is perfect, and even as it is, we value it to-day at £25 per ton. We are of opinion that if care were taken to improve the colour a considerably higher price would be readily attainable, perhaps as much as £50 per ton, if a pure white fibre could be attained without loss of strength and lustre"

AMONG the other contents of this number of the *Kew Bulletin* is an account of the fibre industry in the Bahamas, communicated to Kew by Sir Ambrose Shea, Governor of the Bahamas. Extracts from a report by Mr. A. White, a naturalist attached to the staff of Mr. H. H. Johnston, H.M.'s Commissioner and Consul-General for the territories under British influence to the north of the Zambesi, throw welcome light on the botany of Milanji in Nyassaland. Mr. N. E. Brown contributes notes on the botany of plants yielding Paraguay tea. There are also sections on the Nonnen pest in Bavaria, the prickly pear in Mexico, and the Palmyra bass fibre.

THE collection of hardy bamboos and allied plants having outgrown the space allotted them in the beds near the Temperate House of the Royal Gardens, Kew, a new garden has been made for them in a wood near the Rhododendron Dell. Of this garden the *Kew Bulletin* gives the following account:—It is in the form of a shallow depression with sloping banks 12 feet wide and a central pear-shaped bed 125 feet by 75 feet. To make it, the surface soil had to be removed and the gravel taken out to a depth of about 3 feet. A large quantity of new soil and manure was added so that the bamboos have now a good depth of rich soil. Two new paths leading to the Bamboo Garden have been made, one from the Syon vista and the other from the Stafford walk. The bamboos planted in the garden are:—*Arundinaria Fortunei* (Bambusa Fortunei), *A. japonica* (Bambusa Metake), *Bambusa albo-striata*, *B. gracilis*, *B. nana* (Hort), *B. palmata*, *B. plicata*, *B. pumila*, *B. tessellata*, *B. Veitchii*, *Phyllostachys bambusoides*, *P. nigra*, *P. Quilloi* (Bambusa Quilloi), *P. violescens* (Bambusa violescens), *P. viridi-glaucescens* (Bambusa viridi-glaucescens), *Thamnocalamus Falconeri* (Bambusa Falconeri), and several others unnamed. Besides bamboos it contains such plants as *Arundo*, *Eulalia*, *Crinum*, *Funkia*, *Yucca*, &c. It is also intended to bring together in this garden a number of the coarser growing monocotyledonous plants which can be grown in the open air at Kew.

ACCORDING to an official "Notification of the Trustees of the Schwestern Frohlich Stiftung" at Vienna, certain donations and pensions will be granted from the funds of this charity this year in accordance with the will of the testatrix, Miss Anna Frohlich, to deserving persons of talent who have distinguished themselves in any branch of science, art, or literature who may be in want of pecuniary support, either through accident, illness, or infirmity consequent upon old age. The grant of such temporary or permanent assistance in the form of donations or pensions is, according to the terms of the foundation deed, primarily intended for Austrian artists, literary men, and men of science, but foreigners of every nationality, English and other, may likewise participate, provided they are resident in Austria. Particulars may be obtained at the Austrian Embassy, London.

MR. T. S. SHEARMEN, of Brantford, Canada, has recently issued a pamphlet, in which he claims priority in the discovery of the fact that the influence of sun-spots on terrestrial magnetic conditions depends upon the positions of the spots on the sun's disc as seen from the earth. He states that he has succeeded in convincing Prof. Young that this claim is justified. His observations have led him to believe that, in the great majority of cases, magnetic disturbances are most numerous when spots are at or near the eastern limb. In many cases, however, especially when the spots were very large, the disturbances have been greatest when the spots were near the central meridian, but even then it is stated that on nearly every occasion in which this has happened, another spot was making its appearance on the eastern limb. M. Veeder (NATURE, vol. xlvi. p. 29) also concludes that in order for a solar disturbance to have its full magnetic effect upon the earth, it is necessary that it should be at the sun's eastern limb, and as nearly as possible in the plane of the earth's orbit.

IN the tenth annual report of the Fishery Board for Scotland a striking instance is given of the advantage which persons engaged in the fishery industry derive from the electric telegraph. The Orkney officer reports that on Saturday morning, August 22, a large shoal of herrings was discovered about three to seven miles off the island of Stronsay by a few boats which happened to be at sea. Having ascertained the position of this shoal the officer wired the particulars, for the fishermen's information, to all the stations in Orkney. On the Monday following every boat employed in the herring fishery in Orkney was on the fishing ground indicated, with the result that the heaviest fishing ever obtained in one day in Orkney (for the number of boats employed) was landed on Tuesday, the average catch for the whole fleet being fifty crans. The number of boats fishing was 108, and their total catch was 5400 crans, valued at £3240, a large proportion of which would have been lost but for the telegraph. Wick fishermen having also been apprised of the circumstance, a number of the Caithness boats had good takes on the same ground and landed them at Wick. Consequent upon such a heavy and unexpected fishing, additional coopers, gutters, packers, barrels, and salt had to be immediately sent for from Wick so that the herrings might be cured while they were in a fresh state, and this was accomplished by means of the telegraph.

AN interesting exhibit of tobacco will be sent from Kentucky to the Chicago Exhibition. There will be exhibits of different varieties of plants in various stages of growth, and illustrations of the manner of shipping and handling "the weed" from the time the seed is put in the ground until the final product is ready for use. The various ways in which tobacco is used in manufacture will also be illustrated.

DURING the last few years much has been said about the supposed European origin of the so-called Aryan race. The honour of having first suggested this theory is usually attributed to Dr. Latham, but, according to Dr. D. G. Brinton, it really belongs to Omalius d'Halloy. In *Science* (June 24), Dr. Brinton refers to a paper in the *Bulletins de l'Académie Royale de Belgique*, tome xv., No. 5, May, 1848, entitled "Observations sur la distribution ancienne des peuples de la race blanche," in which Omalius begins by speaking of a series of notes presented by him to the Academy from 1839 to 1844. In these notes he had sought to prove that the Asiatic origin of the white race had never been demonstrated. "Having recorded this fact, he proceeds "to discuss the evidence, physiological, historical, and linguistic, which had been thought to show that the Indo-European peoples originated in Asia; and combats it at every point, marshalling his arguments to prove that the true white type is distinctly European; and that the ancient Sanscrit and Zend are in no wise maternal languages of the Indo-European stock, but merely sisters of the Greek, Latin, and ancient German." The earliest date at which Dr. Latham expressed similar views was 1851.

SOME suggestive notes on Fuegian languages, by Dr. D. G. Brinton, were read lately before the American Philosophical Society. He refers to a very early Fuegian vocabulary, collected by the French navigator, Joüan de la Guilbaudière, during a sojourn of eleven months in the Straits of Magellan during the year 1695. It includes about three hundred words and short phrases, and no part of it has been published. The MS. copy of it in Dr. Brinton's possession he owes to the courtesy of M. Gabriel Marcel, the Librarian of the Geographical Section of the National Library of France. As M. Marcel intends to give it

publicity in the Compte-rendu of the Congress of Americanists, Dr Brinton contents himself with illustrating its character by a limited selection of words These show that the basis of the tongue is Alikuluf, and it differs, he says, scarcely more from the Alikuluf of the present generation than do between them selves the vocabularies of that tongue by Fitzroy and Dr Hyades in the present century A few words belonging to the Tsoneca and the Yahgan may be detected, probably introduced by trading natives.

THE new number of the Journal of the College of Science, Imperial University, Japan (vol v, Part 1), contains studies on reproductive elements, by C Ishikawa, further studies on the formation of the germinal layers in Chelonia, by K Mitsukuri, papers on the development of *Limulus longispina*, and on the lateral eyes of the spider, by Kamakichi Kishinouye, a paper on the formation of the germinal layers in Petromyzon, by S Hatta, and notes on a collection of birds from Tsushima, by I Ijima The papers are most carefully illustrated

WE have also received the second part of the first volume of "Iconographia Floræ Japonicæ," by Ryōkichi Yatabe (Tokyo Z B Maruya and Co) The work consists of descriptions, in Japanese, of plants indigenous to Japan, with figures

MR T E BUCKLEY contributes to the current number of the Annals of Scottish Natural History some interesting notes on the vertebrate fauna of Sutherland and Caithness The object of the notes is to bring the fauna of these two countries up to date One bird, the ruff, is new to the Sutherland list, and Mr Buckley is able to show the spread of certain other species such as the stock dove, tree pipit, &c Eagles still hold their ground fairly well, but other birds of prey show a decrease This, the author thinks, is only what might be expected, but it is sad, he says, to see how the hen harrier is rapidly approaching extermination Plantations are growing up, and increase the number and breeding areas of certain species When staying at Badenoch, he has been repeatedly struck in the autumn with the attraction which a few (say three or four hundred) small firs, a garden, and an acre or two of cultivated ground, have for migrating birds Constantly in the early October mornings he has seen flocks of small birds, such as greenfinches, chaffinches, &c, descend into these trees, rest for a short time, then, with an unanimous twitter, rise up and pursue their onward course As a rule everything was quiet for the day by nine o'clock

AT the meeting of the Field Naturalists' Club of Victoria on May 9, Mr T S Hall read an interesting note on musical sands While on a trip to Phillip Island at Christmas time, Mr Hall was struck by the musical note given out by the sea sand when walked over. He had never noticed this phenomenon before, though it occurs not uncommonly in other parts of the world His first idea was that the sound was caused by the india-rubber soles of his shoes, but he found he could get the musical note by striking the sand with his hand, or by drawing a stick rapidly over the surface The sound was produced only where the sand was dry, and resembled almost exactly that caused by drawing the finger rapidly over a piece of corded silk On making the sound by skating over the surface, he found that the note could be detected at a distance of forty paces. The sands were musical wherever he tried them about Cowes, and the only person to whom he spoke who had noticed the phenomenon said he had also noticed it at San Remo Mr Hall has since tried the sand at Geelong, Barwon Heads and Warrnambool without any result. He referred to the theories of Mr Carus Wilson on the one hand, and Dr. A. A Julien and Prof H. C Bolton on the other, and expressed a hope that some attention would be given to the subject in Australia.

IN the latest quarterly statement of the Palestine Exploration Fund it is said that considerable progress is being made with the Akka-Damascus Railway, the route of which, after various expensive surveys, has been definitely decided upon The line chosen is practically that first suggested by Major Conder, R E, several years ago Beginning at the great fortress of Acre, the railway will run down the plain of Acre parallel with the sea, throwing out a branch to Haifa, at the northern foot of Mount Carmel, and thence to and across the plain of Esdraelon, passing near Nazareth to Shunem and Jezreel, and through the valley of Jezreel, skirting the slope of the hills, to the River Jordan, which will be crossed within sight of Bethshean. The Jordan here offers exceptional facilities for the erection of the railway bridge, consisting of two spans. Not only are the two opposite banks of the river formed of solid rock, but the centre of the river contains a large block of similar rock, from which each span of the bridge will be thrown to the east and west bank respectively From the Jordan the railway will ascend the slope of the Jaulan Plateau, along the crests that close the eastern shores of the Sea of Galilee, this ascent constituting the only difficult portion of the line, but which the surveys now made show to be much easier of accomplishment than was originally anticipated The plateau near El 'Al being reached, an easy gradient will carry the line by Seil Nawa and Kesweh to Damascus Passing through the finest plains of Western and Eastern Palestine, the railway will be one of great importance The authorities of the Palestine Exploration Fund are of opinion that its construction can hardly fail to lead to important archæological discoveries, and the committee hope to make arrangements for obtaining full information respecting these

THE additions to the Zoological Society's Gardens during the past week include a Pig tailed Monkey (*Macacus nemestrinus*) from Java, presented by Major Day, two Red handed Tamarins (*Midas rufimanus*) from Surinam, presented by Mr J J Quelch, C M Z S, two Sœmmerring's Gazelles (*Gazella sœmmerringi* ♂ ♀), three Egyptian Gazelles (*Gazella dorcas* ♂ ♀ ♀) from Suakim, presented by Colonel Holled Smith, C B, a Red Deer (*Cervus elaphus*), European, presented by Mr J Newton Hayley, a Slender-billed Cockatoo (*Licmetis tenuirostris*) from South Australia, presented by Mrs Duppa, a Rough eyed Cayman (*Alligator sclerops*) from South America, presented by Dr Rudyard, two Dwarf Chameleons (*Chamæleon pumilus*) from South Africa, presented by Mr E Windgate, a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr J Cornwall, two Green Lizards (*Lacerta viridis*), two Green Tree Frogs (*Hyla arborea*), European, presented by Count Pavoleri, F Z S, a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Mr Conrad Kelsal, a West African Python (*Python sebæ*) from West Africa, received in exchange, six Mandarin Ducks (*Æx galericulata*), five Summer Ducks (*Æx sponsa*), seven Chilian Pintails (*Dafila spinicauda*), six Australian Wild Ducks (*Anas superciliosa*), a Variegated Sheldrake (*Tadorna variegata*), four Upland Geese (*Bernicla magellanica*), a Cheer Pheasant (*Phasianus wallichii*), Himalayan Monaul (*Lophophorus impeyanus*), bred in the Gardens

OUR ASTRONOMICAL COLUMN

A NEW NEBULOUS STAR —Mr Barnard, in *Astronomische Nachrichten*, No 3101, gives a brief account of a new nebulous star that he found when photographing, on May 31 last, a region situated in the Milky Way, 18h. 10m, – 20° This star (B D – 19° 4953), when examined (visually) with his 12 inch, was quite devoid of nebulosity owing to the brightness of the star in question, but the photograph showed a faint nebulosity of about 15' in diameter symmetrically surrounding it A

former photograph taken in 1889, July 28, indicated also the same nebulosity The exposure in the former case was of 3h 29m duration, a Willard lens of 6 inch aperture being used The position of the star for 1860 was R A. 18h 9m 23 2s, Decl − 19° 42′ 7

Atmospheric Depressions and their Analogy with the Movements of Sun-Spots.—The solar photosphere, although so different in chemical composition from our own atmosphere, yet affords us many points of resemblance with regard to its general circulation One special analogy, and that a comparison of the motions of storms here with those of spots on the solar surface, is treated of in the July number of *L'Astronomie* by M Camille Flammarion In this article he has brought together sufficient observations to trace out the paths of many of the most violent storms that have from time to time visited Europe generally The first storms which he gives are those which occur in the Atlantic, their general direction of motion seems to be from south west to north-east, pursuing generally the path of the Gulf Stream Their centres, when traced on a map, seem to just graze the shores of the British Isles, France very rarely being reached by them From observations made on land, and more especially from those at Paris, M Flammarion remarks that certain curves with regard to these storms seem to offer many analogies to solar spots, this is so not only for the regular displacements, but even for those which at first sight seem to be totally void of all regularity The diagrams which he gives, showing both the paths of the storms and those of sun spots, afford most interesting comparisons and seem to confirm the view suggested by M Faye that the constitution of spots resembles somewhat that of the cyclones with which we are familiar

Yale College Observatory Report.—In this report, submitted by the Board of Managers to the President and Fellows of the Yale Observatory, Mr Brown makes us acquainted with the present condition of the Observatory generally, while Dr Elkin gives an account of the work done by the heliometer during the past year The satellites of Jupiter formed the principal object of work from July 1891 to January 1892, 570 complete measures of their relative positions having been obtained on 114 nights Dr Chase, with the same instrument, has been measuring the cluster in Coma Berenices, securing from 18 to 20 measures for each of the 32 stars, besides determining the required data for the reduction constants In the work on the parallaxes of the first-magnitude stars in the northern hemisphere, the 100 sets of measures of each of the ten stars have not yet been fully completed, but the following table shows the results obtained up to the present, Dr Elkin thinking that it will require two more years before the final results can be published —

Star	Parallax ″	Prob Error ″	No of comp stars	No of Sets.
α Tauri	+ 0·101	+ 0·022	6	65
α Aurigæ	+ 0·095	0·021	5	51
α Orionis	+ 0·022	0·022	6	48
α Canis Minoris	+ 0·341	0·020	6	48
β Geminorum	+ 0·057	0·021	6	48
α Leonis	+ 0·089	0·026	10	43
α Bootis	+ 0·016	0·018	10	89
α Lyræ	+ 0·092	0·019	6	67
α Aquilæ	+ 0·214	0·023	10	46
α Cygni	+ 0·012	0·020	7	49

GEOGRAPHICAL NOTES

The condition of affairs in Uganda, of which much has recently been made in home and foreign newspapers, is a question rather of politics than of geography, yet problems of a geographical kind are involved in it So far the progress of civilization amongst the Waganda has served only to introduce new elements of dissension, and the attempts to carry out the policy of preventing the sale of spirits, firearms, and ammunition have only been partially successful Scientific exploration in a country so unsettled must necessarily be suspended If the British occupation is to be productive of benefit either to British trade on the one side or to native interests on the other, the firm and impartial rule of Captain Lugard and Captain Williams must be maintained and reinforced. The urgent request which these officers have made for additional white assistance demands all the more attention since the garrison under their control has been swelled by the survivors of Emin's force in Equatoria.

Although, as announced in Nature (p 230), Captain David Gray's Antarctic expedition has fallen through, it is satisfactory to know that three Dundee whalers, which are shortly expected back from the Arctic "fishing," will be refitted immediately and despatched about the beginning of September to the Falkland Islands, and as far to the south as may be necessary in order to get a cargo The proposed cruise is to be purely commercial, and it is not likely that any exploring work will be done It is probable that berths will be available on board for two or more scientific men, who should have good opportunities of collecting natural history specimens The experience of the whale ships will be valuable in supplying hints for the equipment and route of the great Antarctic expedition which under some European flag cannot be long delayed

Dr Oscar Baumann, charged with the survey of a road to the Victoria Nyanza, reached the shores of that lake in April, after an unprecedentedly rapid journey from the coast. From the *Times* report of a letter written by Dr Baumann from Kadoto, we learn that the route, after passing around Lake Manyara, struck across an unknown stretch of country in which a new lake of large dimensions was discovered Even in Africa few lakes of such magnitude can now remain unknown, at least from native reports Lake Eiassi lies on the plateau south east of Victoria Nyanza, and from the report of the neighbouring Masai, it seems to be about ninety miles long, while the breadth of the northern portion, along which Dr Baumann marched, varied from eighteen to thirty miles. This lake is presumably filled with fresh water, but no outlet is mentioned It is interesting, however, to find native reports of a great river flowing in on the western side, which may be confidently identified with the Wemberi, a river shown on recent maps as flowing north eastward from the border heights of Unyamwesi, and losing itself on the plateau It is possible that the new lake may discharge into the Victoria Nyanza by the Simiu river, the head waters of which have not previously been explored

The recently founded New Zealand Alpine Club has published the first number of its *Journal*, devoted to the exploration of the glaciers and peaks of the Southern Alps The magnitude and difficulty of these snow mountains of the south has hitherto been very inadequately realized

THE MUSEUM QUESTION[1]

Gentlemen of the Museums Association,—In taking the chair which was so ably filled by my predecessor at Cambridge, I must first of all give you a hearty welcome on the part of the Committee of the Manchester Museum There is to my mind a singular fitness in the selection of Manchester as a place of meeting after Cambridge At Cambridge you had the opportunity of studying the various museums which have in the course of time naturally grown out of the development of that ancient seat of learning. In Manchester you will see the collections which have been gathered round Owens College, which represents the newest University development in this country. The genius of the place has left its mark in both In Cambridge the collections are, as they should be in a region of academic calm, free from trade-winds, arranged mainly, if not entirely, with an eye to University students, and not for the general purposes of a miscellaneous public In this busy centre of movement and commerce, you will find that the principle of arrangement is twofold. It first aims at meeting the needs of the University students, and of the Mechanics' Institutes, and schools, and other educational bodies, which are daily being drawn closer to Owens College, and next at the instruction and enjoyment of the general public Our collections are for the most part older than the college and have been absorbed from without into our educational centre

The problem which we have attempted to solve is this: How to arrange and organize collections which are in part as old as the second quarter of this century, so that they may become valuable in the new learning and at the same time put an outline of the history of nature within reach of the people This

[1] Address to the Museums Association, Manchester meeting 1892, by the President, Prof. Boyd Dawkins, F R S

problem, as we all know, is not an easy one. It has, however, to be faced in most of the museums of this country. Whether it has been solved or not in Manchester, it is not for me to say. Prof. Huxley, in addressing us some years ago on the question of technical education, said that he did not know exactly what shape it should take, but that Manchester was a good place in which to make an experiment for the good of the Commonweal. *Fiat experimentum in corpore Mancuniensi*. The result of our experiment in museum organization is here and speaks for itself.

Before, however, I deal with this special attempt to meet the needs of Manchester I must touch on the general question of museums.

The Museum Idea and its Place in Culture.

A museum was to the Greeks a place haunted by the Muses, and in a secondary sense a building in which liberal studies were carried on such as that at Alexandria, which was a great University endowed by the State, divided into colleges, and frequented by men of science and letters. This museum included picture galleries and statuary, and it is not at all improbable that it contained also collections of Natural History. Aristotle, it must be noted, made vast collections, which he used in his history of animals, by the aid of his friend Alexander the Great, and it is hard to believe that the impulse which he gave to the study of natural history should not have been felt in Alexandria, where his memory was venerated. With the destruction of this museum in the days of Aurelian in the last quarter of the third century after Christ, the name as applied to a public institution gradually dropped out of use, and was only revived with the revival of learning in the West in the times of the Renascence. We owe the first idea of a great national museum of science and art to the "New Atlantis" of Lord Bacon, the first scientific museum in this country to Elias Ashmole, who founded the museum which bears his name in 1667 at Oxford. It consisted mainly of the natural history collections made by the Tradescants, and miscellaneous objects of antiquarian interest, which in the course of time swamped the natural history. Now, under the care of Mr. Arthur Evans, reorganized and rearranged, it is taking its place among the educational institutions of the University. It was not until 82 years after the foundation of the Ashmolean that museums were recognized by the Government of this country in the establishment of the British Museum in 1749 by Act of Parliament.

The modern museum is the outcome of the Renascence, and must keep pace with those great accessions to our knowledge of the history of Nature and of Man which distinguish the new from the old learning of to-day. If it cease to grow it is dead, and should be removed. There is no finality in museum work any more than there is finality in the acquisition of knowledge.

The Muses should not be forgotten in museum arrangements, and form, beauty, and symmetry should be studied as well as the outlines of a rigid classification. As an illustration of this I would refer to the groups of birds in the Natural History Museum at South Kensington, or to some of those in the museum at Newcastle. "A thing of beauty is a joy for ever." There is no reason why things beautiful in themselves should be treated so as to repel rather than attract. The element of fit association, too, is one of the important principles. In the case of the temporary exhibition of pictures in the Academy, the fit association of subjects cannot be studied, but there is no reason why in an art gallery the Muses should be scared by a Venus being placed close to local worthies, or a Madonna close to a party of Bacchanals. In museums as in armies the results are largely dependent on the leaders, who leave the impress of their personal character on their commands. The impulse to the new learning given by Ashmole, Hunter, Flower, and by Franks and Newton in this country, by Leidy, Dana, Marsh, and Agassiz in the United States, will last as long as the museums which they founded and organized. In Paris the name of Cuvier is inseparably bound up with the Museum of Natural History in the Jardin des Plantes. In Berlin the Ethnological Museum, and the anatomical collection at the Charité, will keep fresh the memory of Bastian and Virchow in a far distant future when the names of the great political leaders of these times are fading away. It is, therefore, of primary importance to choose good leaders for museum work, and to offer those inducements which will command the services of the best men.

The Old Local Museums in Britain.

When I first began to study the question, some thirty years ago, most of the local collections in this country were in a deplorable state. They consisted largely of miscellaneous objects huddled together with more or less care, and more or less—generally less—named. In one you saw a large plaster cast of a heathen divinity, surrounded by stuffed crocodiles, fossils, and models of Chinese junks, which looked like the offerings of devout worshippers. In another I remember a small glass case containing a fragment of human skull, labelled "human skull," and a piece of oatcake, labelled "oatcake," while underneath was a general label with the inscription, "A piece of human skull very much like a piece of oatcake." In a third wax models were exhibited of a pound weight of veal, pork, and mutton chops, codfish, turnips, parsnips, carrots, and potatoes, which must have cost the values of their originals fifty times over. They had labels explaining how much flesh and fat they would make—theoretically—for we who are either lean or fat know that the personal equation has to do with the actual results. They were as carefully modelled as the most delicate preparations of human anatomy. I quote them merely as illustrations of the misapplication of time, money, and museum space.

In many collections art was not separated from natural history, nor from ethnology, and the eye took in at a glance the picture of a local worthy, a big fossil, a few cups and saucers, a piece of cloth from the South Seas, a model of a machine, and probably also a mummy. These objects would be all very well in their places, but being matter in the wrong place, they were covered by the Palmerstonian definition of rubbish. Such collections as these neither please nor instruct. They have no more right to the name of a museum than a mob has to be called an army. Most of us, I think, are acquainted with this type of collection, which is rapidly becoming extinct with the spread of knowledge. I merely quote them as examples of a state of things from which we have fortunately escaped.

The Place of Museums in the New Learning.

The rapid increase of knowledge makes it more and more necessary for museums to be organized, so as to be in harmony with the swiftly changing conditions. The study of things as well as books is daily growing in importance. The historian, for example, formerly content with written records, now counts the results of archæological discovery among the most valuable and trustworthy of his materials in dealing with the history of the past. The story of Ancient Greece is incomplete if the explorations at Mykenæ and Ilios, in Athens, in the Greek islands, and in the Egyptian cities and tombs be left out of account. To the historian the collections of Schliemann, Flinders Petrie, and others are most precious. Nor are they less precious to him who studies art, or to the ethnologist who studies civilization, or to the naturalist who is interested in the distribution of the various types of mankind, or to the technologist who looks to the evolution of handicrafts. The public mind is beginning to realize the value of well-organized museums for purposes of special research as well as of general culture, and thus they appeal to the interest of the many, while books and a taste for books interest a narrower circle. To contemplate in the British Museum the frieze of the Pantheon is of itself an education in Greek art and in Greek ideas of beauty, and the most unlettered visitor to the Natural History Galleries cannot fail to carry away new ideas about the realm of nature. It is obvious, therefore, that in museums we have an instrument of great educational value, if they be organized to meet the increasing demands of modern investigation.

The Classification of the Museums of To-day.

The museums of to-day fall naturally into four groups. (1) The Art Museum, which includes also antiquities arranged from the art point of view. (2) The Natural History, which illustrates the history of nature in its widest sense, and of man in his physical aspects. (3) The Archæological and Ethnological, which deals with the works of man and his progress in civilization. (4) The Technical, in which objects are arranged in relation to industry. The leading idea of the first is art, of the second nature, of the third civilization, and of the last the conquest of mind over matter.

The Principles of Museum Organization.

These four groups are sharply defined from each other In practice however it is often necessary to use for the illustration of one what, strictly speaking, belongs to the others In all such cases, however, the reason of the presence of the alien object must be made obvious, if the general effect of the arrangement is to be preserved For example, in the Manchester Museum, I found it necessary to complete the history of the Tertiary Period to illustrate the first appearance of man, and to carry on the narrative through the prehistoric and historic divisions down to modern times by a small selected series of specimens, showing the progress of mankind Were it not for this they would be wholly out of place in a collection of natural history In like manner our Egyptian mummy has its due place in the National Gallery in Trafalgar Square, its *locus standi* consisting in the fact that it illustrates the art of portrait painting among the Alexandrine Greeks of the first century after Christ

Next in the point of importance to the leading ideas in museum work comes the question of labelling and illustration The labels should be clear and distinct, and if possible in English as well as in Latin The specimens should illustrate the labels quite as much as the labels the specimens All possible means of illustration should be employed, maps, diagrams, restorations, and the like, so that the main points and relations are clearly brought home to the visitor In addition to the systematic catalogue of each specimen there should also be a popular guide similar to those of the British Museum It goes without saying that a collection of books is also necessary

The kind of museum most desirable in any place depends entirely on the local conditions, and there is no hard and fast scheme applicable to all cases Nor is the question of great or small to be looked at otherwise than as one of detail A small well arranged collection in a school or in a village will do the work which it is intended to do as well as large museums in the metropolis, or in a university, or in a centre of commerce The principles of success are the same in all they must be orderly, they must be intelligible, they must as far as possible appeal to the sense of beauty Under no circumstances must unnamed and unknown specimens be allowed to appear A ragged recruit may be drilled into a good soldier, but he spoils the parade if he appears out of uniform in the ranks Nearly all of us who have had to do with museums have sinned in this matter, and it is not for me to cast a stone at my fellow sinners.

The work, however, is only partially done when a museum is properly arranged, labelled, and catalogued on the above lines To make it intelligible in the best possible way, it is necessary that there should be lectures and demonstrations given in the museum itself, in which some special points should be taken up which interest either the general public or the special worker In my experience oral instruction with the things before the eyes in the museum, and not away from it in the lecture-room, is the best manner of doing this As an example of this, I would refer to the demonstrations organized in the British Museum by Prof Stewart Poole, in which ancient art and civilization were dealt with, and to those which have from time to time been given in the national collection of natural history, under the auspices of Dr Flower In this relation the British Museum will be found to be one of the most valuable instruments for spreading knowledge in the University which London will have in the future In this relation, too the Geological Museum in Jermyn Street, around which are centred some of the ablest men of the time — De la Beche, Murchison, Ramsey, Edward Forbes, Tyndal, Huxley, and many others—has done most valuable service It is in this direction that museums will influence the general education in this country, and take their natural place in the new learning

Application of these Principles to the Manchester Museum

I pass now to the application of the above principles to the Manchester Museum, Owens College. Our experience gained in bringing the old collection into harmony with modern requirements cannot fail to interest those who are now engaged in like work, because it may show not only what is to be copied, but what is to be avoided.

When the task of organization was entrusted to me in 1869, there was a large general collection of natural history, and a large geological collection. The former had been a first class collection in the second quarter of this century, but had ceased to grow, and therefore had become dead The second was in good order, and, under the care of its founders, Binny, Ormerod, and others, was properly named Both, however, were in a most deplorable state so far as relates to fittings, and were simply ignored by the general public, and scarcely used by students The first step was to sweep out of the way the miscellaneous objects which had no place in a Natural History Museum The next was to organise what remained into a systematic collection in rooms and cases which were unfit for the purpose Then followed evening lectures and demonstrations in the old Museum building in Peter Street Later the teaching collections in Owens College were added, and the Museum began to revive and grow, slowly but steadily, as the connection with the College grew closer, till, in 1874, it was transferred to temporary quarters in the attics and basement of the Owens College It continued to grow in spite of the removal and of the inadequate cases, and the interest of the public was maintained very largely by the system of Saturday afternoon demonstrations in the only part open to the public—the Geological Museum

The systematic rearrangement in view of the new buildings was taken in hand The minerals were arranged, labelled, and catalogued, Dana's "Hand book of Mineralogy" offering a ready-made catalogue To meet the mining interests of Manchester special groups of the minerals found in association were organized to illustrate the minerals of Derbyshire, the Lake District, Cheshire, the diamond mines the apatite mines, and the like

For the special ends of the geological teaching, the rock specimens were also arranged, and special groups were formed to illustrate their association—such as the products of Vesuvius, and of the volcanoes of Auvergne—and to illustrate the destruction of rocks by natural causes Then naturally followed the classification of the fossils to show the sequence of events in the geological record In this the Carboniferous flora and fauna naturally took a prominent place, because of the vast importance of the coal fields to this district The arrival, too, of the existing higher Mammalia, including man, on the earth, took a prominent place in the Tertiary collections, and formed the leading idea in the Tertiary chapter of a history of the earth, while the story of the earth was fitly closed by a series of groups illustrating the evolution of human culture and the prehistoric and historic periods The general principle of classification throughout the whole geological series, or, in other words, the historical method, was that of *time* Next the zoological collections were arranged, as far as the changing classification would allow, zoologically, with a special group for the zoology of Great Britain. The botanical collections, which offered exceptional difficulty, are now in hand In this manner the whole of the collections were arranged for the time when they should find their place in the new buildings, and pass under the care of the professor in each department A scheme of uniformity was carried out with regard to fittings and mounts also, a definite unit of size, 4" × 1½", was decided upon, and all tablets and glass boxes were made either on that or on multiples of that This unit also ruled the size both of the drawers and of the cases in the new fittings The system of printed labels in which black ink represents the specific name and the red the name of the group was also devised In the plans of the new Museum the maximum amount of light, consistent with stability and architectural beauty, was the leading idea, while the laboratories and lecture room of the whole of the Natural History Department of the College were brought as close as they could be to the Museum The building itself was designed to suit the organization of the collections Thus step by step the present Museum was gradually built up, and when the buildings were completed in 1884 the collections were transferred to the quarters which they now occupy, and where they form a centre towards which other collections gravitate

While the museum has been rapidly growing during the last eight years, the system of museum lectures and addresses to various organizations, mechanics' institutes, schools, and the like has been largely developed In its present state it is used largely by students of Owens College, and is growing in favour with the general public. In other words it is taking the place it ought to have in the education of this densely populated district These results, it must be observed, have only been possible through the liberality with which the Museum has been treated both by the public and by Owens College. I look forward with confidence to the time when both will be amply repaid by the impulse it is giving, and will give, to the new learning.

I do not for one moment suppose that a natural history museum of this kind is suitable for all places. The *genius loci* must be, in all places, the genius of the museum. The principles however of success are the same in all, and success can only be achieved in a limited degree if there be no signs of the worship of some of the Muses in the arrangements.

The Work of the Museums Association.

In ending this address, all too long, I fear, for my audience, all too short for my subject, I must add a few words as to our work as a Museum Association. It is twofold. First, we must arouse ourselves to the present situation and note the directions which the intellectual movement of the day is taking. Next, it is our duty to arouse the public to the importance of museum development, and to take care that the claims of museums as instruments of education shall not be ignored in the grants made by public bodies for the good of the commonweal.

ON THE CARBURIZATION OF IRON.

I.

THE conditions under which carbon combines with iron have been closely studied, and the observed phenomena fully discussed. Even now, however, it is doubtful whether true chemical combinations of carbon and iron are formed. It has been alternatively assumed that carbon is with difficulty soluble in iron, and that at low temperatures solution may proceed very slowly. In other words, carbon is not easily dissolved except at high temperatures; and it follows that if highly heated iron fully charged with carbon be cooled, a portion of the carbon must be precipitated in this state, existing simply as foreign matter in the metal, but that, on reheating, it may again enter into solution. Low carbon steels may be regarded as dilute solutions of carbon in iron; pig or cast iron as saturated; and intermediate grades may be termed moderately concentrated solutions.

Against this, however, there is a mass of evidence which deserves attention and cannot be ignored. Percy states that for the full carburization of iron a high temperature is necessary, and further, considering the absolute infusibility of carbon, it seems reasonable to assume that these elements must enter into chemical combination. It is, however, admitted that this compound may have the power of dissolving additional carbon; this explains the copious deposition of carbon in the graphitic form when iron is cooled. Dr. Percy finally concludes that there must be at least one definite compound of carbon and iron, but adds that there seems to be no reason why solution should not occur, as in the case of mercury, which liquefies gold, silver, or copper.

Prof. Roberts Austen also ("On Certain Properties common to Fluids and Metals," Royal Institution, March 26, 1886) speaks of the power which certain solid metals have of even rapidly taking up fluids—clearly cases of solution. Abel claims to have proved the existence of a definite compound of carbon and iron. Prof. Roberts Austen also finds that heated iron combines with pure carbon in the form of diamond dust. The author also has succeeded in directly combining iron fused *in vacuo* with pure sugar charcoal presumably freed from gases by repeated heatings *in vacuo*. Yet it is obvious these instances may *all* be explained on the theory of solution at elevated temperatures, with the exception of Prof. Abel's, who claims to have isolated a definite carbide of iron from the metal.

Matthieson, as the result of an elaborate research, states that "with few exceptions" most of the known two-metal alloys are solidified solutions of one metal in another. Carbon-iron alloys may be looked upon as solidified solutions of carbon in iron, and the analogy of cast iron with other alloys indicates the non-existence of chemical combination between carbon and iron.

Again, viewing alloys as definite chemical combinations, the facility with which heated iron absorbs certain gases does not admit of easy explanation.

Deville, however, imagines a kind of porosity in the metals, terming it an intermolecular porosity, sufficient to admit of the passage of gas at a low temperature; and supposes it developed by the expansive agency of heat. Graham assumes that the affinity of the gases for iron and platinum is as the attraction admitted to exist between a soluble body and its solvent.

Other metallurgists are of opinion that carbon does not directly combine with iron, attributing their union to the indirect action of carbon monoxide gas always present in iron; by the agency of this gas carbon is indirectly transferred to iron; but it would appear that this cannot be maintained, for it has been proved that carbon combines directly with iron one way or the other, *i.e.* by solution or chemical combination.

Whatever may be said of irons containing an excess of carbon, *i.e.* cast iron and very hard steel—which, if one grants that carbon is not very soluble in iron at a low temperature may be termed supersaturated solutions—in the case of low carbon steels there seems some ground for assuming that carbon is merely dissolved in the metal.

Sir L. Bell tells us that, on heating thin sheets of carburized metal or steel piled closely together, the excess of carbon contained in one or more of the sheets is transferred to the others. Wrought iron is carburized in much the same manner by the cementation process, and it is equally possible that heterogeneous iron, *i.e.* iron containing intermixed carbon or graphite, and as a rule not equally diffused, may by continued sufficient heating become practically homogeneous.

It is a well known fact that the carbon in low carbon steel—for instance, Bessemer steel—exists in at least two different forms; Prof. Ledebur says four. Akerman (Iron and Steel Institute) classifies these as (1) hardening carbon, or the carbon which determines the quality of steel, (2) cement carbon, and also graphite may be present.

The united researches of many workers in this field of research indicate generally that a portion of the total carbon is in intimate union with the metal, and that the more intimately combined or hardening carbon determines the quality of the steel. The carbon incompletely combined (or intermixed carbon) is termed cement carbon, because it occurs in the largest proportion in blister or cement steel.

Does not the above point to a case of solution of carbon, in which the quantity in solution is determined by temperature, just as with other solutions?

Metallurgists, however, can hardly accept the theory of solution without qualification.

Mr. Spencer states that "unhardened steel containing 1·18 per cent. total carbon—of which the colour test indicated ·89 per cent. as combined carbon, and residual carbon or graphite ·29 per cent.—after being hardened, gave only ·58 by colour test, and only traces of graphitic carbon, showing a loss of ·51 per cent. of carbon. A softer steel, containing ·50 total carbon—equalling ·45 per cent. by colour test, ·04 per cent. graphitic carbon—after hardening, only ·21 colour test carbon, graphitic carbon ·00, showing a loss of ·29 per cent. Other analyses were made confirming the above, and establishing the fact that after hardening there is always a proportion of carbon which can neither be determined as graphite or by the colour test, and this proportion is found to increase according to the larger amount of carbon in the metal, and the rapidity with which it was cooled" (Mr. Spencer, Iron and Steel Institute).

The facts above quoted are not apparently in accord with the theory of solution; but there are undoubted allotropic modifications of carbon, and this peculiar form may be one of these, "uncombined," and may be classified with the graphite, or really as merely intermixed foreign matter.

There is the alternative assumption that the missing carbon may exist in some form or combination with the iron, possibly not capable of being registered by the colour test; but as the steel is treated with dilute nitric acid, in which it is completely soluble, with the exception of the graphite, this assumption can hardly be maintained.

Referring to Akerman's assertion that only combined "hardening" carbon determines the physical properties of steel—an assertion with which Mr. Spencer agrees—"The apparent loss of carbon shown by the latter, and which we have determined as intermixed carbon or a form of graphite"—it may well be that the missing carbon is so intimately mixed as to be in a state closely bordering on solution, for it is well known that it is difficult to draw the line between absolute solution and matter finely suspended in a liquid. The latter practically often presents the appearance of a solution scarcely to be distinguished from it. Messrs. Harold Picton and L. E. Linder (Chem. Soc., January 1891) are of opinion that there is a continuous series of grades of solution passing without break from suspension to a crystallizable solution. This seems very probable, and in accordance with our chemical experience.

Graphite, if the author has adequately grasped Prof. Akerman's views, has little or nothing to do with the quality of

iron "Graphite carbon exerts an influence only on iron in so far as it diminishes the continuity of the iron molecules We often meet with the incorrect statement that the influence of carbon on pig-iron is quite different from its action on steel and malleable iron

"It is easy to prove to the contrary if we distinguish properly in pig-iron between the combined carbon and that which is only mechanically incorporated as graphite, which ought not to be included in the calculation if we wish to form a judgment on the properties of pig-iron as dependent on its contents of carbon"

As one understands this, the same applies to steel

So far there can be no difficulty in assuming at least the probability of the solution of carbon in iron, and that the physical qualities of the metal are determined by the quantity of carbon in solution, *i e* Akerman's hardening carbon

The facts, *per contra*, appear mainly to indicate that carbon is merely sparingly soluble in iron at temperatures below its fusion-point

A more serious objection (previously referred to) is that carbon is practically infusible, more especially in the graphitic form How this intractable body so readily interpenetrates iron is a problem not easily solved

The ordinary chemical theory of solution as usually understood does not, however, seem applicable on the whole, but some of the results accruing from the recent development of the gaseous, or rather physical theory of solution, may be made available for this purpose

The Physical or Gaseous Theory of Solution

In cases of simple solution the dissolved substance may be regarded as being evenly distributed throughout the solvent. The substance is dissolved by virtue of osmotic pressure, and Van 't Hoff has shown that osmotic pressure in solutions corresponds to gaseous pressure in space.

Further, it appears that both Boyle's and Charles's law holds good, at least for dilute solutions, osmotic being the equivalent for gaseous pressure, which pressure increases for constant volume proportionally to the absolute temperature It has been, however, objected that Boyle's law is not strictly applicable to "more especially concentrated solutions," but Prof Orme Masson (NATURE, February 1891), states that these are comparable with the case of gases at high pressures Again, exceptions are claimed under the law of Avogadro, *i e* equal volumes of gases contain equal numbers of molecules under like conditions of temperature and pressure, but as regards compound gases exceptions occur, as also with dilute solutions

Exceptions can be explained by the theory of dissociation The analogy between gases and the physical theory of solutions thus seems complete, and Ostwald describes an experiment indicating the existence of free ions in a dilute solution of potassium chloride, other instances might also be quoted

The author's object, however, is not to discuss the absolute correctness or otherwise of the theory of gaseous solution, which seems pretty well established, but to show that it may be applicable to the solution of carbon in molten, semi fluid, or even merely heated iron, apart from possible cases of dissociation and chemical combinations Solution is simply the even distribution of one body in another, or such distribution as that of permanent gaseous matter through space It may be urged that the theory is not applicable to semi-fluid or merely heated iron No definite line can, however, be drawn, it is obvious that the different grades of temperature are simply approximations, more or less, to the ideal fluid condition The law of solution, as above defined, may suffer modifications, but need not in consequence be rejected

"*Definition of Osmotic Pressure* [1]

"Osmotic pressure is really a definite force With suitable apparatus this force can be measured, in centimetres of a mercury column, and Pfeffer has shown that this, the osmotic pressure, is intimately connected with the nature of the dissolved substance.

"The pressure was found to be dependent on, and in proportion to, the concentration of the solution, the pressure at a specified concentration is dependent on the temperature—a rise in temperature corresponds to an increase in pressure

"This discovery remained unnoticed. In the first instance the facts were only required for the elucidation of certain physiological questions

"And it was not until 1886 that Van 't Hoff developed a theory of solution based on these phenomena

"Osmotic pressure is a specific property of the substance in solution, and in this respect resembles gaseous pressure The analogy between the state of solution and the gaseous state is clearly shown (pp 115–17) Dissolved substances exert the same pressure in the form of osmotic pressure as they would exert if they were gasified at the same temperature without change of volume

"All that we know of gases holds good for solutions, substituting *osmotic for gaseous pressure*

"Osmotic pressure is, in some instances, very great."

And it seems clear that osmotic pressure is not a mythical, but a real or actual force of considerable power, and one which may be rationally applied to the elucidation of the cause of the carbonization of iron, further, it may even afford a clue to the phenomena observed in the production of other alloys

As regards the carburization of iron, the physical theory of solution, "founded on the identity of osmotic with gaseous pressure," seems the only one capable of affording a satisfactory explanation of the facility with which carbon combines with iron

The chemical, or old, theory of solution apparently fails to do this. The same may be said of the assumption that chemical combinations of iron and carbon are formed Although it must be granted such combinations may exist, yet, in the author's opinion, complete proof is still wanting It is really difficult to realize, when dealing with stable bodies like iron and carbon, how their union can be thus accomplished

On the contrary, the application of the law of osmose renders the conception of the transfer of carbon to iron very easy This force, exerting probably almost illimitable power in nature, seems the only one capable of overcoming the *inertia* of bodies, such, for instance, as that of iron and carbon

The physical theory of solution has hitherto only presumptively herein been applied to the solution of solids in liquids, and it may be asked, Is it applicable to the case of the solution of solids in solids, such as carbon and iron, when heated?

To this one can reply with confidence that the absolute solid has no existence Unless we reject the atomic theory, it is evident that no tangible mass of matter can be termed a solid it is an agglomeration of atoms. Further, accepting the definition of what is termed the atomic volume—*i e* the space occupied or kept free from the access of other matter, by the material atom itself, together with its investing sphere of heat—it follows that the atoms must be apart from each other in the so called solid mass, and the distances between the atoms are probably considerable as compared with the actual volume or size of the atoms themselves. Therefore, there can be no difficulty in conceiving that osmotic pressure plays a part in the case of a mass of matter, "conventionally termed a solid" It is only a question of degree, the quantity of matter dissolved in a given time is simply a function of the temperature applied, and at a low temperature, the effective osmotic pressure in the case, of solids seems comparable to that of a liquid evaporating under pressure of its own vapour Evaporation is retarded, and the analogy may hold good in the case of the conventional solid

JOHN PARRY

PHOTOMETRIC OBSERVATIONS OF THE SUN AND SKY.[1]

ATTEMPTS have been made by Clausius and various other mathematicians to calculate the light at different points of the perfectly clear sky, and to compare the light of the whole (or a portion) of the sky with that of the sun The difficulties of photometric measurement have prevented any of the theories being thoroughly established by experimental verifications.

In the first period of photography, it became a matter of practical importance to have some way of testing roughly the "actinic activity of diffused daylight," in order to obtain a guide for the time of exposure Very many photographers, in those days when the evils of over-exposure could not be corrected in the printing, must have exposed a scrap of sensitive paper, and thence concluded how many seconds' exposure they would allow.

[1] Ostwald, "On Solution"

[1] "Photometric Observations of the Sun and Sky," by Wm Brennand. Proceedings of the Royal Society, vol. 49, n 288, April 18, 1891, pp. 255-260.

From this point it would be a very easy step to test the "actinometric effect on sensitized paper" ("chemical action" of Roscoe) of different skies, or of the sun at different altitudes It is not probable that the chemical action is simply proportional to the light, but it would be soon found that the "chemical action" could be much more accurately measured than the light

Sir Henry Roscoe (partly in junction with Bunsen and with Thorpe) made many investigations and various publications between 1859–70 on the chemical action of the sun and sky as measured by its effect in darkening photographically sensitized paper Roscoe delivered the Bakerian Lecture in 1865, "On a Method of Meteorological Registration of the Chemical Action of Total Daylight"

Throughout his investigations Roscoe pursued a direct method of experiment: he elaborately investigated a method for obtaining always paper of standard sensibility, he devised a plan for obtaining a light of standard intensity, he then exposed a piece of the paper to the action of the sky, or of sun and sky, or of a portion of the sky, and compared the effect produced in a given number of seconds with that produced in the same paper in the same number of seconds by his standard light Roscoe also, by a laborious method, verified his fundamental assumption that light of intensity 50 acting for 1 second has the same effect as light of intensity 1 acting for 50 seconds.

Roscoe took half-hourly readings at Manchester, and thence gave the (comparative) actinic effects of the sky at different seasons of the year Also he compared the chemical intensity of total daylight at Kew and Para, and investigated the relation between the sun's altitude and the chemical intensity of total daylight in a cloudless sky By total daylight Roscoe meant the chemical action produced by the sun and whole sky together on a piece of paper exposed horizontally

Roscoe found that his readings were enormously affected by the cloud-haze or invisible vapour in the air in England, he got his results, as to comparison of the chemical intensity at different seasons of the year, and at different altitudes of the sun, by assuming that in the average of a large number of observations, the effects of cloud, &c, would be self-destructive

Roscoe found that the "chemical effect" of the sun depended only on his altitude (in a cloudless sky), being the same at Para and at Kew He got very anomalous results as to the effects in spring and autumn in England, probably because the effects of cloudiness were not self-destructive in his series of observations He arrived, by "averaging" the cloud irregularities, at the law that "the relation between the sun's altitude and the chemical intensity of total daylight is graphically represented by a right line" (a result only a rough first approximation to the truth) Roscoe obtained small result in comparing the chemical action at different points of the same sky, partly because he could make no experiments in person on a tropical clear sky, partly because to note these differences requires superior instruments to the direct experiment method alone tried by Roscoe

Mr W Brennand was engaged at Dacca in observations, parallel to those of Roscoe, and nearly contemporaneous, 1861–66 Brennand was quite unaware of Roscoe's experiments Being an amateur photographer, and his own photographic chemist, he was first led to devise an instrument for testing the chemical action of sun and sky, in order to obtain guidance for the number of seconds to expose a photographic plate He was soon led on to investigate the effect of the sun at different altitudes, the effect of the sky for different altitudes of the sun, and finally the law of distribution of the "chemical action" in a perfectly cloudless sky

Brennand's procedure in experiment differed fundamentally from Roscoe's in two points:—

(1) Brennand only attempted observation in the cold weather at Dacca when he had a complete horizon of clear sky He was thus enabled to carry his investigations into the laws of chemical action in a cloudless sky much farther than Roscoe, 90 per cent (at least) of whose observations were obscured by cloud irregularities that could not be allowed for.

(2) Instead of Roscoe's direct method of observation, Brennand was early led to devise an instrument (the water-motion actinometer (see NATURE, January 8, 1891, p 237), by the aid of which he was independent both of the standard light and standard paper attained by Roscoe with so great labour The sun himself was, in fact, Brennand's standard light, and the darkening of each paper was read as a ratio, for instance, if an exposure of 10 seconds to sun and sky produced the same tint in the paper that was produced by the sun alone in 17 seconds, then the effect of the sun alone was reckoned $\frac{10}{17}$ of the sun and sky together It is clear that *any* uniform paper should give such ratios the same, though the actual shades produced would be different in different papers All the papers made by Brennand himself were found "uniform," *i.e* to within the limits of variation (say, 2 per cent) within which the darkened paper can be read, *i e* the shades can be matched Any good photographic paper is found uniform enough for the purpose, but some of the ordinary photographic papers tried lately in England have been found not good enough, the nature of the irregularities introduced by imperfect paper is such as to suggest very soon their cause

It is to be noticed that all that can be observed is a ratio the observations in Roscoe's direct process are not absolute In that process there is a standard unit, viz the blackness produced in the standard paper by the standard light action at the unit of distance for n seconds Any other light that produces this blackness has the numerical value $\frac{1}{n}$ in Roscoe's unit There is little doubt but that Roscoe got his standard light and standard paper, each time he recovered them, correctly within the percentage of error involved in the reading He would be certain to have prepared his salts of exactly the proper strength, but there is an element of uncertainty in the degree in which papers apparently of similar texture and in a similar state of dryness, &c, take up salts. This element of uncertainty is avoided by Brennand's method, which is far more absolute than Roscoe's

The water motion actinometer gave Brennand, for each observation, a shaded strip darkened gradually from 0 to 8 (or to 16) seconds He could note on this the point at which a particular unit of darkening was produced, and the inverse of this time gave him a measure of the ratio of the observed "chemical action" to that which had produced the unit darkening

This, of course, involved the assumption that light of intensity 50 acting for 1 second has the same effect as light of intensity 1 acting for 50 seconds This Brennand thought might be assumed, but he proved it in the following very simple manner

A slip of sensitized paper is formed into a ring (a short cylinder) and placed round a light (the wick of a candle was used, but any light would do, irregular or not) excentrically After a certain time the slip is examined and found to be shaded gradually from the farthest to the nearest point, the effect at each point varying inversely as the square of the distance

Thus if A be the source of light, O the centre of the ring, and if we have OB = a, OA = b, POB = θ, we shall have the chemical effect at any point P of the slip vary as

$$\frac{1}{R^2} = \frac{1}{AP^2} = \frac{1}{a^2 + b^2 - 2ab\cos\theta}$$

In a particular experiment Brennand took a = 1·4 inch, b = 4 inch

$$\cos^2\frac{\theta}{2} = \frac{3\ 24 - R^2}{2\ 24}$$

Taking the unit of intensity that at the distance 1 inch from the wick, and calculating the values of θ for values of the intensity 1, 75, 5, and 3, we have θ = 0, 20° 10′, 78° 34′, and 141° 48′ respectively The lengths of arc corresponding to these are found to be 49 inch, 1 92 inch, and 3 45 inches respectively These lengths can be marked off on the slip Another slip can then be darkened in the water motion actinometer, by any light, a unit can be marked on this slip at the point where the shade corresponds with that at the unit in the ring slip, it then can be seen whether the intensity of shade at the distance 49 on the ring slip agrees with that at three-fourths the time for unit on the actinometer slip, and similarly for the other calculated values. This experiment verifies the law assumed, and moreover affords a check on the paper employed, and on the closeness with which tints can be matched.

Another important means of verification was employed by Brennand, which Roscoe does not appear to have availed himself of Calling the effect of the sky alone in darkening paper B, and the effect of the sun and sky together A, Roscoe observed A and observed B, and then calculated the effect of the sun alone as A − B. Brennand did this, but also observed the sun alone by the simple device of a vertical slit in a shutter, and was thus able to check the accuracy of his method and of his work

Having thus established the trustworthiness of his *modus*

operandi, Brennand, with his water-motion actinometer, drew up, by an ample series of observations extended over several years, the Table B given in NATURE (January 8, 1891, p. 237). The numbers in this table are ratios, and they may be all multiplied by any number without any real alteration in the table. The unit of chemical action originally started with was the blackness produced by 100 grains of a candle burnt at the unit of distance, and this is the unit which underlies Table B. Brennand early found, as Roscoe found, that the sun has always the same effect at the same altitude in a perfectly clear sky. Hence, in all the later observations the unit was recovered from the sun.

Thus, to take a series of observations, with the water motion actinometer, with strips of an unknown (but uniform) paper: first, a strip is placed in the instrument, the sun alone being admitted by the vertical slit, and the sliding shutter is run up; we thus get a gradually tinted slip beside the gauge marked in seconds. The altitude of the sun is noted, suppose it 30°, the number in Table B for this altitude is 0.1070, *i.e.* the number of seconds which produces unit darkening by sun alone at this altitude is $\frac{1}{0.107}$ seconds $= 9\frac{1}{3}$ seconds. Then on the sun strip a mark is made opposite the $9\frac{1}{3}$ seconds graduation on the gauge; this is the unit blackness for the paper, and any subsequent strip exposed is "read" by marking the point on it which has the same blackness.

This method of recovering the unit is not sufficient to determine, for instance, whether the sky in England on a certain morning was really clear, *i.e.* as truly clear as the Dacca cold weather sky. To determine this particular point, Brennand lately in England burnt 100 grains of a candle (as near as he could get) similar in composition to his Dacca candle, and the result shows conclusively, by the exact accord of several observations lately made near Taunton with corresponding old observations at Dacca, that in this case the two candles must have produced equal effects. But it is obvious that the candle could only be trusted by these results. The experiments made with the candle were not made to recover the Dacca unit, but to test the candle. The exact agreement in the several results raises the very strongest presumption that the Taunton candle was equal to the Dacca candle. It is, however, possible that the Taunton sky varied for the several observations in exact ratio with a variation in the Taunton candle, and it can only be said that Brennand's observations on this particular point, so far as they go, support Roscoe's result that the chemical action of the sun is the same at the same altitude in a perfectly clear sky, always and everywhere.

When the chemical action of the sky (or of some portion of it) on a piece of flat paper is observed, what is measured is the integral of the resolved effects of each sky element. Thus if, as in Roscoe's experiments, the piece of sensitized paper is exposed horizontally, and the effect of the whole sky (the sun being stopped off) is taken, we have the total effect of a ring of the sky distant θ from the zenith to be multiplied by $\cos\theta$, and then the effect of all such rings from the zenith to the horizon to be summed. This view of the resultant action suggested to Brennand the more original branch of his investigations. He was early led to suspect that the chemical action of the sky varied in different parts of it. He devised an instrument, which he calls the mitrailleuse actinometer, by which he was enabled to prove that the chemical action of the sky is a minimum in the great circle distant 90° from the sun; for an altitude a of the sun this minimum he calls s_a. Brennand then further proves that the chemical action (at the same time) at any other point of the sky distant θ from the sun is then $s_a \operatorname{cosec}\theta$.

Having established these important laws, Brennand is able, by mathematical process, having s_a given him, to calculate the total effect of any defined portion of the sky on a plane of sensitized paper exposed at any given angle. He was thus enabled to compare Roscoe's readings of total diffused daylight on paper exposed horizontally with his own Dacca readings on paper exposed perpendicularly to the direction of the sun.

These investigations led Brennand to a theoretic value for the duration of twilight, and to the devising a new instrument, the "octant actinometer," by which the fundamental constant s_a can be observed directly.

This "octant" actinometer observes one eighth of the heavens, cut out by three planes at right angles to each other, placed so that the line OS, the intersection of two of the planes, passes through the sun. Owing to the cloudy skies of Taunton, Brennand (who experiments only with a clear sky) had been able very imperfectly to test this instrument at the time his paper was read to the Royal Society. He has since found that this "octant" may be turned in any way round OS (above the horizon, of course) without altering the reading on either of the three planes of the octant. This "octant," therefore, only requires one fourth of the visible hemisphere round the zenith to be clear, for a good observation. What is more important, it enables the observer, when the sky is clear, and the sun's altitude from 30° to 60°, to take an observation of a part of the sky entirely 30° from the horizon, so that the uncertainty arising from haze near the horizon (which could not before be allowed for) may by this capital instrument be avoided, and s_a obtained without any integrations or calculations beyond division by a number.

In the whole of these later developments, Brennand's work is entirely original. Sir Henry Roscoe, following a somewhat different course of inquiry, has made experiments on the chemical action of the sun and sky at different levels above the sea, and on the total effect during different months or seasons of the English sky with all its cloud, fog, and smoke, which last is an important practical measure of the climate in its influence on vegetation, and perhaps on human health.

The researches of Roscoe and Brennand have thus, though overlapping at particular points, extended mainly in different directions. Brennand, in the ground covered by both, puts forward far the more accurate determinations; his table (B) given in NATURE, January 8, 1891, p. 237, professes to be of the same character and value as a table of the constants of refraction,—Brennand has had half a century's experience with the chemistry of photographic paper, and is an excellent mathematician of the old school. Moreover, the three leading actinometric instruments he has devised, the water-motion, the mitrailleuse, and the octant, show him to be possessed of much resource in devising instruments of research.

INORGANIC SYNTHESIS OF AZOIMIDE, N_3H

A METHOD of synthesizing this interesting compound of nitrogen and hydrogen, by means of a simple reaction involving only purely inorganic substances, has been discovered by Prof. Wislicenus, and is described by him in a communication to the current number (No. 12) of the *Berichte* of the German Chemical Society. The reactions by which azoimide has hitherto been obtained have all been of an organic nature, and more or less complicated. The mode of preparation described by its original discoverer, Prof. Curtius, in reality depends upon a very simple reaction, that of nitrous acid upon hydrazine, N_2H_4, the other hydride of nitrogen whose preparation we also owe to Prof. Curtius,

$$\begin{matrix} NH_2 \\ | \\ NH_2 \end{matrix} + HNO_2 = N_3H + 2H_2O$$

Hydrazine, however, has only yet been prepared from its organic derivatives, and moreover it has not been found practicable to actually convert free hydrazine itself by means of nitrous acid into azoimide, only certain organic derivatives being acted upon by nitrous acid with production of azoimide. The perfected mode of preparation described by Prof. Curtius at the close of last year is very briefly as follows. Benzoyl hydrazine, $C_6H_5.CO.NH.NH_2$, is first formed by reacting with ethyl benzoate upon hydrazine hydrate.

$$C_6H_5.COOC_2H_5 + N_2H_4.H_2O$$
$$= C_6H_5.CO.NH.NH_2 + C_2H_5OH + H_2O$$

The benzoyl hydrazine is then converted by means of nitrous acid, obtained from a mixture of glacial acetic acid and sodium nitrite, into the benzoyl derivative of azoimide:

$$C_6H_5.CO.NH.NH_2 + HNO_2 = C_6H_5.CO.N\left\langle\begin{matrix} N \\ \| \\ N \end{matrix}\right. + 2H_2O.$$

From benzoyl azoimide the sodium salt of azoimide is next formed by treatment with sodium ethylate:—

$$C_6H_5.CO.N\left\langle\begin{matrix} N \\ \| \\ N \end{matrix}\right. + C_2H_5ONa$$
$$= C_6H_5.COOC_2H_5 + Na - N\left\langle\begin{matrix} N \\ \| \\ N \end{matrix}\right..$$

Free azoimide is finally obtained by distilling the crystals of the sodium salt with dilute sulphuric acid, and repeatedly re-distilling over fused calcium chloride the hydrated liquid which first passes over

As an alternative method which has some advantages as regards facility of manipulation, Prof Curtius employs the hippuryl derivative of hydrazine instead of the benzoyl compound The product of the action of nitrous acid upon this compound is a substance which can be readily isolated in crystals, and if these crystals are dissolved in dilute caustic soda, the solution at once yields azoimide upon distillation with dilute sulphuric acid

Before describing the inorganic synthesis of Prof Wislicenus, it may be mentioned that a still simpler organic synthesis of azoimide from the long known diazobenzene imide, $C_6H_5N_3$, has been achieved by Drs Noelting and Grandmougin Although diazobenzene imide itself is too stable a substance to yield azoimide directly by simple saponification with soda, these chemists found that its dinitro derivative yielded directly to the attack of an alcoholic solution of potash, the potassium salt of azoimide being formed, which of course gave free azoimide upon distillation with dilute sulphuric acid

The inorganic synthesis of azoimide now achieved by Prof Wislicenus depends upon the interaction of ammonia gas and nitrous oxide in the presence of heated metallic sodium Ammonia and nitrous oxide do not act directly upon each other, not even when a mixture of the two gases is passed over caustic bases—soda lime for instance But they react readily in presence of metallic sodium The explanation of this lies in the fact that the sodium amide discovered by Gay Lussac and Thenard is first formed, and this compound reacts with the nitrous oxide with production of the sodium salt of azoimide —

$$NaNH_2 + N_2O = NaN_3 + H_2O$$

The water produced at the same time reacts with one-half of the sodamide, forming caustic soda and liberating ammonia gas —

$$NaNH_2 + H_2O = NaOH + NH_3$$

Hence the complete reaction may be expressed by the equation—

$$2NaNH_2 + N_2O = NaN_3 + NaOH + NH_3.$$

As the sodium salt is less explosive than most of the other salts of azoimide, requiring a higher temperature and not being sensitive to percussion, the experiment is not dangerous if proper care is exercised, and even if local explosions do occur they have not yet been observed to shatter the glass tube Unfortunately glass is somewhat strongly attacked during the reaction, but if iron tubes are employed the reaction is not so completely under control

In actually conducting the experiment, metallic sodium, in pieces not exceeding half a gram in weight, is placed in a series of large porcelain boats, which are then laid in a glass combustion tube, from which the air is subsequently displaced by means of a current of ammonia gas The tube is heated carefully in a combustion furnace, when the sodium fuses and gradually passes into sodamide When all the metal has been thus changed, the stream of ammonia is replaced by one of dry nitrous oxide The temperature should now be lowered to between 150° and 250°, and for this purpose Prof. Wislicenus surrounds it by an iron explosion chamber, which forms a capital air bath, the temperature of which can be regulated by observing a thermometer or thermometers inserted in it The sodamide now slowly increases in bulk and becomes converted into the sodium salt of azoimide As soon as ammonia ceases to be carried away in the stream of issuing nitrous oxide the reaction is completed. Upon cooling the sodium salt is found as a porous pumice-like substance, much distended by the escaping ammonia

The sodium salt of azoimide is also formed when ammonia and nitrous oxide gases are simultaneously passed over melted sodium, the yield, however, is not so large, and there is danger of the sodium inflaming in the nitrous oxide

The fact that the sodium compound obtained is the sodium salt of azoimide has been proved both by direct analysis (a determination of nitrogen yielding close upon the theoretical amount) and by its properties The product of the reaction on being removed from the combustion tube was thrown into water, and the filtered solution distilled with dilute sulphuric acid. The distillate possessed the intolerable odour characteristic of azoimide, and behaved exactly like a solution of that substance in water It gave precipitates with nitrates of silver, mercurous mercury and lead, which when separated and dried were found to possess all the properties of the silver, mercury, and lead salts of azoimide respectively The fact that these salts were those of azoimide was indeed sufficiently apparent from their violently explosive nature, and the characteristic flames which were produced during their explosion Moreover, gold dust was rapidly dissolved with production of the red solution described by Prof Curtius.

A quantity of the silver salt was subjected to analysis, and was found to contain 71 7 per cent of silver, the amount calculated for AgN_3, being 71 8

Instead of sodium, either potassium or zinc may be employed Potassium answers almost as well as sodium, forming first an amide when heated in a current of ammonia, which is subsequently converted by nitrous oxide into the potassium salt of azoimide Zinc likewise behaves in a similar manner, but the yield of the zinc salt of azoimide, ZnN_6, is not so good as in the cases of sodium and potassium To a greater or less extent, therefore, it would appear that metallic amides when heated in a current of nitrous oxide are generally converted into salts of azoimide The alkali metals, however, appear to be best suited for practical use

A E TUTTON

THE REPORTED VOLCANIC ERUPTION AT GREAT SANGIR

ACCORDING to a Reuter's telegram from Sydney, despatched on July 17, the vessel *Catterthun*, belonging to the Eastern and Australasian Steamship Company, which had arrived at Sydney from China, brought a report of a terrible disaster in the vicinity of the Philippine Islands She called on her voyage at one of the chief ports of the island of Timor, where rumours had been received according to which the island of Sangir, situated between Celebes and Mindanao, had been destroyed by a volcanic eruption The whole population, numbering 12,000, was reported to have perished The captain of the *Catterthun* stated that on the voyage his vessel passed through some miles of volcanic *débris*

We may not for some time receive further details as to the real extent of the disaster reported by the captain of the *Catterthun*, but in the meantime the following account, by Mr Sydney J Hickson, author of "A Naturalist in North Celebes," of the island and of the history of its volcanic energy—which appeared in the *Times* of Tuesday—will be read with interest.—

Sangir, or "Great Sangir," as it is more frequently called by the natives of the Archipelago, is the largest of a chain of volcanic islands that connects the northern peninsula of Celebes with the southern point of the island of Mindanao The islands, rising abruptly from the floor of the very deep Celebes sea—a depth of over 2,000 fathoms was found by Her Majesty's ship *Challenger* quite close to Great Sangir—are very mountainous and covered by dense tropical forests

The islands Ruang and Siauw are both little more than volcanoes standing in the sea, but Sangir is a large island 25 miles long by about 15 miles broad, with undulating hills and valleys occupying its southern half, and the great Awu volcano and its slopes the greater part of its northern half

When I visited the islands in November, 1885, the Ruang and the Awu were quiet, but the Siauw was sending out dense volumes of smoke that varied little in intensity from day to day.

From the accounts I received from the natives and from the records of the islands in the Dutch books of travel, it seems that the Siauw volcano has never been very violently active, but both the Ruang and the Awu have a history full of most terrible and heart-rending episodes Of the Ruang I need not say much The last serious eruption occurred in 1871, when at least 400 persons lost their lives either by the sudden rise of the sea water that accompanied the eruption, or by the showers of stones and ash Of the Awu volcano we find recorded in Valentijn's "Oud en Nieuw Oost Indien" that a most terrible eruption occurred which lasted from the 10th to the 16th of December, 1711 Sjamslalam and his son, the Princess Lorolabo and her daughter Sarabanong, and over 2000 people of the kingdom of Kandahar were killed On March 2, 1856, there was another fearful eruption, which lasted until March 17, and destroyed nearly 3000 human lives. The streams of boiling water and of steam which poured down the mountain slopes rather than the flow of lava caused the enormous mortality of this second eruption. After the eruption of 1711 it seems that a large lake of water was formed in the crater, and a certain privileged class of Sangirese were allowed by the gods to visit this lake every three or four months to test the water with their rice If

the water was hot enough to cook their rice they took it for a sign that an eruption would shortly follow The great eruption came in 1856 The waters of the lake began to boil, burst their banks, and flowed down the sides of the mountain towards Tabukan and Taruna, causing immense destruction of human lives and property

Concerning the present eruption we learn very little at present, but it seems to me very improbable that the whole island has been destroyed, and, from the sparseness of the population on the slopes of the Awu, it is also very improbable that so many as 12,000 persons have lost their lives

The population consists of one Dutch Controlleur, who may possibly be married, some three or four German missionaries with their wives and children, one or two European traders, a few Chinamen, and the remainder Sangirese Malays The island is governed by five native Rajahs, who are advised by the resident Dutch Controlleur. For many years there has been no war or other disturbance, but the island, notwithstanding the richness of its soil, is not in a very prosperous condition The only produce of any importance is copra, but some good ebony and other timber is found in the forests that cover the islands

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, July 11 —M d'Abbadie in the chair —On a slight additive correction which may have to be applied to the heights of water indicated by sea-gauges when the swelling or choppy agitation of the sea attains a great intensity, case of a swell, by M J Boussinesq From theoretical considerations and practical experiments it appears that a tide-gauge exposed in a lateral basin will not give correct indications of level for a choppy sea, but that it will register a lower level than it would if the water were at rest For a wave 1 metre high the difference may amount to 1 cm —On the determination of the density of gases, by MM Henri Moissan and Henri Gautier This is achieved by a new method, which makes it possible to determine the density within one or even one-half per cent from a volume of 100 cc of the gas The principle is analogous to that adopted by Dumas in his researches on vapour-densities, and consists in measuring the difference between the weight of a known volume of the gas and an equal volume of air at the same temperature and pressure If this difference in grammes be denoted by p, and if v denote the volume of the gas or air at temperature t° and pressure H, the density is given by the equation

$$p = v \times 0{\cdot}001293\,(1 - 1) \times \frac{H}{760} \times \frac{1}{1 + 0{\cdot}00367t}$$

The apparatus consists of a glass cylinder of about 90 cc capacity connected at its lower end with a glass tube leading through an india-rubber tube to a movable flask filled with mercury, by means of which the pressure inside the measuring cylinder can be regulated The latter is surmounted at its upper end by a weighing bulb separated by a three way cock, by which communication can be established with a fine bent tube In the experiment, the bulb is first exhausted, then filled with dry air and again exhausted, this being repeated about ten times. It is then shut off, and the fine tube and the measuring cylinder are filled with mercury by lifting the reservoir. The capillary tube can now be used as a pipette, and the gas is drawn into the cylinder and allowed to assume a constant temperature during the night at the pressure of the atmosphere The bulb is then exhausted and placed in communication with the cylinder, and all the gas is driven into the bulb by raising the mercury flask The bulb is then carefully removed, and dry air is allowed to enter so as to bring the pressure nearly up to that of the atmosphere Lastly, the bulb is placed on the balance, the weight which has to be added or removed to obtain equilibrium represents p, which, substituted in the above equation, gives the density. The specimen of gas operated upon can be subsequently used for other experiments —On the order of appearance of the first vessels in the flowers of some *Lactuca*, by M A. Trécul —On the effects of cold and drought on this year's harvests, and the means by which it has been attempted to combat the evil, by M. Chambrelent — On the alcoylcyanocamphors and the benzine-azocamphocarbonic ethers, by M A. Haller —On the *Libytherium maurusium*, a great Ruminant of the plaisancian pliocene formation of Algiers, by M. A Pomel.—Measurement of the absolute intensity of gravity at Breteuil (International Office of Weights and Measures), by M. G Defforges. This was carried out by means of two reversible pendulums constructed by the brothers Brunner, one being 1m, the other 0 5m long between the knife edges. The oscillations took place in air and in a vacuum, the latter being continued for 12 to 24, and once for 50 hours The results were —

For the length of the seconds pendulum . . 0 993952
For g . 9 80991

—Photographs of the chromosphere, the prominences, and the solar faculæ, taken at the Kenwood Astro physical Observatory, Chicago, by M E. Hale —On the practical calculation of the dimensions of the outflow orifices of saturated vapour into the atmosphere, under constant or varying conditions; application to safety valves, by M H Parenty —On a chloro-nitrogen salt of palladium, by M M. Vèzes —Double chlorides formed by lithium chloride and the chlorides of the magnesium series, by M A Chassevant.—Researches on nickel and cobalt, by MM Ch Lepierre and M Lachaud —On the iodomethylates of quinine, by M. E Grimaux.—On the camphocarbonic methyl ethers, methyl camphor, and some nitrogen derivatives of cyanocamphor, by M J Minguin —Action of the metalloid nitrides and hydronitrides on the oxy-hydrocarbon compounds, by M R Vidal —On some ferruginous medicines, by M. H Le Chatelier.—Contributions to the history of mineral waters, on the alumina contained in these waters, by M F Parmentier —The respiratory value of hæmocyanine, by M L. Cuénot.—Physiological action of spermine, interpretation of its effects on the organism, by M Alexandre Poehl.—On the embryonic circulation in the head of the axolotl, by M F Houssay —On the *Belisarius Viguieri*, a new fresh-water copepod, by M Maupas —On the evolution of the embryo of a fowl submitted during incubation to a continuous rotation, by M. Dareste —The boghead of Autun, by MM C Eg Bertrand and B Renault —On the constitution of the fructifying ears of *Sphenophyllum cuneifolium*, by M. R Zeiller —A review of the geological constitution of the regions situated between Bembé and Crampel Peak (Congo), after specimens collected by M Jean Dybowski

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THURSDAY, JULY 28, 1892.

GROUSE DISEASE AND FOWL ENTERITIS

The Etiology and Pathology of Grouse Disease and Fowl Enteritis By E Klein, M D, F R S (London Macmillan and Co 1892.)

IN this book Dr Klein has given the results of an important series of researches made by him upon certain diseases in birds The malady which has specially occupied his attention is that commonly known as the grouse disease The book will therefore find a large and appreciative circle of non-professional readers To all interested in the preservation of game it may be commended as furnishing for the first time an adequate and satisfactory explanation of the origin and mode of propagation of the grouse disease The book is over and above that a valuable contribution to bacteriology The very excellent illustrations appended enable one to follow the text with great ease The birds affected are the red grouse (*Lagopus scoticus*) of our moors The disease, when it breaks out in the spring or summer, is usually of a very virulent type. A fatal epidemic then arises which carries off large numbers of the birds, to the despair of the owners and keepers, who find themselves powerless to cope with the malady. It is to this quickly fatal epidemic that the name of the grouse disease is applied Though much written about and much discussed, the origin of this disease has hitherto remained undiscovered

During the last five years numbers of birds, dead or dying from the disease, were sent to Dr Klein from moors in England and Scotland The large amount of material furnished has enabled him to make an exhaustive inquiry

The result is the most noteworthy account yet published of the etiology and pathology of the disease Dr Klein has proved that it is an acute infectious malady primarily affecting the lungs and liver of the birds. The symptoms and appearances are those of an acute infectious pneumonia. Dr Klein has further discovered the *causa causans* of the disease in the shape of a minute unicellular organism, belonging to the class of the bacteria This microbe has its special seat in the lungs and liver It is a bacillus, and is found filling and blocking up the capillary blood vessels in the diseased areas of the lungs and liver. The organism can be isolated from the diseased tissues and grown on suitable media outside the body In this way a series of culture of the bacilli were made on various soils—gelatine, Agar, beef broth, &c The manner of growth of the microbe in these culture media is very fully described The growths obtained were always of the same bacterial species The pure culture of the bacillus subcutaneously inoculated into healthy animals reproduced the symptoms and appearances of the disease They proved fatal to mice and guinea pigs, and caused in them a congestion of the lungs and liver No effect was produced on pigeons and fowls. The most virulent cultures of the microbe were those grown in meat broth to which a piece of coagulated white of egg had been added. The most positive results were obtained with the common bunting and yellow-ammer These birds were inoculated with a minute drop of a meat-broth culture of the microbe They succumbed within twenty-four hours The post-mortem appearances were similar to those found in the grouse, viz, a marked congestion of the lungs and liver The bacilli were found in large numbers in the lungs From these experiments Dr Klein was able to conclude that the grouse disease is due to the microbe isolated by him from the diseased organs of the birds Unfortunately he has not been able to reproduce the disease in large birds, or to utilize healthy grouse for his experiments In the latter case the difficulty in obtaining living birds and keeping them in captivity prevented this last and most important proof being furnished The larger birds experimented with (fowls and pigeons) proved unsusceptible

The infection of the birds seems to take place through the respiratory organs Dr Klein furnishes a very striking experiment in support of this view A yellow-ammer, after being inoculated with the grouse bacillus, was placed in a cage adjoining to one containing six healthy ammers These six healthy birds acquired the disease and died

The autumnal disease of the grouse is similar to the spring and summer disease, and both are caused by the same microbe

The bacilli found in the autumnal disease are, however less virulent than those found in cases during the spring and summer The buntings and ammers inoculated with the autumn microbe died at a much later period Mice that had survived inoculation with the autumn microbe did not succumb when inoculated with the more virulent spring microbe Dr Klein suggests that cultures of the autumnal microbe might be used as a protective vaccine for the young birds on the moors It is to be feared that those on whose shoulders this task would fall might prefer the disease to the cure

The bacillus is easily killed. A temperature of 60° C completely destroys its life in five minutes On the other hand, virulent meat broth cultures heated for twenty minutes to 55° C, retained their virulence and yielded normal growths when grown in a fresh soil This more prolonged heating so near the critical temperature for the bacilli (60° C) did not, as one would have supposed, produce any retardation in their subsequent growth or any attenuation of the organisms

Meat broth cultures, in which the bacilli had been destroyed by heat, produced in mice all the symptoms of the disease This points to the presence in the meat broth of some poisonous chemical product The matter is referred to very briefly, but we hope Dr Klein will soon be in a position to tell us more about this interesting and important discovery

To prevent the spread of the grouse disease the importance of weeding out suspicious birds from the moors is emphasized The birds killed should be removed and burned

Dr Klein describes in the next place a bacillus which he isolated from garden earth. Guineapigs, rabbits, and mice, when inoculated with this organism, developed an œdema of the subcutaneous and muscular tissues. The organism is aerobic, and grows well in the presence of free oxygen, and on the surface of culture media. It is therefore not identical with Koch's bacillus of malignant

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œdema, which is an anaerobic organism. Though it resembles the bacillus of grouse disease in certain respects, they are not to be regarded as one and the same microbe.

The second part of the book contains an account of a fatal epidemic amongst fowls which broke out at Orpington in Kent. The symptoms and post-mortem appearances led Dr. Klein to designate the disease fowl enteritis, in order to distinguish it from fowl cholera. The bacillus which is the cause of fowl enteritis is not identical with the bacillus of fowl cholera, and Dr. Klein clearly proves this.

Dr. Klein's bacillus is evidently a less virulent organism. In only one case was the disease produced by feeding fowls with the intestinal contents of a diseased fowl. Experiments on other animals gave practically negative results, except in the case of one rabbit. The virulence of the bacilli was lessened by heat. Fowls inoculated with this attenuated virus could not be infected with the disease. Some practical suggestions are given with a view to combating such epidemics.

The concluding chapter of the book contains an interesting account of a disease in young pheasants known as "Cramps."

We have given but a very brief account of Dr. Klein's important investigations. The book will, however, be read by every one interested in the subjects of which it treats, and with great profit. To other workers in the same field it will prove an indispensable work of reference. We have only detected one misprint, on page 53, where "30° Fahr." should no doubt have read 50°C.

We cannot close this notice without a word of praise for the excellent photograms of Mr. Pringle and Mr. Bousfield.

A. M.

ELECTRIC LIGHT CABLES

Electric Light Cables. (London: Whittaker and Co., 1892.)

A DOZEN years ago, when dynamos and lamps, both arc and incandescent, had been pretty well developed, the general public arrived at the conclusion that it was time to commence the work of central station lighting by electricity. It was not until the plans of these proposed works were taken in hand by the consulting engineers that the difficulties in the way of distribution became fully apparent. It was not well known what strength of current could be safely carried through the conductors; and engineers were rather appalled at the cost of the copper required for maintaining uniform pressure over a district, and at the waste of energy in the conductors. Besides these theoretical troubles in the way, engineers were met by the practical difficulty of devising a secure and efficient means of laying conductors under the streets, and ensuring their proper insulation. Until recently, the rules which must be attended to by engineers to enable them to handle these questions were only to be found in scattered pamphlets and Proceedings of societies. Several scientific men dealt independently with the heating of the conductors, and finally Mr. Kennelly published his splendid experimental work on the subject. Other writers went fully into the economical principles which must be followed in order to secure the most uniform distribution at the least cost. When the alternating-current rendered the employment of high pressures both safe and convenient, many of these precautions became less necessary, but new problems arose which are also generally dealt with only in isolated papers. Inventors sprang up, each advocating his own system of laying mains, and an outsider can gain a knowledge of these only by reading the patent specifications, or by inspecting the progress of works. The mechanical details of making joints, insulating, and so forth, are not much dealt with in the literature of the subject.

The book before us is one of the first attempts to collect all the above principles within one binding. The first few chapters deal principally with the heating of conductors and the economical laws of distribution. Well-known writings on the subject are here condensed into convenient compass, and Kennelly's experimental results are given in sufficient detail. Series and parallel systems and their combinations, including the three-wire and five-wire systems, which serve so much to economise copper, are explained, and also the principles involved in the use of transformers with alternating currents. Having thus described the systems available, we have, in Chapter v., a useful account of the cost of cables and conduits, with tables showing the relative cost of different systems when the distribution extends to different distances, showing the advantages of using high pressure for long distances. Chapter vi. gives a number of practical data about different kinds of conductors and the manner of making joints, which, though not exhaustive, will be of use to many. The next chapters deal with the characters of the insulation, including air insulation, lead-covered cables, the various bituminous compounds known as bitite, &c., oil insulation, and, of course, vulcanized india-rubber, about which the author is particularly capable of giving information. The effects of capacity, which has given so much trouble at some central stations, are also alluded to. These chapters are very fairly written, and give as good an account of the various systems of insulation as is likely to be found anywhere, or as we might expect in a volume of this size, which is more a hand-book of the subject than an exhaustive treatise. Some of the principles of testing are then shortly, but very clearly, described; and the principles of house wiring are clearly shown, and safety devices described. Several good chapters come near the end of the book on the practical construction of lines, whether overhead or underground, the latter dealing chiefly with the actual work which has been done in London of late years.

This book is one of the best which could be taken up by the student to give him a general knowledge of what is involved in the comprehensive title—"The Distribution of Electricity." It does not pretend to be a complete manual for the office, containing all the information required by the consulting engineer in dealing with these problems, but the descriptions are clear and generally accurate, and the only criticism which we feel compelled to make is that sometimes, apparently with the desire of preventing the book from being too technical, or requiring too much mental effort to read it, the author has been, perhaps, a little too sketchy, and might with advantage have given

some more detailed information on a variety of points Nevertheless, we consider that this book is a useful addition to electrical literature, and must be of the utmost use to students in showing the difficulties which have to be encountered in designing a plan of central station working The general reader will also be much interested in learning something more of the meaning of the work which he sees being carried out at present in the streets of many of our towns Should the book chance to fall into the hands of any members of electric lighting committees of Municipal Corporations, it will do a vast amount of good, by opening their eyes as to the number of problems that have to be considered in their dealings with different contractors, each generally wedded to a special system It is to be hoped that this book will teach them that, in trying to act as consulting engineers without the special training necessary, they are not serving the best interests of the towns they represent Altogether, "Electric Light Cables" is a useful addition to the literature of electrical engineering, and the absence of too many technicalities will make it popular with a large class of readers

OUR BOOK SHELF

Distribution de l'Electricité I "Installations isolées" II "Usines centrales" Par R V Picou, Ingenieur des Arts et Manufactures (Paris Gauthier-Villars, 1892)

THESE two small volumes are portion of a series belonging to "L'Encyclopédie scientifique des Aide-Mémoire," published under the direction of M Léauté, Member of the Institute The second volume is the only one which calls for remark It deals with the methods, well known in England, of distribution of continuous and alternating currents and systems of high and low pressure The information given concerning the multiphase and rotary current systems is very scanty and quite out of proportion to the other matters treated of The reader will naturally look for an account of the method employed for the transmission of power from Lauffen to Frankfort, but he will find no information of any practical service The author, however, gives a short discussion of the difficulties that must be surmounted if arc and incandescent lamps are to be installed on a circuit fed by a triphaser and three wires

Information is given concerning the working of some of the principal existing central stations, and there is a useful bibliography

Popular Readings in Science By John Gall, M A, LL B, and David Robertson, M A, LL B, B Sc (Westminster Constable and Co, 1892)

THIS forms the second volume of Constable's Oriental Miscellany of original and selected publications, and is intended to form the basis of a general course of instruction in science, suited to the requirements of the pupils in Indian schools who are preparing for matriculation at the University The authors lay no claim to originality, but have exercised a judicious choice in the selection of subject matter The first chapter deals with meteorology, special prominence being given to Mr. Blandford's researches on the climate of India Then follow chapters on the vegetable kingdom, evolution, both in its biological and chemical aspects, mimicry, the nebular hypothesis, tidal evolution, energy, the spectroscope, molecular forces, and Bacteria A reference to the meteoritic hypothesis would make the chapter on the nebular theory more complete The authors have wisely contented themselves with *descriptions* of theories and plain matter-of-fact statements The book is very readable, but at times somewhat technical It would, however, be improved by the addition of more diagrams, though it may be that more can safely be left to the imagination of the Oriental than the Western mind The narrative style which has been adopted by the authors will make the book acceptable to general readers who are anxious to make acquaintance with modern science

Geometrical Deductions, Book II By James Blaikie and W Thomson (London Longmans, Green, and Co, 1892)

THIS treatise is intended to afford a systematic course of training in the art of solving geometrical problems The basis of the system which the authors have employed is to be thoroughly recommended, being both logical and simple The book is divided into sections, each of which consists of three parts In the first a model deduction is fully worked out to illustrate the method of solution, then follow similar deductions with their figures, and occasional hints, while, lastly, the student is left to himself to solve the problems without any such aid This principle is maintained throughout the entire book, so that a student should be able to obtain a good working knowledge and should also to a great extent be quite rid of a teacher

The Appendices will also be found very useful, as they contain the enunciations of the propositions in Euclid's second book and of standard theorems and loci, together with a set of miscellaneous deductions covering the range of Euclid's first two books

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications*]

B A Procedure

THE coming meeting of our ancient and venerable institution, the British Association *for the Advancement of Science*, will doubtless be a large one, as the beauties of Edinburgh are sure to tempt many to attend, and may therefore give opportunity for discussion on a subject of fundamental importance—the future well being of the Association and the means of retaining it as an object of veneration on account of the services which it *is* rendering and not merely on account of those which it *has* rendered

It is beyond question that there are many who have long been dissatisfied, and who are of opinion that B A procedure is not in harmony with the times Moreover, to speak plainly, many of us feel that the "tripper" element has become too predominant, and that the credit of science will suffer if a large number of persons be permitted, year after year, to make pleasant holiday, "supported by voluntary contributions," under the pretence of advancing science, while the number of true workers whose reputation alone upholds the claim of the Association to public recognition is but small

In the great majority of instances the reading of papers on technical questions in the sections has become little less than a solemn and dreary farce played to almost bare benches, and it is only in exceptional cases—such as Section A affords—that a small and devoted body of true believers worship at an inner shrine without regard to the general public, and are thus able among themselves to do work of high value to science

The B.A. should exercise an influence in two directions—it should advance scientific knowledge among scientific workers, and it should aid the general public in understanding and appreciating scientific work, its methods and results. It may effect the

former by bringing scientific workers together and giving them due opportunity for the interchange of knowledge and opinions. To secure this end, it is important that *sectional* and *intersectional discussions* should, in future, become *the feature* of the meetings, but to be successful these must be conducted with far greater forethought than heretofore—they must be true discussions and must not consist of a number of short papers written without reference to each other or to any central idea, and there must be no limitation of discussion so long as it is to the point. Probably the best plan will be that sectional committees, specially appointed for the purpose, select subjects, and that on each of these some one open a discussion by means of a carefully-prepared paper, printed and circulated at least a month beforehand, among those likely to take part in the debate. Such discussions should be carefully reported, and the edited report should be subsequently published, those who had taken part in the discussion having full liberty allowed them to give expression to their carefully considered opinions instead of being required merely to punctuate their sentences in proof. The resolution not to report discussions arrived at last year by the Council is most unfortunate. If it were understood that discussions would be reported, speakers would be far more interested, and would take far more pains in preparing to take part in them than has hitherto been the case. It is, I think, unnecessary to dwell on the value of true discussion among workers in different, but cognate, branches of science.

As regards the public functions of the Association, it is unquestionable that much more might—and should—be done on behalf of those who are interested spectators rather than active workers in science. The evening lectures now delivered are often very brilliant expositions, but, as a rule, they have been "above the heads" of a very large proportion even of the members of the Association who have listened to them. I know many who think with me that a more direct effort should now be made to advance the knowledge of science among the general public at these meetings.

One great reform which *must* be carried out is the general curtailment of the expenses of the meetings, which make it impossible for any but the largest and richest towns to receive the Association. The lavish expenditure on the Reception Room which has been so frequently witnessed of late years should be unnecessary. So long as we can come together and can accomplish our object—the *advancement of science*—we should be satisfied with the most modest accommodation and should even be prepared to submit to some privation. At the German Naturforscher Versammlungen the vast majority cater for themselves, and private hospitality is almost unknown, the social demon, which is so ruthless a destroyer of much of the effectiveness of the B.A. meetings, being kept entirely in the background, and yet, in my opinion, these meetings are at least as enjoyable and fruitful of result as our own B.A. meetings.

Then we want younger presidents, on the average—men who are in their prime as scientific workers.

Of late years our Council has been far too cautious and conservative a body, and a large infusion of a liberal and progressive element is necessary if we are to set our house in order, so that it may suit the times. Many of us think that the Council is not in touch with us as a body—somehow we know of its existence, but its functions are mystic and akin rather to those of the Archives of the Royal Society than to those of an energizing and propulsive organ. In these democratic days, it would be well if each section were to return a member to Council.

HENRY E. ARMSTRONG.

The Position of 4π in Electromagnetic Units.

THERE is, I believe, a growing body of opinion that the present system of electric and magnetic units is inconvenient in practice, by reason of the occurrence of 4π as a factor in the specification of quantities which have no obvious relation with circles or spheres.

It is felt that the number of lines from a pole should be m rather than the present $4\pi m$, that "ampere turns" is better than $4\pi n$C, that the electromotive intensity outside a charged body might be σ instead of $4\pi\sigma$, and similar changes of that sort, see, for instance, Mr. Williams's recent paper to the Physical Society.

Mr. Heaviside, in his articles in the *Electrician* and elsewhere, has strongly emphasized the importance of the change and the simplification that can thereby be made.

In theoretical investigations there seems some probability that the simplified formulæ may come to be adopted—

μ being written instead of $4\pi\mu$, and k instead of $\frac{4\pi}{K}$,

but the question is whether it is or is not too late to incorporate the practical outcome of such a change into the units employed by electrical engineers.

For myself I am impressed with the extreme difficulty of now making any change in the ohm, the volt, &c., even though it be only a numerical change, but in order to find out what practical proposal the supporters of the redistribution of 4π had in their mind, I wrote to Mr. Heaviside to inquire. His reply I enclose, and would merely say further that in all probability the general question of units will come up at Edinburgh for discussion.

OLIVER J. LODGE.

Paignton, Devon, July 18, 1892.

MY DEAR LODGE,—I am glad to hear that the question of rational electrical units will be noticed at Edinburgh—if not thoroughly discussed. It is, in my opinion, a very important question, which must, sooner or later, come to a head and lead to a thoroughgoing reform. Electricity is becoming not only a master science, but also a very practical science. Its units should therefore be settled upon a sound and philosophical basis. I do not refer to practical details, which may be varied from time to time (Acts of Parliament notwithstanding), but to the fundamental principles concerned.

If we were to define the unit area to be the area of a circle of unit diameter, or the unit volume to be the volume of a sphere of unit diameter, we could, on such a basis, construct a consistent system of units. But the area of a rectangle or the volume of a parallelepiped would involve the quantity π, and various derived formulæ would possess the same peculiarity. No one would deny that such a system was an absurdly irrational one.

I maintain that the system of electrical units in present use is founded upon a similar irrationality, which pervades it from top to bottom. How this has happened, and how to cure the evil, I have considered in my papers—first in 1882–83, when, however, I thought it was hopeless to expect a thorough reform, and again in 1891, when I have, in my "Electromagnetic Theory," adopted rational units from the beginning, pointing out their connection with the common irrational units separately, after giving a general outline of electrical theory in terms of the rational.

Now, presuming provisionally that the first and second stages to Salvation (the Awakening and Repentance) have been safely passed through, which is, however, not at all certain at the present time, the question arises, How proceed to the third stage, Reformation? Theoretically this is quite easy, as it merely means working with rational formulæ instead of irrational, and theoretical papers and treatises may, with great advantage, be done in rational formulæ at once, and irrespective of the reform of the practical units. But taking a far-sighted view of the matter, it is, I think, very desirable that the practical units themselves should be rationalized as speedily as may be. This must involve some temporary inconvenience, the prospect of which, unfortunately, is an encouragement to shirk a duty, as is, likewise, the common feeling of respect for the labours of our predecessors. But the duty we owe to our followers, to lighten their labours permanently, should be paramount. This is the main reason why I attach so much importance to the matter, it is not merely one of abstract scientific interest, but of practical and enduring significance, for the evils of the present system will, if it continue, go on multiplying with every advance in the science and its applications.

Apart from the size of the units of length, mass, and time, and of the dimensions of the electrical quantities, we have the following relations between the rational and irrational units of voltage V, electric current C, resistance R, inductance L, permittance S, electric charge Q, electric force E, magnetic force H, induction B. Let x^2 stand for 4π, and let the suffixes $_r$ and $_i$ mean rational and irrational (or ordinary). Also let the presence of square brackets signify that the "absolute" unit is referred to. Then we have—

$$x = \frac{[E_r]}{[E_i]} = \frac{[V_r]}{[V_i]} = \frac{[H_r]}{[H_i]} = \frac{[B_r]}{[B_i]} = \frac{[C_i]}{[C_r]} = \frac{[Q_i]}{[Q_r]},$$

$$x^2 = \frac{[R_r]}{[R_i]} = \frac{[L_r]}{[L_i]} = \frac{[S_i]}{[S_r]}.$$

The next question is, what multiples of these units we should take to make the practical units In accordance with your request I give my ideas on the subject, premising, however, that I think there is no finality in things of this sort

First, if we let the rational practical units be the same multiples of the "absolute" rational units as the present practical units are of *their* absolute progenitors, then we would have (if we adopt the centimetre, gramme, and second, and the convention that $\mu = 1$ in ether)

$$
\begin{aligned}
[R_r] \times 10^9 &= \text{new ohm} = x^2 \text{ times old} \\
[L_r] \times 10^9 &= \text{new mac} = x^2 \quad ,, \quad ,, \\
[S_r] \times 10^{-9} &= \text{new farad} = x^{-2} \quad ,, \quad ,, \\
[C_r] \times 10^{-1} &= \text{new amp} = x^{-1} \quad ,, \quad ,, \\
[V_r] \times 10^8 &= \text{new volt} = x \quad ,, \quad ,, \\
10^7 \text{ ergs} &= \text{new joule} = \text{old joule.} \\
10^7 \text{ ergs per sec} &= \text{new watt} = \text{old watt}
\end{aligned}
$$

I do not, however, think it at all desirable that the new units should follow on the same rules as the old, and consider that the following system is preferable —

$$
\begin{aligned}
[R_r] \times 10^8 &= \text{new ohm} = \frac{x^2}{10} \times \text{old ohm} \\
[L_r] \times 10^8 &= \text{new mac} = \frac{x^2}{10} \times \text{old mac} \\
[S_r] \times 10^{-8} &= \text{new farad} = \frac{10}{x^2} \times \text{old farad} \\
[C_r] \times 1 &= \text{new amp} = \frac{10}{x} \times \text{old amp} \\
[V_r] \times 10^8 &= \text{new volt} = x \times \text{old volt} \\
10^8 \text{ ergs} &= \text{new joule} = 10 \times \text{old joule} \\
10^8 \text{ ergs per sec} &= \text{new watt} = 10 \times \text{old watt}
\end{aligned}
$$

It will be observed that this set of practical units makes the ohm, mac, amp, volt, and the unit of elastance, or reciprocal of permittance, all larger than the old ones, but not greatly larger, the multiplier varying roughly from $1\frac{1}{4}$ to $3\frac{1}{2}$

What, however, I attach particular importance to is the use of one power of 10 only, viz 10^8, in passing from the absolute to the practical units, instead of, as in the common system, no less than four powers, 10^1, 10^7, 10^8, and 10^9. I regard this peculiarity of the common system as a needless and (in my experience) very vexatious complication In the 10^8 system I have described, this is done away with, and still the practical electrical units keep pace fairly with the old ones The multiplication of the old joule and watt by 10 is, of course, a necessary accompaniment. I do not see any objection to the change Though not important, it seems rather an improvement (But transformations of units are so treacherous, that I should wish the whole of the above to be narrowly scrutinized)

It is suggested to make 10^9 the multiplier throughout, and the results are .—

$$
\begin{aligned}
[R_r] \times 10^9 &= \text{new ohm} = x^2 \times \text{old ohm} \\
[L_r] \times 10^9 &= \text{new mac} = x^2 \times \text{old mac} \\
[S_r] \times 10^{-9} &= \text{new farad} = x^{-2} \times \text{old farad} \\
[C_r] \times 1 &= \text{new amp} = \frac{10}{x} \times \text{old amp} \\
[V_r] \times 10^9 &= \text{new volt} = 10x \times \text{old volt} \\
10^9 \text{ ergs} &= \text{new joule} = 10^2 \times \text{old joule} \\
10^9 \text{ ergs p. sec} &= \text{new watt} = 10^2 \times \text{old watt}
\end{aligned}
$$

But I think this system makes the ohm inconveniently big, and has some other objections But I do not want to dogmatize in these matters of detail Two things I would emphasize :— First, rationalize the units Next, employ a single multiplier, as, for example, 10^8

OLIVER HEAVISIDE.

P.S —Heaven preserve us from dynamics based on the Act of Parliament !

Neutral Point in the Pendulum

IN the theory of the pendulum the position of the neutral point of support is a matter of practical importance, which is, nevertheless, quite disregarded

Taking a rigid uniform bar as the simplest case, there are four points of support from which its vibrations are equal, the two ends and the two respective centres of oscillation But there are two symmetric points, situated between either end and the centre of oscillation nearest to that end, from which points of suspension the rate of vibration is most rapid Hence, when suspended from these points, a change in the position of the point of support produces a minimum difference in the rate of vibration Or, in practical terms, there is a great advantage in having a small amount of overhead weight above the support, as then, if the support approach the bob (owing to changes in elasticity of the spring, or wear of knife edges), and so increase the number of vibrations, it recedes from the top weight, and so diminishes the vibrations to a corresponding amount, and *vice versa*

This neutral point of support seems to have been overlooked in the main pendulum researches, as it was what had to be avoided rather than sought in the determination of the length, which was then the main interest Probably some one has already noticed such an elementary property, but it is of so much value in minimizing sources of error that it is worth some attention

Bromley, Kent W. M. FLINDERS PETRIE.

Induction and Deduction.

CAN we determine the precise relation between Induction and Deduction? Both are said to be a species of Inference *Deduction* is, no doubt, Mediate Inference Is *Induction* Mediate or Immediate Inference? If Immediate it must be of the form

This X is Y (or these X's are Y's) (1)
All X's are Y's (2)

But such "inference" as this is not illative, (1) can furnish only a suggestion, not by any means a justification, of (2)

Still it is true that if, *e g* I have proved that the angles at the base of an isosceles triangle are equal to each other, I henceforth believe and assert unhesitatingly, that *all* isosceles triangles have the angles at the base equal *How* do I justify such a conclusion of an universal from a particular? In this way, I think —Every nameable or cognitable object is an identity in diversity—that is, it is itself, it is *something*, and it has a plurality of characteristics This principle is involved in the assertion of any statement of the form *A is B*, and it seems moreover to be, in itself, evident on reflection Further (as Bacon surmised), every property (or group of properties) has a "form," some invariable and inevitable coexistent In other words, there is uniformity of coexistence as well as of causation in nature In the case of any one isosceles triangle, I have *seen* the connection of interdependence that there is between the characteristics of "having equal sides," and "having the angles at the base equal," I have perceived it to be self evident that the one property involves the other Hence, my whole argument might run thus —

Every characteristic is invariably accompanied by some other characteristic,
Equality of sides in a triangle is a characteristic,
Equality of sides in a triangle is invariably accompanied by some other characteristic

Again —

Equality of angles at the base is a characteristic which is (self-evidently) inseparable from equality of sides in one [this particular] case ;
What is inseparable from equality of sides in one case is inseparable in all cases ;
Equality of angles at the base is inseparable from equality of sides in all cases—
That is, *all* isosceles triangles have the angles at the base equal

What we rely on here is Interdependence of characteristics and Uniformity of that interdependence ; *i e* we rely on a principle of coexistence or coinherence, parallel to Mill's "Law of Causation", and this is a principle which we find to be a necessary condition of what we accept as strictly self-evident propositions. The assertion with which we conclude in the above generalization, is an assertion of uniformity of interdependence between certain specified characteristics.

Again, if I administer a certain amount of arsenic to a healthy animal, and it dies, and I hence conclude that arsenic is a cause

of death, I argue thus —Since every event (= change of attributes in subjects) has a cause, the death in question had a cause, the only precedent event that was relevant, was the administration of arsenic, therefore the arsenic was in this case the cause of death (this last result is obtained by the Method of Difference—by it we prove cause—*i e* interdependence of successive events) But (by the principle of uniformity) if arsenic is on one occasion cause of death, it is always cause of death, therefore arsenic is always a cause of death

It will be observed that in this second induction, though not in the first, we make use of one of Mill's "Inductive Methods" The function of these Methods is to prove interdependence between phenomena—whether it be an interdependence of concomitance or of causation In the case of the Method of Difference we proceed on the assumption that if the introduction of A is followed by the appearance of C, or the removal of A by the disappearance of C, then A and C are causally interdependent In the Method of Agreement we proceed on the assumption that if A is never found without C, A has a connection of interdependence with C

We do not use, and do not need, these Methods in mathematical generalizations, because there we *see* the interdependence upon which generalization to unknown cases is based, it is this actual apprehension of interdependence that both makes the methods unnecessary and gives mathematical generalizations the peculiar certainty which is generally attributed to them In the case above cited, for instance, we *see* that equality of angles at the base is self-evidently and necessarily bound up with equality of sides in a triangle. We do *not* see that there is a self-evident interdependence between the obvious properties of arsenic and poisonousness

A further interesting point is that our power of predicting that one event, A, will be *followed* by another event, C, seems to depend wholly upon *coexistence* of attributes in the subjects concerned If we have seen one animal dosed with arsenic and subsequently die, and hence conclude that another animal called by the same name, and dosed with an equal amount of arsenic, will die, is not our inference based upon the assumption of a certain constant coinherence of attributes, both in the animal and in the poison—a coinherence of such a kind that when the two subjects are so collocated as to act upon each other, a result similar to that produced in the first case will be produced in the second also? If the properties of this arsenic are different from the other, or if the second animal, though looking like the first, has a different internal constitution, there is no reason why death should result. Hence, laws of succession in events seem to depend upon laws of coexistence of attributes in subjects

Even those generally unquestioned axioms of logic, the Law of Contradiction and the Law of Excluded Middle, might be appealed to (if it were necessary) in support of the Principle of Interdependence—for the Law of Excluded Middle intimates a thoroughgoing connection (positive or negative) between all nameable things, and the Law of Contradiction asserts a certain definite amount of necessary interdependence of properties in every imaginable case—interdependence, namely, between *the presence of any characteristic* and *the absence of its negative*

Looking at the whole process of inductive reasoning, it appears to be in the application of the "Methods" that the principles used approach nearest to the character of mere assumptions, and this is so only because of the difficulty of applying the Methods precisely—of being sure, *e g* in the case of the arsenic, that the administration of arsenic *was* the only new antecedent relevant to death

It may just be noticed that in an argument by analogy we rely upon an interdependence which is inferred from the complexity or amount of interdependence already known or supposed

If the above account of inductive reasoning is accepted, it appears that the connection between Induction and Deduction is very close—in fact, that the one distinctive feature of logical induction is the element of hypothesis or discovery—the supposition of a given connection—from which every Induction must set out.

Cambridge E E Constance Jones

The Scale for Measurement of Gas Pressures.

I venture to ask you to print the following suggestion It is one likely enough to have been made before, but I do not remember having met with it

We generally measure gaseous pressures in millimetres of mercury, and 760 mm. is adopted as the standard pressure. It would certainly be more convenient if we expressed the measurement in degrees, the degree being of such magnitude that the standard pressure were 273° All calculations involving change of P, T, and V to or from the standard conditions would be simplified in an obvious way The equation $PV = RT$ would become $V = R$ at standard pressure and temperature. R being the same constant for all gases under all conditions, if V stand for the molecular volume, it would be convenient to remember it as identical with the well-known number expressing the standard volume of a gramme-molecule 1°P would correspond to about 2 78 mm or $\frac{1}{9}$ inch of mercury.

Orme Masson.

The University of Melbourne, June 21

Luminous Clouds

Bright luminous clouds were seen here on the night of Sunday the 24th inst, in the north and north north-east, from 9 35 to 10 35 p m As usual they distinctly resembled *cirri*, having some definite upward curls The actual cirri, which had after sunset been moving rapidly from east-south-east, now appeared dusky against the twilight glow The filature of the upper or luminous cirri was, as appears to be usual, west and east, while that of the ordinary cirri was east south-east and west north-west

These luminous clouds, although no doubt simply reflecting solar light, generally appear to the casual observer as incandescent or self luminous

They were seen from the summit of Ben Nevis all through the night of the 24th–25th, according to the report in the *Times*

Lutterworth W Clement Ley

Whirlwinds in the South Indian Ocean

The following account of whirlwinds met with in the South Indian Ocean at the end of last May, which has been supplied to the Meteorological Office by Messrs Sandbach, Tinne & Co, of Liverpool, may be of interest to your readers

Robert H Scott,
July 22 Secretary, Meteorological Office

Extract from a Letter received from Capt S P Hearn, Ship "Genista"

"At noon on May 26, lat 42° 0′ S, long 99° 0′ E, wind fresh from N W —weather very squally with rain, barometer steady at 29 82 in, thermometer 49° since midnight A very heavy black squall with rain began to rise in the W Barometer suddenly fell 0 1 in As the squall neared the ship it arched up in the centre, showing a very bright blue sky at the back of it, the ends of the squall on either side were quite black and thick with rain On its nearer approach to the ship I saw two immense whirlwinds, just a little on either side of the centre of the arch and coming direct for the ship, the sea under and near the whirls being carried around and up in great volumes I thought at first they were two waterspouts forming, but I saw no descending column or clouds from above, as is seen when a waterspout is forming, when these whirls came to within two miles of the ship, the squall seemed to part in the centre of the arch—one half passing to the N E, the other half to the S E., one whirl following in rear of each part of the squall, and not where the clouds were heaviest During the time of the separation of the arch we had the wind very unsteady from N.W to S W There was only a fresh breeze with thick rain in that part of the squall that neared the ship, yet the squall was travelling along at a great rate, the whirls keeping in the rear till out of sight. I shortened sail to topsails as soon as I saw the squall rising After it passed, the weather looked very fine, bright, and clear, but the sky was a windy one, being a very bright blue By 3 p m the wind shifted to W., and barometer had fallen to 29 67 in, thermometer 48° At 4 p m saw another whirl passing along to windward in the rear of a squall, the clouds above it being twined and twisted every way. During the whole night we had very heavy squalls, sometimes following one another very quick, with little wind between—direction W S W At daylight the weather was much finer After that, to lat 40° 22′ S, long. 125° E, I had very peculiar

weather Wind from N W to S and back again, from a light breeze to a moderate gale, barometer never rising higher than 29 90 in., or falling below 29 66 in

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The Cause of the Great Fire at St. John's

A FEW days ago you inserted a letter calling attention to the large number of fatal accidents occurring every year caused by the upsetting of paraffin lamps, the great majority of which could easily be prevented if the use of automatic extinguishers were made compulsory

Now we are startled by the report of the huge conflagration at St John's, which, in addition to having caused terrible and widespread suffering, has resulted in the loss of a large amount of property, valued at many millions of dollars

Amongst the principal sufferers by this great fire are some of the leading English insurance companies, and various estimates have been published of the amounts which they will lose by this great fire *The Policy Holder*, an insurance journal, in its last issue, mentions the following figures —

	£		£
Phœnix	120,000	to	140,000
Royal	80,000	to	100,000
Liverpool, London, and Globe	50,000	to	70,000
London and Lancashire	50,000	to	60,000
Commercial Union	40,000	to	50,000
North British and Mercantile	50,000	to	60,000
Northern	40,000	to	50,000
Manchester	8,000	to	11,000
Lancashire	5,000	to	7,000
Norwich Union	7,000	to	10,000

Also the "General," said to be £30,000, and the "Lion" for a comparatively large sum, making in the aggregate a loss for English insurance companies alone of over £500,000 sterling

The same journal explains how this great fire was brought about —

"It is worthy of note that, like the Chicago fire, this conflagration was caused by the upsetting of an oil lamp in a stable Fire business was already this year going badly enough, and there now seems little reason to doubt that to the companies as a whole 1892 will prove a disastrous year and a dead loss"

The Mayor of Manchester (Alderman Bosdin Leech), in presiding yesterday at a meeting of citizens called for the purpose of raising a fund in aid of the sufferers by this great catastrophe, stated—

"Since the fire of forty or fifty years ago many substantial public and private buildings had been erected, all of which have been destroyed. On one side, at any rate, a thriving town had been reduced to a heap of ashes, and about 10,000 people had been rendered homeless, and damage had been done to the extent of about 2,500,000 dollars With such an event coming suddenly upon them, they could imagine how the people were prostrated The heart of the people was completely crushed A great many of the sufferers were of the poorest class, and they were almost powerless to help themselves They were without food, except such as had been supplied to them through the kindness of their neighbours, they were without clothes, for all their clothes had been destroyed, and, unfortunately, the working people of the community had been almost entirely bereft of the tools and implements with which they were in the habit of earning their daily bread"

It is indeed very sad to think that this terrible calamity might have been avoided had the oil lamp which was the cause of all this mischief been fitted with a simple application of science in the shape of a simple automatic extinguisher

July 20. HUMANITY.

THE WASHINGTON COLLECTION OF FOSSIL VERTEBRATES

WE are pleased to learn from a transatlantic contemporary that the enormous collections of vertebrate remains, obtained under the superintendence of Prof O. C. Marsh from the Tertiary and Secondary strata of the north-western United States, are about to be transferred to the National Museum at Washington, where they will eventually be properly arranged, and exhibited to the public For the last nine years, as we are informed, the United States Government has voted funds for the collection and preservation of these wonderful remains, descriptions of which have been from time to time presented to the scientific world with a wealth of illustration which cannot but render European palæontologists somewhat envious

Hitherto the whole of this collection (together with Prof Marsh's private collection) has been stored in the palæontological department of the unfinished Peabody Museum, at Yale College, New Haven, Conn, where want of space has totally prohibited its proper exhibition Indeed, those who have had the opportunity of inspecting this unrivalled series inform us that the specimens are so crowded together—the smaller ones in tier upon tier of trays, and the larger ones on the floors and in every available corner—that it has hitherto been quite impossible to form any adequate judgment as to the extent and importance of the collection It is, however, satisfactory to learn that the whole series has been carefully labelled and registered, so that the locality and date of acquisition of every individual bone are fully recorded

To prepare such an enormous collection for transit by rail is a work demanding both extreme care and a considerable amount of time, while the Museum space required for the exhibition of entire skeletons of the bulk of those of the Jurassic and Cretaceous Dinosaurs must be proportionately extensive We are informed, indeed, that if the whole collection were transferred to Washington at the present time it would occupy fully one-half of the buildings of the National Museum Accordingly, only a portion of it is to be immediately transported, while the remainder is to wait until Congress has provided suitable quarters for its reception It is to be hoped that the moiety now to be transferred will include a representative selection from the entire series, so that palæontologists will have an opportunity of seeing more or less nearly entire skeletons, not only of the Dinosaurs and other huge Saurians of the Mesozoic, but likewise those of the equally wonderful Tertiary mammals We may also venture to express the hope that the United States Government will before long see its way to enriching European Museums with some of their duplicate specimens, of which there must be a large number for disposal

With a wise liberality, the Government of the United States appears to have made a regular business of the collection of these fossils, under the able direction of Prof Marsh, this business being conducted much after the manner of any other mining enterprise One of the favourite hunting-grounds is the region lying between the "Rockies" and the Wasatch Mountains, and the accounts of the richness of some of these deposits in vertebrate remains is absolutely marvellous Thus Prof Marsh is reported to know of one small valley where bones of Mosasaurians are in such profusion that in passing through it he observed at one time no less than six entire skeletons of these monstrous reptiles, each averaging some 80 feet in length At such a rate of discovery it is no wonder that Museum accommodation cannot be procured fast enough The care taken to prevent other fossil-hunters from discovering the more productive localities affords rather amusing reading, but, under the circumstances, it is, perhaps, natural

Whenever a likely-looking bone or skeleton is seen projecting from a rocky cliff, skilled workmen are at once set to work on its extraction, a single specimen sometimes leading to the discovery of a regular golgotha of remains. The wonderfully perfect condition of some of these fossils, and the rapidity with which the carcasses of their former owners must have been entombed in sand

or mud, are brought prominently under notice by a recent reported discovery in Wyoming This is said to be nothing less than the disentombment of an entire skeleton of that stupendous Dinosaur known as the Brontosaur, in which not only is every bone in place, but an actual mould of the surface of the eye, formed in the sand upon which the creature lay, has been preserved in the solid rock.

Prof Marsh's restoration of the Brontosaur—a creature 60 feet in length, walking on all fours, with an enormously long neck and tail, a disproportionately small head, and the bony substance of its backbone reduced to a mere shell and a honeycombed interior—has been long before the world Less known, however, is his later reconstruction of the skeleton of one of the gigantic horned Dinosaurs from the Laramie Cretaceous, which he calls *Triceratops* the skull and pelvis of which were referred to in an earlier number of NATURE. In this restoration the Professor has certainly succeeded in producing a most marvellous animal, although, so far as we see, the figure appears to be true to nature It will be remembered that one of the most remarkable features in the skull of *Triceratops* (which in some specimens was upwards of 12 feet in length) is the production of the hinder regi on into a huge fan like shield, the use and purpose of which it was at first a little difficult to understand This is, however, explained by the restored skeleton, where we see this shield overlapping and protecting the first six vertebræ of the neck, to which additional strength was imparted by the bony union of several of them In the shortness of its neck and the enormous size of its skull, *Triceratops* presents a striking contrast to *Brontosaurus* Like the latter, however, it habitually walked on all fours, while in correlation with its massive skull its fore-limbs were relatively stouter than in any other Dinosaur In this respect it differs widely from its near ally, *Stegosaurus*, which, at least occasionally, walked in a bird-like manner, and since *Triceratops* is evidently a more specialized creature than *Stegosaurus*, the suggestion arises that the former has undergone a retrograde development from a bipedal to a quadrupedal mode of progression. No attempt has yet been made to represent the position on the skeleton of the dermal bony armour with which many parts of the body of *Triceratops* were protected during life, the precise position of the various spines, knobs, and plates, which have been found in association with the bones, being largely a matter of conjecture The size in life of the restored example would be approximately some 25 feet in length by 10 in height, but these dimensions must have been exceeded by other specimens

By the completion (so far as anything connected with fossils can be said to be complete) of our knowledge of the skeleton of *Triceratops*, we are acquainted with the bony framework of all the chief types of Dinosaurian reptiles at present known These may be classed as the Sauropodous type, as represented by *Brontosaurus*, the Theropodous type, as represented by *Megalosaurus* and its allies, and the Ornithopodous modification, represented on the one hand by *Iguanodon*, and on the other by *Stegosaurus*, *Triceratops*, &c

In the contemporary publication to which we have referred some interesting suggestions as to the probable habits of these Dinosaurs are put forth, although how far they will meet with acceptation remains to be seen Thus it is suggested that the honeycombed vertebræ of the Brontosaurs and their allies were filled with warm air from the lungs (which assumes that these reptiles were warm-blooded), by which means their bodies were partly floated when they wandered out of their depth in the sea shallows, from whence they stretched their long necks to crop the seaweed near the shore Again, the long hind legs of the Hadrosaur (an ally of our Iguanodon) are considered to have enabled their owner to wade far out to sea in search of seaweeds growing on the ocean-floor, while the armoured kinds, like *Stegosaurus* and *Triceratops*, are considered to have been essentially terrestrial

As we have indicated, the great bulk of the collection is composed of Secondary reptiles and Tertiary mammals, and from their large size it is these which form its most striking feature We most not omit to state, however, that it also contains the Toothed Birds from the Cretaceous of Kansas (of which our English collections do not at present possess a single bone), as well as hosts of teeth of Mesozoic mammals, although we have no definite information as to what proportion of these are the property of the State, and what belong to Prof Marsh Then, again, scattered among the trays and drawers more especially devoted to the remains of mammals and reptiles is an extensive collection of fish-remains from Cretaceous and Tertiary strata, and especially from the Green River Eocene shales of Wyoming, most of which we believe to be at present totally undescribed.

Space prevents us from saying more as to the extent of this marvellous collection—a collection which, with others from the same regions, has done more in ten years to revolutionize our classifications, and to give us a definite knowledge of many groups of animals previously known by battered fragments, than would have resulted from half a century's work upon European materials We may, however, conclude by offering our hearty congratulations to the Governments of the United States and to Prof Marsh, who have succeeded, by the liberality of the one and the untiring energy of the other, in amassing this magnificent collection, which is now, for the first time, in a fair way to be exhibited in a manner befitting its value and importance Prof Marsh's magnificently illustrated monographs on the Toothed Birds and the Dinocerata are splendid examples of how a collection like this ought to be made known to the scientific world at large, and we trust ere long to be able to welcome his long-promised volumes on the Dinosaurs and the Brontotheres, which will render its riches yet better known

R LYDEKKER

DYNAMO-ELECTRIC MACHINERY[1]

THIS is the first part of a treatise dealing with dynamo-electric machinery and its applications, and comprises the theory and practical construction of dynamos and motors, and an account of instruments and methods of electrical measurement Such subjects as the fusion and welding of metals by electricity and the transmission of power are reserved for a second part, to be issued in the autumn of the present year

The author begins with a chapter entitled "Generalities regarding Dynamos," in which he discusses the early rudimentary magneto-machines of Pixii and Clarke, and the multipolar machines of the same class invented by Stöhrer and Niaudet, gives a general explanation of the self-excitation and action of series of shunt and compound dynamos, and describes the various typical forms of armature used in constant and alternating-current machines In this part there is room for little novelty of treatment, the author could only endeavour to be impartially historical and clearly descriptive, and give as complete and useful an account of the more important examples of dynamo machinery as his space would admit of In this Signor Ferrini seems to have succeeded very well. He does not weary his readers with descriptions of mere antiquities, but supplies only such a brief account of earlier forms as is sufficient to enable the reader to trace the evolution of the modern constant-current dynamo, with its beautiful balance and inter-relation of

[1] "Recenti Progressi nelle Applicazioni dell' Elettricità di Rinaldo Ferrini" Parte Prima Della Dinamo (Milano, Ulrico Hoepli, 1892)

parts, from the rudimentary, uneconomical, and violently periodic machine of twenty years ago, or to compare the powerful alternator of the present day with the ineffective and wasteful toy instrument, which used to figure in cabinets of apparatus and the older books on electricity

Chapter ii deals with magnetic induction, and chapter iii. with the induction of currents by the motion of conductors in a magnetic field These extend over almost 100 pages, or about one-fourth of the whole volume, a space none too large for the subject, but perhaps a little out of proportion to that devoted to dynamo machinery, which is still further restricted by the allocation of fifty pages in chapter iv to methods of measurement

Signor Ferrini's treatment of the theoretical part of his subject seems on the whole marked by completeness and accuracy He has evidently given careful attention to the late developments of magnetic research, and in his chapter on measurements has included most of the improvements recently made, such, for example, as the methods of measuring power, &c, in the circuits of alternators and transformers which have been invented by Ayrton and others No mention is made, however, of Blakesley's ingenious "split dynamometer" method for transformers, and determining the difference of phase of two alternating currents Nor is the method (p 171) of finding the true mean activity in an alternating current from the apparent activity attributed to its inventor, Prof Ayrton

We notice here a few points which have occurred to us in looking over this part of the book as perhaps calling for remark First of all with respect to the definition of a uniform magnetic field given at p 58, it may be noticed that if the numerical value of the intensity of the magnetic force be the same at all points of a finite space, its direction must be the same at all points of the same space, and that the intensity cannot vary in magnitude from point to point without varying also in direction, and *vice versâ* This does not seem to be generally understood, at any rate it is common to define a uniform field as one for which the magnitude *and the direction* of the magnetic force are the same at every point That the former implies the latter, and the latter the former, may be seen by considering a closed surface formed by a portion of a tube of force, in the field, intercepted between two equipotential surfaces The cross-sections at the two ends must have the same area, since the magnetic force at each end is the same Further, the lines must be straight, for if they be supposed curved, the portion of the tube may be taken so that it is concave on one side and convex on the other The line integral of magnetic force round a closed circuit, taken along the convex and concave sides and across the ends, vanishes But nothing is contributed to it by the ends of the tube Hence the magnetic force along the convex side must be on the whole less than that along the shorter concave side, which contradicts the supposed uniformity of magnitude of the field-intensity.

At p 66 difference of potential, $V_1 - V_0$, between two points is defined as the work which must be done against magnetic forces in carrying a *unit* magnetic pole from the point of lower to that of higher potential, and at p 74, where the field of a solenoid is considered, $-dV/dx$ appears as the force on a pole of strength m

At p 81 mention might have been made of the influence of mechanical stress and disturbance on the magnetization of iron observed by Lord Kelvin and others, and of the fact that very much higher permeabilities than the 2000 quoted from Rowland's experiments have been obtained by Ewing for soft iron subjected to molecular vibration produced by tapping

The subject of hysteresis is dealt with at p. 91, and again at p 235 in the chapter on the construction of a continuous-current dynamo In the latter place a proof is furnished of the well-known formula given by Warburg in 1881 or 1882, and a little later by Ewing, for the energy dissipated in a closed cycle of magnetization In the course of that proof, to which in itself we take no exception, one or two statements are made which, if we have understood the author aright, are erroneous It is stated that when the integral induction Φ through each turn of a magnetizing helix of n windings, each carrying a current ι, is increased by an amount $d\Phi$, a quantity of energy $= -n\iota d\theta$ $(= -v\mathbf{H}d\mathbf{B}/4\pi)$, where v is the volume of the medium magnetized, $\mathbf{H}$ the field intensity and $\mathbf{B}$ the induction, both supposed uniform) is given out by the spiral *and converted into heat* Now (the sign being left out of account) this is certainly the energy sent into the field from the battery or generator, but it is not the case that it is all converted into heat The amount of energy spent in unit volume of the magnetized medium is $\mathbf{H}d\mathbf{B}/4\pi$, but of this $(\mathbf{H}d\mathbf{B} + \mathbf{B}d\mathbf{H})/8\pi$ goes to increase the electrokinetic energy, the amount of which per unit volume of the medium is $\mathbf{BH}/8\pi$ The total amount of energy spent per unit volume in the cycle of magnetization, otherwise than in increasing the electrokinetic energy, is therefore

$$\frac{1}{4\pi}\int\left\{\mathbf{H}d\mathbf{B} - \frac{1}{2}(\mathbf{H}d\mathbf{B} + \mathbf{B}d\mathbf{H})\right\},$$

the integrals being taken round the cycle (It is to be noticed that this balance of energy may be negative, and in that case energy is taken from the field to make up the increase of electrokinetic energy [1])

But for a closed cycle

$$\int(\mathbf{H}d\mathbf{B} + \mathbf{B}d\mathbf{H}) = 0,$$

and hence the energy spent is

$$\frac{1}{4\pi}\int\mathbf{H}d\mathbf{B}.$$

This must have been dissipated, since the medium at the end of the cycle has returned to the same state as at first

No affirmation can be made as to what becomes of the balance of energy, except with reference to a closed cycle

Again, at p 237 it is stated that if $\mathbf{H}_1$, $-\mathbf{H}_1$, be limits of $\mathbf{H}$ corresponding to limits $\mathbf{B}_1$, $-\mathbf{B}_1$ of $\mathbf{B}$,

$$\int_{-\mathbf{H}_1}^{\mathbf{H}_1}\mathbf{H}d\mathbf{B} = \int_{-\mathbf{B}_1}^{\mathbf{B}_1}\mathbf{B}d\mathbf{H}$$

This is certainly not correct, as may be easily seen by representing the integrals graphically, or by considering that taken round a closed cycle

$$\int\mathbf{B}d\mathbf{H} = -\int\mathbf{H}d\mathbf{B},$$

since

$$\int(\mathbf{H}d\mathbf{B} + \mathbf{B}d\mathbf{H}) = \int d(\mathbf{BH}) = 0$$

for the cycle

This error, a mere oversight no doubt, has appeared more than once in connection with this subject, and an erroneous demonstration founded on it and a mistaken identification of the energy dissipated with the electrokinetic energy, has been used by more than one writer

The chapters on the "Continuous Current Dynamo," the "Dynamo in Action," and "Alternating Dynamos," are excellent in many respects The subject is well and fairly comprehensively treated, and the very useful notion of the magnetic circuit has been employed throughout with good effect. Some well-known machines do not seem to be described, for example, the Victoria among

[1] See a paper by the writer in the *Phil Mag*, December 1890

continuous-current machines, and the latest form of Mordey's alternator

The inclusion of a larger number of thoroughly practical examples of dynamo specification and construction would also be an improvement

On the whole, Signor Ferrini's book seems the outcome of an earnest endeavour to give an accurate and full account in moderate, compass of an important and difficult subject It will be more easy to judge of the full measure of the author's success when the work is completed In any case the book seems likely to be a credit to Italian technical literature A GRAY

MR A NORMAN TATE

BY the death of Mr A Norman Tate, F I C, Liverpool has lost one of her most prominent citizens and men of science. It is not only as an able analytical chemist that Mr Tate will be missed by a large section of the public to whom his genial presence was familiar, but as a scientific teacher and pioneer of the technical education movement in Lancashire, his place is one that will not easily be filled For some time past Mr Tate has had indifferent health, and has had to give up much of his active work in connection with the Society of Chemical Industry, of whose Publication Committee he was a member, and the numerous local and other learned societies to which he gave great aid Latterly, symptoms of an ulcerous tumour in the stomach presented themselves, from which he died on the 22nd instant

Mr Norman Tate was a native of Wells, Somerset, and came to Liverpool about thirty-five years ago, when he entered the laboratory of the late Dr Sheridan Muspratt He published several papers bearing on his early researches in the journals of the Chemical Society of London and the Royal Dublin Society After acting for some years as chemist to the firm of John Hutchinson and Co, of Widnes, he commenced practice as an analyst in Liverpool, and became consulting chemist to several important local bodies and chemical manufactories At that time the importation of petroleum from America was beginning, and on this subject Mr Tate became an authority, one of his works, "Petroleum and its Products," being translated and re-published in France and Germany For a time Mr Tate superintended the working of oil refineries in the Isle of Man and in Flintshire, where he erected a manufactory for the production of coal and shale oils In 1870, Mr Tate, in conjunction with Mr James Samuelson, undertook the initiation of the Liverpool Science and Art Classes, which grew to be a great educational power in the city As honorary principal, Mr Tate had charge of these classes, besides giving lectures himself and teaching several of the classes in chemistry, botany, and general biology He also instituted the Liverpool Science Students' Association, and the Liverpool District Science and Art Teachers' Association, of both of which bodies he was the first president, a post he also filled in the local Geological Association, Microscopical Society, Liverpool Section of the Society of Chemical Industry, and other institutions, contributing largely to their "Transactions" The "Proceedings" of the Liverpool Geological Society also contain many of his papers and memoirs He discovered the presence of iserine in the decomposed greenstones of the Boulder Clay in the Valley of the Mersey, and showed that the black colour of certain sandstones in the trias in the neighbourhood of Liverpool is due to the grains being coated with peroxide of manganese

Mr Tate was an ardent supporter of every educational movement, especially in connection with science teaching, and his death, at the early age of fifty-six, will be much deplored by a circle of friends extending far beyond the limits of the city which he had made the chief scene of his labours O W J.

THE BRITISH ASSOCIATION

EVERYTHING is now practically ready for the meeting of the British Association, which begins next week, and promises to be in every way most successful Many distinguished foreign men of science—among them Helmholtz, Cremona, and Sachs—are expected to be present. The arrangements made by the local committee we described last week

In compliment to the President there will be a specially strong muster of geologists We hear that a number of professors and others connected with the Geological Survey of France are coming Baron von Richthofen and Prof Credner will represent the geologists of Germany, Prof Renard those of Belgium There will be many other representatives from different countries in Europe and from America The geological excursions will likewise form a prominent feature in the proceedings, and one of these is to be conducted by the President of the Association in person The Prince of Monaco, well known for his scientific researches, intends to bring his deep-sea dredging vessel to Granton, and to read a paper on the results of his marine surveys, while two members of his scientific staff will communicate papers on some of the natural history objects obtained by them Already a large amount of hospitality has been organized, and the meeting bids fair to be as successful in a social as in a scientific way.

We have already announced that at the meeting of Section A on Monday, August 8, a discussion on the subject of a national physical laboratory will be opened by Prof Oliver J Lodge, F R S

A meeting of the Electrical Standards Committee will be held on Thursday, August 4. It is expected that Dr von Helmholtz, Dr Lindeck of the Berlin Reichsanstalt, and others interested in electrical measurements, will be present A discussion will take place with a view to securing an absolute uniformity in the standards adopted in England and elsewhere The following points will be considered —(1) The value of the B A unit in ohms, (2) the specific resistance of mercury in ohms, (3) standardizing by the electrolysis of silver, (4) the electromotive force of a Clark cell, (5) Report of the Committee for 1892 It is proposed to take the report of the Committee in Section A on Tuesday, August 9 The draft prepared by the secretary is formal, but it is hoped that the discussion in the Committee may lead to some resolutions, which will be included in the report

The proceedings of Section D promise to be exceptionally interesting The President's address will relate to some qualities of sensation, with special reference to colour sense On Friday there will be a joint discussion with B on chemical aspects of the action of Bacteria, which will probably be opened by Prof. Marshall Ward On Monday there will be a discussion on some matters connected with sea-fishes and fisheries, in which the following will read short papers or take part – Sir J Gibson Maitland, Prof M'Intosh, Prof Ewart, Dr Fulton Prof Herdman, Mr E Holt, Mr R Smith, Mr G Brook, &c

NOTES

THE summer meeting of the Institution of Mechanical Engineers, to which we referred last week, began at Portsmouth on Tuesday, under the presidency of Dr William Anderson, F R S The president, council, and members were received by the Mayor, who cordially welcomed them to Portsmouth

THE British Medical Association's sixtieth annual meeting was opened at Nottingham on Tuesday, the chair being occupied by Dr W Withers Moore In his presidential address Dr. Moore dealt with the progress which has been made in surgery and medicine since 1857, when the Association held its last meeting at Nottingham

A GENERAL meeting of the Sanitary Inspectors' Association was held at Carpenters' Hall, London Wall, on Saturday evening last, the president, Dr B W Richardson, presiding The council presented a report upon the question of examination for sanitary inspectors, recommending that they should be empowered to confer with the court of the Carpenters' Company in order to arrange for lectures and examinations The report was adopted. A report upon the association's recent visit to Paris was also presented, setting forth the principal features and incidents of the journey The adoption of this report was moved by Mr Alexander, and seconded by Mr Tidman The chairman, in supporting the motion, said the association had learned many important lessons upon the question of sanitation by their visit to the French capital After comparing the French and English systems of sanitation, he expressed the opinion that in the matter of disinfection the English might learn much from their French neighbours He believed that in London there might with advantage be established one or more grand centres for disinfection such as existed in Paris He deprecated the system in use at the Paris Morgue of freezing dead bodies for the purpose of identification as being, in his belief, utterly useless for that purpose On the question of the inspection of animal food, he thought that England could not do better than follow the system adopted in France of testing every doubtful animal before it went to the shambles A discussion followed, and on the motion of the chairman an ambulance committee was formed to report on the ambulance system in London The report was adopted

AN official telegram received at the Hague from Batavia confirms to some extent the statement made at Sydney as to a terrible volcanic eruption in the island of Great Sangir The volcano which caused the disaster is named Gunona Awu The telegram adds that the whole of the north-western portion of the island was entirely destroyed, 2,000 persons being killed The victims included no Europeans The rest of the island has also suffered seriously by the eruption, but it is hoped that the damage may be repaired in the course of six months The crops have been destroyed

FOR some days the eruption of Mount Etna seemed to be gradually decreasing, but on Tuesday it was again very violent, and there were loud subterranean noises. On Monday evening there was a shock of earthquake at Mineo, thirty-seven miles to the south of the volcano A correspondent of the *Times*, writing from Catania on July 18, says that the exact seat of the eruption cannot be discovered from that city on account of the dense masses of smoke with which that side of the mountain is enveloped, but from Augusta, a town situated about 15 miles away, the summit and western outline are to be seen standing out in bold prominence against the deep, gentian-blue of the Mediterranean sky, and, with its endless volumes of steam and smoke rolling away to the eastward, Etna presents an indescribably imposing, not to say majestic, appearance From this little town the scene is sublime

THE cause of the terrible disaster at St Gervais is now being investigated by several men of science There can be no doubt that it originated in the small glacier called the Tête Rousse, which is nearly 10,000 feet above sea level According to a correspondent of the *Times*, who writes from Lucerne, Prof Duparc is of opinion that the habitual drainage of this glacier had for some reason or other become either totally blocked or obstructed, the water gradually accumulated in its natural concavity or bed, and the ever-increasing volume had exercised such an enormous pressure as to force a passage and carry away a portion of the face of the glacier with it The mass of ice and water rushed down the rocks which dominate the glacier of Bionnassay, not in a single stream but in several, and then reunited into one enormous torrent at the foot of the Bionnassay glacier A different theory is held by Prof Forel, of which the correspondent of the *Times* gives the following account --Professor Forel does not see how a quantity of water sufficient to force away so large a portion of the glacier could possibly accumulate in so small a body as the Tête Rousse, which has a total superficies of less than one hundred acres It slopes freely on three sides, it is, in fact, one of the most abrupt of the whole chain of Mont Blanc, and, in a glacier of this description, with an altitude of nearly 10,000 ft, there are none of the conditions of a great accumulation of water In his opinion, therefore, we must look for the main cause of the disaster in the natural movement and breaking up of the glacier He estimates the volume of ice which fell at between one and two million cubic metres The mass, first in falling and then rushing down the rapid slope, became transformed, for the most part, into what he calls a lava of ice and water The ravine, he says, through which this avalanche rushed shows no traces of any great evacuation of water, in the upper portions of its transit there is no mud and no accumulation of sand, but, on the other hand, there are great blocks of glacier ice strewn everywhere, and at several points he found portions of powdered ice mixed with earth Then, again, if this had been simply a torrent of water falling, it would have found its way down the more violent inclines, instead of, as in this case, passing straight over the frontal moraine at the foot of the glacier In this higher region, therefore, all the evidence points to an avalanche of ice, which, starting at an altitude of nearly 10,000 ft, and descending at an incline of 70 per cent for 5,000 ft, was pulverized by its fall, a large portion of it being melted by the heat generated in its rapid passage and contact with matters relatively warm It rushed into the ravine by the side of the glacier of Blonnassay and joined the waters of the torrent which issues therefrom, and, further aided by the stream of Bon Nant, it became sufficiently liquid to travel down the lower portions of the valley at the slighter incline of 10 per cent, and yet retained sufficient consistency to destroy everything in its passage That this torrent was not composed merely of mud and water is proved, he says, by the fact that it did not always maintain the same height when confined to the narrower ravine, and that the remains on the sides of the rock show it to have been a viscous substance rather than fluid

AN entire change of weather set in over these islands during the past week The severe storm referred to in our last issue passed quickly to the south eastward across the Channel, and subsequently traversed Switzerland and Italy. This was succeeded by an area of high barometer readings, which reached this country from off the Atlantic, and extended eastwards over a great part of Europe Anticyclonic conditions have since been very persistent, with an unusual amount of cloud, especially in the north and south, and, occasionally, mist or fog, but the weather was otherwise fine and very dry Temperature remained low, under the influence of northerly and easterly winds, the maxima seldom exceeding 70°, while the night minima have also been low, especially over the inland districts of England, where, in places, readings have fallen to within 10° of the freezing point

THE Vatican Observatory, recently established by Pope Leo XIII, has issued volume ii of its "Pubblicazioni," containing the results of the most important researches undertaken at the observatory, together with a summary of the proceedings of the meetings held in the year 1891, which comprise a collection of notices relating to astronomy and terrestrial physics. Prof J Buti contributes papers (1) on the variations of temperature at different heights. The maxima were generally highest at the

lower station, especially in spring and summer, while in winter the conditions were reversed The minima were higher throughout the year at the higher station than those near the ground These results are in accordance with those obtained by the director, Padre Denza, in the case of observations taken at Turin (2) On rainfall at different heights The results show that the amount of rainfall is greater at the higher station at times of heavy rain, and conversely at times of slight rain (3) Comparisons of relative humidity, tension of vapour, and temperature, accompanied by curves The work also contains hourly observations from January to June, photograms of lunar regions, phototypes of some constellations and nebulæ

As an illustration of the specialization of scientific teaching on the Continent, we may mention that Dr H Schinz has been appointed Professor of Systematic Botany at the University of Zurich, in order that Prof A Dodel may devote his course of lectures entirely to Anatomical and Physiological Botany

GENERAL PARIS, of Dinard (Ille-et Vilaine, France), is engaged in the preparation of a *Nomenclator Bryologicus*, on the plan of Steudel's "Nomenclator Botanicus" He will be greatly obliged if bryologists of all countries will send him copies of recent memoirs, or an exact reference to the description of all new species, accompanied, where possible, by a specimen

A NEW botanical publication has made its appearance under the title *Arbeiten aus dem K Botanischen Garten zu Breslau* It is edited by Prof Prantl and will be devoted to the record of work done in the Botanic Garden at Breslau The first number contains a paper by Prof Prantl, on the Classification of Ferns, one by Herr Pomrencke on the structure of the wood of certain gamopetalous families, and one by Herr Mez on the Lauraceæ

IN addition to the Vascular Cryptogams collected under the auspices of the West India Exploration Committee by Mr R V. Sherring, F.L S , in the island, and described in the *Annals of Botany*, Vol vi , No 21, April, 1892, by Mr J G Baker, F R S , his collections at Kew have yielded about thirty species of Orchids from Grenada, some of which are of considerable interest They have now been determined by Mr R A. Rolfe, A L S The orchids of Grenada appear not to have been systematically collected before There are no records of species from that island in Grisebach's *Flora of the British West India Islands*, 1864, and only about three or four were represented in the Kew Herbarium Mr Sherring's collections, therefore, enable us to arrive at a tolerably good idea of the distribution of orchids in the island A species of *Brachionidium*, a genus not hitherto represented in the West Indian flora, is probably new, as also species of *Scaphyglottis* and *Cranichis* *Hexisia reflexa*, *Pleurothallis pruinosa*, *Oncidium luridum* and *Ornithocephalus gladiatus* have not hitherto been found in the smaller islands, the recorded specimens being chiefly from Jamaica and Trinidad *Dichæa hystricina* has not been found before except in Cuba by Wright and Eggers *Xylobium* (*Maxillaria pallidiflora*) was recorded before only from St Vincent, and *Elleanthus lepidus* is new to the West Indian flora. The remaining species are found in many islands, such as Jamaica and Dominica, but their occurrence still further south is a point of some interest

THE City and Guilds of London Institute has issued a list of the candidates who have passed its examination for the teacher's certificate in manual training The examination is limited to teachers in public elementary schools. It was held this year for the first time, and related to woodwork As a large number of teachers had been receiving manual instruction before the institution of the examination, a limited number of candidates were allowed to present themselves for the final examination without having passed the first year's examination There were 275 candidates for the first year's examination, and of these forty seven passed in the first class, 108 in the second, and 120 failed For the final examination there were 340 candidates, of whom forty nine passed in the first class, 146 passed in the second class, while 145 failed The examiners report, as regards the first year's examination, that the practical wood-working was uniformly well done, but that the drawing was badly done by a large number of candidates "It is obvious," they add, "that the instruction in practical drawing is not good Many candidates failed even to understand the examination paper" In the advanced examination the drawing was much better

THE Yorkshire College, Leeds, has issued the first report of its department of Agriculture We are glad to note that the County Lectures to farmers have, as a whole, been successful beyond the most sanguine anticipations of the committee. The unsympathetic attitude which the farmers at some of the centres assumed at first with respect to these lectures was often speedily changed to warm appreciation, which rose, in certain cases, to enthusiasm The attendance, which was sometimes small at the beginning, grew larger and larger as the course proceeded, and although it afterwards fluctuated for various reasons, the chief of which was the unfavourable state of the weather, which in sparsely populated districts made a journey to the lecture a matter of considerable time and difficulty, the average attendance was extraordinarily good To the classes and practical demonstrations, which followed many of the lectures, a considerable portion of the audience remained, and their eager participation in the discussions and tests, which formed a conspicuous part of the work of these classes, was extremely encouraging to the lecturers

AT a meeting of the London Chamber of Commerce on Monday, Mr J Ferguson read a paper on "The Production and Consumption of Tea, Coffee, Cacao (cocoa), Cinchona, Cocoanuts and Oil, and Cinnamon, with reference to Tropical Agriculture in Ceylon" He referred to the position of Ceylon, its forcing climate, its command of free cheap labour, and its immunity from the hurricanes which periodically devastated Mauritius, from the cyclones of the Bay of Bengal, and from the volcanic disturbances affecting Java and the Eastern Archipelago The plantations of Ceylon afforded, he said, the best training in the world for young men in the cultivation and preparation of tropical products, and in the management of free coloured labour The cultivation of cane sugar, although tried at considerable outlay on several plantations forty and fifty years ago, proved a failure More recently experiments by European planters with tobacco had not been a success, nothwithstanding that the natives grew a good deal of a coarse quality for their own use Although cotton growing had not been successful, the island had proved a most congenial home for many useful palms, more particularly the coconut (spelt without the "a" to distinguish it and its products from cocoa—the beans of the shrub Theobroma cacao) and palmyra, as also the areca and kitul or jaggery palms. Within the past few years Ceylon had come to the front as one of the three great tea-producing countries in the world, India and China being the other two, with Java at a respectable distance Mr Ferguson said one of the chief objects of his pape was to demonstrate which of the products of the island it was safe to recommend for extended cultivation in new lands and which were already in danger of being over produced, and he had arrived at the conclusion that coffee, cacao, and rubber-yielding trees were the products to plant, while tea, cinnamon, cardamoms, cinchona bark, pepper, and even palms (for their oil) did not offer encouragement to extended cultivation Statistics relating to the total production and consumption were given in an appendix

AN interesting paper on Indian types of beauty was read some time ago by Mr R W Shufeldt, before the Philosophical Society of Washington, and has now been issued as a pamphlet It is admirably illustrated

MR. A G. HOWES, British Consul at Tahiti, in his latest annual report to the Foreign Office, has the following note respecting pearl shell diving in Tahiti —Since the introduction of the diver's dress and apparatus at the pearl fisheries in 1890 a considerable increase in the export of shell has been maintained over the previous years A strong feeling has, however, been exhibited by the natives, who adhere to their own system of diving, against this means of taking the shell, and has resulted in a communication being made by the Director of the Interior of the colony to the Chamber of Commerce at this place, recommending the gradual abolition of the diving dress and apparatus and the stoppage of further issue of patents for the same, from January 1, 1893 The Chamber of Commerce have expressed their approval of the suggestion, but consider that an entire and not gradual abolition of the diving dress and apparatus should take place, and they have decided to lay this proposal before the Conseil Général when it assembles next August The reasons set forth by the Chamber of Commerce for adopting this course are that the regulations for the use of the diving dress and apparatus have been abused They state that French citizens, contrary to rule, have under their name employed diving dress and apparatus owned by foreigners, that the law prohibiting pearl fishing by this means in a depth of less than ten fathoms had not been adhered to, and they also give as their opinion that the shells found in a greater depth than ten fathoms are those mostly important for reproduction, and to destroy them will ruin the fisheries and bring distress upon the natives who depend upon the pearl shell diving for their livelihood

THE additions to the Zoological Society's Gardens during the past week include a Common Marmoset (*Hapale jacchus*) rom South-east Brazil, presented by Mr Gerald F Youll, an African Civet Cat (*Viverra civetta*), a white-tailed Ichneumon (*Herpestes albicauda*), two Ostriches (*Struthio camelus* ♀ ♀) from East Africa, presented by Mr F Pardage, a Pine Marten (*Mustela martes*), British, presented by Mr Harold Hanauer, F Z S, three North American Turkeys (*Meleagris gallo pavo*) from North America, presented by Col H W Feilden, C M Z S., two Rufous-necked Wood Doves (*Haplopelia larvata*) from South Africa, presented by Mr W H Wormald, a Grand Eclectus (*Eclectus roratus*) from Moluccas, presented by Messrs Chas. and Walter Seton, two Red-crested Cardinals (*Paroaria cucullata*) from South America, presented by Miss Edith M. Fox, a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mast S E Thorns, a Large Brown Flying Squirrel (*Pteromys oral*) from the Shevaroy Hills, South India, three American Bisons (*Bison americanus* ♀ ♀ ♀) from North America, a Barraband's Parrakeet (*Polytelis barrabandi*) from New South Wales, deposited, a Mongoose Lemur (*Lemur mongoz*) from Madagascar, purchased, an American Bison (*Bison americanus* ♀) from North America, received in exchange

OUR ASTRONOMICAL COLUMN

MADRAS OBSERVATORY.—This year being the centenary of the founding of the Madras Observatory, the officiating astronomer, Mr. C. Michie Smith, prefaces his report with a brief historical sketch. It seems that the East India Company were the first to propose the establishment of such an Observatory, but Sir Charles Oakeley, taking time by the forelock, and, as we are informed, anticipating the orders from the India Office, set about constructing it on his own authority. With the aid of Mr. William Petrie, who placed his own observatory at their disposal, the scheme was soon brought to a practical head, and by the time the orders arrived in 1792 the Observatory, besides being actually built, contained many instruments The first astronomer was Mr J Goldingham Mr Thomas Glanville Taylor, F R.S., was Director of the Observatory from 1830 to 1848 After erecting new instruments, he began his catalogue of 11,000 stars, publishing it in the year 1844. Hourly meteorological and magnetic observations were also carried on by him He died in England in May 1848, having never completely recovered from a serious injury caused by a fall In 1849 Captain W S Jacob was appointed astronomer, he made a new departure in the form of extra-meridional observations Owing to ill-health Captain Jacob resigned his appointment in 1859, and during the next two years the office was held partly by Major W K Worster, R A, and Major (now General) J F Tennant, R E About this time the work of the observatory was delayed, as more modern instruments were being erected, and it was not till May 1862 that the new transit circle of 5 inches aperture and 42-inch circle was ready for use The late Mr N R Pogson, who had then arrived in Madras as Government Astronomer, commenced his catalogue of 5,000 stars, observing each at least 5 times He also used very considerably the 8 inch equatorial The present astronomer, Mr C Michie Smith, in his report, suggests a further increase of the observatory equipment

OXFORD UNIVERSITY OBSERVATORY —During last month the seventeenth annual report of the Savilian Professor of Astronomy was presented to the Board of Visitors of the University Observatory This report showed that the work of the Observatory during the past year has been very considerable The Grubb equatorial, the transit circle, and the De la Rue equatorial have been severally occupied, while the new micrometer for the Grubb instrument has worked efficiently, and forms a valuable addition to the resources of the Observatory The work upon the international chart has formed one of the important features throughout the year, and for the measurement of the photographic plates a new and costly form of micrometer had to be devised, the reseaux have not proved to be very enduring, so that in consequence a new one had to be obtained from Messrs Gautier of Paris The work connected with stellar parallax has now been completed after a period of four years' hard work, and this fact deserves the highest consideration in face of the magnitude of the staff and the amount of work done The manuscript consists of (1) the concise but complete history of all effective researches in stellar parallax up to the present date, (2) the results of the parallax work completed in this Observatory, extending on the whole to some thirty stars, (3) a catalogue of all parallactic determinations effected by other astronomers Among some of the other work commenced or completed during the present year we may mention the photometric catalogues of stars of the ninth and eleventh magnitudes within small specified areas for the eighteen Observatories engaged in the international chart, observations of Nova Aurigæ, and the investigation of the amount of light "lost by the moon at the commencement and termination of the lunar total eclipse on November 15, 1891" The finances of the Observatory at present, owing to previous economy, seem to cover the expenditure, but Prof Pritchard seems to refer to the fact that the quinquennial grant expires at the end of the present year, as if next year the University will be called upon to make a slight additional increase to counterbalance the cost of the instrumental equipment that has been required for the chart work We are glad to note that at this meeting of the Board Prof. Pritchard was able to attend, having completely recovered from his illness

GEOGRAPHICAL NOTES.

M DYBOWSKI has returned to France in bad health His last work in the French Congo territory was an expedition up the Ubangi to avenge the murder of M. Crampel

THE Royal Belgian Society of Geography has of late been devoting special attention to home affairs, and in particular to the publication of more or less exhaustive monographs of the local geography of the communes The last number of their *Bulletin* contains an able summary of the geography of the commune of Familleureux, under the main heads of physical, economic, administrative geography and history, with carefully planned subdivisions By multiplying such studies, the material for a really exhaustive geography of the country will be obtained. Some such scheme might well be applied to the United Kingdom, where a series of county geographies on a definite system and rigorously edited would be peculiarly

advantageous The idea was present in Sir John Sinclair's famous "Statistical Account," but has had no recent or adequate embodiment

The *Scottish Geographical Magazine* for July contains a translation by Mr C E D. Black of M Dauvergne's recent journey in the Pamirs, the original paper appearing simultaneously in the *Bulletin* of the Paris Geographical Society The journey carried out in 1889 90 was a most successful one and opened up some new ground The geographical results are summed up in four sentences —(1) That there is another great chain running parallel to the Kuen Lun and facing Kashgaria. (2) That the river in the Tung valley is an affluent of the Zarafshan, not of the Taghdumbash (3) That the Oxus rises in the great glaciers of the Hindu Kush at 37° 10' N and 75° E (4) That the Karambar valley, although difficult, is practicable for ponies

Dr Theodor Menke, one of the best known of German historical geographers, died in Gotha in May last His work in the compilation of atlases of historical geography was exceptionally thorough His first work in this direction was a popular school atlas of classical geography, entitled "Orbis Antiqui Descriptio", but his most important contribution to cartography was his edition of Spruner's great historical atlas, begun in 1858 and completed in 1879

Dr Stuhlmann, according to a telegraphic report in the *Times*, has furnished additional particulars of Emin Pasha's expedition, although no more recent news The real and only aim of Emin's journey to the Equatorial province, was to rescue those of his former subordinates, whose vacillation and delays kept them from joining Stanley's march to the coast It was then his purpose to make his way across Africa to Adamawa and the Cameroons, a purpose which, as we already know, he had to abandon It is satisfactory to learn that Dr Stuhlmann had with him at Bukoba all the valuable scientific records and collections of the expedition

The current number of *Petermann's Mitteilungen* calls attention to a curious literary fraud to which in the two previous numbers it fell a victim, and from which many geographical journals in the habit of faithfully reproducing the articles of *Petermann* also suffer A Dr Ceyp professed to have made a journey recently in south eastern Persia, and communicated to *Petermann* a detailed account of it, which now appears to have been copied verbatim from a little-known work, "Gasteiger Khans," reprinted from the "Boten fur Tirol und Vorarlberg," 1881 General Houtum Schindler, of Teheran, who knew that Ceyp's Persian travels had not led him beyond that city, gave the information which led to this discovery The episode furnishes a fresh proof of the necessity for the great caution in accepting the records of unknown travellers which has always been exercised by the leading English authorities

THE BEARING OF PATHOLOGY UPON THE DOCTRINE OF THE TRANSMISSION OF ACQUIRED CHARACTERS

FOR more than two years the English public has been in possession of an excellent translation of sundry of Weismann's more important essays.[1] The object of this paper is not to expound Weismann's views generally. That office has already been undertaken by the persons best qualified to perform it[2] We propose merely to discuss one of his topics under a single aspect—the "Transmission of Acquired Characters" in its relations to pathology

We cannot, however, avoid reviewing some of the leading points in Weismann's system which bear upon our immediate topic.

At the root of the matter lies the all-important distinction between reproductive and somatic cells. Saving among the lowest forms of animal life, an organism may be regarded as made up of two parts There are the reproductive cells With these the future of the species lies. They are the visible basis of its perpetuity The remaining tissues of the body are styled "somatic." It is natural to us to think of the "somatic" tissues as something higher and nobler than the reproductive cells—to contrast the simplicity of the latter in structure and endowment with the intricacy of the former But there is another point of view, which inverts matters, which regards the somatic tissues—the body and its manifold endowments—simply as a sort of living case or appendage of the reproductive cells The reproductive cells look after the perpetuity of the species, the somatic cells look after the reproductive cells

Now, if we travel back to the simplest forms of animal life, we lose sight of this distinction The principle of differentiation of labour is not yet recognized Among the Protozoa the distinction between reproductive and somatic cells has no place Every part of the organism has it in its power to reproduce the entire organism No special material is reserved to serve the purposes of reproduction As we ascend in the scale of animal life, differentiation of labour begins There is from the outset a reservation of reproductive cells, which serve as the demonstrable links between successive generations of organisms But in sundry of the highest forms of animal life a third condition obtains There is at the outset no reservation of cells differentiation overtakes the entire organism—there is no exemption

Not till the close of embryonic life do the reproductive cells appear, and when they do so it is as the offspring of somatic cells This third condition was felt by Weismann as a difficulty, and led to an important modification in his terminology The problem he had to explain was this, How can cells which have apparently lost their reproductive characters afterwards regain them? The solution he found was that the differentiation undergone by certain cells was never in reality thoroughgoing enough to deprive them of their original characters Sooner or later, a moment arrives at which the original "germ plasm" becomes again predominant Instead, then, of in "germ cells," the basis of perpetuity of the species is laid in "germ-plasm"[1]

We have now to consider the bearing of these views upon the doctrine of the transmission of acquired characters

It is of the utmost importance to understand precisely what Weismann means by the term "acquired character" Acquired characters are opposed to original characters To grasp the distinction we are sent back to a time before the distinction between reproductive and somatic cells existed The characters already present at this early period are original characters Later on, the reproductive and somatic cells part company, to follow separate careers of their own It is the somatic cells—the body—which comes chiefly into collision with the environment, and in doing so undergoes various modifications Now these modifications are the "acquired characters" the transmissibility of which Weismann denies

They may be something purely local, as a scar or a mutilation They may be something which involves the modification of complex musculo-nervous mechanisms, as in delicate manipulations and tricks of skill, such as violin-playing Now, how is it conceivable, he argues, that such specific changes in the somatic tissues should influence the reproductive cells in the same direction? Whether they influence them at all is not the matter in dispute That they do this is not only conceivable, but highly probable But how can the somatic cells stamp their own special characters upon the reproductive cells?

We now turn to the main topic of this paper Has pathology anything to say, either for or against, the transmissibility of acquired characters?

Now, as to the transmissibility of sundry forms of disease there is no question That pathological characters are transmitted is universally allowed The difficulty, however, is to decide whether such characters were really acquired, in the strict sense in which Weismann uses the term. We shall find that it will require considerable care to adduce instances which are really appropriate With this preliminary caution we may proceed to attempt some sort of preliminary classification of our pathological data We shall find that they fall, roughly, into three main groups:—

(1) Morbid characters which are obviously acquired by the organism, and as obviously transmitted But since they are in no sense the acquisition of the somatic cells as such, but of the entire organism—somatic and reproductive cells alike—they cannot be allowed to "rank"

(2) Morbid characters in which an element of transmission is obvious, but where a closer investigation reveals the fact that, supposing them to have been acquired, in Weismann's sense of

[1] Translation edited by E B Poulton, Schönland, and Shipley

[2] Prof Moseley's two articles in Nature, vols xxxiii and xxxiv Discussion introduced by Prof Lankester at the meeting of the British Association, 1887

[1] See Weismann's essay on "Foundation of a Theory of Heredity," *passim*

the word, it is not precisely what was acquired that is transmitted, but something broader and more general.

(3) The cases which are really in point: morbid characters which were really acquired by the somatic tissues alone. We shall see, later, whether or no these are transmitted.

(1) This group embraces all those cases in which a morbid character is acquired by the entire organism, somatic and reproductive cells alike. Behind the distinction between somatic and reproductive cells lies the fact of a common relation to the circulatory and nervous systems. Any change, therefore, in the circulation for example, will affect both. A pregnant woman takes a fever, and transmits it there and then to her offspring. There is no more mystery in this than in the fact that certain poisons produce abortion—indeed, the *materies morbi* is a poison in either case. But this explanation has, in all probability, a much wider range than the zymotic diseases. Consider, for example, gout. In a sense it is no doubt true to say that gout was an acquired disease. We can point to periods in the world's history in which gout was conspicuous by its absence. We can trace with some degree of accuracy its rise and progress at different epochs, and point to the conditions under which it rose, as, for example, in the early days of the Roman Empire.[1]

But even if we allow that gout was, in a general sense, an acquisition of civilized society, we have only to reflect on its pathology to see that it could never have been acquired in Weismann's sense. For what is gout? People usually think of gout by one of its manifestations—inflammation. This, however, is in reality no more than a symptom—perhaps than an incident—of a condition. The gouty attack is due to the existence of certain sites in the system conveniently cool and dry for the deposition of what are popularly known as chalk stones, if, indeed, it be correct to think of the morbid process as a deposition. The general morbid condition lies deeper, and still eludes us. But if we are in the dark as to the precise nature of the pathology of gout, it would be affectation to say that we are unable to prescribe its general outlines. Is it a degeneration, in which the entire organism shares? Then it will be a morbid acquisition of both somatic and reproductive cells alike. Or is it a failure in metabolism generally? The same will be the case. Or is it due to a failure in some particular gland to elaborate the materials brought to it, or to do its share of excretion? If so, the mischief will immediately make itself felt in the circulation, and the conditions of the sufferer will become practically those of slow self-poisoning. So that on no hypothesis can we represent gout as an acquisition of the somatic cells exclusively.

It is the element of progressive heredity which makes the hypothesis of transmission of acquired characters an attractive one in a disease like gout. This element is, in the case of certain families, strongly marked. We even see children suffering from the disease. And bearing in mind what we know of its ætiology, we naturally say to ourselves, "It was not this child's fault that he was born gouty. 'The fathers must have eaten the sour grapes,' or in this case, perhaps, have drunk the sweet ones." But it needs but a moment's reflection to convince us that the element of progressive heredity, so far from being an anomaly, is deducible from the facts of the case. It is true that here we cannot directly apply the theory of natural selection. We are not now concerned with conditions of progress, but with those of regress. Nature selects the fittest. There is no reason why she should select the goutiest. The question we have to ask in disease is not whether Nature selects, but whether she summarily rejects. If she stepped in and exterminated the gouty, she would stop gout altogether, and with it the feature of progressive heredity. But there is no reason to suppose that, as a fact, she does anything of the kind. In the first place, gout is not a disease which seriously shortens life; in an advanced stage of civilization its existence is quite consistent, not merely with life, but with the active discharge of elaborate duties.

But there is another more important consideration. Strange as it may sound, there may be good reasons for supposing that Nature, so far from rejecting, might even select, the goutiest. For gout, like other diseases, is only one corner of a much wider question. Diseases have coincidents and relations which stretch beyond the bounds of pathology, and trespass upon biology. This, indeed, is a side of clinical study which has only comparatively recently received its proper recognition.

In former days men contented themselves with observing the morbid symptoms of a gouty patient; they paid no regard to his other "points"—his nails, his teeth, his intellectual endowments. But it may often happen that morbid characters have their good affinities. This is probably the case in gout. We have heard it said, for example, by one of wide experience in this disease, "No gouty person is a fool"—a statement which derives some support from the number of eminent men who have been the subjects of this disease. It is often implied that in what is termed an "artificial" civilization natural selection ceases. Might we not, perhaps, say that it still proceeds, only upon a modified plan. The conditions of the competition for existence have altered. The fittest in one generation need not be the fittest of another. Thus, in a rude state of society, in which sustained physical strength is the one thing needful, the gouty man would have no chance. His enemies, however inferior they might be, would have nothing to do but to lay by for the next attack of gout, when they would easily kill him. In a more advanced state of society all this is changed. If the gouty man has talents, he probably has friends and money. There is no demand for sustained physical strength. If he has the gout he can be nursed. His gout may be even of advantage to him—he gets into the papers. So that, paradoxical as it may seem, Nature may even select the gouty, not for their gout, but for their biological equivalents.

We have shown then that Nature, so far from interfering to exterminate the gouty, might even select them. But a more plain and obvious reason exists for the progressiveness which we sometimes observe in gout. If gout be a modification of the system generally, if its progressive increase in the tissues of a gouty patient with increasing years is in some cases a matter of observation, it would only be reasonable to infer that the same is true of the reproductive cells. For, if they share in the degeneracy, why should they not share in the progressive tendency? In the light of this consideration we can explain a fact widely received among medical men—that the incidence of a gouty inheritance falls mainly upon the younger children. Since the reproductive cells as well as the somatic grow goutier and goutier as age advances, the later their separation occurs the more likely will they be to manifest gout.

(2) The second group includes cases in which there is an undoubted transmission of morbid characters, but where it is by no means certain that they were "acquired" in the sense under discussion. But even if they were, it does not seem that what was acquired is transmitted, but something broader, and more general. We shall take as examples two important diseases—phthisis and "new growths"—alluding briefly to the phenomena of "short sight."

Phthisis may be said to be in one sense, like gout, a disease acquired by civilized humanity. "The naked savage," writes Dr. Andrew in 1884,[1] "whatever ills he may have to bear, rarely reckons phthisis among them; with every addition to his clothing and the comfort of his tree or cave, proclivity to it increases,"—a statement which is fully borne out by what we know of the spread of phthisis in the Rocky Mountains and the islands of the Pacific. If we know less of the history of the rise and spread of phthisis than we do of gout, we have more definite conceptions regarding its pathology. At the present day that pathology may be said to have two sides. There is the side originated and elaborated by Koch—the demonstration of the constant presence of a vegetable parasite in the tissues in this disease. There is the chemico-physiological side. Before Pasteur's time, such terms as "medium," "soil," as applied to the human organism, were little more than metaphors, while such words as "constitution," "predisposition," had little more than a metaphysical value. At present, scores of workers are busily engaged in translating these terms from the language of metaphysics into their chemical and biological equivalents.

If, then, phthisis was originally acquired, what was it that was acquired? It would seem that we can take our choice between saying that the microbe was acquired, or a habit of body favouring its growth. Supposing, then, the acquisition to have been no more than the lodgment of a parasite in the tissues, can we suppose that it is the parasite which is transmitted? Our facts will hardly warrant such an assumption. How, for example, could we interpret such familiar incidents as the following? A mother, after giving birth to several children, who successively fall victims to phthisis in young adult life, is ultimately attacked herself by the same disease, at a date removed by an interval of

[1] Pliny, "Hist. Nat.," lib. xxvi. cap. lxiv., ed. Franzius. Senecæ Opera, F. Haase (Lips., 1886), Epistul. Mor., lib. xv., Ep. 3 (95). Galen, "Comment. in Hipp. Aphorism," cap. xxviii., ed. Kühn, xviii. A. 42.

[1] *Brit. Med. Journ.*, 1884, 707.

several years from the birth of the last phthisical child Here we should be driven to assume, not in the case of the mother alone, but in each of the several children, a long latent period, during which the parasites, though present in the tissues, made no sign Such an assumption presents great difficulties Again, the direct transmission of tuberculosis from a mother to her fœtus is admittedly rare, whereas on the supposed hypothesis we should expect to find it common [1]

But if it is not the parasite that is transmitted, what *is* transmitted? We are driven back on the "other side" of the pathology of phthisis But if we suppose that the transmission is not one of a parasite, but of a "diathesis," or "predisposition," then we desert the only standpoint from which there is any chance of proving that the disease was acquired in the sense under discussion For what reasonable ground could we have for restricting this "predisposition" to the somatic cells alone, to the exclusion of the reproductive cells?

On the hypothesis that the thing transmitted is a "predisposition," we can, as in gout, explain the element of progressive heredity in phthisis For, the admission of a morbid change once made, the difficulty is not so much to explain its progression as its arrest In certain consumptive families we have in the limits of a single generation this morbid progress going on under our very eyes. It is the rule to find in such families, where several brothers and sisters are attacked, the younger fall victims at an earlier age than the elder, showing in this way their increasing liability The explanation is probably identical with the one suggested in gout The entire organism of the parent becomes more and more phthisically disposed—somatic and reproductive cells alike The later the separation of the latter occurs, the more likely will they be to manifest phthisis

The same line of argument is applicable to the facts of "short sight" [2] Short-sightedness is certainly hereditary—it runs in families—but that does not prove that we have in it an example of the transmission of acquired characters For in the first place it would be very difficult to prove that the short sight was in the first instance acquired in the sense under discussion While the progressiveness of the morbid character—which seems to support the theory—can be as well explained without it For if there is no proof that the morbid character—the faulty build of the eye—is itself progressive, there is good reason to suppose that the habits of close attention which minister to the defect are so In one generation we find a man simply tasking his eyes, his son works with a simple microscope, his grandson with an improved microscope

I pass on to consider another group of pathological facts, of the highest importance and interest—new growths The element of heredity doubtless obtains here as in the case of gout and phthisis Thus the statistics of Sir J Paget in this island, and those of Velpeau on the Continent, agree in showing that heredity can be traced in about one third of the entire cases of cancer [3] And among the benign tumours, as they are called, warts and exostoses are hereditary Further, there is in some cases evidence of progressive heredity, the irregularity appearing in the children at an earlier age than it appeared previously in the parent And we have here what might look at first sight more like a real transmission of acquired characters than anything we have yet dealt with. No one questions that something is transmitted The theory of the local origin of the new growths is gaining ground everywhere, and might appear to carry the inference that they are acquired, and that no constitutional element is involved in them Here, however, we must be on our guard against the fallaciousness of words If by constitutional we mean something pervading the entire organism—a taint in the blood, and so forth—then there is little or no evidence to warrant our calling new growths constitutional. But if we mean, on the other hand, something which was represented in the original germ—an error in the original plan, not a supervening flaw—then there is nothing to encourage us in denying, and a good deal to warrant our asserting, their constitutional origin However, such an admission is not necessary to our present purpose. Let us assume that they are acquired in the sense in which a scar is acquired Is it a fact that what is acquired is transmitted? If so, we should look for identity in position and histological character in the thing transmitted. But on the whole neither of these conditions is fulfilled Certainly they are not, in the case of cancer, as the analysis by Mr Morrant Baker [1] of 103 of Sir J Paget's cases clearly shows The distribution of the cancers proper shows a variation within certain limits. There is a strong predilection for certain sites, but these sites are sufficiently numerous Now, it often happens that, where several children inherit cancer from a parent, the growth appears in each case in a different site Nor are the precise histological characters of the growth at all faithfully preserved in the course of transmission, while it has been often observed that on the bodies of cancerous people innocent growths exist as well [2] So that the inheritance does not appear to be a liability to a peculiar modification in a certain part, but a tendency to one or more of a group of modifications in one of many possible sites

Once more we find ourselves driven to a choice between two alternatives, either of which excludes the transmission of acquired characters For if new growths are really acquired characters, then it is not exactly what is acquired that is transmitted, but something broader than it If, on the other hand, they are only acquired in a more general sense, they fall outside the limits of Weismann's sense of the term "acquired character"

(3) There remain for our consideration the third, and, in one sense, the most important, group of pathological data—those which answer to the qualifications of acquired characters in Weismann's stricter usage of the term. Here, if anywhere, would be the ground in pathology to select for proving the theory of the transmission of acquired characters, but it must be confessed that this is just the region in which that theory receives the least support This group of pathological facts embraces a number of accidental lesions, such as scars and mutilations, which are certainly acquired in the strictest sense of the word But the evidence for the theory seems strong only in the dubious cases, weak in the unexceptionable ones We have examples of mutilations practised for many centuries by entire races, without being transmitted in a single instance Nor is it the experience of surgeons that scars and mutilations which are the results of operations are ever transmitted On the other hand, we have histories of tailless cats and hornless cows But here everything turns upon the comparative certainty with which we can prove that the initial lesion was really in the first instance acquired Have we here to do with an accidental lesion or a deformity? A closer investigation has, in many instances, rendered the latter the more probable explanation of the two For example, in the case of the tailless cats, closer research made it appear that the irregularity involved an abnormality affecting many of the lower vertebræ In other cases, the abnormality in the child was so little like that in the parent, as to suggest that it was a merely accidental coincidence of two different lesions in one site [3]

If we turn to the results of experimental research, we are confronted by more than one remarkable series of experiments, upon the bearing of which it is impossible as yet to pronounce decisively The most notable work done in this direction is, perhaps, a series of experiments upon guinea-pigs, undertaken by Brown Séquard, and repeated by Westphal [4] They produced epilepsy in a number of these animals by various methods —section of the cord, section of different nerves, &c —and observed subsequently that certain of the offspring were epileptic too.

But there are several reasons which prevent our accepting these results as decisive The records of the experiments are said not to be very perfect. Then it is not contended that epilepsy was uniformly transmitted. What happened was that each member of the offspring presented some morbid symptom—usually some nervous trait, such as epilepsy or paralysis So that the result of Brown-Séquard's experiments would rather seem to be this. By producing one morbid trait in the parents, he set up a liability to one of several in the offspring By producing a single character, he set up a tendency. All this is of extreme importance, and it may well be that the future has much that is interesting to reveal in this direction But, meanwhile,

[1] See *Fortschritte der Medicin*, Bd. iii, 1885, p 198, bacilli found in lungs of fœtal calf, æt. 8 months, whose mother was tuberculous.
[2] Ziegler and Nauwerck, "Path," vol i pp 393 94
[3] Erichsen, "Surgery," seventh edition, p 787

[1] See "St Bartholomew's Hospital Reports," 1866.
[2] Observation of Mr J Hutchinson, quoted in Fagge's "Medicine," vol i, p 106.
[3] For a number of other instances, see Weismann's essay on "The Supposed Transmission of Mutilations," *passim*
[4] See Brown-Séquard, "Researches on Epilepsy," Boston, 1857, Papers in *Journal de Physiologie de l'Homme*, tom i and iii, 1858 1860, *Archives de physiologie normale et pathologique*, tom i–iv, 1868–1872 Ziegler and Nauwerck, vol i p 390 See also Weismann on Brown-Séquard, pp 81, 310, 313, translation, edited by Poulton

it cannot be said to lend very much direct support to the theory now under discussion[1]

Again, the choice of lesion in these experiments was a somewhat unhappy one. Epilepsy is a symptom which can be produced in a number of ways—its proximate cause, if there be a single one, we are not as yet in a position to formulate. Attempts in this direction usually go no further than a vigorous and often highly poetical description, in which metaphors drawn from the phenomena of electricity are liberally employed. It might have been more advantageous to have aimed at the production of less equivocal symptoms, whose pathology is less disputed—such, for example, as facial palsy.

Lastly, we cannot exclude from these experiments the possibility of the introduction into the system of chemical poisons or even parasites, as incidental results of the operations.

But this does not by any means exhaust our stock of instances. The pages of pathology furnish us with more than one group of important facts which satisfy all the conditions of acquired characters.

Chief among these stand those numerous modifications of various organs which we regard, and rightly regard, from a clinical point of view, as part of a given disease, but which might perhaps be more correctly described as secondary adjustments made by the organism to meet certain primary morbid changes induced in different organs by the disease itself. Such, for example, is hypertrophy of the heart consequent upon valvular disease. Such hypertrophy is or is not a morbid symptom according to the point of view we happen to take. From the clinical standpoint it may be conveniently treated as part of the disease. From the biological standpoint it is an effort on the part of the organism to adjust itself to altered conditions brought about by the disease. It is certainly an acquired character, in the strict sense of the term.

An illustration will make this plain. Rheumatic fever is an hereditary disease.[2] Inflammation of the valves of the heart is common in rheumatic fever, and hypertrophy of that organ often follows as a consequent of this. But who would reckon hypertrophy of the heart as forming part of a rheumatic inheritance? It is true, no doubt, that whoso is heir to a disease is heir by implication to all the biological incidents of that disease. But he is not heir to them for the same reason. The one belongs to him as the inheritor of a morbid tendency, the other as the possessor of an organism. Diabetes, again, is in some cases markedly hereditary. Secondary characters are acquired in the course of this disease also, such as hypertrophy of the bladder or stomach. But, however doomed from his cradle to diabetes a person may be, he is not born with an hypertrophied bladder and stomach. We should think it absurd that such accommodations as these should be made before they were wanted. If, then, we are right in regarding these as really acquired characters—and it is difficult to see how we can avoid so doing—it seems that pathology has here afforded us a sort of crucial experiment. Of the morbid characters of which sundry diseases are constituted, some are inherited, some are acquired—the one are constantly transmitted, the others, so far as we know, never are.

But no one pretends that every disease is inherited. Consider, for example, such a disease as lead-poisoning. Here, there is not, obviously, any element of heredity. That two people are not equally liable may be true enough, that predisposing causes exist is doubtless the case; but that does not prove an element of heredity. Predispositions may be themselves acquired, as is the case in alcoholism. In such diseases as lead poisoning, we rightly stress the importance of the environment, and minimize inherited tendencies. But such diseases will be of little use to us here, unless two conditions are complied with. The first is that they leave durable and definite lesions behind them, the second is that such lesions are not inconsistent with the procreation of children. Of such lesions the familiar "wrist drop" of lead poisoning may be cited as a good example. It is often durable, in not a few cases it is not cured, it is not inconsistent with the procreation of children. But there is no evidence to show that this or kindred lesions are ever transmitted. Facial palsy would be another instance, this malady being often of considerable duration. This group of cases constitutes another piece of negative evidence, not so important as the last, because these cases are rarer, but still not unimportant.

It can hardly be disputed that these characters are acquired in the sense under discussion. There must have been frequent opportunities of transmission, but we have no evidence of anything of the kind.

The general conclusion we have arrived at in this paper is that pathology, so far from offering any support to the hypothesis of the transmission of acquired characters, pronounces against it. We have seen that it is possible to bring up a mass of evidence, which seems at first sight to favour that hypothesis. On further consideration, however, it becomes clear that only a small portion of that evidence can be allowed to "rank."

A considerable number of facts must be rejected, because though there can be no doubt that the morbid characters here present are both acquired and transmitted, they are not acquired in the sense under discussion—that is, by the somatic cells exclusively—but by the entire organism.

A considerable number of facts, again, meet with a like rejection, because there is no question that here certain morbid characters are transmitted, yet even supposing them to have been acquired, it does not appear that precisely what was acquired is transmitted, but something broader and more general.

A considerable number of facts remain, which may be allowed to "rank" as genuine instances of acquired characters. These, if the hypothesis be correct, should be transmitted. But of such transmission we find little or no trace.

If we begin with scars and mutilations, even if the facts are not all on one side, the balance of evidence is decidedly against the hypothesis. If we appeal to the results of experimental research, the question is more open, but if the hypothesis does not encounter quite so decided an opposition in this quarter, it can scarcely be said to derive much support there.

If we pass into the main region of pathology, we have to use some circumspection in looking about for instances which shall be genuine examples of acquired characters. That such instances really exist it has been our endeavour to show, notably in those secondary characters which organisms acquire by way of accommodating themselves to the effects produced by disease. So far from being rare or recondite, these constitute a group of familiar and well ascertained facts. If transmission has not occurred, it cannot be for want of opportunity—there must have been scores of such opportunities. That it has not occurred, constitutes a piece of very important evidence against the hypothesis under discussion.

HENRY J. TYLDEN

A TRIP TO QUEENSLAND IN SEARCH OF CERATODUS[1]

MY main object in going to Queensland was to procure, if possible, the eggs of Ceratodus and the creature itself; secondly, I wanted to collect earthworms; and, thirdly, to see the country. In my main object I was quite unsuccessful, for the simple reason that this year Ceratodus did not lay its eggs till late on in November—two full months later than the time recorded by the only observer who had up till then procured them. University work forced me to return, not by any means empty-handed, but without the one thing which had tempted me to go north.

To save time, and avoid unpleasantness also, I went by train. It is a long weary ride across New South Wales, especially in warm weather. Unfortunately I left Sydney by the northern mail on Friday evening. There were very few carriages, and some of what there were were "engaged" for legislators who travelled home free and in ease whilst we who paid for our journey were huddled and crowded together. This discreditable state of affairs seems to be common at the close of each week during the sitting of Parliament in Sydney.

The journey north leads by the side of the Hawkesbury River, and after passing across the well-known bridge the train skirts the shores of what appears to be a succession of lakes. In reality, the winding river, shut in by wooded hills, expands every now and then into sheets of water, each of which in the gathering darkness seemed to be a little lake. About eleven o'clock you find yourself apparently running along through the streets of Newcastle, and stretching out eastwards see the long quays and

[1] For other instances of supposed transmission of morbid characters artificially produced, see Ziegler and Nauwerck "Pathology," vol. i pp. 391-92; Brown-Séquard's operations on eyes, Mason's on the spleen.

[2] "Treatise on Medicine," by Fagge and Pye Smith. Third edition, vol. ii, p. 694.

[1] Paper read by Prof. W. Baldwin Spencer, before the Field Naturalists Club at Victoria, on March 14. Reprinted from the *Victorian Naturalist* for June and July.

open water leading out to the sea The whole is brilliant with numberless electric lights, though you have an idea that in day light coal dust would be a little too prominent As it is, however, Newcastle is associated in one's mind with a series of flashing and twinkling lights prettily reflected in the water and with a very second-rate refreshment room After Newcastle you settle yourself down as comfortably as possible for a run northwards of 400 miles, through the night and greater part of the next day, to the Queensland border You seem to get gradually more and more out of the world until at five o'clock next afternoon the train pulls up at the border station By that time our number of passengers has been reduced to four After looking about, a minute train, which at first sight you take for a toy, is descried at the end of the platform Further searching shows a very narrow gauge line streaking away through the limestone hills northwards into Queensland The original name of this border station was Wallangarra, but unfortunately this is now being changed to Jennings It is a pity to lose the old native names and to substitute for them such ugly ones. One would have thought that a more effective plan of perpetuating the memory of legislators might have been devised

Small though the railway is, it is very comfortable and well managed, and all officials uniformly courteous The carriages are like the insides of omnibuses, with a broad seat all round the windows On express trains the last car is always for smokers, and has a little balcony on which you can sit out in the open air right at the end of the train, and hence shielded from wind and dust This is a most excellent arrangement From Wallangarra the train runs to Warwick, and then, across the uplands forming the Darling Downs with their wonderfully rich dark-red soil, on to Toowoomba. Here the line turns nearly due east and begins to climb gradually to the top of the Dividing Range close to the eastern escarpment of which Toowoomba lies Suddenly you turn a corner, the upland country ends abruptly, and the train zig-zags rapidly down the face of the lofty escarpment which rises directly from the flat coastal district The sun was setting just as we reached the crest, and in the brief twilight we had magnificent glimpses of the distant plains with the abrupt hill sides and deep gorges in the foreground Close upon midnight Brisbane is reached

A slight difficulty arose in Brisbane with regard to my small amount of collecting material, but on learning that it was simply intended for scientific purposes, the Customs officials at once courteously saved me all trouble by allowing it to enter free of duty In fact my experience in Queensland was that I met with the greatest courtesy from all officials, and the greatest kindness from such friends and strangers as it was my good fortune to be brought into contact with—an experience common, I believe, to all visitors to the Northern colony

From Brisbane the line is now continued through Maryborough on to Bundaberg at the mouth of the Burnett River

About seventy five miles north of Brisbane the vegetation changes almost suddenly, and the line runs across a belt of country, perhaps twenty miles wide, of a semi-tropical description To this we will return presently, suffice it to say at present that the traveller finds himself suddenly surrounded by palms and pines and fig trees, and sees all the tree trunks covered with epiphytic ferns—with great masses especially of staghorn and bird-nest ferns, and with orchids from which hang down long clusters of yellow blossom

This belt of vegetation stops as suddenly as it began some few miles south of Gympie—a well known gold mining town, which lies by the side of the Mary River, and where I had been told that Ceratodus was to be had in abundance Here I determined to stay, and began at once to make inquiries. To my disappointment I found that no one at the hotel knew anything about the animal, but I wandered forth in quest of information The river itself was dirty with the washings from the mines, and looked anything but promising, however, I made for some miserable huts on the outskirts occupied by Chinese, and after a little trouble found a fisherman amongst them This individual was decidedly apathetic, but after some time said that he might or might not be able to catch me a few Wandering along by the river I began to feel rather as if I were searching for a needle in a haystack. However, I learnt that the fish certainly were to be caught, though some few miles away, but that there was no chance whatever of getting assistance from any blacks, simply because there were not any in the neighbourhood, and at that time I thought their assistance indispensable. It was late in the afternoon and I wandered on by the river searching for planarians and earthworms Amongst the former I secured two specimens of a beautiful new species, to which Dr Dendy has given the name of *Geoplana regina*, and also specimens of the almost cosmopolitan form, *Bipalium kewense*, and of *Geoplana cœrulea*, a form common in New South Wales, rare in Victoria, and very abundant indeed in Queensland. This was, I believe, the first time on which land planarians had been collected in Queensland—not that there was any difficulty in finding them, but that no one had taken the trouble to look before Amongst earthworms, I collected for the first time for myself a true perichæte—that is, one in which the little setæ, or bristles, form a complete circle round each segment of the body In all our Victorian forms, without exception, there is a break in the mid-dorsal and ventral lines where the setæ are absent True perichætes do not appear to come further south than the north of New South Wales Under the logs also were specimens of a common Queensland worm, *Cryptodrilus purpureus*, of a new species of perichæte worm, *P gympiana*, together with three species of frogs—*Pseudophryne bibronii*, *P australis*, and *Limnodynastes tasmaniensis*

During the evening I had the opportunity of talking to one or two who were well acquainted with the country, and was strongly advised to go on without delay to the Burnett River I determined that this would be the wisest course to adopt, and accordingly packed up next morning, and after an hour or two's stroll round Gympie, during which I did a large amount of log rolling with but scanty success, owing to the extreme dryness of the country, once more took train northwards towards Maryborough I spent the night at a little wayside inn, where considerable surprise was evinced at my putting in an appearance, however, a wandering lascar turned up, so that I was more or less kept in countenance, and together we had tea in what was presumably a combination kitchen and scullery During two or three hours' collecting I met with nothing but gum trees, endless ants and scorpions, a few stray specimens of *Geoplana cœrulea*, and one or two lizards and frogs I somehow had the idea that north of Brisbane everything would be at least semi tropical, and could not at first help feeling disappointed to find myself, except in the small district mentioned before, surrounded by little else but gum trees, without a trace of a palm or of anything which looked at all tropical Eastern Gippsland was really richer in vegetation and more varied in form of animal life than the part of Queensland in which I spent most of my time In fact, so far as my experience yet goes, Gippsland, as a general collecting ground, would be very hard to beat

Early in the morning I started in a mixed train along a branch line leading inland for some fifty miles, till it stopped apparently nowhere in special, and not far from a fine mountainous bluff The station is called Biggenden, and here we found coaches waiting for us A Queensland coachdriver is a most marvellous man, both in the way in which he accepts with almost pleasure any amount of luggage, and in the way in which he stows it all on board From Biggenden came a hot ride of about forty miles across uninteresting country The only township we passed was a small place known as "The Shamrock," not far from the gold-field of Paradise After changing horses we started off again, seeing nothing but gum trees and a few emus and kangaroos Among the gums were what are locally known as blood gums, whose light-coloured trunks are covered with reddish blotches, due to the exhalation of kino, woollybutts, which for perhaps ten feet above the ground have the trunk somewhat like that of a stringybark, and above this are quite smooth and whitish, and a form of gum called brigalow. This grows in clumps, and differs from all the others in having its foliage comparatively dense, so that it affords a good deal of shade The cattle congregate in the shade, and these dark patches give a curious and characteristic appearance to the landscape. Every now and then we came across a few birds, known as squat pigeons. These have the habit of squatting on the ground when approached, and, being of a brownish colour, are hard to see. Sometimes they can be knocked over by the whip of an experienced driver

Late in the afternoon we mounted a slight ridge and came down through a gap into the wide Burnett Valley. On either side of this rise low hills, and through the middle flows the river with a broad channel, occupied chiefly—except during the flood season—by long, broad stretches of sand A short ride brought us to Gayndah, a long, straggling township on the river banks, and here I took up my quarters in the comfortable

Club Hotel At one time Gayndah was the centre of a wool producing district, and bears evident signs of having seen a better day

Intent on meeting with Ceratodus, I made my way to Mr Thomas Illidge, the postmaster of Gayndah, to whom I had been recommended, and I gladly take this opportunity of expressing my thanks to him, not only for the valuable help and information which he gave me, but for many acts of kindness which added greatly to the pleasure of my stay in Gayndah I may here also express my thanks to my friends, Dr Cole and Messrs Frank and Virgil Connelly, from whom—though a complete stranger—I received most valuable help If a naturalist wishes to meet with genuine kindness and every possible assistance, I can warmly recommend Gayndah to him

One of the first things I learnt was that Dr Siemen, of the University of Jena, had recently come to the Burnett district for the purpose of securing the eggs of Ceratodus, and the various development stages of Platypus and Echidna, and not only this, but that he had secured the services of the available blacks I must confess to a feeling of something like chagrin at having come so far to meet with, apparently, no chance of success in what was my main object

After sleeping over my preliminary disappointment, I determined on carrying out the only plan possible, which was to obtain one or two boys accustomed to the river, and, with their help, to at any rate get Ceratodus, and, if possible, the eggs It was now well on in September—the time at which Mr Caldwell had found that the animal had laid eggs—so there was still hope that I might secure them Perhaps it may be well here to state briefly the special interest which attaches to this particular form Ceratodus As you all know, there are two groups of animals—the fishes and the amphibia—of which the first live in water, and breathe by means of gills, whilst the second either spend, as the newts do, their whole life in water, breathing by means of gills, or else, like the frogs, spend the early part of their life in water, breathing by gills, and then come out of the water and breathe by lungs just as reptiles and mammals do

Now there is a very small group of animals known as the Dipnoi, which are, we may say, intermediate between the fishes and the amphibia They are neither so lowly developed as the fishes, nor so highly developed as the amphibia—in fact, they may almost be described as "missing links" which still exist, and show us the way in which air breathing were evolved from water breathing animals If we simply went by their external appearance we should class them amongst fishes, which they closely resemble in many respects Now, fishes have what is known as a swim bladder, which is merely a long hollow process developed from the œsophagus This serves, probably, mainly as a float, and not at all for respiratory purposes, but in the small group, Dipnoi, of which Ceratodus is one, this same swim-bladder becomes modified to act as a lung Not only this, but, whereas in fishes the impure blood which is carried from the body to the heart passes to the gills, is purified there and then goes straight to the body, in the Dipnoi part of the blood goes from the heart to the lung, and then is carried back again to a chamber in the heart specially developed for its reception In fact, in the Dipnoi we can see some of the earliest stages in the evolution of important organs of the body as we now find them in all animals above fishes

At the present time only three examples of the Dipnoi are known to exist in the world—one form, Lepidosiren, lives only in the Amazon, another, Protopterus, is only found in tropical Africa, and the third, Ceratodus, occurs only in the Burnett and Mary Rivers, in Queensland In past times, however, Ceratodus lived in other parts, such as Europe, as its fossil remains testify, and in Australia Prof Tate has recorded the presence of its teeth in the strata of the Lake Eyre basin In fact, Ceratodus is one of those rare forms of which fossil remains were found and named before the living form was discovered

The habits of Protopterus have been studied, and it is stated that during seasons of drought it makes a cocoon of mud for itself, and breathes by means of its lung On account of this habit, these forms have often been called mud and lung fishes

My main aim, then, was to find the eggs of the Ceratodus From Mr Caldwell's published notes, which are only too brief, I knew that it deposited them much like some amphibians, such as the Axolotl, do, on weeds, and that he had found them in September.

To return now to Gayndah, I purchased a tent and provisions, and having hired two boys accustomed to the river, started away to camp out some few miles up the Burnett The country was very dry and sandy, with all the creeks empty of water The outcropping rocks are granitic, with basalt capping the hills around, and the disintegration of the granite appears to give rise to a vast amount of sand Along the river itself there is an alternation of large sandbanks, where the stream is shallow, and of long deep pools with great granite masses The banks are bordered by bottle-brush trees (Callistemon), which at that time were crimson with flowers, and alive with thickheads Leaving my stores to find their way to an appointed spot, I kept by the river bank on the look out for weeds, for without these it was hopeless to set to work After a short halt at a station close to Mt Debatable, where the sociable wasp (*Polistes ferrugineus*) was busy making its nest in the verandah, I walked on until we were some six or seven miles out of Gayndah but there was not a trace of weed in the river Close in to Gayndah, there was a small quantity, but where we expected to find a good supply there was none at all, owing apparently to heavy floods which in the last wet season had swept down the river Accordingly we turned back and pitched our camp not far from Gayndah It was evening by the time we were settled down, and too dark to see the eggs, so we lit a fire and fished It was a lovely moonlight night and the coolness was delightful after the heat of the day The river is full of fish, and we caught sand eels and mud eels, jew fish, perch, and bream, but not a single Ceratodus—or, as they call it locally, salmon Turtles kept rising to the surface and showing their black heads above the water, and every now and then when we sat still we could recognize a Platypus In the morning I set to work to search over the weed One of my boys stripped and went into the river for it, whilst I sat half in and half out of the water looking carefully over each piece In the hot blazing sun this was not enjoyable, and after some hours' work, and not the slightest sign of an egg, and when the small patch of weed was pretty well exhausted, I sat down to think, and questioned my boys closely as to where there was more weed A little way on the other side of Gayndah they told me there was a backwater usually full of weed Why they had not told me of this before I could not imagine, and the remarks made probably conveyed this idea to them However, we were close to the end of this weed, and as we had to get to some more, I sent one boy into Gayndah to procure help in removing our camp, for which, fortunately, I had made previous arrangements In the afternoon I finally exhausted the weed and myself with no result, and for a change set to work to turn over a few logs Amongst planarians, *Geoplana cærulea* and *variegata*, amongst earthworms, *Cryptodrilus purpureus*, amongst frogs, *Limnodynastes tasmaniensis* and *Hyperolia marmorata*, and amongst lizards, species of Pygopus, Hinulia, and Egernia, and a small mammal, a species of Antechinus, rewarded my efforts, but everything was too dry, though the season was early, for anything very much in the nature of worms Along the river banks endless numbers of the beautiful butterfly *Danais erippus* attracted my attention It was feeding on the plant (Lanthana) along with which it has been introduced. In the river itself was to be seen the curious water lizard *Physignathus lesueurii*, of which we caught a small specimen, and also the frog *Hyla lesueurii*, whilst the Callistemon trees contained plenty of a little green species of Hyla which the boys used as bait for fishing, and which appears to be new to science I also caught this same frog on window panes at night in Gayndah, where, like a moth, it goes to the light As the evening came on the mullet began to jump They feed especially on a filamentous alga which grows in the water, and contains numerous crustaceans, especially a prawn like form, for the sake of which they eat the alga The latter is used as bait for them At night we caught a large mud eel, five feet long, which we eagerly drew into land, thinking it to be a salmon. I tried sugaring the trees, but it was of no use, not even a single ant put in its appearance, and thus ended another day of hard work and disappointment

In the morning I had my boys up by 4 a m, and before six we were out of camp, and by nine o'clock had our tent pitched by the side of a backwater on the other side of Gayndah This contained plenty of weed, and here I spent some days We procured a long pole, with three prongs at the end, to pull the weed up with We used to get a large bucketful at a time, and then go over it piece by piece This process had to be conducted under a hot sun, and the result was that my arms became swollen to about double their natural size—so much, indeed, that I could

not sleep with anything like comfort, since the slightest pressure woke me up. The final result was that I did not see the slightest trace of any Ceratodus eggs, though, had they been there, there is no doubt but that we should have found them. I then sent one of my boys down the river for some miles to see if there were any more weeds, but there were none to be seen. Just at this juncture I heard of some blacks, but on trying to secure them found that they were anticipating a "muster" on one of the neighbouring stations, and were not to be procured. Seeing no prospect of getting what I wanted, and being none the better for my exposure to the sun, I went into Gayndah.

Here I may, perhaps, say something as to some conclusions I had come to with regard to the habits of Ceratodus. With the exception of the brief account given by Mr. Caldwell as to the laying of its eggs on weed, and the curious amphibian-like embryos, we know little about the natural history of the animal. As before said, it is confined to two Queensland rivers—the Mary and the Burnett, and my experience is limited to the latter. Firstly, with regard to the animal's name. The Dipnoi have two popular names—"lung fishes" and "mud fishes"—the latter given to them because, in the case of Protopterus, the animal may live for a part of the year in mud. The Ceratodus is not known locally by either of these names; it is, however, sometimes called the "barramundi" and sometimes the "salmon." The first of these is, however, really that of a true osseous fish (*Osteoglossum leichardtii*), which lives chiefly in the Dawson and Fitzroy Rivers, further north than the Burnett. The second is a fanciful name, given on account of the very pink coloured flesh of the animal. Beyond this there is no resemblance whatever between the real and the so called Burnett "salmon." Mr. Saville Kent, in his report on fishes to the Queensland Government, states that Ceratodus is a valuable food fish. This is a curious mistake. Its flesh is very oily, coarse, and disagreeable, and it is but rarely eaten, and then only by Chinese and those who can afford nothing better. There is thus, I am thankful to feel, not much fear that so interesting an animal will become rapidly exterminated.

Now, as to its method of life. Ceratodus is a big fish, and may reach the length of six feet, and even more. I believe the largest ever caught weighed eighty-seven pounds. It is always to be met with in the deep pools, and not in the shallow waters, and it is important to notice that these pools are many of them of considerable extent, some more than a mile long. In the hottest summer they contain a good supply of water, and thus, though occasionally a Ceratodus may, of course, find its way into a shallow pool which gets dried up, normally no such thing happens, and the animal passes its whole life in water. The usual idea is that the lung is of service to the animal, as in the case of Protopterus, when the waters practically dry up. I very much doubt if Ceratodus ever makes for itself a mud cocoon, as Protopterus does. It may possibly, but very rarely, bury itself in mud, but the fishermen with whom I spoke, and who were perfectly well acquainted with the animal, knew nothing of its ever doing this. On the contrary, I fancy that the lung is of at least as great service to the beast during the wet weather as during the dry season—and probably even of greater.

Normally, then, we may say that Ceratodus never leaves the water. If by any chance it gets out of the water it is perfectly helpless. You may put one close to the edge and there it lies passively. Its weak limbs are quite incapable of sustaining the weight of the body. Nor can it live out of the water, unless kept constantly damp, for more than a very few hours—not, indeed, so long as the jew-fish from the same river. In the water, however, it constantly uses its lung. Sitting by the stream when all is quiet in the evening, you can hear a diminutive kind of spouting going on, the animal at intervals rising to the surface and expiring and inspiring air much as a minute whale might do. Out of the water, too, it does not open and shut its gill flaps like an ordinary fish, but they remain tightly shut, and the animal opens and closes its mouth, to all appearances breathing like one of the higher forms.

If we consider the environment of the Ceratodus we shall see that there are two special and constantly recurring conditions under which a lung would be useful to it.

In the wet season the tributary creeks, dry in summer, become transformed into roaring torrents, and when once you have seen the great sandbanks along the river bed and the dry sandy country through which the creeks pass, you can easily recognize what a vast quantity of sand must be brought down during the course often of a very few days, and how thick the water must become with fine particles. On the other hand, during the hot season there suddenly grow with enormous rapidity great quantities of water weeds. The river is then at its lowest and the decaying vegetable matter will often render the water foul. Under either of these conditions you can see that the possession of an organ enabling the animal to remain in its natural element and yet breathe air directly will be of great advantage to it. It is the shallower pools especially which become chocked with weeds, and since normally the Ceratodus lives in the deeper pools, in which is the purer water, it is, I think, very probable that the flood season, when the water is disagreeably full of sand and mud, is the time when the lung is of greatest service.

In Gayndah I learned that Dr. Siemen was camped out some forty miles up country, where the Auburn and Bowen Rivers join the Burnett, close to one another. Accordingly I made up my mind to go up the river, both to see him and to search for weed. The difficulty was how to get there. However, I met with a friend in the person of Mr. Bailey, proprietor of the Queensland Hotel, who, at considerable inconvenience to himself, promised to see me through the difficulty; and, taking one of my boys with me, we left Gayndah early one morning, before 4 a.m.

The country was extremely dry and sandy, with poor gum trees, and every now and then a patch of brigalow. By 10.30 we reached a wayside accommodation house, and then in the heat of the day we started off along a most miserable track across country as utterly uninteresting and monotonous as can well be imagined. We had two good dogs with us, and the only break in the monotony was when they put up a big "iguana." Most were much too quick for them, but one they got hold of, and it was wonderful to see how they stuck to him without getting within reach of his mouth. When all was over I slung him over a dead trunk, to get his head on the way back. However, when we came back he was not perfectly fresh, and was left behind. By 4 o'clock we had crossed the Bowen River and pitched our camp about a mile beyond. Then I walked on to Dr. Siemen's camp. My advent was announced by the yelping of sundry mongrels, the property of a small camp of blacks. On these animals I kept a sharp look-out. Dr. Siemen I found living in comparative luxury, and from him I received a most cordial welcome. We spent the evening most pleasantly talking over matters of common scientific interest. Three of his blacks came in with a few Echidnas. I learnt from him that he had been no more successful than myself in procuring Ceratodus eggs—that, in fact, they had not begun to spawn yet. Unlike myself, however, he was able to stay there until they did spawn, and most generously offered to procure certain material for me. There was a small amount of weed in the river but not a trace of an egg. On cutting open the body of a "salmon" I found the spawn inside, looking very similar indeed, to that of a frog, each separate egg being black in colour at one pole. It was evidently not yet quite ripe for laying. The season when Mr. Caldwell got his eggs in September seems to have been an exceptional one as regards the temperature and amount of weed in the river. There had been no big flood for some time previously to his visit, so that the river was full of weed and everything was favourable for the depositing of spawn. This season, as luck would have it, the warm weather started rather late and the weeds had been largely washed away by heavy floods, the river at the end of September being comparatively high. I think it safe to say that, granted the presence of eggs, they could be got by "whites" just as well as by "blacks." Any collector going at the right time and not frightened of tiring and tedious work could get them for himself now that the manner of spawning has once been ascertained. Each egg, surrounded by a little gelatinous capsule, is laid on weed, but I think, from what I heard with regard to Mr. Caldwell's methods, that he found it necessary to spend a very considerable time in the neighbourhood of the river whilst the embryos were slowly developing, as they were not easily and safely carried about. The next day Dr. Siemen and I spent together with, I trust, mutual enjoyment—at all events, to myself it was one of the pleasantest days I spent in Queensland. I did a small amount of collecting, but it was far too dry and sandy to get anything in the way of worms. Down by the river I came across a black woman and pickaninny fishing, but they were frightened when I spoke to them, and fled. There were large numbers of *Danais erippus*, and of a beautiful species of Acraea with transparent wings. Late in the afternoon I at-

tempted, but with not very great success, to photograph some blacks One especially, named Frank, had his back scored with cicatrices in regular pattern I spent the evening till 11 o'clock with Dr. Siemen, and said good-bye to him, wishing sincerely that he might be successful in his endeavours to secure what we were both in search of, and what it was perfectly evident that I myself could not obtain

I may here say that Dr Siemen had with him the best of the blacks who were with Mr. Caldwell, and who secured for the latter the eggs of Ceratodus. These blacks were fine and powerfully-built fellows, but here, as everywhere else, rum and disease are rapidly lessening their numbers

On the way back our dogs started many big lizards, and it was amusing to see one of them hanging on to the tail of a large *Cyclodus gigas*, whose head and body were hidden in the hollow of a log Jew lizards we met, as well as species of Hinulia and Liolepisma We camped by the Burnett, some twenty miles out of Gayndah, and spent the evening fishing in a little backwater. There are two kinds of turtle in the river, the long-necked (*Chelodina longicollis*) and the short-necked (*Chelymys macquariensis*), and sometimes one is surprised at pulling out a turtle instead of a fish Next day we made our way back into Gayndah, passing by large patches of grass trees in full flower, with swarms of the little black native bees hovering around them Just as we were passing through a mob of travelling cattle our dogs started two kangaroo rats (*Bettongia*, sp) There was a general scattering as the little animals, with the dogs in full chase, ran through the mob After a short run one was caught, which had in its pouch a single small young one not more than 1½ inch long

I stayed a few days in Gayndah, hoping to make a collection of earthworms, which up till then there had been very little chance of collecting The name of the township will be well known to Australian etymologists, since it was here that Mr Masters made a very fine collection; he was fortunate enough to have almost a year in the district, and thus secured forms at all seasons. About a mile behind the township is a large stretch of scrub, where I spent a considerable time, often accompanied by one or other of my friends—Messrs Illidge, Cole, and Connelly—to whom I am indebted for help in the laborious task of digging out worms from dry ground My favourite place was a large patch centering in a big bottle tree, *Sterculia quadrifida* (?) Here was an open space, lightly timbered with small trees of *Melia azedarach*, the light green foliage of which formed a strong contrast to the sombre foliage of the dense scrub all around. Besides eucalyptus and bottle trees, the scrub was made up of such trees and shrubs as *Geijera muelleri* and *salicifolia*, which were covered with small yellowish flowers, *Leptospermum lanigerum*, *Bursaria spinosa*, *Nephelium* (sp), *Hovea longipes*, *Solanum stelligerum*, &c I am indebted to the Baron von Mueller for his kindness in giving me the names of plants, to Mr C. French for names of Coleoptera, to Mr A H S Lucas for names of amphibia and lizards From the open spaces alleys lead away into the recesses of the scrub, and along these numbers of the beautiful *Danais erippus*, *Papilio erectheus*, and *Acraea* (sp) kept flying to and fro. Of birds, probably because I was not specially on the look-out for them, I saw very few

The two most numerous forms of life were ants and millipedes. The moment you put anything which could serve as food for them on the ground, the former appeared as if by magic Several times they spoilt butterflies just while I put them down on the ground and made a paper bag for them. They always bit off first the little knob at the end of the antennæ White ants of course abounded, and in the tree trunks were swarms of native bees There were not as many logs to turn over as could have been wished for, and the ground also was rather too dry and sandy.

We began by digging around the base of the big bottle tree, and, after digging some time, came across some large worms, about two feet in length. These differ in habit from any others I have collected The burrow runs down for perhaps two feet, and then opens into a small chamber. The head-end of the worm lies usually a short distance up the burrow, whilst the greater part of its length is twisted into a knotted coil, and lies in the chamber which may also contain one or two smaller, immature forms, evidently the young of the larger ones Under and in rotten logs you often meet with a shortish, stout worm, perhaps six or eight inches in length, which, at first sight, differs very much from the long one Its body is stiff, and the surface comparatively dry, whilst the other is four or five times its length, the body soft and the surface always very slimy The short one I met with all along the Burnett River, at Gympie and in the palm district between this and Brisbane, whilst Mr. D Le Souef collected it at Toowoomba. It is the *Cryptodrilus purpureus* of Michaelsen, and, much though the two differ in habits and appearance, the long one is at most a variety of the short, typical form I only got it in this one spot. In the scrub were some four new species of the same genus, and three new species of a genus (Didymogaster) of which previously only one species had been described from New South Wales, by Mr Fletcher Of the typical Victorian genus, Megascolides, to which our large Gippsland earthworm belongs, I did not find any example in Gayndah, but the Perichætes were fairly well represented

Most of the earthworms were secured under fallen logs and in rotten trunks of the bottle tree In times of drought the latter are cut down, and, containing a great amount of moisture, are eaten readily by cattle

The season was too early for beetles, but amongst others I secured specimens in the family Carabidæ of *Carenum deauratum* and *bonelli*, *Eutoma* (sp), *Philoscaphus mastersii*, and *Homalosoma hercules*, and, in the Paussidæ, of *Arthropterus* (sp) One species of the genus *Leptops*, in the Curculionidæ, simply swarmed on the bark of the bottle trees and some of the upturned logs in the more open parts were alive with the little red form, *Lemodes coccinea*

A short time before leaving for Queensland I had been struck with the presence of curious laterally-placed segmental openings in a very large millipede from Fiji, which Mr. French had kindly forwarded to me In the Gayndah scrub—where smaller, but still large, millipedes abounded—I was interested to find the meaning of these openings Each one is connected with a gland, and, when irritated, the animal passes out a few drops of a most obnoxious fluid, of a red-brown colour, the function of which must be protective. Whilst on this subject, I may mention that one morning, when Mr Frank Connelly and myself were digging for worms, we accidentally cut in two a cockroach. From between the segments in its back it poured forth a milky white fluid, possessing an odour so execrable and pungent that it drove us from the spot

Under logs we found, also, of land planarians, *Geoplana cærulea* and *variegata*, and amongst Vertebrata, the frogs *Limnodynastes tasmaniensis*, which was common everywhere, and *Hyperolia marmorata* Of lizards, we secured species of Phyllodactylus, Pygopus, Grammatophora, Hinulia, Liolepisma, and Egernia Snakes were rare, only the genera Morelia, Furina, and Hoplocephalus being represented Whilst in the scrub I did not see a single marsupial.

On the road from Biggenden to Gayndah I had been struck with the appearance of two small hillocks capped with basalt The country all round was thinly wooded with nothing but gum trees, but just the tops of these two hillocks were rich with vegetation, though each was at most fifty yards in width Dr Cole, Mr. Illidge, and myself drove out to see if there were anything worth collecting Unfortunately, since I had passed along the country had been fired and everything was as dry and parched as it well could be However, just the very cap of the hills still formed a strong contrast to the surrounding country, and here we found growing—though nowhere else, apparently, except in these two very limited areas—*Damara robusta*, the Queensland Kauri, *Cupania xylocarpa*, *Micromelum pubescens*, *Carissa brownii*, *Citriobatus* (sp), and amongst ferns a rich growth of *Polypodium* (sp), and *Adiantum* (sp). Animal life was almost absent We disturbed three wallabies, but except these and a few millipedes and scorpions and endless ants, there was nothing to be seen.

My time was passing by rapidly, and though I would much have liked a few more days in the Gayndah scrub, it was a choice between this and two or three days in the palm district between Gympie and Brisbane. Regretfully I left Gayndah, and taking the coach back to Biggenden, found myself in the evening in Maryborough. In the morning I had about two hours to wander about. Close to the town were camped some blacks It was curious to note how they had adapted themselves to their environment. They had made their "humpies" out of old sheets of corrugated iron. A semi-clothed native lying down in the shelter of a mia-mia made of English corrugated iron formed as incongruous a mixture as could well be imagined Early in

the afternoon I left the train at Cooran and took up my quarters in a delightful little wayside inn surrounded by ferns On going up to the house I detected at once the genuine Lancashire dialect, and knew that the owner hailed from within ten miles of Manchester. I was accordingly made welcome, and wandered out to do a little collecting before evening came on I found myself just on the northern border of the palm scrub which ran in a broad belt of about twenty miles width across the country from east to west, inland from the sea coast The country was fairly hilly with a few isolated peaks standing out clearly I was just at the base of one of these—Cooran—and to the south lay two more—Cooroora and Pimparan South from these again the ridges increased in height, and then the country fell away into the slightly undulating plains which stretched eastwards towards Bribie Island and southwards to Brisbane Some remarkable peaks, called the Glass Mountains, mark the southern end of the hilly district

So far as animals are concerned, I was much disappointed with this palm scrub, but equally delighted with the richness of the vegetation.

Commencing first near to Cooran, I followed back the line and "log-rolled," finding a few worms and four land planarians (*Rhynchodemus obscurus*), a small, dark coloured form, and *Geoplana cærulea* and *variegata*, together with specimens of a very small new white species, to which Dr Dendy has given the name of *G minor* After long searching I came across *Peripatus leuckartii*, very dark purple in colour and evidently similar to the typical form and without the curious diamond-shaped markings characteristic of the Victorian form Though searching hard, I only found nine specimens altogether, and all these close to Cooran Most of my time was spent in this scrub at different parts, and usually in company with George Martin, the son of my Lancashire friends, who helped me very considerably in collecting The scrub was very thick with vines and prickly lawyers and barristers and supplejack, making progress tedious, and there were comparatively few logs on the ground What delighted me most were the ferns The trunks of the pines and gums were often covered over with them and with orchids High up were enormous clumps of the bird-nest fern (*Asplenium nidus*), and larger ones of the staghorn (*Acrostichum alcicorne*) Some of the latter measured fully twelve feet through, and from them hung down lovely pendant fronds of smaller ferns, especially of *Polypodium tenellum*, which is locally known as the feather fern On the ground grew various species of Davallia, Adiantum, Pteris, Doodia, Aspidium Polypodium, &c Perhaps the most beautiful of all were the large and delicate fronds of *Adiantum formosum*. There were apparently three forms of palms—species of Ptychosperma, Livistona, and Kentia The latter is very common, and usually known as the walking stick palm In the scrub were great pine trees, and under the bark stripped off from these, and lying about in large slabs, I expected to find any number of worms and insects, but was much disappointed Millipedes and scorpions were there, and two large forms of land shells, but scarcely an insect to be seen, and not a planarian or peripatus I got a few new species of earthworms, of which, again, the commonest form was *Cryptodrilus purpureus*, and in rotten logs, which, unfortunately, were few in number, were large forms of cockroaches. The earthworms formed the best part of my collection here, and comprised representatives of five genera—Perichæta, Megascolides (one species, the only one found), Cryptodrilus, Perissogaster, and Acanthodrilus The latter is only recorded, as yet, from Northern Australia, where there are two species, and is characteristic of New Zealand Perissogaster is peculiarly Australian and has only three species yet known. My specimens were obtained by digging on the banks of a creek at Cooran and were whitish in colour and about 1 to 1½ feet in length. The boys use them for fishing, quite unaware of their scientific value

In Queensland, as in Victoria, I could very rarely, indeed, find traces of casts made by worms or of leaves dragged down into the burrows, and it would appear that here, as in Africa, the ants are of more use than the worms as agents in turning over the soil Under the bark and logs were a few frogs—*Pseudophyrne bibronii* and *coriacea*, *Crinia signifera*, and a female specimen of *Cryptotis brevis* In certain spots there were great numbers of trap-door spiders Some of the tubes, which led for about 2 4 inches down into the ground, were an inch in diameter The top of the tube, with its semi circular trap door, projects slightly above the surface

One of the most striking features of the scrub were the epiphytic orchids, of which, owing to its size and large pendant masses of yellow-brown flowers, *Cymbidium canaliculatum* was the most noticeable. In parts the ground was crimson with the fallen berries of a species of Eugenia, we cut one down about sixty feet high, laden with fruit, which has a tart taste, and from its colour and size has caused the tree to be known as the native cherry Another Eugenia has a large purple fruit, and is hence known as the native plum. High up, some fifty feet above ground, we saw hanging down clusters of light brown fruit. Luckily there was a hanging vine close at hand, and up this George Martin went like a monkey The fruit belonged to the tree *Dysoxylon rufum*, and each was covered over with innumerable minute stiff hairs, which pierced the skin in hundreds Other plants we noticed were the wistaria, which here grows wild, *Dracæna angustifolia*, and one which Baron von Mueller has marked as rare—*Rhipogonum elseyanum* Two dangerous ones are common, one with large bright green leaves and succulent sheathing stalks, which is locally known as the "Congey Boy"—this is eaten greedily by the native turkeys, but has the effect of making a man's tongue swell to an enormous extent, the other is the stinging tree, *Urtica gigas*—the sting of this is extremely painful, and seems to prove fatal to horses, driving them rapidly frantic

Close by the base of Mount Cooroora, a beautiful specimen of *Macrozamia denisoni* in fruit was growing, and on Mount Cooran the rock on the western side was completely overgrown with staghorn and bird-nest ferns and with an orchid, *Dendrobium* (sp), with beautiful clusters of delicate white flowers, amongst which trailed *Kennedya rubicunda*, its bright red blossoms contrasting strongly with the pure white of the orchids

My last day I spent at the Glass Mountains—curious cone-like basaltic structures rising abruptly from almost flat country The day was oppressively hot, making it no small exertion to even turn over a log, and as the sun went down a heavy storm came up, and from the train I caught my last glimpses of this delightful district lit up by almost incessant flashes of brilliant lightning

SCIENTIFIC SERIALS

The American Journal of Science, July —The change of heat conductivity on passing isothermally from solid to liquid, by C Barus The method employed was a modification of Weber's, who placed a thin, wide, plane-parallel plate or layer of the substance to be examined between and in close contact with two thick plates of copper The system was first heated so as to be at a given temperature throughout It was then suddenly and permanently cooled at the lower surface, and the time rate at which heat travelled from the top plate to the bottom plate, through the intervening layer, was measured by a thermo-couple From these data the absolute thermal conductivity of the layer may be computed, the constants of the system being known In the experiments discussed, the liquid was thymol, which can be kept either solid or liquid between 0° and 50° C This was heated above its melting point, and introduced through a central hole in the upper plate, it was then allowed to cool down until undercooled The temperature was regulated by enclosing the whole apparatus in a sheet iron jacket, through which water was kept circulating The lower plate could be cooled by flushing it with water from below The difference of temperature of the plates was measured by means of a copper german-silver couple The liquid was solidified by introducing a crystal through the central hole The results obtained gave for the absolute conductivity of thymol in g/cs

Solid thymol at 12°, $k = 359 \times 10^{-6}$
Liquid thymol at 13°, $k = 313 \times 10^{-6}$

The thermometric conductivity was found to be—

For solid thymol at 12°, $= 1077 \times 10^{-6}$
For liquid thymol at 13°, $= 691 \times 10^{-6}$

—On polybasite and tennantite from the Mollie Gibson mine in Aspen, Colorado by S L Penfield and Stanley H. Pearce Large quantities of polybasite or "brittle silver" have been mined nearly free from gangue, assaying from 10,000 to 16,000 ounces of silver to the ton. Tennantite, arsenical tetrahedrite, or "grey copper," was found in smaller quantities, containing about fourteen ounces of silver The rich ore occurs between a

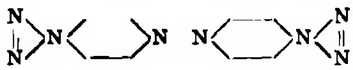
hanging wall of black carbonaceous shale and a foot wall of grey magnesian limestone, which is probably of lower carboniferous age The ore is richest and most abundant immediately under the black shales. Other minerals observed are native silver, argentite, galena, sphalerite, siderite, barite, and calcite —Post Laramie deposits of Colorado, by Whitman Cross. This paper, published by permission of the director of the United States Geological Survey, deals with some beds occurring between the lowest eocene and the marine cretaceous deposits, which have hitherto been classed with the Laramie formation of the Rocky Mountains The age of the firm grey sandstones and coal measures of the latter has long been doubtful, and they have been variously described as secondary and tertiary In the Denver region, two beds are found overlying the Laramie unconformably, the one consisting of a pebbly conglomerate, the other of débris of andesitic lavas, they have been termed the Denver and Arapahoe formations respectively Their equivalents have been found in various other parts of Colorado When, after the continental elevation which caused the retreat of the Laramie seas, sedimentation began again, it was in comparatively small seas or lakes Succeeding the first period of lake beds came a time of great volcanic outbursts over a large area The length of geologic time occupied may not have been very great, but the extent of country in which eruptions occurred at this time, and the great variety of lavas found in the Denver and Middle Park regions, argue for the decided importance of the event as a dynamic manifestation The writer wishes to advocate the restriction of the term Laramie, in accordance with its original definition, to the series of conformable beds succeeding the marine Montana cretaceous, and the grouping of the post-Laramie lake beds in another series, to which a comprehensive name shall eventually be given —On the alkali-metal pentahalides, by H L Wells and H L Wheeler With their crystallography, by S L Penfield An account of the preparation and properties of compounds of the formulæ CsI_5, $CsBr_5$, $CsCl\ Cl_3I$, $RbCl\ Cl_3I$, $KCl\ Cl_3I$, $NaCl\ Cl_3I\ 2H_2O$, $LiCl\ Cl_3I\ 4H_2O$ The first is triclinic, the third, fourth, and fifth are monoclinic, and the Na salt is orthorhombic —Fossils in the "archæan" rocks of Central Piedmont, Virginia, by N H Darton Remains of crinoids belonging to the upper Ordovician fauna were found in the roofing slate of Arvon, Buckingham County, Virginia, which has hitherto been classified as Huronian —Notes on the Cambrian rocks of Virginia and the southern Appalachians, by Chas D Walcott It is shown that towards the close of middle Cambrian time, and during upper Cambrian time, there was a decided continental movement, resulting in the depression of the interior continental plateau, and that this was accompanied by the formation of conglomerates of the older Cambrian rocks in the valley of the St Lawrence, and by a great deposition of sediments of later Cambrian time in the southern Appalachian region —Synthesis of the minerals crocoite and phœnicochroite, by C Ludeking, Ph D This was accomplished by exposing for several months to the air a solution of lead chromate in caustic potash in a flat dish A mixture of the two kinds of crystals resulted, which could be easily sorted by means of a pincette —A hint with respect to the origin of terraces in glaciated regions, by Ralph S Tarr Tracing a resemblance between the flood terraces of the Colorado in Texas, and the glacial terraces of the Connecticut —Occurrence of a quartz boulder in the Sharon coal of north eastern Ohio, by E Orton —A method of increasing the range of the capillary electrometer, by John Whitmore An account of some experiments performed in the Sloane Physical Laboratory of Yale College, with a view towards improving the mercury and sulphuric acid electrometer as constructed by Lippmann and Pratt Instead of having alternate bubbles of the two liquids, the surface of the mercury exposed to oxygen polarization was increased by blowing the tube into bulbs at the junction A series of bulbs was blown, spaced at equal intervals along a capillary tube, the diameter of the bulbs being two centimetres, that of the tube 0 6 mm , then the tube was so bent, that the whole contained as many U shaped parts as there were cells One arm of each U was provided with a bulb, which was situated at a distance of two-thirds the height of the U from the base The apparatus was filled by connecting it with an aspirator, and drawing in sufficient mercury to half fill each bulb, after which dilute sulphuric acid was added by the same means Platinum electrodes were used, and the variations in the height of the mercury columns produced by the E M F examined, were read by means of a cathetometer The deflection produced by a standard Clark cell was 3 20 mm. The range of the instrument is limited by the E M F required to produce continuous electrolysis, but it was found that it could be considerably increased by using a larger number of cells in series It is possible to determine with this electrometer the E M F of a cell correctly to 0 001 of a volt

SOCIETIES AND ACADEMIES.

LONDON

Chemical Society, June 16 —Prof A Crum Brown, F R S , President, in the chair —The following papers were read ,—Contributions to an international system of nomenclature The nomenclature of cycloids, by H E Armstrong, An account was given of the proceedings at the recent Conference on Chemical Nomenclature at Geneva, and attention was directed to the significance of the chief resolutions A report of the conclusions arrived at by the Conference has already appeared in NATURE (this vol , p 56) —The production of pyridine derivatives from the lactone of triacetic acid, by N Collie and W S Myers The product of the interaction of ammonia and triacetic lactone is most probably an $\alpha\gamma$ dihydroxy-α picoline By the action of phosphorus oxychloride on this substance a compound possessing all the properties of a dichloropicoline is obtained, and on passing this, together with hydrogen, over heated zinc dust, α-picoline boiling at 128-129° is produced The melting points of the platini- and auri chlorides, obtained from the synthetical alkaloid, agree with those given by the corresponding compounds prepared from pure α picoline which was made by heating pyridine methiodide —The fermentation of arabinose by *Bacillus ethaceticus*, by P F Frankland and J MacGregor The products are qualitatively the same as were obtained in the fermentations of glycerol by the same organism, consisting of ethyl alcohol, acetic acid, carbon dioxide, hydrogen, and traces of succinic acid, together with another acid which was not identified When the fermentation is conducted in a closed space a notable proportion of formic acid also occurs among the products In this case the products are formed approximately in the proportions—$3C_2H_6O$, $3C_2H_4O_2$, $4CH_2O_2$, the formic acid as well as the carbon dioxide and hydrogen found being all collected together as formic acid in this statement In the fermentations conducted in flasks plugged only with cotton wool, on the other hand, the alcohol and acetic acid were formed in the proportion $2C_2H_6O$, $3C_2H_4O_2$ It appears, therefore, that in the fermentation of arabinose by *Bacillus ethaceticus*, the proportion of acetic acid to alcohol is greater than in that of dextrose, and still greater than in the cases of mannitol and glycerol, but less than in that of glyceric acid —Resolution of lactic acid into its optically active components, by T Purdie and J W Walker The authors have resolves ordinary inactive lactic acid into lævo- and dextro lactic acid by taking advantage of the different solubilities of the strychnine salts of these components Strychnine lævolactate is considerably less soluble in water than the dextrolactate, although both salts may be crystallised By fractional crystallization of the mixed salts and subsequent removal of the strychnine from the crystals and mother liquor, by means of ammonia or barium hydrate, solutions were obtained which were respectively dextro- and lævo-gyrate The dextrolactate yielded a zinc dextrolactate having the same composition and solubility as zinc sarcolactate A well-defined dextro zinc ammonium salt of the composition $Zn\ NH_4\ (C_3H_5O_3)_3$, $2H_2O$ having the specific rotatory power $[\alpha]_D = +6\ 49$ (approx) was prepared The dextrogyrate salts yield a lævogyrate acid, which, like sarcolactic acid, gives an oppositely active anhydride The quantities of oppositely active acids separated from each other by means of the strychnine salts possessed equal amounts of optical activity Fermentation lactic acid is thus shown by analysis to consist of two oppositely active isomeric acids, one of which is identical with dextrogyrate sarcolactic acid, and the other with the lævogyrate acid prepared by Schardinger by the bacterial decomposition of cane sugar —A new method for determining the number of NH_2 groups in certain organic bases, by R. Meldola and E. M Hawkins In order to ascertain the number of NH_2 groups present in certain organic bases the authors propose to form the azoimides , on analysis of these substances, the number of amidogen groups which have been diazotized, can be determined For example, paradiamidoazobenzene$(NH_2, C_6H_4)_2N_2$ was diazotized and converted into

tetrazoperbromide in the usual way. This latter substance, by the action of ammonia, yields lustrous silvery scales of the azoimide



The analysis of this substance proves without doubt that two amidogen groups were present in the original base.—The existence of two acetaldoximes Second notice, by W R Dunstan and T S. Dymond The authors have more fully investigated the change undergone by acetaldoxime on heating (see NATURE, this vol, p 94) The pure crystals melt at 46 5°; after heating at 100° for a few minutes the liquid does not begin to crystallize until 13° On separating the crystals now formed, and cooling the liquid still more a further crop of crystals is obtained. Each of these separations is found to melt at 46 5°. Acetaldoxime therefore exists in two modifications, one, the crystalline form melting at 46 5°, and the other, a liquid form which the authors find cannot be obtained in a pure state, as when it approaches purity it partially reverts to the modification melting at 46 5° —The dissociation constants of organic acids, by J Walker The author has measured the dissociation constants of a number of organic acids and ethereal salts.—Note on the preparation of alkyl iodides, by J Walker The author has devised a method for conveniently and rapidly preparing considerable quantities of methyl and ethyl iodides The apparatus employed consists of a modified fat extraction apparatus, by means of which the iodine is dissolved by the condensed alcohol, and runs into a vessel containing the phosphorus and alcohol The method gives a good yield, and may be applied to the preparation of higher iodides —An examination of the products obtained by the dry distillation of bran with lime Preliminary communication, by W F Laycock a d F Klingemann On distilling a mixture of bran and quick-lime, a black oil, floating on an aqueous solution is obtained. The aqueous solution smells of herring brine, contains much ammonia, and on boiling evolves inflammable gases The oil is evidently a complex mixture, and has not yet been separated into its constituents —The atomic weight of palladium, by G H. Bailey and T Lamb —The action of sulphuryl chloride on acetorthotoluidide and acetparatoluidide, by W. P Wynne.

PARIS

Academy of Sciences, July 18 —M. d'Abbadie in the chair —On a slight additive correction which may have to be applied to the heights of water indicated by sea gauges, when the swelling or chopping agitation of the sea reaches a great intensity case of a choppy sea, by M. J Boussinesq In this second case the correction is much smaller than in the former, amounting to not more than 0 1 mm in an extreme case —Preparation and properties of proto-iodide of carbon, by M Henri Moissan. If an exhausted sealed tube containing crystals of the tetra iodide of carbon be heated in an oil bath to 120°, iodine is liberated and condenses in the cooler portion of the tube, while less volatile crystals of the proto-iodide of carbon are produced, corresponding to the formula C_2I_4 To obtain greater quantities, the tetra iodide is reduced by silver powder The substance obtained presents itself in beautiful pale yellow crystals of density 4 38, fusing at 185°, and volatile without decomposition below their point of fusion By slow volatilization in a vacuum at a temperature between 100° and 120°, transparent crystals are produced, some of which form highly refracting hexagonal tablets The proto-iodide is very soluble in carbon bisulphide, tetrachloride, and ordinary ether, which, by cooling, gives good crystals The new compound is very stable, being not oxidized by potassium permanganate, and boiling chromic and nitric acids.—On one of the reactions of spermine, by M Duclaux —On a fossil baboon of the quaternary phosphorites of Algeria, *Macacus trarensis*, by M A Pomel.—Project of meteorological observatories on the Atlantic Ocean by Albert I, Prince of Monaco A proposal to establish a station on the Azores as soon as the projected cable is laid, and also on Madeira, the Canaries, Bermuda, and the Peak of Teneriffe. It is expected that the prediction of cyclones will be much facilitated, and Monaco is suggested as a centre for the collection and distribution of the information obtained —On the specific heat and the latent heat of fusion of aluminium, by M. J. Pionchon The total quantity of heat required to raise 1 gr. of aluminium from 0° to its fusing point, 625°, is 239 4. The latent heat of fusion is very large, being equal to that of water, viz., 80 cal —On the measurement of the dielectric constant, by M A Perot. The further value obtained for glass was 2 39, which, obtained by means of a glass prism weighing 65 kg, agrees very well with that obtained from very rapid oscillations The values obtained by these two methods, being unaffected by residual charges, are more reliable than those derived from the static, the attraction, and the ballistic galvanometer methods —On the principle of maximum work, by M H Le Chatelier An examination of the bearing of certain thermodynamic laws on Berthelot's principle, showing that the contradiction between them is only apparent —On a basic nitrate of calcium, by M. A' Werner —On the efflorescence of sulphate of copper and some other metallic sulphates, by MM H. Baubigny and E Pechard —On the decomposition of the basic nitrates by water, by MM G Rousseau and G Tite —On phosphopalladic combinations, by M E Fink —On the mechanical contrast between the radical cyanogen and the chloroid elements, by M G Hinrichs —The influence of the substitution of the methyl group for one benzene hydrogen on the properties of orthotoluidine, by M A Rosenstiehl —On the instability of the carboxyl in the phenol acids, by M P. Cazeneuve —On preserved ferruginous mineral waters, by M. J Riban —On a new leucomaine, by M. A B Griffiths —Effects of sudden release on animals placed in compressed air, by M G Philippon It was found that although rabbits subjected to a pressure of six or eight atmospheres were unaffected if the pressure was gradually released, a sudden expansion was followed by almost instantaneous death. The cause of death appears to be the mechanical expansion of the gas contained in the vessels, which, in the case of gradual release, is eliminated by the lungs in a few minutes —On the immediate reparation of losses of intra-osseous substances, with the aid of aseptic bodies, by MM S Duplay and M Cazin —The coxal gland of the scorpion and its morphological relations to the excretory glands of the Crustacea, by M Paul Marchal —The avalanche of the Têtes Rousses Catastrophe of St Gervais les-Bains (Haute-Savoie), by M F A Forel —On certain forms of filling-up observed in some lakes of the Pyrenees, by M Emile Belloc

CONTENTS.

THURSDAY, AUGUST 4, 1892

COAL-TAR COLOURING-MATTERS

Tabellarische Uebersicht der kunstlichen organischen Farbstoffe Von Gustav Schultz und Paul Julius R Gaertner's Verlagsbuchhandlung, Hermann Heyfelder (Berlin, 1891)

DR SCHULTZ is well known to "tar chemists" as the author of "Die Chemie des Steinkohlentheers," the most exhaustive work on coal-tar products which has hitherto been written, and of which the first edition appeared in 1882, and the second, enlarged to two thick volumes, in 1887–1890 His colleague Dr Julius is the author of a useful little work on the same subject published in 1887 The volume before us is a remarkable production from every point of view, and well worthy of the reputation of the two authors who have collaborated in its production Although nothing more than a tabulated catalogue of coal-tar colouring-matters, as it professes to be, the work is in reality a complete index to the literature of this rapidly growing branch of industry, complete, that is to say, to the date of its publication, but development is taking place even now at such a pace that a single year has sufficed to render a supplement necessary, and many of the most recently added colouring-matters are not included in the lists The first edition of the "Tabellarische Uebersicht" was published in 1888 and contained 278 colouring-matters, the present edition contains 392 colouring-matters—a fact which speaks for itself with respect to the progress of chemical discovery in this direction The volume is dedicated to the late Prof von Hofmann, whose labours in this field in the early days of the industry will render his name inseparable from that band of pioneers who were the first to penetrate into the new regions opened up by the discovery of mauve by Dr W H Perkin in 1856

The volume of tables under consideration has become indispensable to every chemist engaged in the manufacture of, or in any way interested in, the coal-tar colouring-matters To the general chemist it will be a matter of wonder that from three to four hundred distinct compounds, for the most part of known constitution, definite in character, often beautiful in crystalline form and appearance, and, in short, all well-characterised "chemical individuals," should be turned out of factories by hundredweights and tons for consumption in the tinctorial industries

The authors group the colouring-matters under sixteen headings. —Nitro-derivatives, Azoxy-compounds, Hydrazones, Azo-compounds, Nitroso-compounds (quinone-oximes), Oxyketones, Diphenyl-methane derivatives, Triphenyl methane derivatives, Indophenols, Oxazines and Thiazines, Azines, Artificial Indigo, Quinoline colouring-matters, Acridine colouring-matters, Thiobenzenyl derivatives, and colouring-matters of unknown constitution The tables are arranged in eight columns, the first containing the commercial name of the colouring-matter, the second its scientific name, the third its empirical formula, the fourth its constitutional formula, the fifth its mode of preparation, the sixth its date of discovery, the seventh the name of the discoverer and literary references, and the eighth its general properties and mode of application From this analysis it will be seen that the work is, as we have stated, a complete epitome of the coal-tar colour industry Its value as a work of reference for technologists will be appreciated by all who may have occasion to consult it, our own experience has been that the many thousand references to chemical literature, patents, and periodicals, are given with an accuracy that leaves nothing to be desired One special feature to which attention must be directed is that the compounds tabulated are or have been actual articles of commerce If the colouring-matter has been superseded, as must inevitably be the case with the progress of discovery, the authors announce the fact by stating *nicht mehr im Handel* Thus the reader is made acquainted with the actual state of the industry, and the student with these tables at hand will be prevented from becoming a prey to the snares of the compilers of examinational text-books, who are only too frequently quite out of touch with the technology of their subject. Writers of this class are apt to set forth lists of compounds which are worthless to the manufacturer, and which are of value only to the examiner in technology by enabling him at once to separate the sheep from the goats among his candidates— to distinguish the students whose knowledge has been derived solely from books from those who are actually engaged in the factory

One very forcible truth which is brought home on running the eye down the seventh column of the tables before us is the great preponderance of references to patents, chiefly German It is evident that the chemist who wishes to keep abreast of modern discovery can no longer afford to neglect the literature of the Patent Office Many discoveries of the greatest scientific importance are buried in these specifications, and it is long before they find their way into the text-books This, so far as we are concerned, is much to be regretted, for, in the first place, the working chemist is already painfully overburdened with literature, and in the next place the statements in specifications require very judicious sifting before they can be admitted as part of scientific knowledge The student who is not familiar with the coal-tar colour industry would be hopelessly entangled among the mazes of patent literature were it not for such practical guides as Drs Schultz and Julius, who have evidently used the greatest judgment in giving their references In other words, the patents quoted have reference to the production of compounds which are, or were, manufactured, and the reader who consults their work may feel assured that the "bogus" or "fishing" patent, which may be so innocently swallowed by the unwary, will not be obtruded on his notice

So far as English technologists are concerned, it is to be regretted that such an overwhelming majority of German patents have to be referred to This, of course, is only to be expected, when we consider the extraordinary activity which the Germans have displayed in the development of the industry of which the foundations were laid in this country about thirty or forty years ago But the technological student is thereby placed at a disadvantage because German patents are not very readily obtainable It is true that all capital discoveries are also patented in this country, but, on the other hand, there are many

important chemical processes discovered and patented on the Continent which are not filed in our Patent Office, and which are so long in finding their way into the current literature that they are apt to be overlooked Chemists who have occasion to consult the admirable series of tables by Schultz and Julius cannot but look with admiration—even if tinged with envy—at the brilliant series of discoveries which have emanated from the laboratories of German universities, technical schools, and factories This is the fruit of technical education in the true sense, no system of cramming for an examination, no method of orthodox "test-tubing," not even the "recreative institute" line of technical training, which is so much in vogue at the present time, will enable us to recover our lost position in this or in any other branch of chemical technology.

R MELDOLA

RAM BRAMHA SÁNYÁL ON THE MANAGEMENT OF ANIMALS IN CAPTIVITY

A Handbook on the Management of Animals in Captivity in Lower Bengal By Ram Bramha Sányál, Superintendent of the Zoological Garden, Calcutta (Calcutta, 1892)

CONSIDERING the number of zoological gardens in Europe, and their long establishment, it is singular that it should have been left to the superintendent of a zoological garden at Calcutta, and to a native of India withal, to produce the first practical handbook on the management of animals in captivity The author, who, we believe, is a member of the "Brahma Somaj," and one of the very few natives of British India that have exhibited any taste for natural history, has been for some years superintendent of the Zoological Garden at Calcutta, an excellent institution mainly kept up by the Government of Bengal, but under the control of a committee of the subscribers This committee, at the suggestion of Sir Steuart Bayley, the Lieutenant-Governor of Bengal, came to the conclusion that, after thirteen years' experience of the management of animals, it might be possible to produce a handbook on the subject which "would be of interest to the scientific world," and at the same time "of great use to nobles and other persons who, on a smaller scale, keep a collection of animals in captivity"

Such was the origin of the present volume, which has been prepared by Babu Ram Bramha Sányál, on a plan drawn up by a sub-committee appointed for the purpose, and has been supervised by Mr C E Buckland, C S, who was at one time honorary secretary to the Calcutta Garden, and is now a member of the Council of the Zoological Society of London It is certainly a work of considerable interest In the first place it has the merit of giving us a complete classified list of all the mammals and birds that have been kept alive in the Calcutta Garden These are, of course, mostly species of British India—241 of the class of mammals, and 402 birds—but there are a good many exotic forms among the birds. In the second place large numbers of notes on the treatment of the animals in health and in sickness, on their length of life in captivity, and generally on their habits as observed in confinement are introduced, which, although in some cases of an apparently trifling nature, are well worthy of study by those who are engaged in the custody of living animals. It is evident that the author has kept a regular journal, and has recorded his experiences very minutely. In a case of a fight between a lioness and a tiger, which were by some accident allowed to pass into the same compartment of the Carnivora house, the tiger was completely victorious and killed the lioness The longest period during which a tiger has lived in the Calcutta Gardens is fourteen years. It is curious that the Lesser Fruit-bat of Bengal (*Cynopterus marginatus*) "does not appear to bear captivity well." A nearly allied African species (*C collaris*) has completely established itself in our Regent's Park Garden, and has bred abundantly for the last twenty years On January 30, 1889, a young rhinoceros was born in the Calcutta Gardens, "the second recorded instance" of this mammal having bred in captivity Interesting details are given of this event. The parents were a male Sumatran rhinoceros and a female of the northern form of the same species, which has been separated as *Rhinoceros lasiotis*. The highest bliss of these animals, as the Babu points out, is to "lie undisturbed in a muddy hollow," besmeared with liquid dirt

In 1886 the Calcutta Garden obtained from Dar-es-Salam, in Eastern Africa, a young hippopotamus, but it did not live for more than eighteen months Probably its voyage from Zanzibar to Calcutta "in an ordinary box without water" materially affected its health, as the hippopotamus, if properly treated, does exceedingly well in captivity

The authorities of the Calcutta Garden have not yet succeeded in keeping the pangolin alive for any lengthened period The same has been the case in our Zoological Gardens, where, although several examples of this Edentate have been received, not one has survived many weeks This is curious, as both the American ant-eater (*Myrmecophaga*) and the African ant bear (*Orycteropus*) maintain excellent health in captivity It is suggested that the difficulty of obtaining a supply of their proper food—the *termites*—is the cause of this failure At the same time, when supplies of this insect have been placed within reach the Pangolin has been "known to take no notice of them." We cannot therefore suppose that the true solution of this difficulty has yet been hit upon It may be stated that in a similar manner ant-eaters kept in this country will not eat ants, but thoroughly enjoy raw meat when minced up small in a sausage machine

The second part of the handbook contains a list of the birds exhibited in the Calcutta Garden, and corresponding observations upon them, but naturally there is not so much to be said on this branch of the subject. Among the more interesting species of this order we notice the fine large Laughing-thrush of the Himalayas (*Garrulax leucolophus*), the gold-fronted chloropsis (*Chloropsis aurifrons*), several sorts of drongo (*Dicruridæ*), Gould's ouzel (*Merula gouldi*), and the pheasant-tailed jacana (*Hydrophasianus chirurgus*), all birds which are rarely, if ever, seen in European aviaries. On the whole we must allow that this volume is a remarkable production, considering the circumstances under which it has been prepared, and that its author deserves great credit for the pains bestowed on its composition, and for much valuable information contained in it.

OUR BOOK SHELF

In Starry Realms By Sir Robert S Ball, D Sc, LL D, F R.S. (London Isbister and Co, 1892)

THIS is another striking example of Sir Robert Ball's skill in popularizing the most fascinating of the sciences Though the same story has been to a large extent told by him before, there are several new features which prevent the least suspicion of staleness The author is perhaps most interesting in his homely illustrations of astronomical dimensions. Among these are the disc of the moon projected on the map of Europe, and three lunar craters similarly compared with the map of England The history of a falling star, as told by a particularly intelligent meteorite, is also worth special notice

The two final chapters consist of "An Astronomer's Thoughts about Krakatoa," and "Darwinism in its Relation to other Branches of Science" The former is a popular account of the Report of the Krakatoa Committee of the Royal Society The moral of the last chapter is that the scientific method of Darwin is closely related to that employed in astronomy "Astronomers were the first evolutionists they had sketched out a majestic scheme of evolution for the whole solar system, and now they are rejoiced to find that the great doctrine of Evolution has received an extension to the whole domain of organic life by the splendid genius of Darwin" (p 349) We can confidently recommend the book to all classes of readers Those who are already familiar with the subject will find much to delight them

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications*]

Basset's Physical Optics

I DESIRE to make a few remarks on Prof Schuster's review of my treatise on physical optics

The sentence in the preface to which he refers is not perhaps very happily arranged, and might be amended as follows —

"I have a profound distrust of arguments based upon vague and obscure general reasoning instead of upon rigorous mathematical analysis." This, however, is a small matter, what I wished to protest against was, the practice which has crept into more than one recent work, of slurring over an investigation by means of a page or two of general talk, instead of writing out a careful mathematical demonstration, or at any rate making a serious attempt to grapple with mathematical difficulties, and trying to arrive at a definite result

I fully admit, that when a subject is in a state of growth it is often impossible to dispense with hypothesis But whenever this is necessary, the hypothesis should be expressed in clear and definite language, the evidence and arguments for and against the hypothesis should be properly marshalled and discussed, the reader should be plainly informed that the proposition which forms the basis of the investigation is a hypothesis and not an established fact, and that consequently further research may show that the hypothesis must either be abandoned or modified When an investigation is conducted on these lines all obscurity and vagueness will be avoided, for the reader will be thereby enabled to clearly understand the exact nature of the assumptions which are made, and will be able to discriminate between those portions of the investigation which consist of hypothesis, and those which constitute results deduced from hypothesis by the aid of mathematical analysis.

The dangerous character of arguments based upon general reasoning is well illustrated by the theory of the deformation of thin elastic plates and shells. When a thin shell is deformed by means of bodily forces, and stresses applied to its edges, the effect produced is extension, change of curvature, and torsion, and it might be argued from this, that the potential energy due to deformation is a homogeneous quadratic function of the quantities by which extension, change of curvature, and torsion are specified But if the expressions for the potential energy of a cylindrical or of a spherical shell be examined (Phil Trans 1890, pp 443, 467), it will be found that they contain certain terms which involve the *differential coefficients* of quantities by which extension is specified

With regard to the concluding portion of the review, I must point out that one of the difficulties with which the author of an advanced treatise is confronted is *where to draw the line* Upon this subject there is necessarily room for a wide difference of opinion As my object was to write a book on physical optics, I considered that the reader might properly be expected to obtain his information respecting the various theories of the electromagnetic field, from the treatises and original memoirs on that subject, and for that reason I abstained from discussing purely electromagnetic theories, further than was necessary for the explanation of optical phenomena A B BASSET

July 25

Causes of the Deformation of the Earth's Crust

THE communication from E Reyer in NATURE of July 7 (p 224) "On the Causes of the Deformation of the Earth's Crust" is interesting from several points of view It is an indication that the theory which looks upon mountain ranges as the effects of the earth's contraction does not satisfy the conditions of the geologist

It is welcome to me individually as in the main accepting the principles of which I happen to be the exponent, and have systematized in the "Origin of Mountain Ranges," published in 1886 It is, however, the addition to this theory explaining the folding of strata by what Mr Reyer aptly calls "gliding" that calls for examination It is shown very clearly by experiment and otherwise that under certain conditions strata, when they reach a certain degree of inclination on the flanks of a mountain chain during elevation, must glide downwards by gravitation and produce folds and disturbances towards the lowlands We have only to consider the effects of land-slides such as occur in the chalk districts in the south of England, and their effects on the shore deposits, to admit the truth of this. This aspect of the problem, though always present, has grown on me since my work was published, and I have little doubt that the "foot-hills" usually formed of the newer strata which flank most great mountain ranges are to a considerable extent due to gravitation and "gliding" I may point to the foot-hills of the Canadian Rockies and of the Himalayas as illustrations. The cases of folded lying upon undisturbed strata mentioned by Reyer are, as he clearly shows, explanatory on this view, but not by general contraction

There are no doubt other effects traceable to the gravitation of masses of the earth's crust during elevation such as the lateral spreading of the plastic cores of mountain ranges in fan-like form, and the consequent shouldering of the strata on either side intensifying the effects of the folding of the strata by thermal expansion, as explained in the "Origin of Mountain Ranges."

I cannot, however, follow Mr Reyer if he considers "gliding" an explanation of all folding I am not sure that this is his meaning, though the last paragraph would seem to bear such an interpretation It seems obvious to me, to mention only one of numerous examples, viz, the folds of Jurassic strata caught up in the gneiss of the Central Alps, as shown in Heim's section, reproduced in "Prestwich's Geology," and in plate xiv, "Origin of Mountain Ranges"

While looking upon "gliding" as only a partial explanation of folding, I welcome Mr Reyer's fresh and vigorous treatment of the important problem of the causes of the deformation of the earth's crust It is evidence that geologists and physicists are now allowing their minds to play freely round the subject of the orogenic changes of the earth's crust, and of the growth of philosophical conceptions on the geological evolution of our planet.

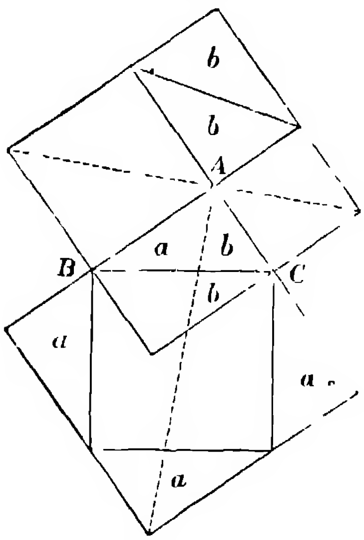
Park Corner, Blundellsands, T MELLARD READE.

July 11

An Obvious Demonstration of the 47th Proposition of Euclid

SOME years ago in trying for a simpler demonstration of this theorem I worked out the following Its extreme simplicity suggested that it could scarcely be original; but as some years have elapsed, and as none of my friends have seen it else-

where, I send it to you as possibly of interest to some and perhaps of use where practical geometry is being taught. It is evident that the two larger squares are equal, the side of each being equal to the sum of the sides AB, AC of the triangle ABC. It is also clear that the four triangles marked "a" are equal to



one another. Again, the four triangles marked "b" are equal to one another, and to the four triangles marked "a."

Hence taking four times the triangle "a" from one of the large squares and four times triangle "b" from the other, there remain in the one case the square on BC, and in the other case the squares on AB and AC, and these remainders are equal. Therefore the square on the hypothenuse is equal to the sum of the squares on the other two sides.

A. J. BICKERTON

Canterbury College, New Zealand University, June 15.

[The principle of the above solution is not new. A proof, by dissection, depending on it is given in several text books. The novelty of it consists in the position of the squares by means of which the truth of the property is seen in one figure.]

Musical Sand. Lava in the Bournemouth Drift.

IN reference to the note in NATURE (July 21) respecting musical sand in Australia, permit me to say that the subject has long since received attention there. I am away from references at present, but I should think it must be over two years since Mr. Sidney Olliff kindly sent me samples from Botany Bay. The samples sent were enclosed in small canvas bags, and, though there was probably not more than half-an-ounce of each, they were very musical on reaching me. For purity and musical effect, the Botany Bay samples were more like the Eigg sand than any other kinds I had previously examined.

During the last five years I have been collecting the various kinds of rock found in the Bournemouth high-level gravels (Codrington). A section has lately been exposed at the head of Alum Chine. Here a bed of angular and sub angular flint gravel 5 ft. (varying) in thickness rests on the Bagshots, and is covered by sand, humus, and peat. At the base of the gravel bed I disinterred (on the 17th inst.) a small piece of vesicular lava, much decomposed in places, but retaining more than sufficient of its original structure for purposes of identification.

The specimen will be sliced for the microscope; in the meantime I draw attention to it because it is, to my knowledge, the first specimen of vesicular lava that has been found in these gravels.

CECIL CARUS WILSON

Oxford, July 27.

The Flora and Fauna of Bromley.

THE Bromley Naturalists' Society have recently appointed a Special Committee to draw up lists of the flora and fauna of the Bromley Union District. This district comprises the parishes of Beckenham, Bromley, Chelsfield, Chislehurst, Cudham, Down, Farnborough, Foots Cray, Hayes, Keston, Knockholt, Mottingham, North Cray, Orpington, St. Mary Cray, St. Paul's Cray, and West Wickham.

I am desired to ask you to allow me to state that the Special Committee will be glad to receive from your readers any information which in their opinion might be of service to the Committee.

J. FRENCH,
Hon. Sec. Special Committee.

99, Widmore-road, Bromley, Kent, July 27.

THE BRITISH ASSOCIATION.

EDINBURGH.

AN Edinburgh meeting of the British Association seems almost a home meeting. At every turn we are reminded of some of those who bore their part in founding and building up the Parliament of Science. Sir David Brewster meets us in the University quadrangle. The chair now set apart for the President of Section A was occupied for many years by James David Forbes, while for one brief year Natural History in Edinburgh was identified with Edward Forbes, to whom the Association owes, among many greater things, the evolution of the Red Lion. Viewed through the vista of years, the intellectual life of Edinburgh seems to have been marked by the combination of the love of science and letters with the full enjoyment of social intercourse, and we have before us such evidence of the persistence of this trait as bodes well for the success of the meeting.

The reception rooms are in keeping with the dignity of the Association, and afford every facility for the transaction of business. The programme of local arrangements which has been put in the hands of members indicates ample variety of occupation for hours of leisure. This pamphlet is of convenient size and easy of reference. In one point of detail it is worthy of remark; its maps do not require to be unfolded; these are two, one showing clearly, although on a small scale, Edinburgh and its suburbs, and the other giving, on a large scale, the part of the city which will be most frequently traversed by visitors. The Excursion Handbook has evidently been compiled with much care, and it will prove an interesting and artistic souvenir of the meeting.

Sir Archibald Geikie, the President of the Association, was President of the Geological section at the 1871 Edinburgh meeting. His address, suggested by the centenary of Hutton's "Theory of the Earth," deals with a subject in which Scottish geologists have ever been well to the front. The last decade of geological work in Scotland has done much to unlock the secrets of rock structure, and there could be no more fit exponent of the results than the president.

In the section programmes we hear promise of many welcome papers and several important discussions; in Section A, on Monday, the question of a National Physical Laboratory will be dealt with; while Tuesday will be devoted to a discussion on electrical units, in this Prof. von Helmholtz is expected to take part; Section B and D will consider bacteriology, with special reference to Brewing; Section D, "Fisheries"; Section F, "Old Age Pensions." In Section C, the feature of the meeting is likely to be the review of recent work in the geology of Scotland, and the presence of a considerable number of foreign geologists is sure to lead to interesting discussions. The Prince of Monaco will give in Section E the results of his observations on ocean currents. Section G will this year devote some attention to the subject on which there is much difference of opinion, the education of engineers.

INAUGURAL ADDRESS BY SIR ARCHIBALD GEIKIE, LL.D., D.SC., FOR SEC. R.S., F.R.S.E., F.G.S., DIRECTOR GENERAL OF THE GEOLOGICAL SURVEY OF THE UNITED KINGDOM, PRESIDENT

IN its beneficent progress through these islands the British Association for the Advancement of Science now for the fourth time receives a welcome in this ancient capital. Once again, under the shadow of these antique towers, crowded memories of a romantic past fill our thoughts. The stormy annals of Scotland seem to move in procession before our eyes as we walk these streets, whose names and traditions have been made familiar to the civilized world by the genius of literature. At every turn, too, we are reminded, by the monuments which a grateful city has erected, that for many generations the pursuits which we are now assembled to foster have had here their congenial home. Literature, philosophy, science, have each in turn been guided by the influence of the great masters who have lived here, and whose renown is the brightest gem in the chaplet around the brow of this "Queen of the North."

Lingering for a moment over these local associations, we shall find a peculiar appropriateness in the time of this renewed visit of the Association to Edinburgh. A hundred years ago a remarkable group of men was discussing here the great problem of the history of the earth. James Hutton, after many years of travel and reflection, had communicated to the Royal Society of this city, in the year 1785, the first outlines of his famous "Theory of the Earth." Among those with whom he took counsel in the elaboration of his doctrines were Black, the illustrious discoverer of "fixed air" and "latent heat"; Clerk, the sagacious inventor of the system of breaking the enemy's line in naval tactics; Hall, whose fertile ingenuity devised the first system of experiments in illustration of the structure and origin of rocks; and Playfair, through whose sympathetic enthusiasm and literary skill Hutton's views came ultimately to be understood and appreciated by the world at large. With these friends, so well able to comprehend and criticize his efforts to pierce the veil that shrouded the history of this globe, he paced the streets amid which we are now gathered together; with them he sought the crags and ravines around us, wherein Nature has laid open so many impressive records of her past; with them he sallied forth on those memorable expeditions to distant parts of Scotland, whence he returned laden with treasures from a field of observation which, though now so familiar, was then almost untrodden. The centenary of Hutton's "Theory of the Earth" is an event in the annals of science which seems most fittingly celebrated by a meeting of the British Association in Edinburgh.

In choosing from among the many subjects which might properly engage your attention on the present occasion, I have thought that it would not be inappropriate nor uninteresting to consider the more salient features of that "Theory," and to mark how much in certain departments of inquiry has sprung from the fruitful teaching of its author and his associates.

It was a fundamental doctrine of Hutton and his school that this globe has not always worn the aspect which it bears at present; that, on the contrary, proofs may everywhere be culled that the land which we now see has been formed out of the wreck of an older land. Among these proofs the most obvious are supplied by some of the more familiar kinds of rock, which teach us that, though they are now portions of the dry land, they were originally sheets of gravel, sand, and mud, which had been worn from the face of long-vanished continents, and after being spread out over the floor of the sea, were consolidated into compact stone, and were finally broken up and raised once more to form part of the dry land. This cycle of change involved two great systems of natural processes. On the one hand, men were taught that by the action of running water the materials of the solid land are in a state of continual decay and transport to the ocean. On the other hand, the ocean floor is liable from time to time to be upheaved by some stupendous internal force akin to that which gives rise to the volcano and the earthquake. Hutton further perceived that, not only had the consolidated materials been disrupted and elevated, but that masses of molten rock had been thrust upward among them, and had cooled and crystallized in large bodies of granite and other eruptive rocks which form so prominent a feature on the earth's surface.

It was a special characteristic of this philosophical system that it sought in the changes now in progress on the earth's surface an explanation of those which occurred in older times. Its founder refused to invent causes or modes of operation, for those with which he was familiar seemed to him adequate to solve the problems with which he attempted to deal. Nowhere was the profoundness of his insight more astonishing than in the clear, definite way in which he proclaimed and reiterated his doctrine, that every part of the surface of the continents, from mountain-top to sea-shore, is continually undergoing decay, and is thus slowly travelling to the sea. He saw that no sooner will the sea-floor be elevated into new land than it must necessarily become a prey to this universal and unceasing degradation. He perceived that, as the transport of disintegrated material is carried on chiefly by running water, rivers must slowly dig out for themselves the channels in which they flow, and thus that a system of valleys, radiating from the water parting of a country, must necessarily result from the descent of the streams from the mountain crests to the sea. He discerned that this ceaseless and widespread decay would eventually lead to the entire demolition of the dry land, but he contended that from time to time this catastrophe is prevented by the operation of the underground forces, whereby new continents are upheaved from the bed of the ocean. And thus in his system a due proportion is maintained between land and water, and the condition of the earth as a habitable globe is preserved.

A theory of the earth so simple in outline, so bold in conception, so full of suggestion, and resting on so broad a base of observation and reflection, ought, we might think, to have commanded at once the attention of men of science, even if it did not immediately awaken the interest of the outside world; but, as Playfair sorrowfully admitted, it attracted notice only very slowly, and several years elapsed before any one showed himself publicly concerned about it, either as an enemy or a friend. Some of its earliest critics assailed it for what they asserted to be its irreligious tendency—an accusation which Hutton repudiated with much warmth. The sneer levelled by Cowper a few years earlier at all inquiries into the history of the universe was perfectly natural and intelligible from that poet's point of view. There was then a widespread belief that this world came into existence some six thousand years ago, and that any attempt greatly to increase that antiquity was meant as a blow to the authority of Holy Writ. So far, however, from aiming at the overthrow of orthodox beliefs, Hutton evidently regarded his "Theory" as an important contribution in aid of natural religion. He dwelt with unfeigned pleasure on the multitude of proofs which he was able to accumulate of an orderly design in the operations of nature, decay and renovation being so nicely balanced as to maintain the habitable condition of the planet; but as he refused to admit the predominance of violent action in terrestrial changes, and on the contrary contended for the efficacy of the quiet, continuous processes which we can even now see at work around us, he was constrained to require an unlimited duration of past time for the production of those revolutions of which he perceived such clear and abundant proofs in the crust of the earth. The general public, however, failed to comprehend that the doctrine of the high antiquity of the globe was not inconsistent with the comparatively recent appearance of man—a distinction which seems so obvious now.

Hutton died in 1797, beloved and regretted by the circle of friends who had learnt to appreciate his estimable character and to admire his genius, but with little recognition from the world at large. Men knew not then that a great master had passed away from their midst, who had laid broad and deep the foundations of a new science; that his name would become a household word in after generations, and that pilgrims would come from distant lands to visit the scenes from which he drew his inspiration.

Many years might have elapsed before Hutton's teaching met with wide acceptance, had its recognition depended solely on the writings of the philosopher himself. For, despite his firm grasp of general principles and his mastery of the minutest details, he had acquired a literary style which, it must be admitted, was singularly unattractive. Fortunately for his fame, as well as for the cause of science, his devoted friend and disciple, Playfair, at once set himself to draw up an exposition of Hutton's views. After five years of labour on this task there appeared the classic "Illustrations of the Huttonian Theory," a work which for luminous treatment and graceful diction stands still without a rival in English geological literature. Though professing merely to set forth his friend's doctrines, Playfair's

treatise was in many respects an original contribution to science of the highest value It placed for the first time in the clearest light the whole philosophy of Hutton regarding the history of the earth, and enforced it with a wealth of reasoning and copiousness of illustration which obtained for it a wide appreciation. From long converse with Hutton, and from profound reflection himself, Playfair gained such a comprehension of the whole subject that, discarding the non-essential parts of his master's teaching, he was able to give so lucid and accurate an exposition of the general scheme of Nature's operations on the surface of the globe, that with only slight corrections and expansions his treatise may serve as a text book to-day In some respects, indeed, his volume was long in advance of its time. Only, for example, within the present generation has the truth of his teaching in regard to the origin of valleys been generally admitted

Various causes contributed to retard the progress of the Huttonian doctrines. Especially potent was the influence of the teaching of Werner, who, though he perceived that a definite order of sequence could be recognized among the materials of the earth's crust, had formed singularly narrow conceptions of the great processes whereby that crust has been built up His enthusiasm, however, fired his disciples with the zeal of proselytes, and they spread themselves over Europe to preach everywhere the artificial system which they had learnt in Saxony By a curious fate Edinburgh became one of the great headquarters of Wernerism The friends and followers of Hutton found themselves attacked in their own city by zealots who, proud of superior mineralogical acquirements, turned their most cherished ideas upside down and assailed them in the uncouth jargon of Freiberg. Inasmuch as subterranean heat had been invoked by Hutton as a force largely instrumental in consolidating and upheaving the ancient sediments that now form so great a part of the dry land, his followers were nicknamed Plutonists On the other hand, as the agency of water was almost alone admitted by Werner, who believed the rocks of the earth's crust to have been chiefly chemical precipitates from a primeval universal ocean, those who adopted his views received the equally descriptive name of Neptunists The battle of these two contending schools raged fiercely here for some years, and though mainly from the youth, zeal, and energy of Jameson, and the influence which his position as Professor in the University gave him, the Wernerian doctrines continued to hold their place, they were eventually abandoned even by Jameson himself, and the debt due to the memory of Hutton and Playfair was tardily acknowledged.

The pursuits and the quarrels of philosophers have from early times been a favourite subject of merriment to the outside world. Such a feud as that between the Plutonists and Neptunists would be sure to furnish abundant matter for the gratification of this propensity Turning over the pages of Kay's "Portraits," where so much that was distinctive of Edinburgh's society a hundred years ago is embalmed, we find Hutton's personal peculiarities and pursuits touched off in good humoured caricature In one plate he stands with arms folded and hammer in hand, meditating on the face of a cliff, from which rocky prominences in shape of human faces, perhaps grotesque likenesses of his scientific opponents, grin at him In another engraving he sits in conclave with his friend Black, possibly arranging for that famous banquet of garden-snails which the two worthies had persuaded themselves to look upon as a strangely neglected form of human food More than a generation later, when the Huttonists and Wernerists were at the height of their antagonism, the humorous side of the controversy did not escape the notice of the author of "Waverley," who, you will remember, when he makes Meg Dods recount the various kinds of wise folk brought by Lady Penelope Pennfeather from Edinburgh to St. Ronan's Well, does not forget to include those who "rin uphill and down dale, knapping the chucky stanes to pieces wi' hammers, like sae mony road-makers run daft, to see how the warld was made."

Among the names of the friends and followers of Hutton there is one which on this occasion deserves to be held in especial honour, that of Sir James Hall, of Dunglass. Having accompanied Hutton in some of his excursions, and having discussed with him the problems presented by the rocks of Scotland, Hall was familiar with the views of his master, and was able to supply him with fresh illustrations of them from different parts of the country. Gifted with remarkable originality and ingenuity, he soon perceived that some of the questions involved in the theory of the earth could probably be solved by direct physical experiment Hutton, however, mistrusted any attempt "to judge of the great operations of Nature by merely kindling a fire and looking into the bottom of a little crucible." Out of deference to this prejudice Hall delayed to carry out his intention during Hutton's lifetime. But afterwards he instituted a remarkable series of researches which are memorable in the history of science as the first methodical endeavour to test the value of geological speculation by an appeal to actual experiment. The Neptunists, in ridiculing the Huttonian doctrine that basalt and similar rocks had once been molten, asserted that, had such been their origin, these masses would now be found in the condition of glass or slag Hall, however, triumphantly vindicated his friend's view by proving that basalt could be fused, and thereafter by slow cooling could be made to resume a stony texture Again, Hutton had asserted that under the vast pressures which must be effective deep within the earth's crust, chemical reactions must be powerfully influenced, and that under such conditions even limestone may conceivably be melted without losing its carbonic acid Various specious arguments have been adduced against this proposition, but by an ingeniously devised series of experiments, Hall succeeded in converting limestone under great pressure into a kind of marble, and even fused it, and found that it then acted vigorously on other rocks These admirable researches which laid the foundations of experimental geology, constitute not the least memorable of the services rendered by the Huttonian school to the progress of science

Clear as was the insight and sagacious the inferences of these great masters in regard to the history of the globe, their vision was necessarily limited by the comparatively narrow range of ascertained fact which up to their time had been established They taught men to recognize that the present world is built of the ruins of an earlier one, and they explained with admirable perspicacity the operation of the processes whereby the degradation and renovation of land are brought about But they never dreamed that a long and orderly series of such successive destructions and renewals had taken place, and had left their records in the crust of the earth They never imagined that from these records it would be possible to establish a determinate chronology that could be read everywhere, and applied to the elucidation of the remotest quarter of the globe It was by the memorable observations and generalizations of William Smith that this vast extension of our knowledge of the past history of the earth become possible While the Scottish philosophers were building up their theory here, Smith was quietly ascertaining by extended journeys that the stratified rocks of the West of England occur in a definite sequence, and that each well-marked group of them can be discriminated from the others and identified across the country by means of its enclosed organic remains It is nearly a hundred years since he made known his views, so that by a curious coincidence we may fitly celebrate on this occasion the centenary of William Smith as well as that of James Hutton No single discovery has ever had a more momentous and far-reaching influence on the progress of a science than that law of organic succession which Smith established At first it served merely to determine the order of the stratified rocks of England But it soon proved to possess a world-wide value, for it was found to furnish the key to the structure of the whole stratified crust of the earth It showed that within that crust lie the chronicles of a long history of plant and animal life upon this planet, it supplied the means of arranging the materials for this history in true chronological sequence, and it thus opened out a magnificent vista through a vast series of ages, each marked by its own distinctive types of organic life, which, in proportion to their antiquity, departed more and more from the aspect of the living world

Thus a hundred years ago, by the brilliant theory of Hutton and the fruitful generalization of Smith, the study of the earth received in our country the impetus which has given birth to the modern science of geology.

To review the marvellous progress which this science has made during the first century of its existence would require not one but many hours for adequate treatment The march of discovery has advanced along a multitude of different paths, and the domains of Nature which have been included within the growing territories of human knowledge have been many and ample. Nevertheless, there are certain departments of investigation to which we may profitably restrict our attention on the present occasion, and wherein we may see how the leading

principles that were proclaimed in this city a hundred years ago have germinated and borne fruit all over the world

From the earliest times the natural features of the earth's surface have arrested the attention of mankind The rugged mountain, the cleft ravine, the scarped cliff, the solitary boulder, have stimulated curiosity and prompted many a speculation as to their origin The shells embedded by millions in the solid rocks of hills far removed from the sea have still further pressed home these "obstinate questionings" But for many long centuries the advance of inquiry into such matters was arrested by the paramount influence of orthodox theology It was not merely that the Church opposed itself to the simple and obvious interpretation of these natural phenomena So implicit had faith become in the accepted views of the earth's age and of the history of creation, that even laymen of intelligence and learning set themselves unbidden and in perfect good faith to explain away the difficulties which Nature so persistently raised up, and to reconcile her teachings with those of the theologians In the various theories thus originating, the amount of knowledge of natural law usually stood in inverse ratio to the share played in them by an uncontrolled imagination The speculations, for example, of Burnet, Whiston, Whitehurst, and others in this country, cannot be read now without a smile In no sense were they scientific researches, they can only be looked upon as exercitations of learned ignorance Springing mainly out of a laudable desire to promote what was believed to be the cause of true religion, they helped to retard inquiry, and exercised in that respect a baneful influence on intellectual progress

It is the special glory of the Edinburgh school of geology to have cast aside all this fanciful trifling Hutton boldly proclaimed that it was no part of his philosophy to account for the beginning of things His concern lay only with the evidence furnished by the earth itself as to its origin With the intuition of true genius he early perceived that the only solid basis from which to explore what has taken place in byegone time is a knowledge of what is taking place to-day He thus founded his system upon a careful study of the processes whereby geological changes are now brought about. He felt assured that Nature must be consistent and uniform in her working, and that only in proportion as her operations at the present time are watched and understood will the ancient history of the earth become intelligible Thus, in his hands, the investigation of the Present became the key to the interpretation of the Past The establishment of this great truth was the first step towards the inauguration of a true science of the earth The doctrine of the uniformity of causation in Nature became the fruitful principle on which the structure of modern geology could be built up

Fresh life was now breathed into the study of the earth A new spirit seemed to animate the advance along every pathway of inquiry Facts that had long been familiar came to possess a wider and deeper meaning when their connection with each other was recognized as parts of one great harmonious system of continuous change In no department of Nature, for example, was this broader vision more remarkably displayed than in that wherein the circulation of water between land and sea plays the most conspicuous part From the earliest times men had watched the coming of clouds, the fall of rain, the flow of rivers, and had recognized that on this nicely adjusted machinery the beauty and fertility of the land depend But they now learnt that this beauty and fertility involve a continual decay of the terrestrial surface, that the soil is a measure of this decay, and would cease to afford us maintenance were it not continually removed and renewed, that through the ceaseless transport of soil by rivers to the sea the face of the land is slowly lowered in level and carved into mountain and valley, and that the materials thus borne outwards to the floor of the ocean are not lost, but accumulate there to form rocks, which in the end will be upraised into new lands. Decay and renovation, in well-balanced proportions, were thus shown to be the system on which the existence of the earth as a habitable globe had been established. It was impossible to conceive that the economy of the planet could be maintained on any other basis Without the circulation of water the life of plants and animals would be impossible, and with that circulation the decay of the surface of the land and the renovation of its disintegrated materials are necessarily involved

As it is now so must it have been in past time. Hutton and Playfair pointed to the stratified rocks of the earth's crust as demonstrations that the same processes which are at work to-day have been in operation from a remote antiquity. By thus placing their theory on a basis of actual observation, and providing in the study of existing operations a guide to the interpretation of those in past times, they rescued the investigation of the history of the earth from the speculations of theologians and cosmologists, and established a place for it among the recognized inductive sciences To the guiding influence of their philosophical system the prodigious strides made by modern geology are in large measure to be attributed And here in their own city, after the lapse of a hundred years, let us offer to their memory the grateful homage of all who have profited by their labours

But while we recognize with admiration the far reaching influence of the doctrine of uniformity of causation in the investigation of the history of the earth, we must upon reflection admit that the doctrine has been pushed to an extreme perhaps not contemplated by its original founders To take the existing conditions of Nature as a platform of actual knowledge from which to start in an inquiry into former conditions was logical and prudent Obviously, however, human experience, in the few centuries during which attention has been turned to such subjects, has been too brief to warrant any dogmatic assumption that the various natural processes must have been carried on in the past with the same energy and at the same rate as they are carried on now. Variations in energy might have been legitimately conceded as possible, though not to be allowed without reasonable proof in their favour It was right to refuse to admit the operation of speculative causes of change when the phenomena were capable of natural and adequate explanation by reference to causes that can be watched and investigated But it was an error to take for granted that no other kind of process or influence, nor any variation in the rate of activity save those of which man has had actual cognizance, has played a part in the terrestrial economy The uniformitarian writers laid themselves open to the charge of maintaining a kind of perpetual motion in the machinery of Nature They could find in the records of the earth's history no evidence of a beginning, no prospect of an end They saw that many successive renovations and destructions had been effected on the earth's surface, and that this long line of vicissitudes formed a series of which the earliest were lost in antiquity, while the latest were still in progress towards an apparently illimitable future

The discoveries of William Smith, had they been adequately understood, would have been seen to offer a corrective to this rigidly uniformitarian conception, for they revealed that the crust of the earth contains the long record of an unmistakable order of progression in organic types They proved that plants and animals have varied widely in successive periods of the earth's history, the present condition of organic life being only the latest phase of a long preceding series, each stage of which recedes further from the existing aspect of things as we trace it backward into the past And though no relic had yet been found, or indeed was ever likely to be found, of the first living things that appeared upon the earth's surface, the manifest simplification of types in the older formations pointed irresistibly to some beginning from which the long procession had taken its start If then it could thus be demonstrated that there had been upon the globe an orderly march of living forms from the lowliest grades in early times to man himself to day, and thus that in one department of her domain, extending through the greater portion of the records of the earth's history, Nature had not been uniform but had followed a vast and noble plan of evolution, surely it might have been expected that those who discovered and made known this plan would seek to ascertain whether some analogous physical progression from a definite beginning might not be discernible in the framework of the globe itself.

But the early masters of the science laboured under two great disadvantages In the first place, they found the oldest records of the earth's history so broken up and effaced as to be no longer legible And in the second place, they lived under the spell of that strong reaction against speculation which followed the bitter controversy between the Neptunists and Plutonists in the earlier decades of the century They considered themselves bound to search for facts, not to build up theories, and as in the crust of the earth they could find no facts which threw any light upon the primeval constitution and subsequent development of our planet, they shut their ears to any theoretical interpretations that might be offered from other departments of science. It was enough for them to maintain, as Hutton had

done, that in the visible structure of the earth itself no trace can be found of the beginning of things, and that the oldest terrestrial records reveal no physical conditions essentially different from those in which we still live. They doubtless listened with interest to the speculations of Kant, Laplace, and Herschel, on the probable evolution of nebulæ, suns, and planets, but it was with the languid interest attaching to ideas that lay outside of their own domain of research. They recognized no practical connection between such speculations and the data furnished by the earth itself as to its own history and progress.

This curious lethargy with respect to theory on the part of men who were popularly regarded as among the most speculative followers of science would probably not have been speedily dispelled by any discovery made within their own field of observation. Even now, after many years of the most diligent research, the first chapters of our planet's history remain undiscovered or undecipherable. On the great terrestrial palimpsest the earliest inscriptions seem to have been hopelessly effaced by those of later ages. But the question of the primeval condition and subsequent history of the planet might be considered from the side of astronomy and physics. And it was by investigations of this nature that the geological torpor was eventually dissipated. To our illustrious former President, Lord Kelvin, who occupied this chair when the Association last met in Edinburgh, is mainly due the rousing of attention to this subject. By the most convincing arguments he showed how impossible it was to believe in the extreme doctrine of uniformitarianism. And though, owing to uncertainty in regard to some of the data, wide limits of time were postulated by him, he insisted that within these limits the whole evolution of the earth and its inhabitants must have been comprised. While, therefore, the geological doctrine that the present order of Nature must be our guide to the interpretation of the past remained as true and fruitful as ever, it had now to be widened by the reception of evidence furnished by a study of the earth as a planetary body. The secular loss of heat, which demonstrably takes place both from the earth and the sun, made it quite certain that the present could not have been the original condition of the system. This diminution of temperature with all its consequences is not a mere matter of speculation, but a physical fact of the present time as much as any of the familiar physical agencies that affect the surface of the globe. It points with unmistakable directness to that beginning of things of which Hutton and his followers could find no sign.

Another modification or enlargement of the uniformitarian doctrine was brought about by continued investigation of the terrestrial crust and consequent increase of knowledge respecting the history of the earth. Though Hutton and Playfair believed in periodical catastrophes, and indeed required these to recur in order to renew and preserve the habitable condition of our planet, their successors gradually came to view with repugnance any appeal to abnormal, and especially to violent manifestations of terrestrial vigour, and even persuaded themselves that such slow and comparatively feeble action as had been witnessed by man could alone be recognized in the evidence from which geological history must be compiled. Well do I remember in my own boyhood what a cardinal article of faith this prepossession had become. We were taught by our great and honoured master, Lyell, to believe implicitly in gentle and uniform operations, extended over indefinite periods of time, though possibly some, with the zeal of partisans, carried this belief to an extreme which Lyell himself did not approve. The most stupendous marks of terrestrial disturbance, such as the structure of great mountain chains, were deemed to be more satisfactorily accounted for by slow movements prolonged through indefinite ages than by any sudden convulsion.

What the more extreme members of the uniformitarian school failed to perceive was the absence of all evidence that terrestrial catastrophes even on a colossal scale might not be a part of the present economy of this globe. Such occurrences might never seriously affect the whole earth at one time, and might return at such wide intervals that no example of them has yet been chronicled by man. But that they have occurred again and again, and even within comparatively recent geological times, hardly admits of serious doubt. How far at different epochs and in various degrees they may have included the operation of cosmical influences lying wholly outside the planet, and how far they have resulted from movements within the body of the planet itself, must remain for further inquiry. Yet the admission that they have played a part in geological history may be freely made without impairing the real value of the Huttonian doctrine, that in the interpretation of this history our main must be a knowledge of the existing processes of terrestrial change.

As the most recent and best known of these great transformations, the Ice Age stands out conspicuously before us. If any one sixty years ago had ventured to affirm that at no very distant date the snows and glaciers of the Arctic regions stretched southwards into France, he would have been treated as a mere visionary theorist. Many of the facts to which he would have appealed in support of his statement were already well known, but they had received various other interpretations. By some observers, notably by Hutton's friend, Sir James Hall, they were believed to be due to violent debacles of water that swept over the face of the land. By others they were attributed to the strong tides and currents of the sea when the land stood at a lower level. The uniformitarian school of Lyell had no difficulty in elevating or depressing land to any required extent. Indeed, when we consider how averse these philosophers were to admit any kind or degree of natural operation other than those of which there was some human experience, we may well wonder at the boldness with which, on sometimes the slenderest evidence, they made land and sea change places, on the one hand submerging mountain ranges, and on the other placing great barriers of land where a deep ocean rolls. They took such liberties with geography because only well-established processes of change were invoked in the operations. Knowing that during the passage of an earthquake a territory bordering the sea may be upraised or sunk a few feet, they drew the sweeping inference that any amount of upheaval or depression of any part of the earth's surface might be claimed in explanation of geological problems. The progress of inquiry, while it has somewhat curtailed this geographical license, has now made known in great detail the strange story of the Ice Age.

There cannot be any doubt that after man had become a denizen of the earth, a great physical change came over the northern hemisphere. The climate, which had previously been so mild that evergreen trees flourished within ten or twelve degrees of the north pole, now became so severe that vast sheets of snow and ice covered the north of Europe and crept southward beyond the south coast of Ireland, almost as far as the southern shores of England, and across the Baltic into France and Germany. This Arctic transformation was not an episode that lasted merely a few seasons, and left the land to resume thereafter its ancient aspect. With various successive fluctuations it must have endured for many thousands of years. When it began to disappear it probably faded away as slowly and imperceptibly as it had advanced, and when it finally vanished it left Europe and North America profoundly changed in the character alike of their scenery and of their inhabitants. The rugged rocky contours of earlier times were ground smooth and polished by the march of the ice across them, while the lower grounds were buried under wide and thick sheets of clay, gravel, and sand, left behind by the melting ice. The varied and abundant flora which had spread so far within the Arctic circle was driven away into more southern and less ungenial climes. But most memorable of all was the extirpation of the prominent large animals which, before the advent of the ice, had roamed over Europe. The lions, hyænas, wild horses, hippopotami, and other creatures either became entirely extinct or were driven into the Mediterranean basin and into Africa. In their place came northern forms—the reindeer, glutton, musk ox, woolly rhinoceros, and mammoth.

Such a marvellous transformation in climate, in scenery, in vegetation and in inhabitants, within what was after all but a brief portion of geological time, though it may have involved no sudden or violent convulsion, is surely entitled to rank as a catastrophe in the history of the globe. It was probably brought about mainly if not entirely by the operation of forces external to the earth. No similar calamity having befallen the continents within the time during which man has been recording his experience, the Ice Age might be cited as a contradiction to the doctrine of uniformity, and yet it manifestly arrived as part of the established order of Nature. Whether or not we grant that other Ice ages preceded the last great one, we must admit that the conditions under which it arose, so far as we know them, might conceivably have occurred before and may occur again. The various agencies called into play by the extensive refrigeration of the northern hemisphere were not different from those with which we are familiar. Snow fell and glaciers

crept as they do to-day. Ice scored and polished rocks exactly as it still does among the Alps and in Norway. There was nothing abnormal in the phenomena save the scale on which they were manifested. And thus, taking a broad view of the whole subject, we recognize the catastrophe, while at the same time we see in its progress the operation of those same natural processes which we know to be integral parts of the machinery whereby the surface of the earth is continually transformed.

Among the debts which science owes to the Huttonian school, not the least memorable is the promulgation of the first well-founded conceptions of the high antiquity of the globe. Some six thousand years had previously been believed to comprise the whole life of the planet, and indeed of the entire universe. When the curtain was then first raised that had veiled the history of the earth, and men, looking beyond the brief span within which they had supposed that history to have been transacted, beheld the records of a long vista of ages stretching far away into a dim illimitable past, the prospect vividly impressed their imagination. Astronomy had made known the immeasurable fields of space; the new science of geology seemed now to reveal boundless distances of time. The more the terrestrial chronicles were studied the farther could the eye range into an antiquity so vast as to defy all attempts to measure or define it. The progress of research continually furnished additional evidence of the enormous duration of the ages that preceded the coming of man, while, as knowledge increased, periods that were thought to have followed each other consecutively were found to have been separated by prolonged intervals of time. Thus the idea arose and gained universal acceptance that, just as no boundary could be set to the astronomer in his free range through space, so the whole of bygone eternity lay open to the requirements of the geologist. Playfair, re-echoing and expanding Hutton's language, had declared that neither among the records of the earth nor in the planetary motions can any trace be discovered of the beginning or of the end of the present order of things; that no symptom of infancy or of old age has been allowed to appear on the face of Nature, nor any sign by which either the past or the future duration of the universe can be estimated; and that although the Creator may put an end, as He no doubt gave a beginning, to the present system, such a catastrophe will not be brought about by any of the laws now existing, and is not indicated by anything which we perceive. This doctrine was naturally espoused with warmth by the extreme uniformitarian school, which required an unlimited duration of time for the accomplishment of such slow and quiet cycles of change as they conceived to be alone recognizable in the record of the earth's past history.

It was Lord Kelvin who, in the writings to which I have already referred, first called attention to the fundamentally erroneous nature of these conceptions. He pointed out that from the high internal temperature of our globe, increasing inwards as it does, and from the rate of loss of its heat, a limit may be fixed to the planet's antiquity. He showed that so far from there being no sign of a beginning, and no prospect of an end to the present economy, every lineament of the solar system bears witness to a gradual dissipation of energy from some definite starting point. No very precise data were then, or indeed are now, available for computing the interval which has elapsed since that remote commencement, but he estimated that the surface of the globe could not have consolidated less than twenty millions of years ago, for the rate of increase of temperature inwards would in that case have been higher than it actually is; nor more than 400 millions of years ago, for then there would have been no sensible increase at all. He was inclined, when first dealing with the subject, to believe that from a review of all the evidence then available, some such period as 100 millions of years would embrace the whole geological history of the globe.

It is not a pleasant experience to discover that a fortune which one has unconcernedly believed to be ample has somehow taken to itself wings and disappeared. When the geologist was suddenly awakened by the energetic warning of the physicist, who assured him that he had enormously overdrawn his account with past time, it was but natural under the circumstances that he should think the accountant to be mistaken, who thus returned to him dishonoured the large drafts he had made on eternity. He saw how wide were the limits of time deducible from physical considerations, how vague the data from which they had been calculated. And though he could not help admitting that a limit must be fixed beyond which his chronology could not be extended, he consoled himself with the reflection that after all a hundred millions of years was a tolerably ample period of time, and might possibly have been quite sufficient for the transaction of all the prolonged sequence of events recorded in the crust of the earth. He was therefore disposed to acquiesce in the limitation thus imposed upon geological history.

But physical inquiry continued to be pushed forward with regard to the early history and the antiquity of the earth. Further consideration of the influence of tidal friction in retarding the earth's rotation, and of the sun's rate of cooling, led to sweeping reductions of the time allowable for the evolution of the planet. The geologist found himself in the plight of Lear when his bodyguard of one hundred knights was cut down. "What need you five-and-twenty, ten or five?" demands the inexorable physicist, as he remorselessly strikes slice after slice from his allowance of geological time. Lord Kelvin is willing, I believe, to grant us some twenty millions of years, but Prof. Tait would have us content with less than ten millions.

In scientific as in other mundane questions there may often be two sides, and the truth may ultimately be found not to lie wholly with either. I frankly confess that the demands of the early geologists for an unlimited series of ages were extravagant, and, even for their own purposes, unnecessary, and that the physicist did good service in reducing them. It may also be freely admitted that the latest conclusions from physical considerations of the extent of geological time require that the interpretation given to the record of the rocks should be rigorously revised, with the view of ascertaining how far that interpretation may be capable of modification or amendment. But we must also remember that the geological record constitutes a voluminous body of evidence regarding the earth's history which cannot be ignored, and must be explained in accordance with ascertained natural laws. If the conclusions derived from the most careful study of this record cannot be reconciled with those drawn from physical considerations, it is surely not too much to ask that the latter should be also revised. It has been well said that the mathematical mill is an admirable piece of machinery, but that the value of what it yields depends upon the quality of what is put into it. That there must be some flaw in the physical argument I can, for my own part, hardly doubt, though I do not pretend to be able to say where it is to be found. Some assumption, it seems to me, has been made, or some consideration has been left out of sight, which will eventually be seen to vitiate the conclusions, and which when duly taken into account will allow time enough for any reasonable interpretation of the geological record.

In problems of this nature, where geological data capable of numerical statement are so needful, it is hardly possible to obtain trustworthy computations of time. We can only measure the rate of changes in progress now, and infer from these changes the length of time required for the completion of results achieved by the same processes in the past. There is fortunately one great cycle of movement which admits of careful investigation, and which has been made to furnish valuable materials for estimates of this kind. The universal degradation of the land, so notable a characteristic of the earth's surface, has been regarded as an extremely slow process. Though it goes on without ceasing, yet from century to century it seems to leave hardly any perceptible trace on the landscapes of a country. Mountains and plains, hills and valleys, appear to wear the same familiar aspect which is indicated in the oldest pages of history. This obvious slowness in one of the most important departments of geological activity, doubtless contributed in large measure to form and foster a vague belief in the vastness of the antiquity required for the evolution of the earth.

But, as geologists eventually came to perceive, the rate of degradation of the land is capable of actual measurement. The amount of material worn away from the surface of any drainage-basin and carried in the form of mud, sand, or gravel, by the main river into the sea, represents the extent to which that surface has been lowered by waste in any given period of time. But denudation and deposition must be equivalent to each other. As much material must be laid down in sedimentary accumulations as has been mechanically removed, so that in measuring the annual bulk of sediment borne into the sea by a river, we obtain a clue not only to the rate of denudation of the land, but also to the rate at which the deposition of new sedimentary formations takes place.

As might be expected, the activities involved in the lowering of the surface of the land are not everywhere equally energetic They are naturally more vigorous where the rainfall is heavy, where the daily range of temperature is large, and where frosts are severe. Hence they are obviously much more effective in mountainous regions than on plains, and their results must constantly vary, not only in different basins of drainage, but even, and sometimes widely, within the same basin Actual measurement of the proportion of sediment in river water shows that while in some cases the lowering of the surface of the land may be as much as $\frac{1}{730}$ of a foot in a year, in others it falls as low as $\frac{1}{6800}$ In other words, the rate of deposition of new sedimentary formations, over an area of sea-floor equivalent to that which has yielded the sediment, may vary from one foot in 730 years to one foot in 6,800 years

If now we take these results and apply them as measures of the length of time required for the deposition of the various sedimentary masses that form the outer part of the earth's crust, we obtain some indication of the duration of geological history On a reasonable computation these stratified masses, where most fully developed, attain a united thickness of not less than 100,000 feet If they were all laid down at the most rapid recorded rate of denudation, they would require a period of seventy-three millions of years for their completion If they were laid down at the slowest rate they would demand a period of not less than 680 millions.

But it may be argued that all kinds of terrestrial energy are growing feeble, that the most active denudation now in progress is much less vigorous than that of bygone ages, and hence that the stratified part of the earth's crust may have been put together in a much briefer space of time than modern events might lead us to suppose Such arguments are easily adduced and look sufficiently specious, but no confirmation of them can be gathered from the rocks On the contrary, no one can thoughtfully study the various systems of stratified formations without being impressed by the fulness of their evidence that, on the whole, the accumulation of sediment has been extremely slow Again and again we encounter groups of strata composed of thin paper like laminæ of the finest silt, which evidently settled down quietly and at intervals on the sea bottom We find successive layers covered with ripple-marks and sun cracks, and we recognize in them memorials of ancient shores where sand and mud tranquilly gathered as they do in sheltered estuaries at the present day We can see no proof whatever, nor even any evidence which suggests, that on the whole the rate of waste and sedimentation was more rapid during Mesozoic and Palæozoic time than it is to-day Had there been any marked difference in this rate from ancient to modern times, it would be incredible that no clear proof of it should have been recorded in the crust of the earth.

But in actual fact the testimony in favour of the slow accumulation and high antiquity of the geological record is much stronger than might be inferred from the mere thickness of the stratified formations These sedimentary deposits have not been laid down in one unbroken sequence, but have had their continuity interrupted again and again by upheaval and depression So fragmentary are they in some regions, that we can easily demonstrate the length of time represented there by still existing sedimentary strata to be vastly less than the time indicated by the gaps in the series.

There is yet a further and impressive body of evidence furnished by the successive races of plants and animals which have lived upon the earth and have left their remains sealed up within its rocky crust No one now believes in the exploded doctrine that successive creations and universal destructions of organic life are chronicled in the stratified rocks It is everywhere admitted that, from the remotest times up to the present day, there has been an onward march of development, type succeeding type in one long continuous progression. As to the rate of this evolution precise data are wanting There is, however, the important negative argument furnished by the absence of evidence of recognizable specific variations of organic forms since man began to observe and record We know that within human experience a few species have become extinct, but there is no conclusive proof that a single new species has come into existence, nor are appreciable variations readily apparent in forms that live in a wild state. The seeds and plants found with Egyptian mummies, and the flowers and fruits depicted on Egyptian tombs, are easily identified with the vegetation of modern Egypt. The embalmed bodies of animals found in that country show no sensible divergence from the structure or proportions of the same animals at the present day The human races of Northern Africa and Western Asia were already as distinct when portrayed by the ancient Egyptian artists as they are now, and they do not seem to have undergone any perceptible change since then Thus a lapse of four or five thousand years has not been accompanied by any recognizable variation in such forms of plant and animal life as can be tendered in evidence Absence of sensible change in these instances is, of course, no proof that considerable alteration may not have been accomplished in other forms more exposed to vicissitudes of climate and other external influences. But it furnishes at least a presumption in favour of the extremely tardy progress of organic variation.

If, however, we extend our vision beyond the narrow range of human history, and look at the remains of the plants and animals preserved in those younger formations which, though recent when regarded as parts of the whole geological record, must be many thousands of years older than the very oldest of human monuments, we encounter the most impressive proofs of the persistence of specific forms Shells which lived in our seas before the coming of the Ice Age present the very same peculiarities of form, structure, and ornament which their descendants still possess The lapse of so enormous an interval of time has not sufficed seriously to modify them So too with the plants and the higher animals which still survive Some forms have become extinct, but few or none which remain display any transitional gradations into new species We must admit that such transitions have occurred, that indeed they have been in progress ever since organized existence began upon our planet, and are doubtless taking place now But we cannot detect them on the way, and we feel constrained to believe that their march must be excessively slow

There is no reason to think that the rate of organic evolution has ever seriously varied, at least no proof has been adduced of such variation Taken in connection with the testimony of the sedimentary rocks, the inferences deducible from fossils entirely bear out the opinion that the building up of the stratified crust of the earth has been extremely gradual If the many thousands of years which have elapsed since the Ice Age have produced no appreciable modification of surviving plants and animals, how vast a period must have been required for that marvellous scheme of organic development which is chronicled in the rocks!

After careful reflection on the subject, I affirm that the geological record furnishes a mass of evidence which no arguments drawn from other departments of Nature can explain away, and which, it seems to me, cannot be satisfactorily interpreted save with an allowance of time much beyond the narrow limits which recent physical speculation would concede.

I have reserved for final consideration a branch of the history of the earth which, while it has become, within the lifetime of the present generation, one of the most interesting and fascinating departments of geological inquiry, owed its first impulse to the far-seeing intellects of Hutton and Playfair With the penetration of genius these illustrious teachers perceived that if the broad masses of land and the great chains of mountains owe their origin to stupendous movements which from time to time have convulsed the earth, their details of contour must be mainly due to the eroding power of running water They recognized that as the surface of the land is continually worn down, it is essentially by a process of sculpture that the physiognomy of every country has been developed, valleys being hollowed out and hills left standing, and that these inequalities in topographical detail are only varying and local accidents in the progress of the one great process of the degradation of the land.

From the broad and guiding outlines of theory thus sketched we have now advanced amid ever-widening multiplicity of detail into a fuller and nobler conception of the origin of scenery The law of evolution is written as legibly on the landscapes of the earth as on any other page of the Book of Nature Not only do we recognize that the existing topography of the continents, instead of being primeval in origin, has gradually been developed after many precedent mutations, but we are enabled to trace these earlier revolutions in the structure of every hill and glen. Each mountain chain is thus found to be a memorial of many successive stages in geographical evolution. Within certain limits, land and sea have changed places again and again. Volcanoes have broken out and have become extinct in many countries long before the advent of man Whole tribes

of plants and animals have meanwhile come and gone, and in leaving their remains behind them as monuments at once of the slow development of organic types, and of the prolonged vicissitudes of the terrestrial surface, have furnished materials for a chronological arrangement of the earth's topographical features. Nor is it only from the organisms of former epochs that broad generalizations may be drawn regarding revolutions in geography. The living plants and animals of to day have been discovered to be eloquent of ancient geographical features that have long since vanished. In their distribution they tell us that climates have changed, that islands have been disjoined from continents, that oceans once united have been divided from each other, or once separate have now been joined, that some tracts of land have disappeared, while others for prolonged periods of time have remained in isolation. The present and the past are thus linked together not merely by dead matter, but by the world of living things, into one vast system of continuous progression.

In this marvellous increase of knowledge regarding the transformations of the earth's surface, one of the most impressive features, to my mind, is the power now given to us of perceiving the many striking contrasts between the present and former aspects of topography and scenery. We seem to be endowed with a new sense. What is seen by the bodily eye—mountain, valley, or plain—serves but as a veil, beyond which, as we raise it, visions of long lost lands and seas rise before us in a far-retreating vista. Pictures of the most diverse and opposite character are beheld, as it were, through each other, their lineaments subtly interwoven and even their most vivid contrasts subdued idto one blended harmony. Like the poet, "we see, but not by sight alone," and the "ray of fancy" which, as a sunbeam, lightened up his landscape, is for us broadened and brightened by that play of the imagination which science can so vividly excite and prolong.

Admirable illustrations of this modern interpretation of scenery are supplied by the district wherein we are now assembled. On every side of us rise the most convincing proofs of the reality and potency of that ceaseless sculpture by which the elements of landscape have been carved into their present shapes. Turn where we may, our eyes rest on hills that project above the lowland, not because they have been upheaved into these positions, but because their stubborn materials have enabled them better to withstand the degradation which has worn down the softer strata into the plains around them. Inch by inch the surface of the land has been lowered, and each hard rock successively laid bare has communicated its own characteristics of form and colour to the scenery.

If, standing on the Castle Rock, the central and oldest site in Edinburgh, we allow the bodily eye to wander over the fair landscape, and the mental vision to range through the long vista of earlier landscapes which science here reveals to us, what a strange series of pictures passes before our gaze! The busy streets of to-day seem to fade away into the mingled copse wood and forest of prehistoric time. Lakes that have long since vanished gleam through the woodlands, and a rude canoe pushing from the shore startles the red deer that had come to drink. While we look, the picture changes to a polar scene, with bushes of stunted Arctic willow and birch, among which herds of reindeer browse and the huge mammoth makes his home. Thick sheets of snow are draped all over the hills around, and far to the north-west the distant gleam of glaciers and snow-fields marks the line of the Highland mountains. As we muse on this strange contrast to the living world of to-day the scene appears to grow more Arctic in aspect, until every hill is buried under one vast sheet of ice, 2,000 feet or more in thickness, which fills up the whole midland valley of Scotland and creeps slowly eastward into the basin of the North Sea. Here the curtain drops upon our moving pageant, for in the geological record of this part of the country an enormous gap occurs before the coming of the Ice Age.

When once more the spectacle resumes its movement the scene is found to have utterly changed. The familiar hills and valleys of the Lothians have disappeared. Dense jungles of a strange vegetation—tall reeds, club-mosses, and tree-ferns—spread over the steaming swamps that stretch for leagues in all directions. Broad lagoons and open seas are dotted with little volcanic cones which throw out their streams of lava and showers of ashes. Beyond these, in dimmer outline and older in date, we descry a wide lake or inland sea, covering the whole midland valley and marked with long lines of active volcanoes, some of them several thousand feet in height. And still further and fainter over the same region, we may catch a glimpse of that still earlier expanse of sea which in Silurian times overspread most of Britain. But beyond this scene our vision fails. We have reached the limit across which no geological evidence exists to lead the imagination into the primeval darkness beyond.

Such in briefest outline is the succession of mental pictures which modern science enables us to frame out of the landscapes around Edinburgh. They may be taken as illustrations of what may be drawn, and sometimes with even greater fulness and vividness, from any district in these islands. But I cite them especially because of their local interest in connection with the present meeting of the Association, and because the rocks that yield them gave inspiration to those great masters whose claims on our recollection, not least for their explanation of the origin of *scenery*, I have tried to recount this evening. But I am further impelled to dwell on these scenes from an overmastering personal feeling to which I trust I may be permitted to give expression. It was these green hills and grey crags that gave me in boyhood the impulse that has furnished the work and joy of my life. To them, amid changes of scene and surroundings, my heart ever fondly turns, and here I desire gratefully to acknowledge that it is to their influence that I am indebted for any claim I may possess to stand in the proud position in which your choice has placed me.

SECTION A

MATHEMATICS AND PHYSICS

OPENING ADDRESS BY PROF. ARTHUR SCHUSTER, PH.D., F.R.S., F.R.A.S., PRESIDENT OF THE SECTION.

IN opening the proceedings of our Annual Meeting the temptation is great to look back on the year which has passed and to select for special consideration such work published during its course as may seem to be of the greatest importance. I fear, however, that a year is too short a time to allow us to form a fair estimate of the value of a scientific investigation. The mushroom, which shoots up quickly, only to disappear again, impresses us more than the slow-growing seedling which will live to be a tree, and it is difficult to recognize the scientific fungus in its early stage. But, although I do not feel competent to give you a review of the progress made in our subject during the last twelve months, there is one event to which some allusion should be made. It has been the sad duty of many of my predecessors to announce the death of successful workers in the field of science, but I believe I am unique in having the pleasure of recording the birth of a scientific man. At the beginning of this year there came into the world a being so brilliant that he could, without preparation, take up the work of the most eminent man amongst us. Believers in the transmigration of souls have speculated on the fact that Galileo's death and Newton's birth fell within a year of each other, but no event has ever happened so striking as that which took place on the 1st of January, when the mantle of Sir William Thomson fell on the infant Lord Kelvin. Those who have attended these meetings will feel with me that the honour done to our foremost representative, an honour which has been a source of pride and satisfaction to every student of science, could not altogether remain unnoticed in the section which owes him so much.

We are chiefly concerned here with the increase of scientific knowledge, and we derive pleasure in contrasting the minor state of ignorance of our own time with that which prevailed a hundred years ago. But when we contrast at the same time the refined opportunities of a modern research laboratory with the crude conditions under which the experimentalist had to work at the beginning of the century, we may fairly ask ourselves whether it is possible by means of any systematic course of study or by means of any organisation to accelerate our progress into the dark continent of science. A number of serious considerations arise in connection with this subject, and though I am not going to weary you by attempting an exhaustive discussion, I should like to draw your attention to a few matters which seem to me to be well worthy of the consideration of this Association. Changes are constantly made and proposed in our existing institutions, or new ones are suggested which are to serve the purpose of a more rapid accumulation of knowledge. I need only allude to the alterations in the curriculum of the science schools

in our old Universities, made partly for the purpose of fitting their graduates for the conduct of original research, or to the national laboratory proposed by my predecessor in this chair for carrying out a certain kind of scientific investigation, which at present is left undone, or is done by private enterprise. Even our own Association has not escaped the evil eye of the reformer, and, like other institutions, it may be capable of improvement. But in choosing the direction in which a change may best be made, I think we may learn something from the way in which Nature improves its organisms. We are taught by biologists that natural selection acts by developing those qualities which enable each species best to survive the struggle for existence; useless organs die off or become rudimentary. Nature teaches us, therefore, how a beautiful complex of beings, mutually dependent on each other, is formed by improving those parts which are best and most useful, and letting the rest take care of itself. But in many of the changes which have been made or are proposed the process of reform is very different. The weakest points are selected, our attention is drawn to some failure or something in which we are excelled by other nations, and attempts are made to cure what perhaps had better be left to become rudimentary. The proceeding is not objectionable as long as the nourishment which is applied to develop the weaker organs is not taken from those parts which we should specially take care to preserve. To apply these reflections to the questions with which we are specially concerned, I should like to see it more generally recognized that although there is no struggle for existence between different nations, yet each nation, owing to a number of circumstances, possesses its own peculiarities, which render it better fitted than its neighbours to do some particular part of the work on which the progress of science depends. No country, for instance, has rivalled France in the domain of accurate measurement, with which the names of Regnault and Amagat are associated, and the International Bureau of Weights and Measures has its fitting home in Paris.[1] The best work of the German Universities seems to me to consist in the following up of some theory to its logical conclusions and submitting it to the test of experiment. I doubt whether the efforts to transplant the research work of German Universities into this country will prove successful. Does it not seem well to let each country take that share of work for which the natural growth of its character and its educational establishment best adapt it?[2] Is it wise to remedy some weak point, to fill up undoubted gaps, if the soil that fills the gaps has to be taken from the hills and elevations which rise above the surrounding level?

As far as the work of this section is concerned the strongest domain of this country has been that of mathematical physics. But it is not to this that I wish specially to refer. Look at the work done in Great Britain during the last two centuries, the work not only in physics, but in astronomy, chemistry, biology. Is it not true that the one distinctive feature which separates this from all other countries in the world is the prominent part played by the scientific amateur, and is it not also true that our modern system of education tends to destroy the amateur?

By amateur I do not necessarily mean a man who has other occupations and only takes up science in his leisure hours, but rather one who has had no academical training, at any rate in that branch of knowledge which he finally selects for study. He has probably been brought up for some profession unconnected with science, and only begins his study when his mind is sufficiently developed to form an entirely unbiassed opinion. We may, perhaps, best define an amateur as one who learns his science as he wants it and when he wants it. I should call Faraday an amateur. He would have been impossible in another country; perhaps he would be impossible in the days of the Science and Art Department. Other names will occur to you, the most typical and eminent being that of Joule. It is not my purpose to discuss why distinguished amateurs have been so numerous in this country, but I am anxious to point out that we are in danger of losing one great and necessary factor in the origination of scientific ideas.

One of the distinctive features of an amateur is this, that he carries the weight of theories, often not the weight of knowledge, and, if I am right, there is a distinct advantage in having one section of scientific men beginning their work untrammelled by preconceived notions, which a systematic training in science is bound to instil. Whatever is taught in early age must necessarily be taught in a more or less dogmatic manner, and, in whatever way it is taught, experience shows that it is nearly always received in a dogmatic spirit. It seems important, therefore, to confine the early training to those subjects in which preconceived notions are considered an advantage. It is to me an uncongenial task to sound a note of warning to our old Universities, for the chief difficulties in which they are placed at present are due to the fact that they have given way too much to outside advice; but I cannot help expressing a strong conviction that their highly specialised entrance examinations are a curse to all sound school education, and will prove a still more fatal curse to what concerns us most nearly, the progress of scientific knowledge. If school examinations could be more general, if scientific theories could only be taught at an age when a man is able to form an independent judgment, there might be some hope of retaining that originality of ideas which has been a distinctive feature of this country, and enabled our amateurs to hold a prominent position in the history of science. At present a knowledge of scientific theories seems to me to kill all knowledge of scientific facts.

It is by no means true that a complete knowledge of everything that has a bearing on a particular subject is always necessary to success in an original investigation. In many cases such knowledge is essential, in others it is a hindrance. Different types of men incline to different types of research, and it is well to preserve the dual struggle. The engine which works out the great problems of nature may be likened to a thermodynamic machine. The amateur supplies the steam and the Universities supply the cold water; the former, boiling over often with ill-considered and fanciful ideas, does not like the icy douche, and the professional scientist does not like the latent heat of the condensing steam, but nevertheless the hotter the steam and the colder the water the better works the machine. Sometimes it happens that the boiler and cooler are both contained in the same brain, and each country can boast of a few such in a century, but most of us have to remain satisfied with forming only an incomplete part of the engine of research.

But while it is necessary to recognize the great work done by the unprofessional scientists, it seems not untimely to draw their attention to the damage done to themselves if they overstep their legitimate boundaries, and especially if they seek popular support for their theories, which have not received the approval of those who are competent to judge. An appeal from Alexander sober to Alexander drunk will not prove successful in the end.

The gradual disappearance of the amateur may be a necessary consequence of our increased educational facilities, and we must inquire whether any marked advantages are offered to us in exchange. There is one direction in which it would seem at first sight, at any rate, that a proper course of study could do much to facilitate the progress of research.

On another occasion I pointed out that two parties are necessary for every advance in science, the one that makes it and the one that believes in it. If the discoverer is born, and cannot be made, would it not be possible at any rate to train the judgment of our students so that they may form a sound opinion on the new theories and ideas which are presented to them? It is too early as yet to judge in how far our generation is better in this respect than the one that has gone before them, but on closer examination it does not seem to me to be obvious that any marked improvement is possible. Every new idea revolutionizing our opinions on some important question must necessarily take time before it takes a proper hold on the scientific world. Is it not true that anyone who can at once see the full importance of a new theory, and accept it in place of the one in which he has been brought up, must stand at a height almost equal to that of the originator? The more startling and fresh the new conception the fewer must be those who are ready to adopt it. But looking back at the history of science during the present century, is there much evidence that great discoveries have been seriously delayed by want of proper appreciation? We may hear of cases where important papers have been rejected by scientific societies, and occasionally a man of novel ideas may have been too much neglected by his contemporaries. I doubt whether such cases of apparent injustice can ever be avoided, and, simply looking

[1] Much of the good work done by this Bureau remains unknown, owing to the miserly way in which their publications are circulated. No copies are supplied even to the University libraries. The explanation, of course, is "want of funds." In other words, England, France, and Germany, together with other nations, unite to do a certain kind of work, but cannot afford to distribute a few copies of the publication to the public for whose benefit the work is undertaken.

back on the great changes involved in matters of primary importance, such as the undulatory theory of light, the conservation of energy, and the second law of thermodynamics, I cannot admit that there is much reason to be dissatisfied with the rate at which new theories have been received. Those who experience a temporary check, owing to the fact that public opinion is not ripe for their ideas, are often amply rewarded after the lapse of a few years. The disappointment which Joule may have felt during the time his views met with adverse criticisms from the official world of science was no doubt amply compensated by the pleasure with which he watched the subsequent progress of research in the new domain which his discoveries have opened out.

The point is not one of academic interest only, for the fear of repressing some important new discovery has a detrimental influence in another direction. The judgment of the scientific world seems to me to be tending too much towards leniency to apparently absurd theories, because there is a remote chance that they may contain some germ of real value. A new truth will not be found to suffer ultimately by adverse and even unreasonable criticism, while bad theories and bad reasoning, supported by the benevolent neutrality of those to whose judgment the scientific world looks for guidance, are harmful in many ways. They block the way to an independent advance and encourage hasty and ill-considered generalizations. The conclusions I should draw from the considerations I have placed before you are these. I believe that a reasonable censorship exercised by our scientific societies is good and necessary; that those whose fate it is to be called on to express an opinion on some work or theory should do so fearlessly according to their best judgment. Their opinion may be warped by prejudice, but I think it is better that they should incur the risk of being ultimately found to be wrong than that they should help in the propagation of bad reasoning. There is one matter, however, on which all opinions must agree. Worse than bad theory or logic is bad experimental work. Should we then not rigorously preserve any influence or incentive which encourages the beginner to avoid carelessness and to consider neither time nor trouble to secure accuracy? There is no doubt to my mind that the prospect of admission to the Royal Society has been most beneficial in this respect, and that the honourable ambition to see his paper published in the "Transactions" of that Society has preserved many a student from the premature publication of unfinished work.

One of the principal obstacles to the rapid diffusion of a new idea lies in the difficulty of finding suitable expression to convey its essential point to other minds. Words may have to be strained into a new sense, and scientific controversies constantly resolve themselves into differences about the meaning of words. On the other hand, a happy nomenclature has sometimes been more powerful than rigorous logic in allowing a new train of thought to be quickly and generally accepted.

A good example is furnished by the history of the science of energy. The principle of the conservation of energy has undoubtedly gained a more rapid and general acceptance than it would otherwise have had by the introduction of the word potential energy. A great theorem, which in itself seems to me to be an intricate one, has been simplified by calling something energy which, in the first place, is only a deficiency of kinetic energy. The only record I can find on the history of the expression is given in Tait's "Thermodynamics," wherein the term statical energy is ascribed to Lord Kelvin, and that of potential energy to Rankine. It would be of interest to have a more detailed account on the origin of an expression which has undoubtedly had a marked influence not only on the physics, but also on the metaphysics of our time. But while fully recognizing the very great advantage we have derived from this term "Potential Energy," we ought not, at the same time, to lose sight of the fact that it implies something more than can be said to be proved. It is easy to overstep the legitimate use of the word. Thus, when Professor Lodge[1] attempts to prove that action at a distance is not consistent with the doctrine of energy, he cannot, in my opinion, justify his position except by assuming that all energy is ultimately kinetic. That is a plausible but by no means a necessary theory. Efforts have been made to look on energy as on something which can be labelled, and identified through its various transformations. Thus we may feel a certain bit of energy radiating from a coal-fire, and if our knowledge was complete, we ought to be able to fix the time at which that identical bit of energy left the sun and arrived on the surface of the earth, setting up a chemical action in the leaves of the plant from which the coal has been derived. If we push this view to a logical conclusion, it seems to me that we must finally arrive at an atomic conception of energy which some may consider an absurdity.

Let, for instance, a number of particles P_1, P_2, &c., in succession, strike another particle Q. How can we in the translatory energy of the latter identify the parts which P_1, P_2, &c., have contributed? According to Professor's Lodge's view, we should be able to do so, for if the particle Q in its turn gives up its energy to others, say R_1, R_2, R_3, &c., we ought to be able to say whether the energy of P_1 has ultimately gone into R_1 or into R_2, or is divided between them. It is only by imagining that all energy is made up of a finite number of bits, which pass from one body to another, that we can defend the idea of considering energy as capable of being "labelled."

In the expressions we adopt to prescribe physical phenomena we necessarily hover between two extremes. We either have to choose a word which implies more than we can prove, or we have to use vague and general terms which hide the essential point, instead of bringing it out. The history of electrical theories furnishes a good example. The terms positive and negative electricity committed us to something definite; we could reckon about quantities of electricity, and form some definite notion of electrical currents as a motion of the two kinds of electricity in opposite directions. Now we have changed all that; we speak of electric displacements, but safeguard ourselves by saying that a displacement only means a vector quantity, and not necessarily an actual displacement. We speak of lines and tubes of force not only as a help to realize more clearly certain analytical results, but as implying a physical theory to which, at the same time, we do not wish to commit ourselves. I do not find any fault with this, for it is a perfectly legitimate and necessary process to state the known connection between physical phenomena in some form which introduces the smallest number of assumptions. But the great question "What is electricity?" is not touched by these general considerations. The brilliant success with which Maxwell's investigations have been crowned is apt to make us overrate the progress made in the solution of that question. Maxwell and his followers have proved the important fact that optical and electrical actions are transmitted through the same medium. We may be said to have arrived in the subject of electricity at the stage in which optics was placed before Young and Fresnel hit on the idea of transverse vibrations, but there is no theory of electricity in the sense in which there is an elastic solid theory of light.

If the term electrical displacement was taken in its literal sense, it would mean that the electric current consists of the motion of the ether through the conductor. This is a plausible hypothesis, and one respecting which we may obtain experimental evidence. The experiments of Rayleigh and others have shown that the velocity of light in an electrolyte, through which an electric current is passing, is, within experimental limits, the same with and against the current. This result shows that if an electrical current means a motion of the ether the velocity of the medium cannot exceed ten metres a second for a current density of one ampere per square centimetre. This, then, is the upper limit for a possible velocity of the medium; can we find a lower limit? The answer to that question depends on the interpretation of a well known experiment of Fizeau's, who found that the speed of light is increased if it travels through water which moves in the same direction as the light. If this experiment implies that the water carries the ether with it, and if a motion of the ether means an electric current, we should be led to the conclusion that a current of water should deflect a magnet in its neighbourhood. An experiment made to that effect would almost certainly give a negative result, and would give us a lower limit for the velocity of the medium corresponding to a given current. Such an experiment, together with that of Rayleigh, would probably dispose of the theory that an electric current is due to a translatory velocity of the medium. This would be an important step, and it would be worth while to arrive at a final settlement of the question.[1] The whole question of the relation between the

[1] *Phil Mag* vol. xi p 36 (1881).

[1] Fizeau's results must either be due to the motion of matter through the medium or to the fact that moving matter carries the ether with it. If it is due to the former cause, and matter does *not* carry the ether with it, may we not consider that matter moving through the ether, that is a relative motion of matter and ether, must produce effects equal and opposite to those of ether moving through matter? In that case the reasoning in the text would, *mutatis mutandis*, hold good.

motion of matter and motion of the medium is a vital one, and we shall probably not make any serious advances until experiment has found a new opening. But we must expect many negative results before some clue is discovered. Nor can we attach much importance to negative results unless they are made by some one in whose care and judgment we place full reliance. We should all the more, therefore, recognize the courage and perseverance of those who spend their valuable time in such investigations as Prof. Lodge has recently undertaken. That ultimately some relation will be found between moving matter and electrical action there is no reasonable doubt.

One of the most hopeful openings for new investigations has always been found in the pursuing of a theory to its logical conclusions, and there is one result of the electromagnetic theory of light which has not, in my opinion, received the share of attention which it deserves.

When sound passes through air it is propagated more quickly with the wind than against it, and we may easily find the velocity relative to the earth by combining the ordinary sound velocity with the velocity of the wind. Similarly, when any waves pass through a medium moving with uniform velocity, the waves being due to internal stresses in the medium, we may treat of the velocity of the waves independently of that of the medium, and say that the wave-velocity in the direction of motion of the medium, and relative to a fixed body, is the sum of the wave velocity, calculated on the supposition that the medium is at rest and the velocity of the medium. Prof. J. J. Thomson,[1] applying Maxwell's equations, has arrived at a different result for electromagnetic waves, and has come to the conclusion that in order to get the velocity of light along a stream of flowing water we have to add to the velocity of light only half the velocity of water. The following considerations suggest themselves to me with respect to this result. Maxwell's theory is founded on certain observed effects, which all depend on the relative motion of matter. A result such as the one referred to implies actions depending on absolute motion, and appears therefore to point to something which has been introduced into the equations for which there is no experimental evidence. The only assumption clearly put down by Maxwell is that electromagnetic actions are transmitted through the medium, and it is possible that that assumption necessarily carries Prof. J. J. Thomson's result with it. If a careful examination of the subject should show that this is the case, we are brought face to face with a serious difficulty. It is said, with justice, to be one of the great advantages of Maxwell's theory that it does away with action at a distance; but what do we gain if we replace action at a distance by something infinitely more difficult to conceive, namely, internal stresses of a medium depending on the velocity of the medium through space? I can only see one loophole through which to escape, namely, that Maxwell's medium is not homogeneous, but consists of two parts, and that if we speak of the medium as moving, we mean the motion of one of these parts relative to the other.

While we may hope to obtain important results from an investigation of the relation between what we call electricity and the medium, we must not lose sight of another avenue, namely, the relation between electricity and chemical effects. The passage of electricity through gases presents us with a complicated problem to which a number of physicists have given their attention of late years. There seems no reasonable doubt that electricity in a gas is conveyed by the diffusion of particles conveying high charges, probably identical with those carried by the electrolytic ion. The fact that this convection is a process of diffusion with comparatively small velocity is shown by the experimental result that the path of the discharge is affected by any bodily motion of the gas which conveys the current. Even the convection currents due to the heat produced by the discharge itself are sufficient to deflect the luminous column which marks the passage of the current.

The most puzzling fact, however, connected with the discharge of electricity through gases consists in the absence of symmetry at the positive and negative poles. There must be some difference between a positively and negatively charged atom which seems of fundamental importance in the relation between matter and what we call electricity. A discussion of the various phenomena attending the discharge of electricity through gases seems to me to point to a conclusion which may possibly prove a step in the right direction.

A surface of separation between bodies having different conductivities becomes electrified by the passage of a current, while at the surface between two chemically distinct bodies we have, according to Helmholtz, a sheet covered at the two sides with opposite electricities. These surface electrifications are not merely imaginary layers invented to satisfy mathematical surface conditions. They can be proved to be realities. Thus, when one electrolyte floats on another, the specific resistances being different, we often observe secondary chemical effects due to the action of the ions which carry the surface electrification.

If the passage of electricity from the solid to the gas involves some work done, we must expect a double sheet of electricity at the boundary, the gas in contact with the kathode becoming positively, and that in contact with the anode negatively, electrified. *A priori* we can form no idea how a layer of gas, the atoms of which carry charges, will behave. The ordinary proof that all electrification must be confined to the surface implies that all forces act according to the law of the inverse square, but where we have also to consider molecular forces, I see no reason why the electrification at a surface may not stretch across a layer having a thickness comparable with the mean free path of the molecule. It is here that there seems to be the fundamental difference between positive and negative electricity. A negative electrification of the gas, like that of a solid or a liquid, seems always confined to the surface, and no one has ever observed a volume electrification of negative electricity. The case is different for the positively electrified part of the gas. Wherever from other considerations we should expect a positively electrified surface sheet, we always get a layer of finite thickness. The result implies a different law of impact between positively and negatively electrified ions, but I see no inherent improbability in this. That the kathode let into a gas is surrounded by a positively electrified layer of finite thickness extending outwards must be considered as an established fact, and several of the characteristic features of the discharge are explained by it. The large fall of potential at the kathode can also be explained on the view which I have put forward, for in order to keep up the discharge there must be a sufficient normal force at the surface, and if this force is not confined to the surface, but necessarily stretches across a finite layer, the fall of potential must be multiplied a great number of times. Similarly Goldstein has shown that some of the phenomena of the kathode are observed at every place at which the positive current flows from a wide to a narrow part of a column of gas. At such places we should expect a positive surface electrification, and here, again, the whole appearance tends to show that we are dealing with a positive volume electrification. No corresponding phenomena are observed when the current passes from the narrow to the wide part.

The fact that in all cases experimented upon positive volume electrifications are observed but never similar negative electrifications is surely of significance.

Some of the results recently brought to light by investigations on the discharge of electricity have interesting cosmical applications. Thus it is found that such a discharge through any part of a vessel containing a gas converts the whole gas into a conductor.[1] The dissociation which we imagine to take place in a liquid before electrolytic conduction takes place must be artificially produced in a gas by the discharge itself. We may imitate in gases which have thus been rendered conductive many of the phenomena hitherto restricted to liquids: thus I hope to bring to the notice of this meeting cases of primary and secondary cells in which the electrolyte is a gas. There are other ways in which a gas can be put into that sensitive state in which we may treat it as a conductor, and we have every reason to suppose that the upper regions of our atmosphere are in this state. The principal part of the daily variation of the magnetic needle is due to causes lying outside the surface of the earth, and is in all probability only an electro-magnetic effect due to that bodily motion in our atmosphere which shows itself in the diurnal changes of the barometer. A favourite idea of the late Prof. Balfour Stewart will thus probably be confirmed. The difference in the diurnal range between times of maximum and times of minimum sun-spots is accounted for by the fact that the atmosphere is a better conductor at times of maximum sun-spots.

The mention of sun-spots raises a point not altogether new to this section. Careful observation of celestial phenomena may

[1] *Phil. Mag.*, vol. ix. p. 284 (1880).

[1] An experiment by Hittorf (*Wied. Ann.*, vii. p. 614) suggested the probability of this fact, which was proved independently by Arrhenius and myself.

suggest to us the solution of many mysteries which are now puzzling us. Consider, for instance, how long it would have taken to prove the universal property of gravitational attraction if the record of planetary motion had not come to the philosopher's help. And surely the most casual observation of cosmical effects teaches us how much we have yet to learn.

The statement of a problem occasionally helps to clear it up, and I may be allowed, therefore, to put before you some questions, the solution of which seems not beyond the reach of our powers.

1. Is every large rotating mass a magnet? If it is, the sun must be a powerful magnet. The comets' tails, which eclipse observations show stretching out from our sun in all directions, probably consist of electric discharges. The effect of a magnet on the discharge is known, and careful investigations of the streamers of the solar corona ought to give an answer to the question which I have put.[1]

2. Is there sufficient matter in interplanetary space to make it a conductor of electricity? I believe the evidence to be in favour of that view. But the conductivity can only be small, for otherwise the earth would gradually set itself to revolve about its magnetic pole. Suppose the electric resistance of interplanetary space to be so great that no appreciable change in the earth's axis of rotation could have taken place within historical times, is it not possible that the currents induced in planetary space by the earth's revolution may, by their electromagnetic action, cause the secular variation of terrestrial magnetism? There seems to me to be here a definite question capable of a definite answer, and as far as I can judge without a strict mathematical investigation the answer is in the affirmative.

3. What is a sunspot? It is, I believe, generally assumed that it is analogous to one of our cyclones. The general appearance of a sunspot does not show any marked cyclonic motion, though what we see is really determined by the distribution of temperature and not by the lines of flow. But a number of cyclones clustering together like the sunspots in a group should move round each other in a definite way, and it seems to me that the close study of the relative positions of a group of spots should give decisive evidence for or against the cyclone theory.

4. If the spot is not due to cyclonic motion, is it not possible that electric discharges setting out from the sun, and accelerating artificially evaporation at the sun's surface, might cool those parts from which the discharge starts, and thus produce a sunspot? The effects of electric discharges on matters of solar physics have already been discussed by Dr. Huggins.

5. May not the periodicity of sunspots, and the connection between two such dissimilar phenomena as spots on the sun and magnetic disturbances on the earth, be due to a periodically recurring increase in the electric conductivity of the parts of space surrounding the sun? Such an increase of conductivity might be produced by meteoric matter circulating round the sun.

6. What causes the anomalous law of rotation of the solar photosphere? It has long been known that groups of spots at the solar equator perform their revolution in a shorter time than those in a higher latitude; but spots are disturbances which may have their own proper motions. Duner[2] has shown, however, from the displacement of the Fraunhofer lines, that the whole of the layer which produces these lines follows the same anomalous law, the angular velocity at a latitude of 75° being 30 per cent. less than near the equator.[3] As all causes acting within the sun might cause the angular velocity of the sun to be smaller at the equator than at other latitudes, but could not make it greater, the only explanation open to us is an outside effect either by an influx of meteoric matter, as suggested by Lord Kelvin, or in some other way. If we are to trust Dr. Welsing's result that faculæ which have their seat below the photosphere revolve in all latitudes with the same velocity, which is that of the spot velocity in the equatorial region, we should have to find a cause for a retardation in higher latitudes rather than for an acceleration at the equator. The exceptional behaviour of the solar surface seems to me to deserve very careful attention from solar physicists. Its explanation will probably carry with it that of many other phenomena.

In conclusion, I should like to return for an instant to the question whether it is possible by any means to render the progress of science more smooth and swift. If there is any truth in the idea that two types of mind are necessary, the one corresponding to the boiler and the other to the cooler of a steam-engine, it must also be true that some place must be found where the two may bring their influence to bear on each other. I venture to think that no better ground can be chosen than that supplied by our meetings. We hear it said that the British Association has fulfilled its object; we are told that it was originally founded to create a general interest in scientific problems in the towns in which it meets; and now that popular lectures and popular literature are supposed to perform that work more satisfactorily, we are politely asked to commit the happy despatch. There is no need to go back to the original intention of those who have founded this institution, which has at any rate adapted itself sufficiently well to the altered circumstances to maintain a beneficial influence in scientific research.

The free discussion which takes place in our sections, the interchange of ideas between men who during the rest of the year have occupied their minds, perhaps too much, with some special problem, the personal intercourse between those who are beginning their work with sanguine expectations, and those who have lost the first freshness of their enthusiasm, should surely one and all ensure a long prosperity to our meetings. If we cannot claim any longer to sow the seeds of scientific interest in the towns we visit, because the interest is established, we can at any rate assure those who so kindly offer us hospitality that they are helping powerfully in the promotion of the great object which we all have at heart.

SECTION B

CHEMISTRY

OPENING ADDRESS BY PROF. HERBERT MCLEOD, F.R.S., F.C.S., PRESIDENT OF THE SECTION.

In endeavouring to prepare myself to properly fulfil the duties of President of this Section, to which I have been elected, and for which honour I am much indebted to the council and members of the Association (although I am only too well aware that the position might have been more efficiently filled by many others), I naturally looked at the reports of the previous meetings held in Edinburgh in 1834, 1850, and 1871, and it appears that on the first two occasions an address was not given by the president, a custom the discontinuance of which I have, at the present moment, much reason to regret.

At the meeting in 1834 a committee was appointed consisting of Dr. Dalton, Dr. Hope, Dr. T. Thomson, Mr. Whewell, Dr. Turner, Prof. Miller, Dr. Gregory, Dr. Christison, Mr. R. Phillips, Mr. Graham, Prof. Johnston, Dr. Faraday, Prof. Daniell, Dr. Clark, Prof. Cumming, and Dr. Prout, to report at the next meeting their opinion on the adoption of an uniform set of chemical symbols. Dr. Turner to be secretary.

In the following year the report contains: "Report of the Committee on Chemical Notation. Dr. Turner, the chairman of the committee appointed to take into consideration the adoption of an uniform system of chemical notation, made a report to the following effect:—

"1. That the majority of the Committee concur in approving of the employment of that system of notation which is already in general use on the Continent, though there exists among them some difference of opinion on points of detail.

"2. That they think it desirable not to deviate in the manner of notation from algebraic usage except so far as convenience requires.

"3. That they are of opinion that it would save much confusion if every chemist would always state explicitly the exact *quantities* which he intends to represent by his symbols.

"Dr. Dalton stated to the Chemical Section his reasons for preferring the symbols which he had himself used from the commencement of the atomic theory in 1803, to the Berzelian system of notation subsequently introduced. In his opinion regard must be had to the arrangement and equilibrium of the atoms (especially elastic atoms) in every compound atom, as well as to

[1] The efforts of Mr. Bigelow have a bearing on this point, also some remarks which I have made in a lecture before the Royal Institution (*Proc. Roy. Inst.* 1891), but nothing decisive can be asserted at present.

[2] Oefvers af Kongl. Vetensk. Ak. Forhandl., 47, 1890.

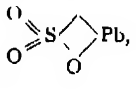
[3] Although the importance of M. Duner's results would make an independent investigation desirable, the measurements of Mr. Crew, who by a much inferior method arrived at other results, cannot have much weight as compared with those of Duner.

their number and weights A system either of *arrangements* without *weights*, or of *weights* without *arrangements*, he considered only half of what it should be"

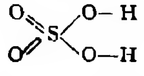
We can all sympathise with the members of the section of 1834 in their desire to obtain an uniform system of chemical notation, for at that time several very different systems seem to have been in use Although the report is a short one, it probably directed the attention of chemists to the desirability of avoiding confusion by the use of various systems, and since that period many advances have been made

There is now little necessity for every chemist to "state explicitly the exact *quantities* which he intends to represent by his symbols" for the accurate determinations of atomic weights by many chemists—and we must not omit to mention the work of Stas (whose death we have had to deplore since the last meeting of the British Association)—have given us a series of numbers which are in the hands of all chemists, so that, except in the cases where great refinement is requisite (or when the atomic weight has not been universally accepted) there is no need to state the values of the symbols.

That great advances have been made in chemical notation is well known to all, even in my own short experience I have had to learn several different methods When I began to work at chemistry I was told that sulphate of lead was to be expressed by the formula PbO,SO_3 Hofmann taught me that it should be $PbSO_4$, then Gerhardt doubled the atomic weights of oxygen and sulphur and the formula became Pb_2SO_4, Cannizzaro showed that the atomic weight of lead should also be doubled, and the formula again became $PbSO_4$, but representing twice as much as formerly, then Frankland taught me to write SO_2Pbo'' as the expression of the graphic formula—



which not only states that the compound contains 207 of lead, 32 of sulphur, and 64 of oxygen, but that the sulphur is hexad, and is combined with two atoms of dyad oxygen, and with a dyad compound radical containing one atom of lead and two of oxygen, and of all the formulæ just given this is the only one which satisfies the requirements which Dalton thought necessary in 1835, namely, to indicate not only the weights of the elements present, but also their arrangement It may be objected that we do not know that this formula really represents the arrangements of the atoms in plumbic sulphate, but there can be very little doubt that the four atoms of oxygen in the compound are not all in the same condition, for if we examine the properties of sulphuric acid (from which the sulphate of lead is derived by the replacement of the hydrogen by lead), we find that two of the atoms of oxygen are more closely associated with the hydrogen than are the other two, and, as there is some evidence, although perhaps not very conclusive, that sulphur may be capable of combining with six monad atoms, although no such compound is yet known, it does not seem unreasonable to suppose that sulphuric acid is really —



What the nature of the attraction that holds the atoms together may be is not known, but it is more probably of a character similar to that of gravity which holds together sun and planets, than of the nature of cohesion which would hold the atoms rigidly together, the atoms in each molecule are therefore most probably in a state of rotation around, or of vibration to and from, the central atom which holds them together The pictorial representation in a plane does not therefore truly express the position of the atoms, but merely the relations existing between them In organic chemistry the use of formulæ expressing such a relation has become indispensable, and in inorganic chemistry I believe such a system is very useful.

Recently this system has been found insufficient for the requirements of organic chemistry, and recourse has been had to the figure of a tetrahedron to represent the atom of carbon, other atoms being attached to the solid angles, in this way the position of the atoms in space is more or less expressed

There are many cases, however, in which the atomicity theory fails us At first it seemed probable that the atomicity of an element varied in pairs of attractions, that is, an element might be monad, triad, or pentad, but not dyad or tetrad, or it might be dyad, tetrad, or hexad, but not triad or pentad, but some great difficulties have been encountered Thus nitrogen, which is pentad in ammonic chloride and triad in ammonia, forms the compound nitric oxide, NO, in which it would appear to be dyad, it has been suggested, however, that in this body the nitrogen is really triad, and that it possesses a "free bond." Now the idea of a "free bond" seems contrary to the principles of atomicity, since it is on the belief that such a free bond is impossible that the explanation of the existence of elementary molecules is formed, for it is said that when hydrogen is liberated two atoms unite to form a molecule, so that their mutual attractions may be satisfied Nevertheless nitric oxide is a very active body, uniting readily with other substances, so the free bond seems to be on the look out for other kinds of matter, but to have no attraction for the free bond of another molecule of nitric oxide As the molecule of nitric peroxide is variable by alterations of temperature, being N_2O_4 at low and NO_2 at high temperatures, it seemed not impossible that at the ordinary atmospheric temperature nitric oxide was a simplified or dissociated molecule, and that if the temperature were sufficiently reduced it would be found that its molecule would be N_2O_2, and thus it would contain triad nitrogen without a free bond The density of the gas has, however, been determined at a temperature as low as $-73°$ and the molecule is still NO Another important exception to the variation of the atomicity of an element in pairs was furnished by the investigations of Sir Henry Roscoe on the chlorides of vanadium, this element which, from analogy, should be a triad or a pentad, appears to form a chloride of the composition VCl_4 Again, the molecule of peroxide of chlorine is ClO_2, which would make chlorine a tetrad or the compound must have a free bond

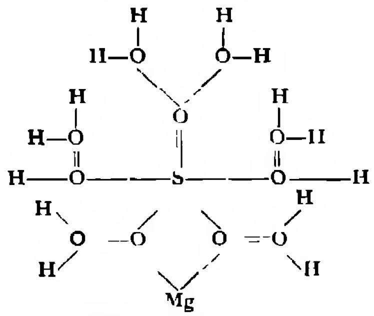
Another set of phenomena which the atomicity theory will not explain is the existence of well-defined crystalline salts containing what is called water of crystallization This water is in many cases held with considerable pertinacity, the body appearing to be a veritable chemical compound. But water appears to be a saturated body, the attractions of the oxygen being satisfied by those of the hydrogen. It is true that water acts vigorously on other compounds, as on metallic oxides to form hydrates, and on some anhydrides to form acids, but these appear to be phenomena of double decomposition, thus the combination of water with sodic oxide and nitric anhydride respectively may be expressed by the equations

$$OH_2 + ONa_2 = OHNa + ONaH \text{ and}$$
$$OH_2 + O(NO_2)_2 = OH(NO_2) + O(NO_2)H$$

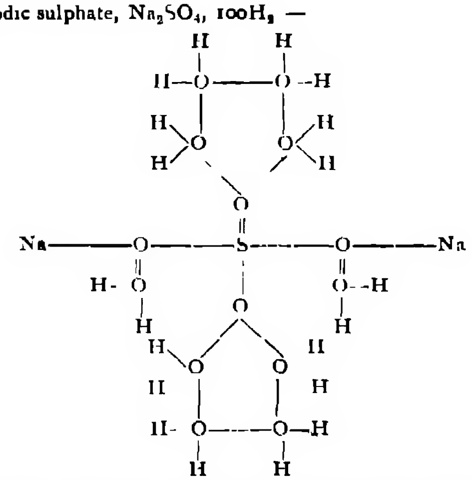
In the combination of water with an anhydrous salt, a phenomenon often accompanied by great rise of temperature, there does not appear to be a double decomposition That there is a chemical combination of some sort is shown by the changes of properties produced, crystalline form and colour being both sometimes altered Compounds so produced have been called "molecular compounds" to imply that saturated molecules are in some way or another combined, the combination being different from "atomic combination," in which the atoms are directly united according to their valencies Another explanation has been suggested by assuming that there is some "residual affinity" not saturated by the constituents of the body, and that this residual affinity enables bodies to unite in a less stable manner than in most compounds But are not these terms—"molecular combination" and "residual affinity"—analogous to the term "catalysis," merely *words* to express—not to explain—what we do not understand? If "residual affinity" really exists, it must reside in the oxygen of the water, or in the hydrogen, or both; if so, what will happen to some of the complex constitutional formulæ of the organic chemist in which the carbon is tetrad, the oxygen dyad, and the hydrogen monad? If any of these elements have a residual affinity should we not expect to find additional unions between some of the atoms of the same molecule over and above those represented by the formula?

Oxygen may be tetrad, for which there is evidence in OAg_4. Under these circumstances water is by no means a saturated compound, and there would be no difficulty in explaining the combination of water with oxygen salts. Thus crystallized

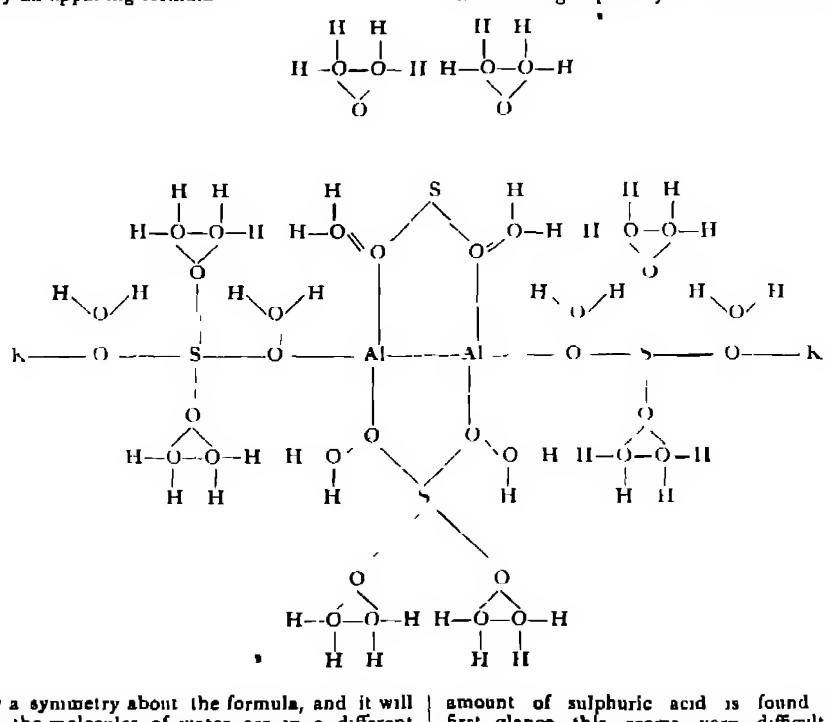
magnesic sulphate, $MgSO_5$, $7OH_2$ or SOHoMgo″, $6OH_2$ would be—



and sodic sulphate, Na_2SO_4, $10OH_2$ —



Even alum, with its 24 molecules of water of crystallization, may be expressed by an appalling formula —



There is certainly a symmetry about the formula, and it will be found that 16 of the molecules of water are in a different position from the remaining 8, this probably has no significance, although Graham found that crystallized alum at a temperature of 61° lost 18 molecules of water, if he had used a temperature a few degrees lower he might have found that only 16 passed off!

By a little stretching of the imagination and altering the atomicities of the elements to suit each particular case, no doubt graphic formulæ might be made for all crystalline salts, but they would be perfectly artificial, and not much good is likely to come from the attempt

I fear we are driven to the conclusion, that, notwithstanding all the progress that has been made in chemical science during the last fifty eight years, we have not yet reached a method of notation that would have satisfied Dr Dalton in 1834

But since that time we have learnt that our formulæ ought to show even more than the number and position of the atoms of a compound, we should like them to indicate the amount of potential energy residing in a body, and our equations ought to indicate the amount of heat generated by a chemical change Let us hope that before the next meeting of the British Association in Edinburgh these desirable developments will have been accomplished

A short time ago I mentioned the word catalysis as being employed to express certain chemical actions which cannot be explained It is applied to those phenomena which take place in the presence of a body which appears to be entirely unchanged by the action Happily these catalytic actions are being explained one after another, so that soon the name itself may become obsolete An example of this action of presence may be given When a mixture of sulphuric acid and alcohol is heated to a temperature of about 140° to 150°, ether passes over Now alcohol contains C_2H_6O, and if from two molecules of alcohol one molecule of water is subtracted a molecule of ether results —$2C_2H_6O = OH_2 + C_4H_{10}O$ As sulphuric acid is known to have a great attraction for water, it is easy to imagine that the acid combines with the water and ether passes off But it is found that a small quantity of sulphuric acid at the temperature of 140° – 150° will transform a very large amount of alcohol into ether and water, much more than can be explained by assuming that the acid has combined with the water If a mixture of sulphuric acid and alcohol is heated to a temperature of 140° – 150°, and alcohol allowed to flow into the liquid, a mixture of ether and water vapours passes over, and after a large quantity of alcohol has been transformed, the amount of sulphuric acid is found to be unaltered At first glance this seems very difficult to explain, but on further investigation it is found that alcohol and sulphuric

acid act one on another to form ethyl sulphuric or sulphovinic acid —

$$SO_2Ho_2 + EtHo = SO_2HoEto + OH_2$$

but when ethyl-sulphuric acid is heated with alcohol, ether is formed with the reproduction of sulphuric acid—

$$SO_2HoEto + EtHo = OEt_2 + SO_2Ho_2$$

the sulphuric acid is then able to produce ethyl sulphuric acid by acting on more alcohol, so a continuous production of ether and water takes place without loss of sulphuric acid. Another well-known action is the combination of oxygen and hydrogen under the influence of spongy platinum. In this case the platinum remains apparently unaltered, and is capable of causing the combination of any quantity of mixed gases. As spongy platinum possesses the power of absorbing large quantities of gases, it is usually said that the molecules of oxygen and hydrogen are so much condensed in the platinum that they are brought within the sphere of one another's attractions, and consequently combine.

Another instance of an action of this kind is afforded by the oxidation of ammonia in the presence of chromic oxide. When ammonic dichromate is heated an evolution of gas occurs, and a residue of chromic oxide is left which bears a striking resemblance to a mixture of black and green tea; when some of this substance is placed on a piece of wire gauze, heated and then supported over a vessel containing a strong solution of ammonia, the oxide glows in a manner similar to the glowing of spongy platinum under the influence of a mixture of hydrogen and air. Under these conditions the chromic oxide facilitates the oxidation of the ammonia, but it becomes changed during the process; instead of having the appearance above described, it acquires a bright green colour. Now, we know that chromium is capable of forming several combinations with oxygen. Is it therefore too much to suppose that the chromium is alternately oxidized by the oxygen of the air, and reduced by the hydrogen of the ammonia, so that, although in the end it has the same composition as at the beginning, nevertheless it has been continuously decomposed and reproduced? Now, may not a similar change take place during the action of spongy platinum on a mixture of hydrogen and oxygen? The alteration of the platinum is very slight, but I believe I have observed a slight modification of the appearance of a fragment of spongy platinum that was kept glowing by a small jet of purified hydrogen for some hours; the gas not being allowed to burn so as to heat the platinum to a very high temperature, the metal appears to be compacted and to be covered by minute spherules of glistening metal. Now, may not the platinum have entered into combination with one or other of the gases and been subsequently reduced? If this is the true explanation, then we have in this case a continuous series of chemical changes and the "catalysis" is explained.

We all know the ease with which oxygen is obtained from potassic chlorate when heated with a small quantity of oxide of manganese; the quantity of peroxide is the same at the end of the process as at the beginning, and it may be used over and over again to assist in the decomposition of fresh potassic chlorate. The oxide of manganese undergoes a molecular alteration; if a crystalline variety is employed, it is found, at the end of the process, to have been transformed into fine powder.

I hope I have proved to the satisfaction of my brother chemists that potassic permanganate is first formed and subsequently decomposed with the reproduction of manganese peroxide.

Oxide of cobalt possesses the remarkable property of decomposing solutions of hypochlorites at moderate temperatures with evolution of oxygen. For some time I have been endeavouring to find the explanation of the change, but hitherto without complete success. At first it seemed probable that an unstable cobaltate, analogous to a ferrate, was formed and decomposed at the temperature of the experiment. In fact oxygen is evolved when chlorine is passed through a boiling solution of sodic hydrate containing ferric hydrate in suspension. But no evidence of the existence of a cobaltate could be found. When a cobaltous salt is added to an alkaline solution of a hypochlorite, a black precipitate is formed which is usually stated to be cobaltic hydrate, Co_2Ho_6, but Vortmann has shown that, when a cobaltous salt is mixed with a solution of iodine in potassic iodide, and the liquid rendered alkaline by sodic hydrate, the precipitate formed at a temperature between 50° and 60° approaches in composition the dioxide of cobalt, CoO_2. He also found that the precipitate lost oxygen at the temperature of boiling water. I have repeated some of his experiments and can quite confirm them, although I have not obtained an oxide containing quite as much oxygen as his richest oxide. The oxides I prepared rapidly effected the decomposition of a solution of sodic hypochlorite, and that without undergoing any loss of oxygen themselves; in fact, in the two experiments made, the cobalt compound contained a little more oxygen after boiling with the hypochlorite.

We have now many instances of the influence which small quantities of substances have upon chemical reactions. These influences may be more common than is generally supposed. The presence of a third body is frequently helpful in the combination of elements with one another: thus dry chlorine will not attack melted sodium or finely divided copper; an electric spark will not cause a dry mixture of carbonic oxide and oxygen to explode; carbon, phosphorus, and sulphur will not unite with dry oxygen, and as chemical science progresses we may find that many well-known actions are conditioned by the presence of minute traces of other matter which have hitherto escaped detection. We all know the profound alterations of the properties of substances by minute traces of impurities; less than one-tenth per cent. of phosphorus will render steel unfit for certain purposes. The sapphire and ruby only differ from colourless alumina by the presence of traces of impurities hardly recognisable by chemical analysis. During this meeting we hope to have a contribution to the section on the influence of minute traces of what may be called impurities on the properties of different substances and their influence on chemical changes.

In this city, where the first public chemical laboratory was started in 1823, by Dr. Anderson, the assistant of Prof. Hope, it is hardly necessary to insist on the extreme importance of teaching chemistry by practical work, but unfortunately, even at the present time, endeavours are made to teach the subject by means of lectures (sometimes without experiments) or by reading. Those who are acquainted with chemistry well know the impossibility (this is hardly too strong a word) of learning the science, especially in the first stages, without actual experiment, by which a practical acquaintance with chemical phenomena is obtained. The attempt to learn chemistry without practical experience reminds one of the well-known story (for the truth of which I will not vouch) of a mathematician who lectured on natural philosophy; he was visiting a foreign laboratory, and stopped before a piece of apparatus and asked what it was: on being told it was an air pump, he exclaimed, "Dear me! I have lectured on the air pump for twenty-five years, and this is the first time I have seen one." It is problematical if his students can have derived much advantage from his lectures. Teaching of the kind to which reference has just been made is generally given to candidates for examinations who do not intend to take up chemistry as their chief subject. At the present time chemistry is required for entrance and preliminary examinations from many classes of students. There is no doubt that it is an excellent means of education, teaching a boy to observe and draw conclusions from his observations; but if he makes no observations it is little more than useless cram, the memory might as well be exercised by learning a novel by heart.

This imperfect mode of teaching chemistry arises principally from the difficulty of obtaining properly appointed laboratories in schools, in addition to which the very strong fumes are sometimes disagreeable, making it inconvenient to have them in or near a house, to say nothing of the possible dangers to the clothes and their contents; but there is no help for it, the teaching must be accompanied by experimental demonstration, as was indicated in the Reports on the teaching of chemistry which have been presented to this Association in former years. It must be admitted that examinations do not always discover the best student; many are capable of preparing for examinations with a small knowledge of their subject, others, with a good knowledge, fail from nervousness or other causes, but at the present time examination, though far from perfect, is almost the only means we have of judging the fitness of the candidate. By properly selecting questions the examiner may, to a considerable extent, discourage cram; he should endeavour to find out what the pupils have actually seen, and to make them draw conclusions from facts which they have either themselves observed, or which have been described to them; it is only in this manner that chemistry can be used as a means of mental training.

These remarks do not apply to the education of students intending to make chemistry their profession, who have many opportunities, in the large laboratories of Great Britain and the Continent, of obtaining all the necessary instruction The Institute of Chemistry, which was founded to improve the status and also the education of professional chemists, requires that its members should have a thoroughly scientific training Before a candidate for the associateship is admitted to examination, he must bring evidence that he has passed satisfactorily through a systematic course of at least three years' study in the subjects of theoretical and practical chemistry, physics, and elementary mathematics, in some recognized college or school, and before admission to the fellowship he must have passed through three additional years of work in chemistry It is to be hoped that an example of this kind will ultimately have a good effect in improving the modes of teaching the science in its elementary stages.

There is another class of workers in chemistry who must not be forgotten at the present time, as they have much influence on the life of the world and have been working for ages, but have only recently been recognized I mean those organisms which are included under the name of microbes. These organisms are capable of producing chemical changes which entirely surpass all the results hitherto obtained by the chemist in his laboratory That the transformation of sugar into alcohol and carbonic anhydride in the ordinary process of fermentation is due to a living organism, has been known for some years, the important transformation of ammonia into nitrous and nitric acids in the soil has been shown to be due to organisms which have recently been investigated by many chemists, it is possible to transform ammonia into these acids in the laboratory by oxidation under certain conditions and at a high temperature, whereas the organism does the work quite as efficaciously at the common temperature Other organisms have the power of producing complex organic poisons by the alteration of some of the constituents of the animal body, and the relation of these products to the study of diseases is of the highest possible importance As we hope to have a discussion on this interesting subject by many eminent authorities, both from the chemical and biological points of view, it will be unnecessary to pursue the subject further, unless it be to urge some of the younger chemists to work at the chemical aspect of bacteriology. They must be prepared for hard work and many disappointments, for the subject is undoubtedly a difficult one

I cannot conclude this address without reference to the great loss which chemistry has sustained by the death of Prof A W von Hofmann. I had the good fortune to be under him as student and assistant from 1856 until he left this country in 1865, all who worked with him must have been deeply impressed by his capacity for work and his power of inducing work in others Although perhaps some of us did not appreciate this at the time, yet we feel we owe him a debt of gratitude for his having started us in the right way The list of papers under his name in the Royal Society Catalogue up the year 1883 is 299, written by himself alone, besides twenty two joint papers One of his characteristics which impressed me was his investigation for the purpose of furthering chemical knowledge without any view to practical applications, and I well remember his lecture at the Royal Institution, in 1862, on Mauve and Magenta (which owed so much of their success to his work), in which he produced the original specimen of benzene which had been obtained by Faraday from oil gas in 1825 He pointed out that Faraday had prepared this substance and investigated its properties without ever supposing that it could have any practical application The following is the concluding paragraph of the lecture —

"Need I say any more? The moral of Mauve and Magenta is transparent enough, I read it in your eyes We understand each other Whenever in future one of your chemical friends, full of enthusiasm, exhibits and explains to you his newly discovered compounds, you will not cool his noble ardour by asking him that most terrible of all questions, 'What is its use? Will your compound bleach or dye? Will it shave? May it be used as a substitute for leather?' Let him quietly go on with his work The dye, the lather, the leather will make their appearance in due time. Let him, I repeat, perform his task Let him indulge in the pursuit of truth—of truth pure and simple —of truth not for the sake of Mauve, not for the sake of Magenta, let him pursue truth for the sake of truth"

This seems to me the true spirit of the scientific investigator, and in many cases the reward consists solely in the consciousness that the investigator has done his duty, in some cases the reward may take a more substantial form, and since the above paragraphs were written I have been informed that Prof von Hofmann has left a large fortune, the result of the applications of his discoveries in technical chemistry

NOTES

WE hope to publish shortly, in the series of "Scientific Worthies," a portrait of Sir Archibald Geikie, whose address as president of the British Association we print to day The portrait will be accompanied by a sketch of Sir Archibald's career as a man of science

THE International Congress of Experimental Psychology began work at University College, Gower Street, on Monday, when an address was delivered by Prof H Sidgwick We propose to give on a future occasion some account of the proceedings

THE Helvetic Society of the Natural Sciences will hold its seventy-fifth annual meeting at Basel from September 5 to 7 The Basel Society of the Natural Sciences will celebrate its seventy-fifth anniversary at the same time

MR J BRETLAND FARMER, M A, Fellow of Magdalen College, Oxford, and Demonstrator of Botany in the University, has been appointed Assistant-Professor in Botany at the Royal College of Science, London, as successor to Dr D H Scott, who becomes Honorary Keeper of the Jodrell Laboratory, at the Royal Gardens, Kew

MR H M BERNARD, M A, has been elected to the Marshall Scholarship, Royal College of Science, South Kensington, for the ensuing year, in place of Mr. G Biebner, whose term of office has expired

MR J P HILL, of the Royal College of Science, South Kensington, and the University of Edinburgh, has been appointed to the Demonstratorship of Biology in the University of Sydney

MR SILVA WHITE has, for reasons of health, resigned his office as secretary and editor to the Royal Scottish Geographical Society, a post he has filled since the institution of the society

WE regret very much to hear of the death of Dr H J Tylden, whose article on "The bearing of pathology upon the doctrine of the transmission of acquired characters" was printed in NATURE last week At the beginning of last week he died of typhoid fever Dr Tylden had been engaged in investigating the etiology of typhoid fever, and there is no doubt that he thus contracted the disease

TWO eminent men who had been intimately connected with India died last week—Dr. Forbes Watson and Dr H W Bellew Dr Bellew was well known as an Oriental linguist and as the author of various works in which he made important contributions to ethnology Dr Forbes Watson acted for many years as Reporter on the Products of India and Director of the India Museum He did much to give the English people a wider and more accurate knowledge both of the races and the material resources of India

THE death of Dr Felice Giordano, of Rome, is announced He was the head of the Geological Survey of Italy and Chief Inspector of Mines

THE Glasgow and West of Scotland Technical College has issued its calendar for the year 1892 93.

ON July 27 the eruption of Mount Etna, which on the previous day had increased considerably in activity, was again as

violent as during the first few days of the outbreak Rocks and masses of volcanic *débris* were ejected from the crater to a great height, as well as a quantity of fine ash, which fell in showers over the country The cloud of smoke over the summit increased, and the subterranean rumblings were so loud and frequent as to make the windows in the houses rattle The lava streams were also extending Similar reports were issued on the three following days, but on July 31 a general decrease in the volume of the lava was noted On August 1 it was stated that the eruption seemed to be subsiding No underground rumblings were heard, the smoke issuing from the crater was white, and the lava streams moved very slowly, and, in fact, almost stopped On August 2 the volcano showed some signs of renewed activity, and the lava streams began to flow afresh The underground rumblings were not, however, so loud as before

SOME information as to the volcanic eruption in Great Sangir is given in letters sent from Menado, the chief Dutch settlement in the north of the Celebes, from which Sangir is about 300 miles distant The letters are dated June 12, and were printed in the *Handelsblad*, of Amsterdam, on July 27 According to a summary in a Reuter's telegram, the disaster came with appalling suddenness At ten minutes past six on the evening of June 7, unannounced by the slightest shock of earthquake, subterranean rumblings, or other seismic warning, a terrific eruption began from the great volcano Gunona Awa, which is not far from Tarvena, the capital of the island Ashes in immense masses and stones of considerable size soon fell all over the island Hundreds were killed by this shower, and even those who reached the shelter of their homes were not safe, for nearly everywhere in the country districts the light wooden houses collapsed under the weight of the stones and ashes which quickly settled on the roofs In the immediate vicinity of the mountain, on the slopes of which are numerous farms and villages with extensive plantations, immense destruction was caused by the great streams of lava, which flowed with astonishing rapidity down into the surrounding valleys Houses were carried away with all their contents, and many of the occupants met a terrible death in these rivers of molten rock Besides the hundreds who are known to have lost their lives on the lowlands, between five hundred and a thousand more who were engaged in the rice-fields on the mountain slopes have not been heard from The crops have been destroyed, the cocoa nut trees have suffered severely, and in many parts of the island the wells have become dry.

AT the time of our last issue the weather was very settled, and the air very dry, scarcely any rain having fallen for some days On Friday, however, July 29, the anticyclone began to give way, and the low pressure over the Bay of Biscay extended northwards and over the eastern parts of England, causing thunderstorms in the southern counties By Sunday, the disturbed weather had extended over the whole country, and rain had fallen at most places, but the area of low barometer was passing away to the eastward, and during the early part of this week the type of weather again became anticyclonic generally, but the sky became cloudy, and rain fell in places, while on Wednesday a depression lay over the North of Scotland, which appeared likely to spread southwards. Temperatures have ranged from 70° to 75° and upwards in the southern districts, but have been considerably lower in the north, the daily maxima frequently not reaching 60° The *Weekly Weather Report* showed that for the week ending July 30 the temperature only slightly exceeded the average in the North of Scotland Rainfall was much below the mean, amounting to six to nine-tenths of an inch in most districts, while reckoning from the beginning of the year there is a deficit in every district, amounting to as much as 7 4 inches in the south west of England

THE Austrian Meteorological Society has issued an appeal for contributions towards the support of the meteorological observatory on the summit of the Sonnblick The observatory was established by M Rojacher in 1886, and completed at the expense of the Austrian Society and the German and Austrian Alpine Club, it has since been maintained at the expense of these two institutions, together with a subvention from the Ministry of Instruction, and aided by a small reserve from the original building fund The recent death of M Rojacher, and the removal of the Alpine Club from a house on the summit, has thrown such additional expense on the Austrian Society as to endanger the efficient maintenance of the Observatory The station has already rendered good service to science and has somewhat modified the theory of the nature and origin of storms, several physicists have also conducted experiments there on radiation, atmospheric electricity, and other subjects of considerable importance We hope, therefore, that the appeal of the Society for funds for the efficient maintenance of the station will meet with entire success

THE trustees of the South African Museum, in their report for the year 1891, record a serious loss in the mineralogical series of the Museum's collection On the night of September 7 and 8 the Museum was robbed of the Stonestreet collection of rough diamonds, a separate diamond in singularly hard rock, and several very interesting nuggets of South African gold The exhibition hall was broken into through one of the small upper windows opening on the higher of the two galleries, and the specially protected table case, containing the diamonds and gold, forced by shattering the lock Two men—whose names, A McEwen and F Cohen respectively, were already too well known in the criminal records—were convicted of the robbery at the Supreme Court session on the 13th November, and sentenced to four years' hard labour The police succeeded in recovering 49 of the 173 diamonds belonging to the Stonestreet collection, including most of the larger stones, but among the missing majority are many unusual and abnormal crystalline forms of much interest, collected with great pains by the late Mr Stonestreet, during the earlier years of mining in Griqualand West The Du Toit's Pan diamond in indurated rock and the gold nuggets have not been recovered

IN the course of an interesting address delivered lately at the opening of the new chemical laboratory of the Case School of Applied Science, Prof C F Mabery called attention to the fact that notwithstanding America's abundant supply of crude materials, with cheap fuel in unlimited quantities, and a ready market with an increasing demand, she continues to pay enormous sums for imported products which should be produced at home Prof Mabery thinks, however, that the outlook for the immediate future is encouraging In several directions the manufacture of chemical products has begun, and others, he believes, will follow There are certain lines along which rapid development may evidently soon be expected, and one of the most promising is sal-soda. Until quite recently the Le Blanc process, which was invented in France to manufacture soda-ash when the supply from natural sources was largely cut off during the French Revolution, has supplied the world since early in the present century In utilizing all bye-products the great Le Blanc works of Europe have been able to produce soda-ash at a trifling cost A Le Blanc plant has never been established in America, and probably one never will be Such a plant requires immense capital, and, besides, a combination of coal, salt, and limestone, that can be found close at hand in but few localities. Within a few years another method, known as the ammonia-soda process, has been put into operation in Europe. The first cost of a plant for this process is not large, and since it furnishes a purer product than the Le Blanc method, it will probably supply a

considerable portion of the sal soda of the future, especially in the United States. The newer method has the especial advantage that it forms bicarbonate of soda direct and very pure. Two plants for this process have been erected in America, one of which has been in operation at Syracuse, N.Y., for several years, and the other has recently been erected in Cleveland. As additional illustrations of the possibilities in store for the United States, Prof. Mabery mentioned the manufacture of porcelain, and the production of artificial dyes and colours from coal-tar.

AN interesting report on the pearl fishery of the Gulf of California is contributed by Mr. C. H. Townsend to the new Bulletin of the United States Fish Commission. The season for pearl fishing begins about the first part of May near Cape St. Lucas, whence operations are gradually carried into the Gulf of California, which is usually entered by May 15. During the summer the entire eastern coast of the peninsula is worked, and in October the base of operations is removed from La Paz, the headquarters of the Pearl Shell Company of Lower California, to Acapulco, where the fishery is continued for two or three months longer. Whatever of romance may hitherto have enshrouded the diver for pearls in the sea, he is now, as described by Mr. Townsend, practically a submarine labourer, who uses all the modern diving paraphernalia available. No longer plunging for sixty seconds into the sun-lit green water that covers a coral bank, he puts on a rubber suit with glass-fronted helmet, and, suitably weighted with lead, descends for hours to gather pearl-oysters, which are hoisted in a wire basket by his companions in the boat above, who supply him through a rubber tube with the air he breathes. The best year at the fisheries in comparatively recent times was 1881. During that year many pearls of extraordinary size and great value were obtained; among them was a black one weighing twenty-eight carats, which sold in Paris for 10,000 dollars.

A VALUABLE report on the petroleum trade of the Caucasus has been sent to the Turkish Government by Aassib, the Turkish Consul-General at Tiflis, and some interesting extracts from it are quoted in the *Board of Trade Journal*. The petroleum springs of the peninsula of Apcheron, not far from the place at present occupied by the town of Baku, were known according to the writer, several centuries before the Christian era, and the phenomena produced by them, totally inexplicable in those barbaric ages, gave rise, he says, to the worship of the Guebres, followers of Zoroaster, which lasted into the nineteenth century, for the temple of the worshippers of eternal fire is seen to the present day. The springs of Balakhani are situated 20 kilometres from Baku on a bare and arid plateau, swept by the winds, at an elevation of about 60 metres above the level of the Caspian Sea. The petroleum lands occupy an area of about 8 kilometres. At the present time Balakhani and Sabountchi possess more than 1000 wells, some of them newly bored, producing in twenty-four hours as much as 400,000 pouds. An era was marked in the history of the naphtha industry by the house of M. Nobel, which started at Baku in 1874, and in the following year purchased a small business and undertook the production of petroleum on a small scale. At that time the conveyance of petroleum to Baku was effected by means of carts and leather bottles. M. Nobel endeavoured to show the absurdity of this primitive method of transport, and recommended that pipes should be constructed, but the majority of the merchants rejected the proposal. He then constructed the first pipe at his own cost, and demonstrated the utility of it to his colleagues, several of whom very soon imitated his example, and Baku has to-day a dozen lines of pipes, each of which costs more than 100,000 roubles. The same house, dissatisfied with the system of shipping petroleum in barrels, proposed to the Kavkaz and Mercury Navigation Company of the Caspian and the Volga that they should build tank boats for the exclusive conveyance of petroleum. This proposal having been rejected, the firm constructed several of these vessels at their own expense. This innovation, of which even the Americans had not yet thought, was accepted by the two petroleum producing countries, and tank boats, the number of which is constantly increasing, are to be found on all the waters of the civilized world. It is also to M. Nobel that those gigantic reservoirs of iron which contain hundreds of thousands of naphtha products are due. They are to be seen in large numbers at Baku, Batoum, and everywhere else where petroleum is carried in bulk. The series of innovations by M. Nobel do not stop there. With a desire to improve land carriage he proposed to the Griazi-Tsaritsine Railway Company the construction of special tank waggons for the transport of the petroleum, guaranteeing a load for them for several years. The railway authorities scoffed at the idea, and it was by the expenditure of very large sums that the Swedish merchant constructed for his own use the first tank waggons. Scorn was immediately changed to enthusiasm, and to-day thousands of these waggons circulate on the railways of Caucasia and Griazi-Tsaritsine.

IN Part xxi. of the Zoological Reports of the Norwegian North Atlantic Expedition, Christiania, 1892, Dr. D. C. Danielssen gives an account of the Crinoids and Echinoids of the North Atlantic. Chief among the former is the beautiful *Bathycrinus carpenteri*, first described as *Ilycrinus carpenteri* by Koren and Danielssen in 1877 from specimens collected by the expedition, and thought to be a new genus, but a careful study and comparison with Herbert Carpenter's description in the report of the *Challenger* Crinoids proved it to belong to *Bathycrinus*. The morphology of this species is very fully described and figured; very interesting are the statements about the apparent formation of "new crown" on specimens which had apparently lost their first crowns; in one of these "the stalk was 110 mm. in height, the crown was 25 mm. high, and the root was 20 mm. in length. The radials of the crown were attached to the basals by a pretty broad seam, the basals being concreted and forming a firm ring as upon old individuals; which distinctly showed that while the radials were a new formation, the basals pertained to the old detached crown and formed the true calyx from which the new crown issued." In this specimen the tentacles could not be seen, and it was very difficult to observe the disc, as it was covered by the closed arms which could not without damage be separated from each other, but that a new crown was in course of formation seemed indubitable. In addition to this species of Bathycrinus, *Rhizocrinus lofotensis*, and the following species of Antedon were found:—*A. tenella*, Retzius; *A. petasus*, D. and K.; *A. prolixa*, Dun. and Sladen; *A. quadrata*, Carp.; and *A. eschrichti*, Muller. Fourteen species of Echinida are mentioned, of which *Echinus alexandri*, Dan. and Kor., is redescribed and figured.

THE additions to the Zoological Society's Gardens during the past week include a Hainan Gibbon (*Hylobates hainanus*) from Southern China, presented by Mr. Julius Newman; a Humboldt's Lagothrix (*Lagothrix humboldti*) from the Upper Amazons, presented by Mr. Chas. Clifton Decconson, F.Z.S.; a Red Howler (*Mycetes seniculus*) from New Granada, presented by Mr. John F. Chittenden, C.M.Z.S.; a Garnett's Galago (*Galago garnetti*) from East Africa, presented by Commander H. J. Keene, R.N.; a Bennett's Wallaby (*Halmaturus bennetti* ♂) from Tasmania, presented by Lieutenant E. A. Findlay, R.N.R.; a Raccoon (*Procyon lotor*) from North America, presented by Mr. A. C. Cooke; a Short-toed Eagle (*Circaetus gallicus*) from Southern Europe, presented by Mr. B. Vincent; a Leadbeater's Cockatoo (*Cacatua leadbeateri*), a Slender-billed Cockatoo (*Licmetis tenuirostris*) from Australia, presented by Mrs. Phillips; a Rock Thrush (*Monticola saxatilis*), two Solitary Thrushes (*Monticola cyanus*), European; a Common Jay

(*Garrulus glandarius*), an Ortolan Bunting (*Emberiza hortulana*), a Blackbird (*Turdus merula*), a Nightingale (*Daulias luscinia*), British, presented by Mr E Cossavella, a Common Jay (*Garrulus glandarius*), a Natterjack Toad (*Bufo calamita*), six Crested Newts (*Molge cristata*), three Palmated Newts (*Molge palmata*), British, three Sand Lizards (*Lacerta agilis*), five Yellow-bellied Toads (*Bombinator bombinus*), an Edible Frog (*Rana esculenta*), European, presented by Mr G B Coleman, four Common Snakes (*Tropidonotus natrix*), British, presented by Count Pavoleri, F Z S, a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, a Barbary Wild Sheep (*Ovis tragelaphus* ♂) from North Africa, two Common Squirrels (*Sciurus vulgaris*), British, deposited, two black Apes (*Cynopithecus niger*) from Celebes, purchased

OUR ASTRONOMICAL COLUMN

SOLAR OBSERVATIONS AT THE R OSSERVATORIO DEL COLLEGIO ROMANO —Prof Tacchini, in the *Memorie della Società degli Spettroscopisti Italiani*, gives a tabular statement of the prominences, faculæ, and spots visible on the sun's surface during the first three months of the present year. Taking the case of the number of prominences, no less than 300 were observed during this period, 161 appearing in northern and 139 in southern latitudes During the first two months prominences were more numerable in the south hemisphere, amounting to an excess of 7 and 5 respectively, but in March as many as 78 were recorded for the northern as against 44 for the southern The latitudes for the regions of greatest frequency were + 40° + 30° and − 20° − 30°

For the faculæ 28, 24, and 18 (total 70) were recorded for the northern latitudes, while very nearly the same number (76 = 20 + 18 + 38) was observed on the southern hemisphere In both cases the record for latitudes ± 50° ± 40° was one, the greatest number appearing in latitudes ± 10° ± 30°

The total number of groups of spots recorded was 80, of which 38 were observed north of the equator Curiously enough the month of February only contributed 21 out of this number, 34 being recorded for January, the region of greatest frequency occupied the zones ± 10° ± 30°

Allowing for the very unfavourable season for observations, a considerable increase over the preceding quarter will be at once noticed The relative amount of spotted area shows an enormous increase for February, the numbers for the months commencing with January being 79 79, 153 61, and 61 57

A REMARKABLE PROMINENCE —Mr J. Fényi, in the *Memorie della Società degli Spettroscopisti Italiani*, gives an account of an unusually large prominence that was visible at Kalocsa, on May 5 last At 10h 25m, Kalocsa mean time, the prominence was very small, but later it developed very considerably, forming itself into a set of small bands, clearly inclined towards the equator At 11h 55m the observed height was 139″, there being no indication of a rapid ascent At 12h 11m a very rapid upward motion had already begun to make itself visible, and by 12h 17m 34s the height reached was 287″, extending to 317″ 1m 11s later, when the velocity of ascent was 306 km per second After a few minutes the lower parts to the height of 360″ became invisible, but the smooth portions ascended at 12h 21m 4s, with a velocity of 368 km per second to a height of 531″ This latter measurement was made at 12h 29m 25s, and soon after the object was no more seen The actual height attained, then, may be reckoned about 381,800 km, or 237,126 miles. At the termination of this eruption, it was noticed that the prominences at 127° and 79°, and even the one at 106°, which very nearly coincided with the position of the eruption itself, still retained the same forms, having apparently suffered no change by this enormous disturbance, no faculæ or spots either were recorded which could in any way be connected with this outbreak

THE TRAPEZIUM IN THE ORION NEBULA.—During the first three months of the present and preceding year Dr L. Ambronn, of the Gottingen Observatory, has undertaken a measurement of the distances and position angles between the four bright stars forming the trapezium in the great nebula of Orion. The results which he has obtained are recorded in the 3103 number of *Astronomische Nachrichten*

Commencing with the star θ′ Orionis, which is here designated *a*, and taking the others in cyclic order following the direction opposite to that of the motion of the hands of a watch, we find there designated by *b*, *d*, and *c* respectively The accompanying table, for the sake of comparison, shows the position angles and distances for the equinox 1870 from the measurements of W Struve, Dembowski, O Struve, Hall, and Ambronn

	W Struve 1836 15	Dembowski 1867 04	O Struve 1870 0	Hall 1877 7	Ambronn 1891 6
	° ′	° ′	° ′	° ′	° ′
ab	311 45	311 22	311 32	311 4	311 15
ac	60 29	61 38	60 22	61 8	60 58
ad	340 20	342 23	342 5	342 15	342 31
bc	95 35	96 2	95 36	95 34	95 26
bd	31 48	32 11	31 43	32 55	33 1
cd	299 34	299 33	299 34	299 18	299 15
	″	″	″	″	″
ab	13 002	12 907	13 049	13 116	13 250
ac	13 344	13 385	13 276	13 453	13 698
ad	16 854	16 681	16 876	16 768	16·997
bc	21 414	21 582	21 410	21·758	22 038
bd	8 706	8 706	8 705	8 772	8 915
cd	10 227	19 340	19 237	19 363	19 576

NEW VARIABLE STARS —A short note communicated by Prof Pickering to *Astronomische Nachrichten*, No 3104, informs us that six new variable stars in the southern sky have been discovered on examination of the photographs of stellar spectra taken at Arequipa in Peru The following are the constellations, positions, and the dates on which the photographs were taken —

Constell	α 1900 h m	δ 1900 ° ′	Date
Horologium	2 49 5	− 50 10	Sept 10, 1891
Octans	6 0	− 86 30	Sept 11, 1891
Bootes	14 22 1	+ 5 2	April 26, 1892
Octans	17 30	− 86 45	Aug 31, 1891
Sagittarius	19 49 8	− 29 27	Oct 3, 1891
Tucana	23 53 2	− 65 56	Aug 25, 1891

All these stars when at a maximum are as bright or brighter than the 8th magnitude, but only one, that in Sagittarius, is a catalogue star (Cord G C 27271, Mag 8½)

THE BRITISH ASSOCIATION COMMITTEE ON ELECTRICAL STANDARDS

IN view of the hoped-for presence of Prof. von Helmholtz and other distinguished foreigners at this year's meeting of the British Association in Edinburgh, it will probably be recognized as suitable to take up and continue the discussion on new electromagnetic units for practical purposes, which was begun last year at Cardiff

I therefore beg to contribute the following notes and to conclude by moving some resolutions.

One great fact brought into prominence by the practical development of electricity is the analogy or reciprocity between the electric and the magnetic circuit, and this is the fact which it behoves us to emphasize in the naming of fresh units

The magnetic circuit has as yet no authorized names applied to it The electric circuit is well provided, but perhaps one or two improvements can be made

(1) THE ELECTRIC CIRCUIT.

The first point on which I consider that practical men would do well to insist is that names shall be given to the complete things dealt with, rather than to mere coefficients Thus of all units with which they are concerned there can be no doubt but that *volt* and *ampere* are the most prominent. These are the active things with which Electrical Engineers have to deal, and these are the things for which meters exist on every wall in an electric lighting station. The ohm, or unit coefficient of resistance, is comparatively academic in character, it is a constant of a coil of wire or of an underground lead, it is nothing vivid

and active. The engineering use of the term ohm is mainly in connection with insulation and other high resistances; for large conductors the equivalent "volt per ampere" is perhaps more often used. It is the drop of potential which a given conductor entails for a given current that is of real interest to an engineer, and it is this of which in large leads he consciously thinks.

A 6 ohm conductor means one that drops 6 volts for every ampere that is sent along it. If you send 3 amperes along such a line, the potential at the far end is 18 volts below that at the near end. The clear realization of this fact would be almost aided by the complete title, 6 volts per ampere, instead of the abbreviation, 6 ohms. Nevertheless, the name ohm is in common use and hence may be assumed useful.

A still more useful name, however, for good conductors would really be the reciprocal of an ohm—the ampere per volt. Suppose this called a mo, as Sir W. Thomson once suggested, then a cable of 20 mos would be one that conveyed 20 amperes with a drop of 1 volt. A thousand-mo cable would convey 500 amperes with a drop of half a volt, and so on. It is more directly practical to think of the amperes conveyed per drop of voltage, than of the drop of voltage per ampere. I believe that some authorized name for unit conductance would be welcomed.

Units of Inconvenient Size

The authorized name "coulomb" for unit quantity is barely used by engineers, who are content with ampere hour, thus proving that what is needed in practical units is not so much a consistent decimal system, as a set of units each of practicable magnitude.

Farad

The effort after consistency has resulted in the useless "Farad", and this should be a lesson not to try and fix units of unreasonable size. The c.g.s. units already exist as a consistent system; the only objection to them is that they are of unpractical size. The whole object of devising a practical system of units was to have things of every-day size to deal with. The volt, the ampere, and the ohm satisfy this condition. The coulomb, the farad, and the watt do not. Already they have practically given place to the ampere hour, the micro farad, and the kilowatt.

Considerably more progress would have been made in knowledge of ordinary capacities if the microfarad had been called the farad, so that easy submultiples of it would have been available to express the capacity of Leyden jars, and such like things. The capacity of an ordinary jar would then have been a few millifarads, and a microfarad would have been the capacity of a short bit of connecting wire. I ask whether this change would introduce serious confusion even now. I think not. Nobody cares the least about "coulombs per volt," and so there is no sense or use in the present farad. Telegraphists would surely soon consent to drop the useless prefix micro, and the factor of a million is too great to render doubt possible as to what was intended, even in the transition stage. It ought to be regarded as essential to have the practical unit somewhere not hopelessly away from the middle of the range of probable multiples and submultiples.

Coulomb

A coulomb again is almost useless as a synonym for the ampere-second, it is so easy to speak of ampere minutes or ampere hours. If the name coulomb could be set free from its present superfluous meaning it could usefully be applied to the electrostatic unit of quantity, which wants a name. Teachers would find it convenient at once, and in the apparently imminent line of development engineers might find it useful before long. It is the charge on a two centimetre sphere at a potential 300 volts (or on a one-foot sphere at 20 volts). The capacity of the two-centimetre sphere would be $\frac{1}{10}$ of a (new) microfarad.

Watt.

Lastly with regard to the watt. The name volt ampere is almost as good as the name watt, especially since the watt is also one joule per second.

Both names, watt and joule, are not really wanted by electricians, to whom their coexistence is rather confusing. I believe it would be more convenient to use the term watt in the sense it gets so frequently used now, viz., energy, say a volt ampere-hour; in which case a kilowatt would be synonymous with the present Board of Trade unit.

The rate of working, or power, could then be expressed in a rational and unforced way as so many watts per hour or so many volt amperes. It is much more natural to give a name to a definite thing like a quantity of energy, than it is to give it to a mere rate of working. The latter is instinctively felt to need a reference to time, just as a velocity unit has not been practically found to need a name, being quite simply expressible in feet per second or miles per hour, and even when a name has been given, like "knot," instinct constrains people to practically get rid of it again by speaking of knots per hour, just as we find "kilowatts per hour" already often used in electrical workshops. I suggest, therefore, that the present watt is too small, that it is sufficiently expressed by a joule per second, and that it would be more useful if magnified 3,600 times, and turned into a unit of energy.

That we should thus have several energy units—the erg, the joule, and the watt, all of quite different sizes, is no objection, but an advantage, seeing the extreme importance of energy. Such things as length, mass, time, and energy demand a fair range of units. It would be tedious to express centuries in seconds.

(2) MAGNETIC CIRCUIT

In speaking of the magnetic circuit I wish to refer back to my opening remarks concerning the electric circuit, and the class of things for which names should be found. In the magnetic circuit the only thing at present seriously attempted to be named is, in accordance with the historic parallel of the ohm, a coefficient or characteristic of a coil of wire—its coefficient of self induction, the unit of which has been called variously a secohm, a quadrant, and a henry.

Total Induction

But the real active thing with which engineers are concerned is total magnetic induction, total number of lines of force across an airgap, as between the polepieces or through the armature of a dynamo, or in the circuit of a transformer. It may be called the electromagnetic momentum per turn of wire, or the surface integral of B. This total induction is in some respects analogous to electric current, and has occasionally been called magnetic current (a bad name), or "magnetic flux." It is, however, more strictly analogous to the coulomb, and its time rate of variation is the more proper representative of electric current.

Its common practical name at present is "total lines," or "total induction," or "number of lines."

Now "one line" is awkward as a unit, besides being (if a c.g.s. line) inconveniently small. The earth, for instance, sends 4,400 such lines through every horizontal square metre about England, through a square inch it only sends a fraction of a line. A practically sized unit of induction badly wants a name, and "henry" would have done for it very well, and have been both more suitable and more useful for the actual quantity than for a coefficient. But "henry" has already been half appropriated to the secohm, so, for illustrative purposes at any rate, I propose to use the name "weber" for the unit magnetic flux.

Concerning the most convenient size for the weber, there is much to be said for making it 10^8 c.g.s. lines, though that is bigger than ordinarily occurs in practice, because then a wire which cuts one weber per second will have a volt difference of potential between its ends. Or a coil of twenty turns through which the magnetic induction changes at the rate of one weber per second will have an E.M.F. of twenty volts induced in it. The average E.M.F. in such a coil, spinning thirty turns a second, and enclosing a maximum total-induction of one weber, is 600 volts.

This is the dynamo use of the unit; the following is the motor use.

A wire carrying an ampere and cutting a weber per second, does work at unit rate, viz., one joule per second.

Probably the simplicity of all this compensates for the rather unwieldy size of the unit. A strongly magnetized piece of iron may have 20,000 lines to the square centimetre; so a weber could occur across a narrow airgap half a square metre in area.

The earth gives an induction of about one weber through every 23,000 square metres of England, or 100 webers per square mile. The earth induction through a horizontal square metre is 44 micro webers, so with micro- and milli-webers the range would

be fairly covered, though a smaller weber would have been better if it had been equally convenient as regards the volt

The pull between two parallel surfaces joined by a weber is $\frac{10^{16}}{8\pi}$ dynes, or four hundred thousand tons. A milli-weber gives less than half a ton pull, and a micro weber less than half a gramme.

Because of the property that the voltage excited in a circuit is equal to the webers cut by it per second, a weber might be called a sec-volt. It is equal to a secohm-ampere-turn, that is to say, if a single turn of wire can have a self-induction coefficient of one secohm, it will excite a weber of induction for every ampere passing through it.

[Such a circuit in the form of an anchor ring would be enormous, something like a mile across, but it could be made in the form of a solid cylinder of best iron ($\mu = 2500$), with an axial perforation for the wire, and 80 metres long.

If a secohm coil has n turns, then an ampere passing through it excites only $\frac{1}{n}$th of a weber, for, since every turn encloses the induction, the latter is effective n times over, and so the induction coefficient is n times the induction per ampere, or n^2 times the induction per ampere turn.]

No name is needed for intensity (or density) of induction (B), for that can always be expressed in webers per unit area.

[For instance, strongly magnetized iron, with say 10,000 lines to the square centimetre, has one tenth of a weber per square foot, or 0.7 milli webers per square inch.]

And there is a practical gain in thus leaving the specification of area open, for it enables British units of length to be employed in measuring air gaps, yokes, cores, and polepieces.

So long as dynamo dimensions are commonly expressed in inches, there is no serious objection to specifying induction in fractions of a weber per square inch or per square foot.

Magnetomotive Force

Now consider the magnetic analogue of the volt, the unit of magnetic potential or magnetomotive force. By this is understood the line integral of the magnetizing force H, the quantity $4\pi n$C, the step of potential once through and all round the circuit of a coil. It is a quantity most important in practice, and requires a name.

Mr Heaviside has suggested the name "gaussage," as analogous to voltage, and, if this were adopted, the unit of magnetomotive force would be the gauss. The intensity of magnetizing force would be the gauss-gradient, or drop of gaussage per centimetre, no special name is needed for the unit of this quantity H.

The common practical unit of gaussage at present is the ampere-turn, and this has several advantages. It may, however, be found better to make some convenient number of ampere-turns into a gauss, for instance, the c g s unit of gaussage would be $\frac{4\pi}{10}$ or 1.2566 ampere turns. If that were adopted as the gauss, the horizontal component of the earth's magnetic intensity about here would be, say .18 gauss per linear centimetre.

But this unit, whether the c g s unit or the ampere turn, is very small. The step of potential all round a single ampere-turn is only equivalent to a vertical step of about 2 centimetres in the earth's field.

Nevertheless, in spite of its smallness, the ampere-turn as practical unit of gaussage will probably commend itself by reason of its simplicity. Let us see how it works out.

Reluctance

The ratio of gaussage to the induction excited by it, is a quantity characteristic of the magnetic circuit, and called its reluctance or magnetic resistance. This is the quantity $\frac{l}{A\mu}$ for simple circuits, or $\Sigma\frac{l}{A\mu}$ for complex ones, it is unfortunately not constant for any but air circuits. This constitutes one difficulty of naming its unit satisfactorily, else it might be expressed as so many "gilberts" or "sturgeons" (analogous to ohms). It is, however, fairly constant under many common conditions of practice, and it can always be expressed as gausses per weber, and perhaps this way is sufficient.

A magnetic circuit with unit reluctance is one that requires one gauss to induce in it one weber.

Permeability

Permeability (μ), analogous to electric conductivity, would be measured by the webers induced through unit cube of the material between whose faces there is unit fall of gaussage. It has been suggested (by Prof Perry) that the permeability of air had better be called $4\pi \times 10^{-9}$. But the whole electromagnetic system of units is based on the μ for air being called 1, so it would be rather confusing to change that. Moreover, it would be a retrograde step to affix another incorrect value to the constant μ, instead of waiting and trying to find out what its value really is. It is better to adhere for the present to the existing table of permeabilities, and to use whatever constant factor may be needed in order to turn $\frac{l}{\mu A}$ into practical units of reluctance.

Permeance

But the reciprocal of reluctance, or the webers induced per gauss, may be the more instructive thing to attend to and name, just as conductivity is often more directly interesting than resistance. This reciprocal ratio, $\frac{\mu A}{l}$, has been called "permeance," and that is not a bad name for it, it is proportional to the inductance of a single-looped circuit. Permeability is the permeance of unit cube of the material. Permeance is the webers induced per unit drop of gaussage. Permeability is the webers per unit area induced by unit gauss gradient.

The permeance of the magnetic circuit enclosed by a solenoid of wire is the same as its appropriate self induction coefficient divided by 4π times the square of its number of turns.

The c g s unit of permeance (or of reluctance) is that of a centimetre cube of air, and is not a bad-sized unit. But it is inconsistent with the weber as 10^8 and the gauss as a single ampere turn.

One of the three must give way.

On the whole I have no hesitation in suggesting that the derived unit (that of permeance) must give way, and be taken as $4\pi \times 10^7$ c g s units, in order to harmonize with the other two as already defined.

The fact is that the great size of the weber renders a small gauss desirable, in order that their product may not represent too large a quantity of energy. For instance, if 1 c g s unit were taken as the unit of permeance, the weber being fixed at 10^8, then the gauss would also be 10^8, and the gauss-weber would be 10^9 joules, or nearly 300 Board of Trade units, which is far too much.

Whereas if the unit of permeance is fixed high, and the gauss kept small, then the energy corresponding to a gauss-weber may be moderate. Thus with 10^8 c g s as weber, and an ampere-turn as gauss, their product is only $\frac{10^9}{4\pi}$ ergs, or $\frac{100}{4\pi}$ or about 8 joules, which will be useful in energy considerations connected with the heating of transformers.

I therefore propose, in order to retain the ampere-turn as unit of gaussage, that the permeance of a cylinder of material of length l and area A be reckoned as $\frac{\mu A}{l}$ multiplied by $4\pi \times 10^7$, if dimensions of the cylinder are measured in centimetres, μ being its ordinarily tabulated value with air = 1. If dimensions are measured in inches, then the permeance of a cylinder will be $\frac{\mu A}{l}$ multiplied by $\frac{4\pi}{2.54} \times 10^7$, that is by about $\frac{1}{2}$ 10^8.

The unit of permeance thus suggested is immensely big, and it requires a name of which easy sub-multiples could be formed.

A slab of iron 1 centimetre thick, and with its $\mu = 2500$, would need an area of 5 square metres in order to have unit permeance, but a micro unit would be possessed by an air-gap a millimetre thick and less than a decimetre square.

PROPOSED RESOLUTIONS

(1) That the unnecessary prefix "micro" be dropped before the word farad, and that the farad be defined afresh as 10^{-15} c g s electromagnetic units of capacity.

(2) That the name "mo" for the unit of conductance or the ampere per volt, be recognized and adopted. (Every *mo* in a cable enables it to carry an ampere with a drop of 1 volt.)

(3) That the ampere-hour be recognized as a convenient practical unit of electrical quantity.

(4) That the volt ampere hour be recognized as a convenient

practical unit of electrical energy, and be called the watt (It equals 2640 foot-pounds, or a trifle over a foot-ton)

(5) That the present Board of Trade unit be called a kilowatt

(6) That the ordinary unit of power be a kilowatt per hour [It equals about 4/3rds of a horse-power, more accurately $\frac{1000}{746}$ HP]

(7) That it is convenient to retain the name joule in its present sense of a volt coulomb, or ten million ergs, for use in the science of heat, since heat-capacities are conveniently expressed in joules per degree, and it will be handy to remember that a volt ampere generates one joule of heat per second

(8) That the name coulomb be affixed to the electrostatic unit of quantity [for academic purposes]

(9) That a name be given to unit magnetic flux or total induction, and that the name weber is suitable

(10) That the most convenient size for the weber is 10^8 c g s units or "lines" (since the rate of change of this through a circuit is equal to the induced voltage)

(11) That a name be given to unit magnetic potential or magnetomotive force, and that the name gauss is suitable

(12) That the handiest size for the gauss is one ampere-turn

(13) That a name be given to the ratio of the weber to the gauss, or unit of permeance, or self-induction per turn of wire [If the above resolutions were adopted, this unit would be $4\pi \times 10^7$ c g s. units, or $\frac{1}{4}$ secohm per turn]

(14) That intensities of field be expressed in gausses per unit length, and densities of induction in webers per unit area (leaving the length or area unit open for practical convenience to arrange)

No doubt many of these recommendations have been made before Mr Preece has often urged the change of farad, so that I hope there will be no difficulty about that

I find that my magnetic suggestions are very similar to those suggested by Prof Perry in his modified letter to the Committee as published in the *Electrician*, vol xxvii p 355 [July 31, 1891], and received there with approving editorial comments The accordance between our suggestions is satisfactory, and makes it likely that they are such as engineers may be satisfied with and be willing to adopt I need hardly say that I lay no stress upon the particular *names* here proposed In choosing them I have been influenced by such trivial considerations as the selection of a monosyllable to correspond with volt, and a dissyllable to correspond with ampere or coulomb

[With regard to Prof Perry's footnote concerning college instruction and use of c g s units, I suppose systems of teaching differ, but a senior student *ought* to be taught to deal with concrete quantities in so familiar a manner that no possible admixture of units can be any puzzle to him, nor involve anything worse than a little tiresome arithmetic]

MECHANICAL UNITS

There are several quantities in dynamics beside the joule and the watt for which brief names would be advantageous I do not propose to discuss these fully now, but the present opportunity might be utilized by agreeing to at least one unit, that of pressure, viz., the "atmosphere", which might be defined as 10^6 c g s, or dynes per square centimetre, and stated to be equal to the pressure of a column of mercury 75 centimetres high at a specified temperature The inconvenient pressure, 76 centims, might be spoken of as a Regnault atmosphere I believe that a smaller unit of pressure, for instance, the micro-atmosphere or "barad," might also be usefully named These pressure units will be useful for expressing energies per unit volume also, and the "barad," or whatever other name is decided on for the erg per cubic centimetre, is of reasonable magnitude for many purposes

OLIVER J LODGE

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE annual summer meeting of the Institution of Mechanical Engineers, held last week at Portsmouth, was a successful gathering in regard to numbers present and the attendance at the excursions, but the business part of the meeting, which consists of the sittings at which papers are read, was of a rather tame character The following is a list of the papers on the agenda:—

On Shipbuilding in Portsmouth Dockyard, by Mr William H White, C B, F R S, Director of Naval Construction and Assistant Controller of the Navy

On the Applications of Electricity in the Royal Dockyards and Navy, by Mr Henry E Deadman, Chief Constructor, Portsmouth

Description of the Lifting and Hauling Appliances in Portsmouth Dockyard, by Mr John T Corner, R N, Chief Engineer, Portsmouth

Description of the New Royal Pier at Southampton, by James Lemon, J P, Mayor of Southampton

Description of the Portsmouth Sewage Outfall Works, by Sir Frederick Bramwell, Bart, D C L, LL D, F R S, Past-President

Description of the New Floating Bridge between Portsmouth and Gosport, by Mr H Graham Harris, of London

Description of the Southampton Sewage Precipitation Works and Refuse Destructor, by Mr William B G Bennett, Borough Engineer and Surveyor

Description of the Experimental Apparatus and Shaping Machine for Ship Models at the Admiralty Experiment Works, Haslar, by Mr R Edmund Froude, of Haslar

Description of the Pumping Engines and Water Softening Machinery at the Southampton Water Works, by Mr William Matthews, Waterworks Engineer

Mr Matthews' paper was adjourned, and that by Mr Froude was not read, as time ran short This was much to be regretted, as the Haslar experimental works are one of the most interesting of all our establishments set apart for scientific investigation It is to be hoped, now Mr Froude has broken the ice, that he will contribute a fairly complete descriptive paper to the Institution of Naval Architects, where he would naturally find a more appreciative audience than amongst the members of a society devoted more exclusively to mechanical engineering Although there was not time for the reading of the paper, Mr Froude very good naturedly stopped and explained to some of those present the working of the apparatus which he had brought for the purpose of exhibition, together with the large wall diagrams that had been prepared expressly for illustrating the paper

On the members assembling in the Town Hall on July 26, Dr Anderson, the President, occupied the chair, and the usual formal business having been disposed of, Mr White's paper was read This was chiefly of a historical character, the author going back to the year 1212, when the sheriff of the county of Southampton was ordered to enclose the King's Dock by a strong wall, and to provide suitable storehouses A dockyard, properly so called, was not, however, founded until the reign of Henry VIII, so it was second in point of antiquity to Woolwich Dockyard The latter was closed in 1869, "so that Portsmouth Yard is now," Mr White says, "the oldest as well as the most important in existence" We do not know whether Mr White means by this that it is the oldest in existence in Great Britain, or in the whole world In 1540 the total area was 8 acres Until nearly the end of last century there was no basin in which ships could lie while completing or repairing, and the dock accommodation was poor, but about that time a basin of 2½ acres and six dry docks were constructed At that time the yard area was 90 acres In 1843 50 a steam factory was added, and another basin of 7 acres, besides four docks, the total area of the dockyard being 115 acres The effect of steam on the navy is well illustrated by the extensions that took place about 1864, when the area of the Dockyard was more than doubled A fitting-out basin of 14 acres, a rigging basin of the same size, and a repairing basin of 22 acres, were made There is also a tidal basin of 10 acres The extent of Portsmouth Dockyard is now nearly 300 acres

Mr Deadman's paper was also largely of an historical nature, giving many interesting details of the introduction of electricity into the navy. Among the most notable features in the application of electricity to naval purposes are the temporary installations used for interior lighting during the building and finishing of the vessel The estimated cost of electric lighting during the period of building the *Royal Arthur* was £1200 This would be about the same sum as would be required were candles used, but naturally electricity affords a far superior light, and it is to its use that is due much of the quickness with which the

Royal Sovereign was finished. There was nothing very startling in Mr Deadman's paper, which was none the less a useful record of facts During the discussion, however, Mr Crompton sounded a very stirring note. He roundly told the whole body of important dockyard officials and Admiralty officers present, including even the Director of Naval Construction, that they were altogether behind the age in the matter of electricity, that the French and German navies were far ahead of them, to say nothing of other powers, and that generally the English Government was the most benighted and non-progressive Government in all the world, so far as the matter of electricity was concerned, for they paid twice as much as they ought to do for an article that was not half as good as it should be That was the purport of Mr Crompton's speech, if not the exact words he used, and one cannot but acknowledge that he did not speak altogether without a text It is hard to fully account for the want of enterprise in the Royal Navy, but there is one point to which we might draw attention The paper read at the meeting was by a naval constructor, and electricity is, we understand, within the Constructor's department Now electrical engineering is essentially an engineering question, and its consideration requires engineering knowledge and ability of a very high order. In the early days nothing kept electric lighting back more than the bad engineering that was associated with it, and thus it will always be so long as engineers are not employed in carrying out the plans which are founded on the researches of those more highly scientific investigators, upon whose experiments and deductions the practical applications are founded

The next paper read was Mr Corner's contribution, in which he described the lighting and hauling apparatus used at Portsmouth These may be divided into the hydraulic installation, the compressed-air appliances, and the ordinary steam cranes There are in the dockyard ninety six boilers, which burn about 10,000 tons of coal per annum, but what proportion of this is used for lifting and hauling we do not know In the hydraulic department there are nearly two miles of pressure pipes varying from 1½" to 4" in diameter There are also some independent installations, as well as the coaling arrangements for the fleet at coaling point There are here ten 30 cwt cranes, and three 10 ton tips, with necessary capstan weigh bridges The more modern lifting and hauling appliances are by compressed air, the air being compressed to 60 lbs With this pressure there is little or no trouble with frost, only a little forming at the exhaust in very damp weather, and altogether the pneumatic system seems to be preferred to the hydraulic It must be remembered that the power required is variable, and this of course brings the advantage of the pneumatic system, in the matter of working expansively, to the fore We understood Mr Corner to say, during the discussion, that when the hydraulic motors and the air engines were both worked at their full power the water system was the most economical, but working linked up, under the prevailing conditions, the air system was the best The condensation of steam in the pipes is the objection to the steam motor when situated at some distance from the boiler, otherwise steam would be the best vehicle The other papers read do not call for any special notice at our hands, their titles giving a sufficient indication of their scope, and there being no features of especial novelty in the matters they described

A number of excursions had been arranged, and were carried out in a very satisfactory manner On the first day, Tuesday, the 26th ult., the members visited the Dockyard, and were welcomed by the Admiral Superintendent in person On Wednesday the Portsmouth Sewage Works were visited, and a trip was made to the Clarence Victualling Yard at Gosport On Thursday a trip was made to Southampton, where the Docks were inspected, and a visit was paid to the Union Steamship Company's new engineering shops There was an alternative visit to the Ordnance Survey Office In the afternoon a visit was paid to the London and South Western Railway Company's new carriage and wagon shops at Eastleigh. Friday was devoted wholly to frivolity, the only item on the programme being a steamer trip round the Isle of Wight On Saturday a good many of the members went to Brighton to visit the locomotive works of the London, Brighton and South Coast Railway. Largely owing to the exceptionally fine weather the meeting was a great success, and, for pleasantness, may rank with the Dublin meeting of three or four years back

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD —The fifth summer meeting of Oxford University students commenced on July 29, and will continue till August 27 The general outline of the programme has already been noticed in these columns, but we may notice here that the popularity which has attended these gatherings shows no signs of diminishing It was announced by the Provost of Queen's College, who presided at the inaugural lecture given by Mr John Addington Symonds, that upwards of 1250 students had come to attend the lectures it was proposed to deliver In welcoming the students to the meeting, Dr Magrath remarked that last winter 60,000 students (including 10,000 artisans) regularly attended the extension lectures of the various universities engaged in the work There had been 312 courses of Oxford lectures He also commended the co operative societies of the North, and particularly the Co operative Union, and mentioned the individual liberality of Mr Dixon Galpin, who had founded scholarships for students from Dorset to attend this summer meeting The munificence of Mr Galpin had been supplemented by the Dorset County Council A University Extension College had been recently established at Reading, under the presidency of Mr MacKinder, an example which he hoped would be followed at other centres

On Monday a conference was held in the Union Debating-room, under the presidency of Mr J G Talbot, M P, to consider the relations between the County Councils and the University extension movement The president invited the lecturers under various County Councils to express their opinion as to the advantages, prospects, and difficulties which they had met or encountered in the course of their peripatetic teaching His own opinion was that one very successful result of these lectures would be the amalgamation of the classes and the masses, and he noticed that one of the candidates to whom a County Council had awarded a scholarship was in the position of an agricultural labourer

Mr Hall, who had been a University Lecturer under the Surrey County Council, cautioned the meeting against entertaining any exaggerated views of the actual information that he had been able to convey to the agricultural labourers He himself was satisfied if he could awaken a desire for knowledge in the rural mind and convince the extremely conservative agriculturist that he had something to learn

Mr Sells, of the Yorkshire College, Leeds, described the activity of that portion of the Victoria University, and believed that in the North they were in advance of the Oxford movement in meeting the actual and practical wants of the labouring section of the community Coal-mining was taken up by them with eagerness, and the agricultural lecturers carried about with them the actual implements of husbandry in order to bring the matter practically before their audience The discussion was continued by Mr Sadler, secretary to the Delegacy, who said that alliances had been entered into with twelve large counties in the past year, and they should be proud of the achievement In his opinion they ought to give a stimulus to learning to the masses, and for this reason they ought also to combine with the elementary teachers Help should also be given to individuals, and it was necessary to secure the services of good men, by enabling the scheme to compete with other professions in the matter of the remuneration offered

Mr MacKinder (University Extension Lecturer) and Dr Magrath agreed in deprecating any fixed cut and dried plan for the whole country, but thought that the scheme should be varied to meet the different circumstances of the various County Councils At the same time, each County Council should have a definite policy

SCIENTIFIC SERIALS

THE *Quarterly Journal of Microscopical Science* for March 1892, contains —On a new branchiate Oligochæte (*Branchiura sowerbyi*), by Frank E Beddard, M A (plate xix) This annelid, found in mud from the "*Victoria regia* tank" in the Royal Botanical Gardens, Regent's Park, London, is remarkable for the unusual contractility of its body, which suggested a leech or flat worm rather than a Chætopod It consists of about 120 segments When magnified the orange-coloured digestive tract traversed by the bright blood vessels is seen, and

at the posterior end of the body there is a series of delicate dorsal and ventral processes, these latter are segmentally arranged, developed in pairs upon the last sixty segments or so of the body There is no connection between the setæ and these processes, as in Bourne's Chætobranchus, also found in the same tank This worm is referred to the Tubificidæ, without having any certain affinities to any of the known genera —On the formation of the germ-layers in *Crangon vulgaris*, by W F R Weldon, M A (plates xx to xxii) The author's conception of the early development differs widely from that of Kingsley —On the pigment cells of the retina, by I S Boden and F C Sprawson The retinal pigment cells are not, as usually represented, invariably hexagonal; in specimens taken from the eyes of sheep, ox, rabbit, kitten, pig, hen, and frog, while hexagonal cells were the most numerous, heptagonal cells were frequently found and scattered at intervals Cells with four, five, eight, nine, ten, and eleven sides were found —Observations upon the development of the segmentation cavity, the archenteron, the germinal layers, and the amnion in mammals, by Dr Arthur Robinson (Plates xxiii to xxvii) There is a general description of the development of the ova of the rat and mouse up to the period of the completion of the blastodermic vesicle, and a comparison with the results obtained by Fraser, Duval, and Selenka there is a description of the formation of the mesoblast and of the chorda dorsalis, followed by a comparison of the ova of the rat and mouse with the ova of other mammals and the lower vertebrates and by a description of the formation of the amnion and a discussion of the relation of amnion formation to "inversion," and by a description of the formation of the cœlom

June —Contains —On the primitive segmentation of the vertebrate brain, by Bertram H Waters, B A (Plate xxviii), concludes that the fore brain is composed of at least two well marked neuromeres, possibly of three, that the mid brain consists of two neuromeres, from which there is every reason to think that the third and fourth nerves take their origin, and hence these deserve to be recognized as segmental structures, and that the hind brain consists of six neuromeres On the oscula and anatomy of *Leucosolenia clathrus*, O S, by E A Minchin, B A (Plate xxix.) In this sponge, in the fresh and healthy condition, not only are there oscula, "but in the full-sized specimens larger oscula than in any other Leucosolenia known to me, whether from pictures or in the flesh" These oscula are provided with a sphincter, and can be so tightly closed as to escape notice Hæckel's four varieties of the sponge are only different states of contraction —Researches into the embryology of the Oligochæta, No I · on certain points in the development of *Acanthodrilus multiporus*, by Frank E Beddard, M A (Plates xxx and xxxi) — On the Innervation of the Cerata of some Nudibranchiata, by Dr W A Herdman and J A Clutt (Plates xxxii to xxxiv) If the cerata of Nudibranchs cannot all be said to be true epipodia innervated by the pedals, it would seem equally impossible to regard them in all cases as pallial outgrowths supplied by the pleural ganglia It is possible that they may have been epipodial in origin, although there be now, in some, a connection with pleural nerves —Notes on Elasmobranch development, by Adam Sedgwick, M A (Plate xxxv) On the paired nephridia of Prosobranchs, the homologies of the only remaining nephridium of most Prosobranchs, and the relations of the nephridia to the gonad and the genital duct, by Dr R v Erlanger (Plates xxxvi and xxxvii)

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 16 —"The Physiological Action of the Nitrites of the Paraffin Series considered in connection with their Chemical Constitution Part II Action of the Nitrites on Muscular Tissue and Discussion of Results" By J Theodore Cash, M D, F R S, Professor of Materia Medica in the University of Aberdeen, and Wyndham R. Dunstan, M A, Professor of Chemistry to the Pharmaceutical Society of Great Britain.

Continuing the examination of the physiological action of various pure organic nitrites of the paraffin series (Part I, Roy Soc Proc., 1891), the authors have studied their effect on striated muscular tissue. When the vapours of these nitrites come into contact with the muscle a paralysant effect is observed All the experiments were made with the triceps and gastrocnemius of *Rana temporaria* The muscle was contained in a specially constructed air tight chamber A very extensive series of experiments was necessary in order to obtain reliable contrasts The amounts of the nitrites employed varied between $\frac{1}{50}$ and $\frac{1}{150}$ c.c

Several series of concordant results have thus been obtained which lead to two different orders of activity, viz (1) with reference to the extent to which equal quantities of nitrites shorten the resting muscle, and (2) with reference to the rapidity with which the shortening is produced The order of activity of the nitrites as regards the extent of the shortening they induce is as follows —(i) Iso butyl, (ii) tertiary amyl, (iii) secondary butyl, (iv) secondary propyl, (v) propyl, (vi) tertiary butyl, (vii) butyl, (viii) α amyl, (ix) β amyl, (x) ethyl, (xi) methyl The order representing the speed with which shortening occurs is (i) methyl, (ii) ethyl, (iii) secondary propyl, (iv) tertiary amyl, (v) primary propyl, (vi) tertiary butyl, (vii) secondary butyl, (viii) α amyl, (ix) β amyl, (x) primary butyl, (xi) isobutyl

The effect of these nutrites in interfering with the active contraction of a stimulated muscle has also been studied, and it has been ascertained that very minute doses, insufficient to cause passive contraction, interfere in a marked degree with the active contraction, and cause the muscle to fail in responding to stimulation, whilst the companion muscle, contained in a closed chamber free from nitrite vapour, still responded to stimulation

The remainder of the paper is devoted to a discussion of the connection between the various phases of physiological action and the chemical constitution of the nitrites which gave rise to them The principal conclusions which have been arrived at are briefly as follows — The physiological action of these nitrites is not solely, and in some cases not even mainly, dependent on the amount of nitroxyl (NO_2) they contain

In respect of all phases of physiological activity, the secondary and tertiary nitrites are more powerful than the corresponding primary compounds This is to be chiefly attributed not to the direct physiological action of the secondary and tertiary groups, but to the great facility with which these compounds suffer decomposition mainly into the alcohol and nitrous acid In respect of the acceleration of the pulse, the power of the nitrites is directly as their molecular weight, and inversely as the quantity of nitroxyl they contain They, therefore, fall into an order of physiological activity which is identical with that in which they stand in the homologous series This same relationship holds, though less uniformly, in their power of reducing blood-pressure, and of inducing muscular contraction

This order appears to be the result not so much of the direct physiological influence of the substituted methyl groups as of the increased chemical instability which their presence confers on the higher members of the series In respect of the duration of subnormal pressure, as well as of the rapidity with which muscular contraction ensues, the activity of the nitrites is expressed by an order which is for the most part the reverse of that representing their power in accelerating the pulse, reducing blood pressure, and contracting muscular fibre, this order being in general contrary to that of the homologous series In these respects the more volatile nitrites of low molecular weight which contain relatively more nitroxyl are the most active It appears probable that these simpler nitrites more readily attach themselves to certain constituents of blood and muscle, and thus act more quickly than the higher compounds, whilst their greater stability causes their effects, *i e*, reduction of blood-pressure, &c, to endure for a greater length of time than that of the higher and more easily decomposed bodies.

A large proportion of an organic nitrite is changed into nitrate in its passage through the organism, and is excreted as an alkali nitrate in the urine

The results which have been gained by this research have an important bearing on the therapeutic employment of the nitrites It is proposed elsewhere to consider what the outcome of this investigation is for practical medicine

PARIS

Academy of Sciences, July 25 —M d'Abbadie in the chair. —Some new observations on the employment of the calorimetric shell, by M Berthelot Different bodies must be treated differently, according as they are fixed, volatile, or gaseous For fixed compounds, solid or liquid, the ratio between the weight of the combustible and the weight of oxygen ought to be such that the gas which remains after combustion contains at least 60

per cent of free oxygen, otherwise some half-burnt gases will remain in the vessel, notably carbonic oxide Excess of oxygen, especially if under a pressure of 25 atmospheres, ensures that the temperature of the centre of combustion should remain as high as possible In the case of gases the oxygen should only be in very slight excess, and should be introduced by tenths of an atmosphere, until the most favourable pressure is reached Volatile bodies should, if possible, be burnt in the liquid state —Study of boron trisulphide, by M Henri Moissan Five new methods of obtaining this body are described by the action of fused sulphur on boron iodide, by burning boron in sulphur vapour at 610°, by the action of hydrogen sulphide on pure boron, by the action of carbon bisulphide on boron, and by the action of the sulphides of arsenic, antimony, and tin upon boron The substance thus obtained shows several remarkable properties —Researches on the chemical constitution of the peptones, by M P Schutzenberger —On two ruminants of the Neolithic epoch of Algeria, by M A Pomel —The two candidates selected for the Directorship of the Paris Observatory were M Tisserand and M Loewy —*Résumé* of solar observations made at the Royal Observatory of the Roman College during the second quarter of 1892 A letter from M P Tacchini to the President The spots, faculæ, and prominences observed show a considerable increase since last quarter —Sun observations made at the Lyons Observatory (Brunner equatorial) during the first half of 1892, by M Em Marchand 125 groups of sun spots have been counted, as against 101 in the previous half-year The southern hemisphere, which used to contain less spots, has lately shown nearly as many as the northern The latitude of the groups continues to diminish —New results with regard to hydrogen, obtained by the spectroscopic study of the sun Similarity with the new star in the Charioteer, by M Deslandres In addition to the nine ultra-violet lines of hydrogen already known, five more have been photographed in the spectrum of a very brilliant prominence, extending up to the oscillation frequency 271,700 They correspond very closely with the frequencies calculated from Balmer's harmonic series The interest of the discovery is augmented by the circumstance that the spectrum obtained shows a great similarity with that of the new star in the Charioteer —On the velocity of propagation of the electromagnetic undulations in insulating media, and on Maxwell's relation, by M R Blondlot Given an oscillator, the wave length which it is susceptible of emitting remains the same, whatever may be the insulating medium in which the experiment is made —On the heat of formation of permolybdic acid and the permolybdates, by M E Péchard —On crystallized phosphide of mercury, by M Granger —On the mineralizing action of ammonium sulphate, by M T Klobb —Micrographic analysis of the alloys, by M Georges Guillemin —On homopyrocatechine, and two derived nitrides of homopyrocatechine, by M H Cousin —On a new class of combinations, the metallic nitrides, and on the properties of nitrogen peroxide, by MM Paul Sabatier and J B Senderens —The specific heat of the atoms and their mechanical constitution, by M G Hinrichs On monopropyl urea and dissymmetrical dipropyl urea, by M F Chancel —On the composition of fossil bones, and the variation in their percentage of fluorine during the various geological periods, by M Adolphe Carnot —Distribution and state of the iron in barley, by M P Petit —On the comparative number of nerve fibres of cerebral origin serving as motor nerves for the upper and lower limbs of man respectively, by MM Paul Blocq and M J Onanoff —On the comparative toxic effects of the metals of the alkalies and of the alkaline earths, by M Paul Binet —Experimental regeneration of the sporogenic property of the *Bacillus anthracis*, previously deprived of it by heat, by M C Phisalix.—Excretion in the pulmonate gasteropods, by M L Cuénot —On a colourless globuline which possesses a respiratory property, by M A B Griffiths —On the constitution of the cystoliths and of membranes encrusted with carbonate of lime, by M Louis Mangin.—On a fresh-water perforating alga, by MM J Huber and F Jadin —On the causes of the catastrophe of St Gervais (Haute-Savoie) on July 12, 1892, by MM J Vallot and A Delebecque.—Contribution to the improvement of cultivated plants, by M Schribaux —The solar period and the last volcanic eruptions, by M. Ch V. Zenger.

BERLIN.

Physiological Society, July 8 —Prof Munck, President, in the chair —Dr Dessoir spoke on the sense of temperature regarded from the anatomical, psychological, and physiological, point of view He did not believe in the existence of separate senses for heat and cold since he had failed to obtain sensations of heat and cold by either mechanical or electrical stimulation of certain points of the skin. The temperature sense is localized, since portions of the body surface can be found which are quite insensitive The above communication was followed by a lengthy discussion

July 22 —Prof Munck, President, in the chair.—Prof. Zuntz had long ago observed that strong muscular exertion has a different effect on the alkalinity of the blood of carnivora as compared with herbivora, thus in dogs the power of their blood to absorb carbon dioxide was practically unaltered by exercise, whereas in rabbits it was considerably lessened This point had recently been reinvestigated in the speaker's laboratory by Dr Cohnstein, who found that the blood of a dog at hard work on a treadmill showed no alteration of alkalinity The result was unaffected by diet, since it was the same when the dog was fed with meat alone, or with rice and fat During very prolonged exertion the blood was finally found to possess an increased alkalinity Dr Lilienfeld had recently discovered Prof Kossel's "histon" in the leucocytes of blood, united to neuclein as "nucleo histon" Histon prevents the clotting of blood, whereas nuclein promotes the formation of fibrin These two facts were regarded as explaining the various phenomena connected with blood clotting Thus the blood is fluid in the blood vessels because nucleo histon is retained by the leucocytes On the other hand, when the blood is shed some of the leucocytes or platelets die, whereupon the nucleo-histon escapes into the plasma, is decomposed by the calcium salts there present into nuclein and histon, and the former (nuclein) then causes clotting These facts also explain the action of calcium salts in promoting clotting. Prof Zuntz stated that, according to his researches, a taste sensation, as of something sweet, is very markedly increased when some other stimulus is simultaneously applied to the organ of taste, even when the stimulus is too weak to alone produce any sensation Thus, for example, a solution of sugar tastes more sweet if it is mixed with some solution of common salt so weak that it excites no saline taste The same result was obtained by the addition of a solution of quinine, also too weak to itself give rise to any sensation of taste

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THE BRITISH ASSOCIATION

EDINBURGH.

THE Edinburgh meeting has not been remarkable for a large turn-out of members Probably the greatest number of members are present on the Friday, when practically all have come and none have left At this high-water mark the number of members, associates, and holders of transferable ladies' tickets, was 2009, and although the tickets sold were increased to 2068 by Wednesday, the total attendance probably never quite reached 2000, which, although greater than last year's meeting at Cardiff, is much less than that twenty-one years ago at Edinburgh Year by year the number of ladies taking part in the proceedings mounts steadily, and on several occasions the "popular" sections of anthropology and geography, which were frequently crowded, showed a great preponderance Everything has not gone quite smoothly in spite of the efforts of the local secretaries Edinburgh society is inelastic in its traditions, and Edinburgh institutions are ruled by rigid laws, which even a meeting of the British Association finds difficulty in relaxing For the first day or two the reading and writing rooms and other apartments were closed at 5 p m, as they occupy part of the Advocates' Library, while the reception-room being in Parliament House remained open for the usual time Unqualified praise can be given to the commissariat arrangements The main luncheon-room in the Students' Union was deservedly busy from 1 to 3 The handsome building containing these commodious rooms was greatly admired, and the enterprise of the students to whose efforts alone its construction is due, and by whom alone it is managed, was the subject of frequent comment. Passing between the section rooms and the Union members availed themselves of frequent opportunities to inspect the great MacEwen Hall of the University, now approaching completion, the prospective use of which, by the way, was one of the considerations that led the deputation from Edinburgh to defer to that from Cardiff in arranging the order of the Association's visits to the respective towns

Rarely is it the privilege of the mixed multitude who throng the hall on the opening night of the meeting to listen to so comprehensible and attractive an address as the President delivered on this occasion Sir Archibald Geikie's lucid exposition was crowned by a characteristically happy speech by Lord Kelvin in moving the vote of thanks Altogether the first gathering dealt a blow at the belief, still amusingly common, that the true scientific man is a being of terms and formulæ, and that true science is colourless and unsympathetic The other evening discourses were highly appreciated, and maintained the high character which the Association lectures have made for themselves Prof Milnes Marshall played upon his vague title of "Pedigrees," until the scintillations lit up a great part of the theory of evolution, while Prof Ewing on Magnetic Induction threw a flood of light on what has hitherto been to ordinary minds one of the obscurest recesses of physics The lecture to the working classes, from which members of the Association are excluded unless they attend on false pretences—turned out a great success Mr Vernon Boys showed and explained his wonderful experiments on photographing bullets and the waves they produce in traversing the air with point and brilliancy The work in some of the Sections has been of a high order of excellence, in Section A especially very few British physicists were absent, and some of the discussions alone justified the existence of the Association as a means of bringing men together from different working centres The reading of the various reports in the different Sections in some cases gave rise to suggestions of high value for future work Unfortunately, in consequence of the illness of the President, the address in the Geological Section was not read till Monday It was not then quite complete, so its publication is postponed for the present

Edinburgh, if possible, exceeded its old reputation for hospitality, and meetings of a purely social character were unusually numerous, and the two conversaziones proved thoroughly enjoyable

Excursions practically took up the whole of Saturday, and an unusually large number took advantage of the opportunity for visiting the many scenes of historical, archæological, geological, and engineering interest which lie around Edinburgh The range was by no means restricted to the immediate vicinity, the excellent railway arrangements permitting of visits to Glasgow, Dundee, and the land of Scott, with no greater expenditure of time than the carriage parties demanded for visiting the Forth Bridge and Roslin, or the pedestrians for geologizing in the Pentlands and on Arthur's Seat The weather for the first few days was favourable, being dry and free from excessive heat But Monday was a most unfortunate sample of Edinburgh's weather at its worst, strong east wind and cold continual showers, even this state of matters failed to empty the section-rooms where papers of popular interest were being read Afternoon receptions both public and private, were particularly well managed, perhaps the most enjoyable being that given by the Royal Scottish Geographical Society in the spacious halls of the National Portrait Gallery, where the Antiquarian Museum is now worthily housed A special reception of foreign members was also given by the University in the Library Hall The number of distinguished foreigners present marked out this meeting from most others of recent years The Prince of Monaco, who, with the princess, lived on board his new yacht the *Princesse Alice*, was perhaps the greatest attraction, and he succeeded in bringing together one of the largest audiences to listen to his papers in Section E He also showed his yacht to a select party of members specially interested in marine studies, and took endless trouble in explaining the ingenious original devices for deep-sea research with which she is fitted Profs von Helmholz, Wiedemann, von Richthofen, Ostwald, and Goebel worthily represented the science of German Universities, and many of their somewhat less distinguished colleagues were also present Baron de Guerner, MM de Margine, Demolins, Bertrand, Manouvrier, Guillaume, and Richard came from France, the Abbé Renard and Profs. Errera and Hulin from Belgium, Drs Arrhenius and Pettersson from Sweden, Prof Fritsch and others well known in the scientific world from Austria, while the United States, Holland, Russia, and Switzerland were also represented The brilliant young physicist, Nikola Tesla, appears in the list as a visitor from America

A small meeting unfortunately means a small sum available for grants to scientific workers, and on account of the large sums asked for by the various Sections, the work of the Committee of Recommendations was no sinecure

Next year's meeting will be held at Nottingham, and that for 1894 at Oxford

The list of awards finally arrived at was as follows —

Investigation of the Eruptive Deposits of Pentland Hills	£10
Isomeric Naphthalene Derivatives	20
Index of Plants, &c	20
Climatology, &c, of Africa	50
Place Names in Scotland	10
Electrical Measurements	25
Observations on Ben Nevis	150
Falmouth Observatory	25
Photography of Meteorological Phenomena	10
Solar Radiation	10
Spectra of Elements	10
Analyses of Iron and Steel	20
Action of Light on Dyed Colours	5
Erratic Blocks of England, Wales, and Ireland	10
Fossil Phyllopoda	5
Geological Intervals	10
Underground Waters	5
High-level Shell-bearing Deposits	20
Zoological Station at Naples	100
Plymouth Biological Station	30
Sandwich Islands	100
West Indies	50
Irish Sea Exploration	30
Oxygen in Asphyxia	20
Exploration of the Karakorum Mountains	50
Methods of Economic Training	5
Anthropometric Tabulations	5
Exploration of Assam	25
North West Tribes of Canada	100
Natives of India	10
Corresponding Societies Committee	30
Total	£970

SECTION D

BIOLOGY

OPENING ADDRESS BY PROF WILLIAM RUTHERFORD, M D, F R S, PRESIDENT OF THE SECTION

AT the meeting of this Association held at Birmingham in 1886 I had the honour of delivering a lecture on the Sense of Hearing, in which I criticized the current theory of tone sensation, and I propose on this occasion to discuss the current theories regarding our sense of colour

I may premise that our conceptions of the outer world are entirely founded on the experience gathered from our sensory impressions Through our organs of sensation, mechanical, chemical, and radiant energies impress our consciousness The manner in which the physical agents stimulate the peripheral sense organs, the nature of the movement transmitted through our nerves to the centres for sensation in the brain, the manner in which different qualities of sensation are there produced—all these are problems of endless interest to the physiologist and psychologist

Every psychologist has acknowledged the profound significance of Johannes Muller's law of the specific energies—or, as we should rather say, the specific activities of the sense-organs To those unfamiliar with it, I may explain it by saying, that if a motor nerve be stimulated, the obvious result is muscular movement, it matters not by what form of energy the nerve is stimulated—it may be by electricity or heat, by a mechanical pinch or a chemical stimulus, the specific result is muscular contraction In like manner, when the nerve of sight is stimulated—it may be by light falling on the retina, or by electricity, or mechanical pressure, or by cutting the nerve—the invariable result is a luminous sensation, because the impression is transmitted to cells in the centre for vision in the brain, whose specific function is to produce a sense of light.

The same principle applies to the other sensory centres, when thrown into activity, they each produce a special kind of sensation The sun's rays falling on the skin induce a sense of heat, but falling on the eye, they induce a sense of sight In both cases the physical agent is the same, the difference of result arises from specific differences of function in the brain centres concerned in thermal and visual sense We have no conception how it is that different kinds of sensation arise from molecular movements in the different groups of sensory cells, we are as ignorant of that as we are of the nature of consciousness itself

The subject I propose to discuss on this occasion is not the cause of the different *kinds* of sensation proper to the different sense organs, but the causes of some *qualities* of sensation producible through one and the same sense organ

The theory of tone-sensation proposed by Helmholz is, that the ear contains an elaborate series of nerve terminals capable of responding to tones varying in pitch from 16 vibrations to upwards of 40,000 vibrations per second, and that at least one different fibre in the auditory nerve, and at least one different cell in the centre for hearing, is affected by every tone of perceptibly different pitch Although the physical difference between high and low tones is simply a difference in frequency of the sound waves, that is not supposed by Helmholz to be the cause of the different sensations of pitch According to his theory, the function of frequency of vibration is simply to excite by sympathy different nerve terminals in the ear The molecular movement in all the nerve fibres is supposed to be identical, and the different sensations of pitch are ascribed to a highly specialized condition of cells in the hearing centre, whereby each cell, so to speak, produces the sensation of a tone of definite pitch, which in no way depends on the frequency of incoming nerve impulses, but simply on the specific activity of the cell concerned

In my lecture on the Sense of Hearing I pointed out in detail the great anatomical difficulties attending the theory in question I endeavoured to show the physical defect of a theory which does not suppose that our sensations of harmony and discord must immediately depend upon the numerical ratios of nerve vibrations transmitted from the ear to the central organ, and I offered a new theory of hearing based upon the analogy of the telephone According to that theory, there is probably no analysis of sound in the ear, the air-cells at the peripheral ends of the auditory nerve are probably affected by every audible sound of whatever pitch When stimulated by sound they probably produce nerve vibration, simple or compound, whose frequency, amplitude, and wave-form correspond to those of the sound received The nerve vibrations arriving in the cells of the auditory centre probably induce simple sensations of tones of different pitch, or compound sensations of harmonies or discords strictly dependent on the relative frequencies of the nerve vibrations coming in through the nerve

I cannot now recapitulate the evidence derived from anatomical, experimental, and pathological observations that give support to my theory of hearing, but I may briefly say that it is opposed to the theory of specific activities, in so far as it has been applied to explain the different qualities of sound sensation It is, however, in strict accord with the fundamental proposition stated by Fechner[1] in his great work on Psychophysics in these words "The first, the fundamental hypothesis is, that the activities in our nervous system on which the sensations of light and sound functionally depend are, not less than the light and sound themselves, to be regarded as dependent on vibratory movements" It is evident that, if we could only comprehend the nature of the molecular movement in the nerve that links the vibration of the physical agent to that in the sensory cell, we could advance towards a true theory of the physiological basis of different qualities of sensation in the different sense-organs As yet no definite answer can be given to the question, what sort of molecular movement constitutes a nerve impulse, but in recent years our knowledge of the subject has been extended in a direction that opens up a vista of new possibilities

A nerve impulse travels at a rate not much more than 100 feet per second—an extremely slow speed compared with that of electricity in a wire It has been thought to be of the nature of a chemical change sweeping along the nerve, but that hypothesis is opposed by the fact that the most delicate thermopile shows no production of heat, even when an impulse is caused to sweep repeatedly along the same nerve Again it is far easier to fatigue a muscle than a nerve A living frog's nerve removed from the animal, and therefore deprived of all nutrition, can retain its excitability for nearly an hour although subjected all the while to thirty or forty stimulation per second An excised muscle, when similarly stimulated is exhausted far sooner, because the mechanical energy entirely

[1] "Elemente der Psychophysik," 1860 2nd edition, 1889, part ii p 28

springs from chemical change in the muscular substance, and therefore the muscle is more easily fatigued than the nerve. The molecular motion in an excited nerve produces a momentary electric current, but that result is not peculiar to nerve. The same occurs in muscle when stimulated. Possibly the molecular movement is of the nature of a mechanical vibration; at all events, we know now that a nerve can transmit hundreds, even thousands of impulses, or let us simply say vibrations, per second. The fact is so important and significant in relation to the physiology of the sense organs, that I show you an experiment to render it more intelligible. A frog's muscle has been hooked to a light lever to record its movement on a smoked cylinder. The nerve of the muscle has been laid on two electrodes connected with the secondary coil of an induction machine. In the primary circuit a vibrating reed has been introduced to serve as a key for making and breaking the circuit, and so stimulating the nerve with periodic induction shocks. If we make the reed long enough to vibrate ten times per second, ten impulses are sent through the nerve to the muscle and ten distinct contractions produced, as shown by the wavy line upon the cylinder. If we shorten the reed so that it will vibrate, say, fifty times per second, the muscle is thrown into a continuous contraction and traces a smooth line on the cylinder; but if we listen to the muscle we can hear a tone having a pitch of fifty vibrations per second, from which we know that fifty nerve impulses are entering the muscle and inducing fifty shocks of chemical discharge in the muscular substance. If we take a reed that vibrates, say, 500 times per second, we hear, on listening to the muscle, a tone having the pitch of 500 vibrations. Observe, that we are not dealing with the transmission of electrical shocks along the nerve, but with the transmission of nerve impulses. By stimulating the nerve with wires of a telephone it has been shown by D'Arsonval that a nerve can transmit upwards of 5000 vibrations per second, and that the wave-forms may be so perfect that the complex electrical waves produced in the telephone by the vowel sounds can be reproduced in the sound of a muscle after having been translated into nerve vibrations and transmitted along a nerve. Such experiments go far in helping us towards a comprehension of the capabilities of nerves in transmitting nerve vibrations of great frequency and complicated wave form; but although they enable us reasonably to suppose that all the fibres of the auditory nerve can transmit nerve vibrations, simple or complex, and with a frequency similar to that of all audible tones, we encounter superlative difficulty in applying such a theory to the sense of sight. In objective sound we have to deal with a comparatively simple wave motion, whose frequency of vibration is not difficult to grasp even at the highest limit of audible sound—about 40,000 vibrations per second. But in objective light the frequency of vibration is so enormous—amounting to hundreds of billions per second—that every one feels the difficulty of forming any conception of the manner in which different frequencies of ether waves induce differences in colour sensation.

But before passing to colour sense, I wish to allude for a moment to the sense of smell. The terminals of the olfactory nerve in the nose are epithelial cells. It has been recently shown by Von Brunn [1] that in man and other mammals the cells have at their free ends very delicate short hairs, resembling those long known in lower vertebrates. These hairs must be the terminal structures affected by substances that induce smell, and are therefore analogous to the hairs on the terminal cells in our organ of hearing. No one ever suggested that the hairs of the auditory cells can analyze sounds by responding to particular vibrations, and I think it quite as improbable that the hairs on any particular olfactory cell respond to the molecular vibrations of any particular substance. If we follow those who have had recourse to the doctrine of specific activities to explain the production of different smells, we must suppose that at least one special epithelial cell and nerve fibre are affected by each different smelling substance. Considering how great is the variety of smells, and that their number increases with the production of new substances, it would be a somewhat serious stretch of imagination to suppose that for each new smell of a substance yet to emerge from the retort of the chemist there is in waiting a special nerve terminal in the nose. It seems to me far simpler to suppose that all the hairs of the olfactory cells are affected by every smelling substance, and that the different qualities of smell result from difference in the frequency and form of the vibrations initiated by the action of the chemical molecules on the olfactory cells and transmitted to the brain. That hypothesis was, I believe, first suggested by Prof. Ramsay,[1] of Bristol, in 1882, and it seems to me the only intelligible theory of smell yet offered. But it must be admitted that a theory of smell, such as that advanced by Ramsay, involves a more subtle conception of the molecular vibrations in nerve fibrils than is required in the case of hearing. It involves the conception that musk, camphor, and similar substances produce their characteristic qualities of smell by setting up nerve vibrations of different frequencies and probably of different complexities. We shall see what bearing this may have on the theory of colour sense, to which I now pass.

No impressions derived from external Nature yield so much calm joy to the mind as our sensation of colour. Pure tones and perfect harmonies produce delightful sensations, but they are outrivalled by the colour effects of a glorious sunset. Without our sense of colour all Nature would appear dressed in bold black and white, or indifferent grey. We would recognize, as now, the beauty of shapely forms, but they would be as the cold engraving contrasted with the brilliant canvas of Titian. The beautiful tints we so readily associate with natural objects are all of them sensations produced in our brain. Paradox though it appear, all Nature is really in darkness. The radiant energy that streams from a sun is but a subtle wave-motion, which produces the common effects of heat on all bodies, dead or living. It does not dispel the darkness of Nature until it falls on a living eye, and produces the sense of light. Objective light is only a wave motion in an ethereal medium; subjective light is a sensation produced by molecular vibration in our nerve apparatus.

The sensory mechanism concerned in sight consists of the retina, the optic nerve, and the centre for visual sensation in the occipital lobe of the brain. In the vertebrate eye the fibres of the optic nerve spread out in the inner part of the retina, and are connected with several layers of ganglionic cells placed external to them. The light has to stream through the fibres and ganglionic layers to reach the visual cells—that is, the nerve terminals placed in the outer part of the retina. They may be regarded as epithelial cells whose peripheral ends are developed into peculiar rod and cone-shaped bodies, while their central ends are in physiological continuity with nerve fibrils. Each rod and cone consists of an inner and an outer segment. The outer segment is a pile of exceedingly thin, transparent, doubly refractive discs, colourless in the cone, but coloured pink or purple in the rod. In man, the inner segment of both rod and cone is colourless and transparent. Its outer part appears to be a compact mass of fine fibrils that pass imperceptibly into the homogeneous-looking protoplasm in the shaft of the cell. Owing to the position of the rods and cones, the light first traverses their inner, then their outer segments, and its unabsorbed portion passes on to the adjacent layer of dark brown pigment cells by which it is absorbed. It is not necessary for me to discuss the possible difference of function between the rods and cones. I may simply say that in the central part of the yellow spot of the retina, where vision is most acute, and from which we derive most of our impressions of form and colour, the only sensory terminals are the cones. A single cone can enable us to obtain a distinct visual impression. If two small pencils of light fall on the same cone the resulting sensory impression is single. To produce a double impression the luminous pencils must fall on at least two cones. That shows how distinct must be the path pursued by the nerve impulse from a visual cell in the yellow spot of the retina to a sensory cell in the brain. The impulses from adjacent terminals must pursue their own discrete paths through the apparent labyrinth of nerve fibrils and ganglion cells in the retina to the fibres of the optic nerve. How these facts bear on the theory of colour sense will presently be apparent. Meantime I pass to the physical agent that stimulates the retina.

When a beam of white light is dispersed by a prism or diffraction grating, the ether-waves are spread out in the order of their frequency of undulation. The undulations of radiant energy extend through a range of many octaves, but those able to stimulate the retina are comprised within a range of rather less than one octave, extending from a frequency of about 395 billions per second at the extreme red to about 757 billions at the extreme violet end of the visible spectrum. The ultra violet waves in the spectrum of sunlight extend through rather more than half an octave. Although mainly revealed by their chemical

[1] Von Brunn, *Archiv für mikroskopische Anatomie*, 1892, Band 39.

[1] Ramsay, NATURE, 1882, vol. xxvi. p. 189.

effects, they are not altogether invisible their colour is bluish-grey The only *optical*—that is, strictly *physical*—difference between the several ether-waves in the visible or invisible spectrum is frequency of undulation, or, otherwise expressed, a difference in wave-length The *chromatic*—that is the colour producing—effects of the ether-waves depend on their power of exciting sensations of colour, which vary with their frequency of undulation

Although the retina is extremely sensitive to differences in the frequency of ether-waves, it is not equally so for all parts of the spectrum In the red and blue portions, the frequency varies considerably without producing marked difference of colour effect, but in the region of yellow and green, comparatively slight variations in frequency produce appreciable differences of colour sensation One striking difference between the effect of ether waves on the eye and sound waves on the ear is the absence of anything corresponding to the octave of tone sensation The ether waves in the ultra violet, which have twice the frequency of those of the red end of the spectrum, give rise to no sense of redness, but merely that of a bluish-grey Even within the octave there are no harmonies or discords of colour sense corresponding to those of tone sensation

Colours are commonly defined by three qualities or constants, —hue, purity, and brightness Their hue depends upon the chromatic effect of frequency of undulation or wave length Their purity or saturation depends on freedom from admixture with sensations produced by other colours or by white light Their brightness or luminosity depends on the degree to which the sensory mechanism is stimulated The loudness of sound depends on the amount of excitement produced in the auditory mechanism by the amplitude of sound waves, but a sound with small amplitude of undulation may seem loud when the nerve apparatus is unduly sensitive The brightest colour of the spectrum is orange-yellow, but it does not follow that the amplitude or energy of the ether-waves is greater than in the region of dull red There is no physical evidence of greater amplitude in the orange yellow, and its greater luminosity is no doubt purely subjective, and arises from the greater commotion induced in the sensory mechanism

The theory of colour sense long ago proposed by Sir Isaac Newton[1] is now commonly treated with what seems to me very undeserved neglect Newton supposed that the rays of light induce vibrations in the retina which are transmitted by its nerve to the sensorium, and there induce different colour sensations according to the length of the incoming vibrations—the longest producing sensations of red and yellow the shortest blue and violet, those of medium length a sense of green, and a mixture of them all giving a sense of whiteness At the beginning of this century Thomas Young proposed a theory which seems to have been intended as a modification of that suggested by Newton rather than as a substitute for it Young supposed that the ether waves induce vibrations in the retina "whose frequency must depend on the constitution of its substance, but as it is almost impossible to conceive that each sensitive point of the retina contains an infinite number of particles, each capable of vibrating in unison with every possible undulation, it becomes necessary to suppose the number limited to three primary colours, red, yellow, and blue, and that each sensitive filament of the nerve may consist of three portions, one for each principal colour "[2] Soon afterwards he substituted green for yellow, and violet for blue, so that he came to regard red, green, and violet as the three fundamental colour sensations, by mixture of which in varying proportions, all other colours, including white, are produced Young believed that his suggestion "simplified the theory of colours, and might therefore be adopted with advantage until found inconsistent with any of the phenomena."

Young's trichromic theory of colour sense was adopted by Clerk Maxwell and Von Helmholz, and underwent important amplification. Helmholz suggested that the three sets of fibres supposed by Young to exist in the optic nerve are connected with three sets of terminals in the retina, that each terminal contains a different visual substance capable of being decomposed by light, that when the substance in the red nerve terminal undergoes chemical change its nerve fibre is stimulated, and the excitement travels to a cell in the brain by whose specific activity the sensation of red arises. In like manner, when the visual substances in the green and violet terminals ar decomposed, nerve impulses travel through different fibres t different cells in the vision centre, by whose specific activitie the sensations of green and violet arise With Helmholz ther was no question as to difference in quality of sensation depending on difference in frequency of nerve vibration arriving in th sensorium, no such hypothesis was entertained by him eithe for tone or for colour sensation With sight, as with hearing he supposed that the function of frequency of undulation virtually stops at the nerve terminals in the eye and ear, and tha the frequency of undulation of the physical agent has no correlative in the quality of motion passing from the receiving terminal to the sensory cell He believes that the different frequencies of ether waves simply excite chemical changes in different nerve terminals He expressly states[1] that the molecular commotion in the nerve fibres for red, green, and violet is identical in kind, and that its different effects depend on the specific activities of the different cells to which it passes in the sensorium It is evident that Helmholz entirely dismissed the Newtonian theory of the production of different qualities of colour sense, and substituted for it the doctrine of his own great teacher, Johannes Muller

The theory of Young and Helmholz offers an explanation of so many facts, and has at the same time provoked so much criticism, that I must enter more fully into some of its details On this theory, the sense of white or grey is supposed to result from a simultaneous and duly balanced stimulation of the red, green, and violet terminals The red terminals are supposed to be excited chiefly by the longer waves in the region of the red, orange, and yellow, but also by the shorter undulations extending as far as Fraunhofer's line F at the beginning of the blue In like manner, the green terminals are excited chiefly by the waves of medium length, and to a less extent by the waves extending to C in the red, and by the shorter waves extending to G in the violet The violet terminals are stimulated most powerfully by the shorter undulations between F and G, but also by the longer ones reaching as far as D in the yellow, therefore, optically homogeneous light from any part of the spectrum, except its extreme ends, does not usually give rise to a pure colour sensation, all three primary sensations are present, and consequently the colour inclines towards white — the more, the stronger the light

The experimental facts in support of Young's theory are familiar to all who have studied physics Compound colour sensations may be produced by causing light of different wave lengths to fall simultaneously or in rapid succession on the same part of the retina The commonest experimental device is to rapidly whirl discs with sectors of different colours, and observe the results of the mixed sensations, or to cause the images of coloured wafers or papers to fall simultaneously on the retina by Lambert's method, or to transmit light through glass of different colours, and cause the different rays to fall on the same surface, or to mix pure homogeneous light from different parts of the spectrum For obvious reasons, the last method yields the most trustworthy results We cannot, by any mixture of homogeneous light from different parts of the spectrum, obtain a pure red or green sensation, and according to Helmholz, the same holds true of violet On the other hand, a mixture of homogeneous rays from the red and green parts produces orange or yellow, according to the proportions employed A mixture of rays from the green and violet gives rise to intermediate tints of blue, and a mixture of red and violet light produces purple. Therefore, Young regarded red, green, and violet as primary sensations, and orange, yellow, and blue—just as much as purple—he regarded as secondary or compound sensations. Helmholz discovered that to obtain a sense of white or grey it is not necessary to mingle rays from the red, green, and violet portions of the spectrum He found that he could obtain a white sensation by mixing only *two* optically homogeneous rays from several parts of the right and left halves of the spectrum. The pairs of spectral colours which he found complementary to each other are, red and greenish-blue, orange and cyan-blue, yellow and ultramarine-blue, greenish yellow and violet, the complement for pure green being found not in any homogeneous light, but in purple—a mixture of red and violet The complementary colours may be arranged in a circle, with the complementaries in each pair placed opposite one another Of course, the circle cannot be completed by the colours of the

[1] See quotations from Newton made by Young in Reference 2.
[2] Thomas Young, "On the Theory of Light and Colours," *Phil Trans Lond*, 1802, p 18

[1] Von Helmholz, *Handbuch der physiologischen Optik*, 2nd edition, 1892, p 350

spectrum, purple must be added to fill in the gap between the red and violet. Helmholz found no constant ratios between the wave lengths of homogeneous complementaries, and it is a striking fact that, while a mixture of the green and red, or of the green and violet undulations gives rise to a sensation such as could be produced by rays of intermediate wave length, no such effect follows the mingling of rays from opposite halves of the spectrum. Pure green, with a wave length of 527 millionths of a millimetre, marks the division between the right and left halves. The mixture of blue from the right and yellow from the left side does not produce the intermediate green, but a sensation of white. A mixture of blue or violet and red produces not green, but its complementary—purple. On the trichromic theory, the sense of white produced by the mingling of any of these two colours is simply regarded as the result of a balanced stimulation of the red, green, and violet terminals.

But Young's theory is beset with serious difficulties. It implies the existence of three sets of terminals in the retina, and these must all be found in the central part of the yellow spot where cones alone are present. Three sets of cones there would be necessary to respond to the red, green, and violet light, and a colourless pencil of light could not be seen uncoloured, unless it falls on three cones, which we know from astronomical observations is not the case. Therefore, if there are three different terminals, it seems necessary, in the human retina at all events, that they should be found in every single cone in the yellow spot. But I cannot believe it possible that within a single cone there can be three sets of fibrils capable of simultaneous stimulation in different degrees, and of ultimately transmitting impulses through three different fibres to three different cells in the brain. That would imply a greater number of fibres in the optic nerve, than of terminals in the retina, and we know that precisely the reverse is the case. The anatomical difficulty is therefore great, and I am unable to see how it can be surmounted.

The phenomena of colour blindness also offer great difficulty. In several cases of apoplectic seizure it has happened that the centre for vision on both sides of the brain has been completely or partially paralyzed by the extravasated blood. In such cases the sense of colour may be entirely lost either for a time or permanently, while the sense of light and form remain although impaired. The loss of colour sense in some cases has been found complete in both eyes, in most of the recorded cases the loss of colour sense was limited to the right or left halves of both eyes, that is, if the lesion affected the vision centre on the right side of the brain, the right halves of both eyes were blind to all colours. That illustrates the fact that a sense of light does not necessarily imply a sense of colour. The colour sense probably involves a more highly refined action of the sensory cell than the mere sense of light and form, and is on that account more liable to be lost when the nutrition of the sensory cell is interfered with. In the normal eye the peripheral zone of the retina is totally blind to colour. If you turn the right eye outwards, close the left, and then move a strip of coloured paper from the left to the right in front of the nose, the image of the paper will first fall on the peripheral zone of the retina, and its form will be seen, though indistinctly, but not its colour. It is difficult to say in that case whether the colour-blindness is due to the state of the retina or to that portion of the vision centre in the brain associated with it. The absence of cones from the peripheral part of the retina has been assigned as the cause, but it is much more probable that the portion of the vision centre associated with the periphery of the retina, being comparatively little used, is less highly developed for form sensation, and not at all for colour sense. It is evident that the production of a sense of white or grey in the absence of all colour sense is not to be explained on the theory that it results from a balanced stimulation of red, green, and violet nerve terminals.

I need scarcely say that colour-blindness has attracted a large share of attention, not only because of its scientific interest, but still more on account of its practical importance in relation to the correct observation of coloured signals. In 1855 the late Prof George Wilson,[1] of this city, called attention to the growing importance of the subject. Some years ago Prof Holmgren made an elaborate statistical inquiry regarding it at the instance of the Swedish Government, and lately it has been investigated by a committee of the Royal Society of London, who have quite recently published their report.[1]

Although colour blindness occasionally results from disease of the brain, retina, or optic nerve, it is usually congenital. Total colour blindness is extremely rare, but partial colour blindness is not uncommon. It occurs in about 4 per cent of males, but in less than 1 per 1000 of females. Its most common form is termed red green blindness, in which red and green sensations appear to be absent. So far as I can find, the first full and reliable account of the state of vision in red-green blindness is that given in 1859 by Mr Pole,[2] of London, from an examination of his own case, which appears to be a typical one. The state of his vision is dichromic, his two colour sensations are yellow and blue. The red, orange, and yellowish-green parts of the spectrum appear to him yellow of different shades. Greenish blue and violet appear blue, and between the yellow and blue portions of the spectrum, as it appears to him, there is a colourless grey band in the position of the full green of the ordinary spectrum. This neutral band is seen in the spectrum in all cases of dichromic vision. It may appear white or grey according to the intensity of the light, and it apparently results from an equilibrium of the two sensations, no such band is seen in the spectrum by a normal eye. Mr Pole, in the account of his case given now three and thirty years ago, considered it impossible to explain his dichromatic vision on the commonly received theory that his sense of red is alone defective, and that his sense of yellow is a compound of blue and green. He believed his green quite as defective as his red sensation, and that yellow and blue are quite as much entitled to be considered fundamental sensations as red and green. He suggested that in normal colour vision there are at least four primary sensations—red and green, yellow and blue. Prof Hering is commonly accredited with the four colour theory, but it was previously suggested by Pole.[3]

A year after Pole's paper appeared, Clerk-Maxwell[4] published his celebrated paper on the theory of compound colours, to which he appended an account of his observations on a case of what he believed to be red-blindness, but which we now know must have been red green blindness. The spectrum appeared dichromic, its only colours being yellow and blue. His description of the case does not materially differ from that given by Pole, but Clerk Maxwell believed in the trichromic theory of normal vision, and that red green and blue are the three primary sensations, consequently he supposed that the yellow sensation of a red blind person is not pure yellow, but green.

It is evident that much depends on the question, "Is the yellow sensation of a red-green blind person the same as that of normal vision?" For many years it was impossible to give a definite answer to that question, but the answer can now be given, as we shall immediately see. Colour-blindness is frequently hereditary, and two or three cases are known in which the defective colour sense was limited to one eye, while in the other eye colour vision was normal. In such a case observed by Prof Hippel, of Giessen, there was red green blindness in one eye. Holmgren, who examined Hippel's case, has published an account of it.[5] With one eye all the colours of the spectrum were seen, but to the other eye the spectrum had only two colours with a narrow grey band between them at the junction of the blue and yellow. The yellow seen by the eye with the red green defect had a greenish tinge like that of a lemon, but in other respects the observations confirmed Pole's account of his own case.

Hippel's case seems to me important for another reason. By some it is believed that congenital colour defect is due to the brain. If there had been defective colour sense on one side of the brain, it would not have implicated the whole of one eye, but the half of each eye. Its limitation to one eye, therefore, seems to me to suggest that the fault was in the eye rather than in the brain.

Another interesting fact in this relation is that in every normal eye, just behind the peripheral zone of total colour-blindness, to

[1] Wilson, "Researches on Colour Blindness," Edinburgh, 1855.

[1] "Report of the Committee on Colour Vision," Proc Roy Soc Lond, July 1892.

[2] W Pole, "On Colour Blindness," Phil Trans., 1859, vol. cxlix p. 323.

[3] *Ibid.*, p. 331.

[4] Clerk-Maxwell, "On the Theory of Compound Colours," &c., Phil Trans., 1860, vol. cl, p. 57.

[5] F Holmgren, "How do the Colour Blind see the Different Colours?" Proc. Roy Soc Lond, 1881, vol xxxi p. 302.

which I have already referred, there is a narrow zone in which red and green sensations are entirely wanting, while blue and yellow sensations are normal. Possibly the red green defect is due to an imperfectly developed colour sense in the portion of the vision centre connected with that zone of the retina, but Hippel's case seems to me to show that such defect might be on the retina

It has probably already struck you that red green blindness is really blindness to red, green, and violet, that Young's three primary sensations appear to be absent, and the two remaining colours are those which he regarded as secondary compounds of his primaries

That, however, is not all that is revealed by colour-blindness There is at least another well known though rare form in which a sense of yellow, blue, and violet is absent, and the only colour sensations present are red and green The defect is sometimes termed violet blindness, but the term is somewhat misleading It is much more in accordance with the fact to term it yellow-blue blindness, indeed, we would define it precisely by terming it yellow-blue-violet blindness Holmgren[1] has recorded a unilateral case of that defect analogous to Hippel's case of unilateral red-green defect, we therefore know definitely how the spectrum appears to such a person In the case referred to all the colours of the spectrum were seen with the normal eye, but to the other eye the spectrum had only two colours, red and green The red colour extended over the whole left side of the spectrum to a neutral band in the yellow-green, a little to the right of Fraunhofer's line D All the right side of the spectrum was green as far as the beginning of the violet, where it "ended with a sharp limit (about the line G)"

If you turn to the Report of the Royal Society's Committee[2] on Colour Vision, you will find the spectrum as it appears to yellow blue-violet blind persons The plate agrees with the description of Holmgren's case already given, but you will not find a representation of the spectrum as it appears to those who are red green blind, and as described by Pole and others In place of it you will find two dichromic spectra, one with a red and blue half said to be seen by a green blind, the other with a green and a blue half said to be seen by a red blind person We have copied the spectra for your inspection, and you will observe that yellow does not appear in either of them I do not for a moment pretend to criticize these spectra from any observations of my own, I am aware Holmgren maintains that red-and green blindness may occur separately, but, on the other hand, Dr George Berry, an eminent ophthalmologist, has assured me that he has always found them associated That statement was originally made by Hering

Of the various methods of testing colour vision, that suggested by Seebeck is most commonly employed The individual is mainly tested with regard to his sense of green and red He is shown skeins of wool, one pale green, another pink or purple, and a third bright red, and he is asked to select from a heap of coloured wools, laid on a white cloth, the colours that appear to him to match those of the several tests We have arranged such test skeins for your inspection, and have placed beneath each of them the colours which a red-green blind person usually selects as having hues similar to those of the test It is startling enough to find brown, orange, green, and grey confused with bright red, pale red, orange, yellow, and grey confused with green, blue, violet, and green confused with pink, but these confusions have all their explanation in the fact that the red-green blind have only two colour sensations—yellow and blue, with a grey band in what should have been the green part of his spectrum

We have now to show you another and far more beautiful method of ascertaining what fundamental colour sensations are absent in the colour-blind It is the method of testing them by what Chevreul long ago termed *simultaneous contrast* If in a semi darkened room we throw a beam of coloured light on a white screen and interpose an opaque object in its path, the shadow shows the complementary colour If the light be red, the shadow appears green-blue, if it be green, the shadow appears purple or red according to the nature of the green light employed. If the light is yellow, the shadow is blue, if it is blue, the shadow is yellow We must remember that the part of the screen on which the shadow falls is not entirely dark, a little diffuse light falls on the retina from the shadowed part, so that the retina and vision centre are slightly stimulated, whereby the image of the shadow

The experiment can be rendered still more striking, though at the same time a little more complicated, by using two oxy-hydrogen lamps and throwing their light on the same portion of the screen If a plate of coloured—say ruby—glass is held before one of the lamps, and an opaque object such as the head of a T-square is placed in the path of both lights, the shadow cast by the white light falls on a surface illuminated by a red light, and shows a deep red far more saturated than the surrounding surface of the screen where the red and white lights fall The shadow cast by the red light shows the complementary bluish green, and the contrast of the two is exceedingly striking

These experiments we have shown you point to some subtle physiological relations between complementary colours A colour sensation produced in one part of the vision apparatus forces, so to speak, the neighbouring part, which is relatively quiescent, to produce the complementary colour subjectively I say *vision-centre* rather than *retina*, because if one eye is illuminated with coloured light while the other eye is feebly illuminated with white light, the complementary colour appears in the centre belonging to that eye The sense of white appears to be a mysterious unity, if you *objectively* call up one part of the sensation, you call up its counterpart *subjectively* If a colour and its complementary counterpart be both displayed objectively at the same time, the action and reaction of effect afford a sensation far more agreeable than is producible by the objective display of only one of them The agreeableness of the contrast of complementary colours, no doubt, springs from the harmony of effect There is no harmony of colour effect analogous to that of music, but there is harmony of a different kind, and that harmony is formed by the contrast of complementary colours

Now I imagine many of you have already anticipated the question, What information can simultaneous contrast give regarding the fundamental sensations of the colour-blind? From an extended series of observations Dr Stilling,[1] of Cassel, has entertained that if a person cannot distinguish between red and green, no complementary colour appears in the shadow when the inducing light is red or green, but if the inducing light is yellow or blue the proper complementary appears in the shadow If a person was blind to red he never found the complementary green appear, if he was blind to green, he never found the complementary red appear When the inducing light appeared colourless, the shadow was also colourless Stilling therefore concluded that either the sensations of red and green or of blue and yellow were wanting at the same time or all colour sense was absent It is difficult to see how these results are to be harmonized with the conclusions arrived at by the Committee of the Royal Society

Facts such as these are regarded by some as lending support to the theory of colour sense proposed by Prof Hering, of Prague[2] He supposes that the diversity of our visual perceptions arises from six fundamental sensations constituting three pairs—white and black, red and green, yellow and blue The three pairs of sensations are supposed to arise from chemical changes in three visual substances not confined to the retina, but contained also in the optic nerve and in the vision centre[3] He imagines that a sense of white results from *decomposition* induced in a special visual substance by all visible rays, and that the *restitution* of the same substance produces a sense of black The sensations of the red and green pair are supposed to arise, the one from decomposition, the other from restitution of a second substance, while yellow and blue are supposed to result from decomposition and restitution of a third substance From our knowledge of photo chemical processes we can readily suppose that light induces chemical change in the visual apparatus, but that the wave-lengths in the red and yellow parts of the spectrum induce *decomposition*, while the wave lengths in the green and blue induce *restitution* of substances, it is difficult to believe How such a visual mechanism could work it would be difficult to comprehend, for example, if we look at a bright red light for a few moments and then close our eyes, the sensation remains for a time, but changes from red to green and then slowly fades away According to Hering's theory, the green

[1] F Holmgren, "How do the Colour Blind see the Different Colours?" Proc. Roy Soc. Lond., 1881, vol. xxxi. p. 306.
[2] See Reference 8, Plate I, No 4

[1] J Stilling, "The Present Aspect of the Colour Question," *Archives of Ophthalmology*, 1879, viii p 164
[2] E Hering, *Zur Lehre vom Lichtsinne*, 2nd ed. Vienna, 1878
[3] Hering, *ibid*, p. 75.

after-sensation results from the restitution of a substance decomposed by the red light But if we reverse the experiment by looking at a bright *green* light and then closing our eyes, the after-sensation changes to *red* The theory in question would require us to suppose that the green light builds up a visual substance which spontaneously decomposes when the eyes are closed, and so produces the red after image I confess that such a hypothesis seems to me incredible Another remarkable feature of Hering's theory is that colours termed *complementary* ought to be termed *antagonistic*,[1] because they are capable of producing a colourless sensation when mingled in due proportions If the complementary colours yellow and blue could, when mixed, produce black, they might well be named "antagonistic," but since their combined effect is a sense of whiteness, and since the addition of them to white light increases its luminosity, it seems very difficult to comprehend on what ground the term *antagonistic* should be substituted for *complementary* I confess I am quite unable to follow Hering when he supposes that three pairs of mutually antagonistic chemical processes are produced in the retina when white light falls on it, that these processes are all continued on through the optic nerve into the vision centre, and there give rise to our different light and colour sensations

In 1881 Prof Preyer[2] advanced a theory of colour sensation, in which he supposes that in the retina there are four sets of cones arranged in pairs—one pair being excitable by the waves in the blue and yellow parts of the spectrum, the other pair being excitable by the red and green He supposes that each pair of cones is connected with a ganglionic cell in the retina, and through that with one fibre in the optic nerve, which transmits the impulse to at least two cells in the vision centre, in which two different qualities of sensation, red and green, yellow and blue, are severally produced I confess, however, that I am not able to understand how nerve impulses received, say, from the red terminal of a pair, can specially affect one of the cells in the nerve centre to produce a red sensation But if the red or green sensation were supposed to arise in the same central cell according to the frequency of the impulses transmitted from either terminal of the pair at the periphery, I should feel that an important difficulty had been removed from Prof Preyer's theory

It must be admitted that the production of nerve impulses within the terminals in the retina is almost as obscure as ever It is still the old question, Does light stimulate the optic terminals by inducing vibration, or by setting up chemical change? Whichever view we adopt, it seems to me necessary to suppose that all the processes for the production of nerve impulses can take place in one and the same visual cell, and are transmitted to the brain through the same nerve fibre, because the image of a coloured star small enough to fall upon only one cone is seen of a fixed and definite colour which does not alter when the position of the eye is changed It seems to me that if there are special cones for red, green, yellow, and blue, the colour of the star should change when its image falls on different terminals, but I am assured by Mr Lockyer that such is not the case

I referred to the sense of smell because it seems to me that we cannot in that case escape from the conclusion that the different sensations arise from different molecular stimulations of the same olfactory terminals.

From Lippmann's recent researches on the photography of colour[3] it appears that all parts of the spectrum can now be photographed on films of albumino-bromide of silver, to which two aniline substances, azaline and cyanine, have been added It seems, therefore, reasonable to suppose that a relatively small number of substances could enable all the rays of the visible spectrum to affect the retina Helmholz believes that three visual substances would suffice; but if the primary sensations are to be regarded as four—red, green, yellow, and blue—at least four visual substances appear to be necessary, and I think we must assume that all of them are to be found in the same visual cell in the retina, and that the nerve impulses which their decompositions give rise to are all transmitted through the same optic fibres to the brain cells, there to produce a sense of uncoloured or coloured light. Evidently such a hypothesis is not altogether novel, it is essentially a return to that long ago suggested by Newton The only difference is that light is supposed to induce photo chemical changes in the retina, as Von Helmholz suggested, instead of mere mechanical vibration, as Newton supposed But if in the sense of smell nerve undulations are induced by mechanical vibrations of molecules acting on delicate hairs at the ends of cells, would it, after all, be unreasonable to suppose that within each visual cell there are different kinds of molecules that vibrate in different mode when excited by ether waves? Four or five sets of such molecules in each terminal element in the retina would probably be sufficient to project successively or simultaneously special forms of undulations through the optic nerve, to induce colour sensations differing according to the wave form of the incoming nerve undulation It seems to me that the question becomes narrowed down to this Do the nerve impulses arise from mere vibration or from chemical change in the molecules of the nerve terminal? The photo chemical hypothesis has much in its favour We know how rapidly light can induce chemical change in photographic films, and we know that light induces chemical change in the vision-purple in the outer segments of the rod cells in the retina The fact that the cones contain no vision-purple is no argument against the theory, for the inner segment of both rod and cone is by many regarded as the true nerve terminal, and there is no vision purple in either of them The visual substances in the cones, at all events, are colourless, and the existence of them as substances capable of producing nerve impulses by chemical decomposition is as yet only a speculation awaiting proof The fatigue of the retina produced by bright light is best explained on a chemical theory, but it could also be explained on a mechanical theory, for we must remember that, even if the nerve impulses produced in the visual cells were merely a translation of the energy of light into vibration of nerve molecules, the nerve impulse has to pass through layers of ganglionic cells before reaching the fibres of the optic nerve, and in these cells it probably always induces chemical change The phenomena of partial colour blindness could be explained on a photo chemical theory by supposing that it arises from the absence of the substances required to produce the wave forms necessary for the colour sensation which is defective, but the total colour blindness at the anterior part of the retina is evidently a difficulty How could we have a sense of light from that portion of the retina if all the visual substances are absent? That is one of the reasons why Hering supposed that a special visual substance is present everywhere in the retina, which by decomposition gives rise to a sense of light as distinguished from colour But even on the hypothesis we are pursuing, it is not necessary to suppose that all visual substance is absent, for colour-blindness in the front of the retina could be explained by supposing that colour perception has not been developed in the corresponding portion of the vision centre, and consequently all nerve impulses coming from that part of the retina produce scarcely anything more than a sense of light

If the photo-chemical theory is entertained, it seems necessary to suppose that there is some singular relation between the pairs of substances which respectively give rise to red and green, and yellow and blue, seeing that both members of a pair frequently, if not always, fail together

It seems to me that the great difficulty arises when we consider the puzzling phenomena of contrast If light of a particular wave length decomposes a special substance, and gives rise to, say, a sense of red, why does the complementary bluish-green sensation appear in the vision centre around the spot in which the red sensation arises? If the induced colour were a pure green, one might attempt to explain it by supposing that a sympathetic change had been induced in a substance closely related to that suffering decomposition by the objective light, but no such simple explanation is admissible, the complementary contrast of red is not green, but a mixture of green and blue The inadmissibility of such an explanation becomes still more apparent if we take pure green as the inducing colour—the complementary contrast that appears is purple, which involves a blue or violet, as well as a red sensation. It matters not what inducing colour sensation we adopt, the induced contrast is always the complementary required to make a sense of white. George Wilson[1] long ago suggested that the simultaneous contrast probably arises from a "polar manifestation of force," indeed, he regarded it as a "true, though unrecognized, manifestation of polarity" It is enough to mention that interesting

[1] E. Hering, *Zur Lehre vom Lichtsinne*, 2nd ed. p. 121

[2] W Preyer, "Über den Farben und Temperatur Sinn," &c., *Archiv für Physiologie*, 1881, Band xxv, p 31

[3] G Lippmann, "On the Photography of Colour," *Comptes Rendus*, 1892, tome 114, p. 961

[1] Wilson, "Researches on Colour-Blindness," Edinburgh, 1855, p. 179

suggestion, but I must not pursue it, for we are dealing with a problem that has as yet baffled the wit of man

I have endeavoured to place before you a subject that involves physical and physiological considerations of extreme difficulty I have endeavoured to show the nature of these difficulties, and although I have not attempted to solve them, I have at all events tried to show reasons why we should refer our different colour sensations to differences in the incoming nerve impulses rather than to specifically different activities of cells in the visual centre. I have not found it an agreeable task to point out the shortcomings of theories advanced by those for whom I have the deepest regard, but in the progress of scientific thought it is especially necessary to keep our minds free from the thraldom of established theory, for theories are but the leaves of the tree of science, they bud and expand, and in time they fade and fall, but they enable the tree to breathe and live If this address has been full of speculation, I trust you will allow that the scientific use of the imagination is a necessary stimulus to thought, by which alone we can break a path through the dense thicket of the unknown

SECTION E

GEOGRAPHY

OPENING ADDRESS BY PROF JAMES GEIKIE, LL D, D C L, F R S S L & E, F G S, PRESIDENT OF THE SECTION

AMONGST the many questions upon which of late years light has been thrown by deep sea exploration and geological research not the least interesting is that of the geographical development of coast-lines How is the existing distribution of land and water to be accounted for? Are the revolutions in the relative position of land and sea, to which the geological record bears witness, due to movements of the earth's crust or of the hydrosphere? Why are coast lines in some regions extremely regular, while elsewhere they are much indented? About 150 years ago the prevalent belief was that ancient sea-margins indicated a formerly higher ocean level Such was the view held by Celsius, who, from an examination of the coast lands of Sweden, attributed the retreat of the sea to a gradual drying up of the latter But this desiccation hypothesis was not accepted by Playfair, who thought it much more likely that the land had risen It was not, however, until after Von Buch had visited Sweden (1806-1808), and published the results of his observations, that Playfair's suggestion received much consideration Von Buch concluded that the apparent retreat of the sea was not due to a general depression of the ocean level, but to elevation of the land—a conclusion which subsequently obtained the strong support of Lyell The authority of these celebrated men gained for the elevation theory more or less complete assent, and for many years it has been the orthodox belief of geologists that the ancient sea-margins of Sweden and other lands have resulted from vertical movements of the crust It has long been admitted, however, that highly flexed and disturbed strata require some other explanation Obviously such structures are the result of lateral compression and crumpling Hence geologists have maintained that the mysterious subterranean forces have affected the crust in different ways Mountain ranges, they conceive, are ridged up by tangential thrusts and compression, while vast continental areas slowly rise and fall, with little or no disturbance of the strata. From this point of view it is the lithosphere that is unstable, all changes in the relative level of land and sea being due to crustal movements Of late years, however, Trautschold and others have begun to doubt whether this theory is wholly true, and to maintain that the sea-level may have changed without reference to movements of the lithosphere Thus Hilber has suggested that sinking of the sea-level may be due, in part at least, to absorption, while Schmick believes that the apparent elevation and depression of continental areas are really the results of grand secular movements of the ocean The sea, according to him, periodically attains a high level in each hemisphere alternately, the waters being at present heaped up in the southern hemisphere Prof. Suess, again, believing that in equatorial regions the sea is, upon the whole, gaining on the land, while in other latitudes the reverse would appear to be the case, points out that this is in harmony with his view of a periodical flux and reflux of the ocean between the equator and the poles. He thinks that we have no evidence of any vertical elevation affecting wide areas, and that the only movements of elevation that take place are those by which mountains are up heaved The broad invasions and transgressions of the continental areas by the sea, which we know have occurred again and again, are attributed by him to secular movements of the hydrosphere itself

Apart from all hypothesis and theory, we learn that the surface of the sea is not exactly spheroidal It reaches a higher level on the borders of the continents than in mid ocean, and it varies likewise in height at different places on the same coast The attraction of the Himalaya, for example, suffices to cause a difference of 300 feet between the level of the sea at the delta of the Indus and on the coast of Ceylon The recognition of such facts has led Penck to suggest that the submergence of the maritime regions of North west Europe and the opposite coasts of North America, which took place at a recent geological date, and from which the lands in question have only partially recovered, may have been brought about by the attraction exerted by the vast ice sheets of the Glacial Period But, as Drygalski, Woodward, and others have shown, the heights at which recent marine deposits occur in the regions referred to are much too great to be accounted for by any possible distortion of the hydrosphere The late James Croll had previously endeavoured to show that the accumulation of ice over northern lands during glacial times would suffice to displace the earth's centre of gravity, and thus cause the sea to rise upon the glaciated tracts More recently other views have been advanced to explain the apparently causal connection between glaciation and submergence, but these need not be considered here

Whatever degree of importance may attach to the various hypotheses of secular movements of the sea, it is obvious that the general trends of the world's coast-lines are determined in the first place by the position of the dominant wrinkles of the lithosphere Even if we concede that all "raised beaches," so called, are not necessarily the result of earth-movements, and that the frequent transgressions of the continental areas by oceanic waters in geological times may possibly have been due to independent movements of the sea, still we must admit that the solid crust of the globe has always been subject to distortion And this being so, we cannot doubt that the general trends of the world's coast-lines must have been modified from time to time by movements of the lithosphere

As geographers we are not immediately concerned with the mode of origin of those vast wrinkles, nor need we speculate on the causes which may have determined their direction It seems, however, to be the general opinion that the configuration of the lithosphere is due simply to the sinking in and crumpling up of the crust on the cooling and contracting nucleus But it must be admitted that neither physicists nor geologists are prepared with a satisfactory hypothesis to account for the prominent trends of the great world ridges and troughs According to the late Prof. Alexander Winchell, these trends may have been the result of primitive tidal action He was of opinion that the transmeridional progress of the tidal swell in early incrustive times on our planet would give the forming crust structural characteristics and aptitudes trending from north to south The earliest wrinkles to come into existence, therefore, would be meridional or submeridional, and such, certainly, is the prevalent direction of the most conspicuous earth features There are many terrestrial trends, however, as Prof Winchell knew, which do not conform to the requirements of his hypothesis, but such transmeridional features, he thought, could generally be shown to be of later origin than the others This is the only speculation, so far as I know, which attempts, perhaps not altogether unsuccessfully, to explain the origin of the main trends of terrestrial features. According to other authorities, however, the area of the earth's crust occupied by the ocean is denser than that over which the continental regions are spread The depressed denser part balances the lighter elevated portion But why these regions of different densities should be so distributed no one has yet told us Neither does Le Conte's view, that the continental areas and the oceanic depressions owe their origin to unequal radial contraction of the earth in its secular cooling, help us to understand why the larger features of the globe should be disposed as they are

Geographers must for the present be content to take the world as they find it What we do know is that our lands are distributed over the surface of a great continental plateau of irregular form, the bounding slopes of which plunge down more or less steeply into a vast oceanic depression So far as geological research had gone, there is reason to believe that these elevated

and depressed areas are of primeval antiquity—that they antedate the very oldest of the sedimentary formations. There is abundant evidence, however, to show that the relatively elevated or continental area has been again and again irregularly submerged under tolerably deep and wide seas. But all historical geology assures us that the continental plateau and the oceanic hollows have never changed places, although from time to time portions of the latter have been ridged up and added to the margins of the former, while ever and anon marginal portions of the plateau have sunk down to very considerable depths. We may thus speak of the great world-ridges as regions of dominant elevation, and of the profound oceanic troughs as areas of more or less persistent depression. From one point of view, it is true, no part of the earth's surface can be looked upon as a region of dominant elevation. Our globe is a cooling and contracting body, and depression must always be the prevailing movement of the lithosphere. The elevation of the continental plateau is thus only relative. Could we conceive the crust throughout the deeper portions of the oceanic depression to subside to still greater depths, while at the same time the continental plateau remained stationary, or subsided more slowly, the sea would necessarily retreat from the land, and the latter would then appear to rise. It is improbable, however, that any extensive subsidence of the crust under the ocean could take place without accompanying disturbance of the continental plateau, and in this case the latter might experience in places not only negative but positive elevation. During the evolution of our continent, crustal movements have again and again disturbed the relative level of land and sea, but since the general result has been to increase the land surface and to contract the area occupied by the sea, it is convenient to speak of the former as the region of dominant elevation, and of the latter as that of prevalent depression. Properly speaking, both are sinking regions, the rate of subsidence within the oceanic trough being in excess of that experienced over the continental plateau. The question of the geographical development of coast-lines is therefore only that of the dry lands themselves.

The greater land masses are all situated upon, but are nowhere coextensive with, the area of dominant elevation, for very considerable portions of the continental plateau are still covered by the sea. Opinions may differ as to which fathoms line we should take as marking approximately the boundary between that region and the oceanic depression, and it is obvious, indeed, that any line selected must be arbitrary and more or less misleading, for it is quite certain that the true boundary of the continental plateau cannot lie parallel to the surface of the ocean. In some regions it approaches within a few hundreds of fathoms of the sea level, in other places it sinks for considerably more than 1000 fathoms below that level. Thus, while a very moderate elevation would in certain latitudes cause the land to extend to the edge of the plateau, an elevation of at least 10,000 feet would be required in some other places to bring about a similar result.

Although it is true that the land surface is nowhere coextensive with the great plateau, yet the existing coast lines may be said to trend in the same general direction as its margins. So abruptly does the continental plateau rise from the oceanic trough, that a depression of the sea level, or an elevation of the plateau, for 10,000 feet, would add only a narrow belt to the Pacific coast between Alaska and Cape Horn, while the gain of land on the Atlantic slope of America between 30° N. L. and 40° S. L. would not be much greater. In the higher latitudes of the Northern Hemisphere, however, very considerable geographical changes would be accomplished by a much less amount of elevation of the plateau. Were the continental plateau to be upheaved for 3000 feet, the major portion of the Arctic Sea would become land. Thus, in general terms, we may say that the coast-lines of Arctic and temperate North America and Eurasia are further withdrawn from the edge of the continental plateau than those of lower latitudes.

In regions where existing coast lines approach the margin of the plateau, they are apt to run for long distances in one determinate direction, and whether the coastal area be high or not, to show a gentle sinuosity. Their course is seldom interrupted by bold projecting headlands or peninsulas, or by intruding inlets, while fringing or marginal islands rarely occur. To these appearances the northern regions, as every one knows, offer the strongest contrast. Not only do they trend irregularly, but their continuity is constantly interrupted by promontories and peninsulas, by inlets and fiords, while fringing islands abound. But an elevation of some 400 or 500 fathoms only would revolutionize the geography of those regions, and confer upon the northern coast lines of the world the regularity which at present characterizes those of Western Africa.

It is obvious, therefore, that the coast-lines of such lands as Africa owe their regularity primarily to their approximate coincidence with the steep boundary slopes of the continental plateau, while the irregularities characteristic of the coast-line of North-Western Europe and the corresponding latitudes of North America are determined by the superficial configuration of the same plateau, which in those regions is relatively more depressed. I have spoken of the general contrast between high and low northern latitudes, but it is needless to say that in southern regions the coast lines exhibit similar contrasts. The regular coast lines of Africa and South America have already been referred to, but we cannot fail to recognize in the much indented sea board and the numerous coastal island of Southern Chili a complete analogy to the fiord regions of high northern latitudes. Both are areas of comparatively recent depression. Again, the manifold irregularities of the coasts of South eastern Asia, and the multitudes of islands that serve to link that continent to Australia and New Zealand, are all evidence that the surface of the continental plateau in those regions is extensively invaded by the sea.

A word or two now as to the configuration of the oceanic trough. There can be no doubt that this differs very considerably from that of the land surface. It is, upon the whole, flat or gently undulating. Here and there it swells gently upwards into broad elevated banks, some of which have been traced for great distances. In other places narrower ridges and abrupt mountain-like elevations diversify its surface, and project again and again above the level of the sea, to form the numerous islets of Oceania. Once more, the sounding line has made us acquainted with the notable fact that numerous deep depressions—some long and narrow, others relatively short and broad—stud the floor of the great trough. I shall have occasion to refer again to these remarkable depressions, and need at present only call attention to the fact that they are especially well developed in the region of the Western Pacific, where the floor of the sea, at the base of the bounding slopes of the continental plateau, sinks in places to depths of three and even of five miles below the existing coast-lines. One may further note the fact that the deepest areas of the Atlantic are met with in like manner close to the walls of the plateau—a long ridge, which rises midway between the continents and runs in the same general direction as their coast-lines, serving to divide the trough of the Atlantic into two parallel hollows.

But, to return to our coast lines and the question of their development, it is obvious that their general trends have been determined by crustal movements. Their regularity is in direct proportion to the closeness of their approach to the margin of the continental plateau. The more nearly they coincide with the edge of that plateau, the fewer irregularities do they present, the further they recede from it, the more highly are they indented. Various other factors, it is true, have played a more or less important part in their development, but their dominant trends were undoubtedly determined at a very early period in the world's history: their determination necessarily dates back, in short, to the time when the great world ridges and oceanic troughs came into existence. So far as we can read the story told by the rocks, however, it would seem that in the earliest ages of which geology can speak with any confidence, the coast-lines of the world must have been infinitely more irregular than now. In Palæozoic times, relatively small areas of the continental plateau appeared above the level of the sea. Insular conditions everywhere prevailed. But as ages rolled on wider and wider tracts of the plateau were exposed, and this notwithstanding many oscillations of level. So that one may say there has been upon the whole a general advance from insular to continental conditions. In other words, the sea has continued to retreat from the surface of the continental plateau. To account for this change we must suppose that depression of the crust has been in excess within the oceanic area, and that now and again positive elevation of the continental plateau has taken place, more especially along its margins. That movements of elevation, positive or negative, have again and again affected our land areas can be demonstrated, and it seems highly probable, therefore, that similar movements may have been experienced with the oceanic trough.

Two kinds of crustal movement, as we have seen, are recognized by geologists. Sometimes the crust appears to rise, or, as the case may be, to sink over wide regions, without much disturbance or tilting of strata, although these are now and again more or less extensively fractured and displaced. It may conduce to clearness if we speak of these movements as regional. The other kind of crustal disturbance takes place more markedly in linear directions, and is always accompanied by abrupt folding and mashing together of strata, along with more or less fracturing and displacement. The plateau of the Colorado has often been cited as a good example of regional elevation, where we have a wide area of approximately horizontal strata apparently uplifted without much rock disturbance, while the Alps or any other chain of highly flexed and convoluted strata will serve as an example of what we may term axial or linear uplifts. It must be understood that both regional and axial movements result from the same cause—the adjustment of the solid crust to the contracting nucleus—and that the term *elevation*, therefore, is only relative. Sometimes the sinking crust gets relief from the enormous lateral pressure to which it is subjected by ridging up along lines of weakness, and then mountains of elevation are formed; at other times, the pressure is relieved by the formation of broader swellings, when wide areas become uplifted relatively to surrounding regions. Geologists, however, are beginning to doubt whether upheaval of the latter kind can affect a broad continental area. Probably in most cases, the apparent elevation of continental regions is only negative. The land appears to have risen because the floor of the oceanic basin has become depressed. Even the smaller plateau-like elevations which occur within some continental regions may in a similar way owe their dominance to the sinking of contiguous regions.

In the geographical development of our land, movements of elevation and depression have played an important part. But we cannot ignore the work done by other agents of change. If the orographical features of the land everywhere attest the potency of plutonic agents, they no less forcibly assure us that the inequalities of surface resulting from such movement are universally modified by denudation and sedimentation. Elevated plains and mountains are gradually demolished, and the hollows and depressions of the great continental plateau become slowly filled with their detritus. Thus inland seas tend to vanish, inlets and estuaries are silted up, and the land in places advances seaward. The energies of the sea, again, come in to aid those of rain and river, so that under the combined action of all the superficial agents of change, the irregularities of coast-lines become reduced, and, were no crustal movement to intervene, would eventually disappear. The work accomplished by those agents upon a coast-line is most conspicuous in regions where the surface of the continental plateau is occupied by comparatively shallow seas. Here full play is given to sedimentation and marine erosion, while the latter alone comes into prominence upon shores that are washed by deeper waters. When the coast-lines advance to the edge of the continental plateau, they naturally trend, as we have seen, for great distances in some particular direction. Should they preserve that position, undisturbed by crustal oscillation, for a prolonged period of time, they will eventually be cut back by the sea. In this way a shelf or terrace will be formed, narrow in some places, broader in others, according to the resistance offered by the varying character of the rocks. But no long inlets or fiords can result from such action. At most the harder and less readily demolished rocks will form headlands, while shallow bays will be scooped out of the more yielding masses. In short, between the narrower and broader parts of the eroded shelf or terrace a certain proportion will tend to be preserved. As the shelf is widened, sedimentation will become more and more effective, and in places may come to protect the land from further marine erosion. This action is especially conspicuous in tropical and subtropical regions, which are characterized by well-marked rainy seasons. In such regions immense quantities of sediment are washed down from the land to the sea, and tend to accumulate along shore, forming low alluvial flats. All long established coast-lines thus acquire a characteristically sinuous form, and perhaps no better examples could be cited than those of Western Africa.

To sum up, then, we may say that the chief agents concerned in the development of coast-lines are crustal movements, sedimentation, and marine erosion. All the main trends are the result of elevation and depression. Considerable geographical changes, however, have been brought about by the silting up of those shallow and sheltered seas which, in certain regions, overflow wide areas of the continental plateau. Throughout all the ages, indeed, epigene agents have striven to reduce the superficial inequalities of that plateau, by levelling heights and filling up depressions, and thus, as it were, flattening out the land surface and causing it to extend. The erosive action of the sea, from our present point of view, is of comparatively little importance. It merely adds a few finishing touches to the work performed by the other agents of change.

A glance at the geographical evolution of our own continent will render this sufficiently evident. Viewed in detail, the structure of Europe is exceedingly complicated, but there are certain leading features in its architecture which no profound analysis is required to detect. We note, in the first place, that highly disturbed rocks of Archæan and Palæozoic age reach their greatest development along the north-western and western borders of our continent, as in Scandinavia, the British Islands, North-west France, and the Iberian peninsula. Another belt of similarly disturbed strata of like age traverses Central Europe from west to east, and is seen in the South of Ireland, Cornwall, North-west France, the Ardennes, the Thuringerwald, the Erzgebirge, the Riesengebirge, the Bohmerwald, and other heights of Middle and Southern Germany. Strata of Mesozoic and Cainozoic age rest upon the older systems in such a way as to show that the latter had been much folded, fractured, and denuded before they came to be covered with younger formations. North and north-east of the central belt of ancient rocks just referred to, the sedimentary strata that extend to the shores of the Baltic and over a vast region in Russia, range in age from Palæozoic down to Cainozoic times, and are disposed for the most part in gentle undulations—they are either approximately horizontal or slightly inclined. Unlike the disturbed rocks of the maritime regions and of Central Europe, they have obviously been subjected to comparatively little folding since the time of their deposition. To the south of the primitive backbone of Central Europe succeeds a region composed superficially of Mesozoic and Cainozoic strata for the most part, which, along with underlying Palæozoic and Archæan rocks, are often highly flexed and ridged up, as in the chains of the Jura, the Alps, the Carpathians, &c. One may say, in general terms, that throughout the whole Mediterranean area Archæan and Palæozoic rocks appear at the surface only when they form the nuclei of mountains of elevation into the composition of which rocks of younger age largely enter.

From this bald and meagre outline of the general geological structure of Europe, we may gather that the leading orographical features of our continent began to be developed at a very early period. Unquestionably the oldest land areas are represented by the disturbed Archæan and Palæozoic rocks of the Atlantic sea-board and Central Europe. Examination of those tracts shows that they have experienced excessive denudation. The Archæan and Palæozoic masses, distributed along the margin of the Atlantic, are the mere wrecks of what, in earlier ages, must have been lofty regions, the mountain-chains of which may well have rivalled or even exceeded in height the Alps of to-day. They, together with the old disturbed rocks of Central Europe, formed for a long time the only land in our area. Between the ancient Scandinavian tract in the north and a narrow interrupted belt in Central Europe stretched a shallow sea, which covered all the regions that now form our Great Plain; while immediately south of the central belt lay the wide depression of the Mediterranean—for as yet the Pyrenees, the Alps, and the Carpathians were not. Both the Mediterranean and the Russo-Germanic sea communicated with the Atlantic. As time went on, land continued to be developed along the same lines, a result due partly to crustal movements, partly to sedimentation. Thus by and by the relatively shallow Russo-Germanic sea became silted up, while the Mediterranean shore-line advanced southwards. It is interesting to note that the latter sea, down to the close of Tertiary times, seems always to have communicated freely with the Atlantic, and to have been relatively deep. The Russo-Germanic sea, on the contrary, while now and again opening widely into the Atlantic, and attaining considerable depths in its western reaches, remained on the whole shallow, and ever and anon vanished from wide areas to contract into a series of inland seas and large salt lakes.

Reduced to its simplest elements, therefore, the structure of Europe shows two primitive ridges—one extending with some

interruptions along the Atlantic sea-board, the other traversing Central Europe from west to east, and separating the area of the Great Plain from the Mediterranean basin. The excessive denudation which the more ancient lands have undergone, and great uplifts of Mesozoic and of Cainozoic times, together with the comparatively recent submergence of broad tracts in the north and north west, have not succeeded in obscuring the dominant features in the architecture of our continent.

I now proceed to trace, as rapidly as I can, the geographical development of the coast lines of the Atlantic as a whole, and to point out the chief contrasts between them and those of the Pacific. The extreme irregularity of the Arctic and Atlantic shores of Europe at once suggests to a geologist a partially drowned land, the superficial inequalities of which are accountable for the vagaries of the coast lines. The fiords of Norway and Scotland occupy what were at no distant date land valleys, and the numerous marginal islands of those regions are merely the projecting portions of a recently sunken area. The continental plateau extends up to and a little beyond the one hundred fathoms line, and there are many indications that the land formerly reached as far. Thus the sunken area is traversed by valley-like depressions, which widen as they pass out to the edge of the plateau, and have all the appearance of being hollows of subaerial erosion. I have already mentioned the fact that the Scandinavian uplands and the Scottish Highlands are the relics of what were at one time true mountains of elevation, corresponding in the mode of their formation to those of Switzerland, and, like these, attaining a great elevation. During subsequent stages of Palæozoic time, that highly elevated region was subjected to long-continued and profound erosion; the mountain country was planed down over wide regions to sea-level, and broad stretches of the reduced land surface became submerged. Younger Palæozoic formations now accumulated upon the drowned land, until eventually renewed crustal disturbance supervened, and the marginal areas of the continental plateau again appeared as dry land, but not, as before, in the form of mountains of elevation. Lofty table lands now took the place of abrupt and serrated ranges and chains—table lands which, in their turn, were destined in the course of long ages to be deeply sculptured and furrowed by subaerial agents. During this process the European coast line would seem to have coincided more or less closely with the edge of the continental plateau. Finally, after many subsequent movements of the crust in these latitudes, the land became partially submerged, a condition from which North western and Northern Europe would appear in recent times to be slowly recovering. Thus the highly indented coast line of those regions does not coincide with the edge of the plateau, but with those irregularities of its upper surface which are the result of antecedent subaerial erosion.

Mention has been made of the Russo Germanic plain and the Mediterranean as representing original depressions in the continental plateau, and of the high grounds that extend between them as regions of dominant elevation, which, throughout all the manifold revolutions of the past, would appear to have persisted as a more or less well marked boundary, separating the northern from the southern basin. During certain periods it was no doubt in some degree submerged, but never apparently to the same extent as the depressed areas it served to separate. From time to time uplifts continued to take place along this central belt, which thus increased in breadth, the younger formations, which were accumulated along the margins of the two basins, being successively ridged up against nuclei of older rocks. The latest great crustal movements in our continent, resulting in the uplift of the Alps and other east and west ranges of similar age, have still further widened that ancient belt of dominant elevation which in our day forms the most marked orographical feature of Europe.

The Russo-Germanic basin is now for the most part land, the Baltic and the North Sea representing its still submerged portions. This basin, as already remarked, was probably never so deep as that of the Mediterranean. We gather as much from the fact that, while mechanical sediments of comparatively shallow-water origin predominate in the former area, limestones are the characteristic features of the southern region. Its relative shallowness helps us to understand why the northern depression should have been silted up more completely than the Mediterranean. We must remember also that for long ages it received the drainage of a much more extensive land surface than the latter—the land that sloped towards the Mediterranean in Palæozoic and Mesozoic times being of relatively little importance. Thus the crustal movements which ever and anon depressed the Russo Germanic area were, in the long run, counterbalanced by sedimentation. The uplift of the Alps, the Atlas, and other east and west ranges, has greatly contracted the area of the Mediterranean, and sedimentation has also acted in the same direction, but it is highly probable that that sea is now as deep as, or even deeper than it has ever been. It occupies a primitive depression in which the rate of subsidence has exceeded that of sedimentation. In many respects indeed, this remarkable transmeridional hollow—continued eastward in the Red Sea, the Black Sea, and the Aralo Caspian depression—is analogous, as we shall see, to the great oceanic trough itself.

In the earlier geological periods linear or axial uplifts and volcanic action again and again marked the growth of the land on the Atlantic sea board. But after Palæozoic times, no great mountains of elevation came into existence in that region, while volcanic action almost ceased. In Tertiary times, it is true, there was a remarkable recrudescence of volcanic activity, but the massive eruptions of Antrim and Western Scotland, of the Faroe Islands and Iceland, must be considered apart from the general geology of our continent. From Mesozoic times onwards it was along the borders of the Mediterranean depression that great mountain uplifts and volcanoes chiefly presented themselves. And as the land surface extended southwards from Central Europe, and the area of the Mediterranean was contracted, volcanic action followed the advancing shore lines. The occurrence of numerous extinct and of still existing volcanoes along the borders of this inland sea, the evidence of recent crustal movements so commonly met with upon its margins, the great irregularities of its depths, the proximity of vast axial uplifts of late geological age, and the frequency of earthquake phenomena, all indicate instability, and remind us strongly of similarly constructed and disturbed regions within the area of the vast Pacific.

Let us now look at the Arctic and Antarctic coast-lines of North America. From the extreme north down to the latitude of New York the shores are obviously those of a partially submerged region. They are of the same type as the coasts of North-western Europe. We have every reason to believe also that the depression of Greenland and North-east America, from which these lands have only partially recovered, dates back to a comparatively recent period. The fiords, and inlets, like those of Europe, are merely half drowned land valleys, and the continental shelf is crossed by deep hollows which are evidently only the seaward continuations of well-marked terrestrial features. Such, for example, is the case with the valleys of the Hudson and the St Lawrence, the submerged portions of which can be followed out to the edge of the continental plateau, which is notched by them at depths of 474 and 622 fathoms respectively. There is, in short, a broad resemblance between the coasts of the entire Arctic and North Atlantic regions down to the latitudes already mentioned. Everywhere they are irregular and fringed with islands in less or greater abundance—highly denuded and deeply incised plateaus being penetrated by fiords, while low lying and undulating lands that shelve gently seaward are invaded by shallow bays and inlets. Comparing the American with the opposite European coasts, one cannot help being struck with certain other resemblances. Thus Hudson Bay at once suggests the Baltic, and the Gulf of Mexico, with the Caribbean Sea, recall the Mediterranean. But the geological structure of the coast-lands of Greenland and North America betrays a much closer resemblance between these and the opposite shores of Europe than appears on a glance at the map. There is something more than a mere superficial similarity. In eastern North America and Greenland, just as in Western Europe, no grand mountain uplifts have taken place for a prodigious time. The latest great upheavals, which were accompanied by much folding and flexing of strata, are those of the Appalachian chain and of the coastal ranges extending through New England, Nova Scotia, and Newfoundland, all of which are of Palæozoic age. Considerable crustal movements affected the American coast lands in Mesozoic times, and during these uplifts the strata suffered fracture and displacement, but were subjected to comparatively little folding. Again, along the maritime borders of North east America, as in the corresponding coast-lands of Europe, igneous action, more or less abundant in Palæozoic and early Mesozoic times, has since been quiescent. From the mouth of the Hudson to the Straits of Florida the coast-lands are composed of Tertiary and Quaternary deposits. This shows that the land has

continued down to recent times to gain upon the sea—a result brought about partly by quiet crustal movements, but to a large extent by sedimentation, aided, on the coasts of Florida, by the action of reef building corals

Although volcanic action has long ceased on the American sea board, we note that in Greenland, as in the West of Scotland and North of Ireland, there is abundant evidence of volcanic activity at so late a period as the Tertiary It would appear that the great plateau-basalts of those regions, and of Iceland and the Færoe Islands, were contemporaneous, and possibly connected with an important crustal movement It has long been suggested that at a very early geological period Europe and North America may have been united The great thickness attained by the Palæozoic rocks in the eastern areas of the latter implies the existence of a wide land surface from which ancient sediments were derived That old land must have extended beyond the existing coast line, but how far we cannot tell Similarly in North-west Europe, during early Palæozoic times, the land probably stretched further into the Atlantic than at present But whether, as some think, an actual land connection subsisted between the two continents it is impossible to say Some such connection was formerly supposed necessary to account for the emigration and immigration of certain marine forms of life which are common to the Palæozoic strata of both continents, and which, as they were probably denizens of comparatively shallow water, could only have crossed from one area to another along a shore-line It is obvious, indeed, that if the oceanic troughs in those early days were of an abysmal character, a land bridge would be required to explain the geographical distribution of cosmopolitan life-forms But if it be true that subsidence of the crust has been going on through all geological time, and that the land areas have notwithstanding continued to extend over the continental plateau, then it follows that the oceanic trough must be deeper now than it was in Palæozoic times There are, moreover, certain geological facts which seem hardly explicable on the assumption that the seas of past ages attained abysmal depths over any extensive areas The Palæozoic strata which enter so largely into the framework of our lands have much the same appearance all the world over, and were accumulated for the most part in comparatively shallow water A petrographical description of the Palæozoic mechanical sediments of Europe would serve almost equally well for those of America, of Asia, or of Australia Take in connection with this the fact that Palæozoic faunas had a very much wider range than those of Mesozoic and later ages, and were characterized above all by the presence of many cosmopolitan species, and we can hardly resist the conclusion that it was the comparative shallowness of the ancient seas that favoured that wide dispersal of species, and enabled currents to distribute sediments the same in kind over such vast regions As the oceanic area deepened and contracted, and the land surface increased, marine faunas were gradually restricted in their range, and cosmopolitan marine faunas diminished in numbers, while sediments, gathering in separate regions, became more and more differentiated For these and other reasons, which need not be entered upon here, I see no necessity for supposing that a Palæozoic Atlantis connected Europe with North America The broad ridge upon which the Færoe Islands and Iceland are founded, seems to pertain as truly to the oceanic depression as the long Dolphin Ridge of the South Atlantic The trend of the continental plateau in high latitudes is shown, as I think, by the general direction of the coast lines of North-Western Europe and East Greenland, the continental shelf being submerged in those regions for a few hundred fathoms only How the Icelandic ridge came into existence, and what its age may be, we can only conjecture It may be a wrinkle as old as the oceanic trough which it traverses, or its origin may date back to a much more recent period We may conceive it to be an area which has subsided more slowly than the floor of the ocean to the north and south, or, on the other hand, it may be a belt of positive elevation Perhaps the latter is the more probable supposition, for it seems very unlikely that crustal disturbances, resulting in axial and regional uplifts, should have been confined to the continental plateau only Be that as it may, there seems little doubt that land connection did obtain between Greenland and Europe in Cainozoic times, along this Icelandic ridge, for relics of the same Tertiary flora are found in Scotland, the Færoe Islands, Iceland, and Greenland The deposits in which these plant-remains occur are associated with great sheets of volcanic rocks which in the Færoe Islands and Iceland reach a thickness of many thousand feet Of the same age are the massive basalts of Jan Mayen, Spitzbergen, Franz Joseph Land, and Greenland These lavas seem seldom to have issued from isolated foci in the manner of modern eruptions, but rather to have welled up along the lines of rectilineal fissures From the analogy of similar phenomena in other parts of the world it might be inferred that the volcanic action of these northern regions may have been connected with a movement of elevation, and that the Icelandic ridge, if it did not come into existence during the Tertiary period, was at all events greatly upheaved at that time It would seem most likely, in short, that the volcanic action in question was connected mainly with crustal movements in the oceanic trough Similar phenomena, as is well known, are met with further south in the trough of the Atlantic Thus the volcanic Azores rise like Iceland from the surface of a broad ridge which is separated from the continental plateau by wide and deep depressions And so again, from the back of the great Dolphin Ridge, spring the volcanic islets of St Paul's, Ascension, and Tristan d'Acunha

I have treated of the Icelandic bank at some length for the purpose of showing that its volcanic phenomena do not really form an exception to the rule that such eruptions ceased after Palæozoic or early Mesozoic times to disturb the Atlantic coast lines of Europe and North America As the bank in question extends between Greenland and the British Islands, it was only natural that both those regions should be affected by its movements But its history pertains essentially to that of the Atlantic trough, and it seems to show how transmeridional movements of the crust, accompanied by vast discharges of igneous rock, may come in time to form land connections between what are now widely separated areas

Let us next turn our attention to the coast lines of the Gulf of Mexico and the Caribbean Sea These enclosed seas have frequently been compared to the Mediterranean, and the resemblance is self-evident Indeed, it is so close that one may say the Mexican Caribbean Sea and the Mediterranean are rather homologous than simply analogous The latter, as we have seen, occupies a primitive depression, and formerly covered a much wider area It extended at one time over much of Southern Europe and Northern Africa, and appears to have had full communication across Asia Minor with the Indian Ocean, and with the Arctic Ocean athwart the low-lying tracts of North-Western Asia Similarly, it would seem, the Mexican Caribbean Sea is the remaining portion of an ancient inland sea which formerly stretched north through the heart of North America to the Arctic Ocean Like its European parallel, it has been diminished by sedimentation and crustal movements It resembles the latter also in the greatness and irregularity of its depths, and in the evidence which its islands supply of volcanic action as well as of very considerable crustal movements within geological times Along the whole northern borders of the Gulf of Mexico the coast lands, like those on the Atlantic seaboard of the Southern States, are composed of Tertiary and recent accumulations, and the same is the case with Yucatan, while similar young formations are met with on the borders of the Caribbean Sea and the Antilles The Bahamas and the Windward Islands mark out for us the margin of the continental plateau, which here falls away abruptly to profound depths One feels assured that this portion of the plateau has been ridged up to its present level at no distant geological date But notwithstanding all the evidence of recent extensive crustal movements in this region, it is obvious that the Mexican-Caribbean depression, however much it may have been subsequently modified, is of primitive origin [1]

Before we leave the coast lands of North America, I would again point out their leading geological features. In a word, then, they are composed for the most part of Archæan and Palæozoic rocks, no great linear or axial uplifts marked by much flexure of strata have taken place in those regions since Palæozoic times, while igneous action virtually ceased about the close of the Palæozoic or the commencement of the Mesozoic period It is not before we reach the shores of the Southern States and the coast-lands of the Mexican-Caribbean Sea that we encounter notable accumulations of Mesozoic, Tertiary, and younger age These occur in approximately horizontal positions

[1] Professor Suess thinks it is probable that the Caribbean Sea and the Mediterranean are portions of one and the same primitive depression which traversed the Atlantic area in early Cretaceous times. He further suggests that it may have been through the gradual widening of this central Mediterranean that the Atlantic in later times came into existence.

round the Gulf of Mexico, but in the Sierra Nevada or Northern Colombia and the Cordilleras of Venezuela Tertiary strata are ridged up into true mountains of elevation. Thus the Mexican Caribbean depression, like that of the Mediterranean, is characterized not only by its irregular depths and its volcanic phenomena, but by the propinquity of recent mountains of upheaval, which bear the same relation to the Caribbean Sea that the mountains of North Africa do to the Mediterranean.

We may now compare the Atlantic coasts of South America with those of Africa. The former coincide in general direction with the edge of the continental plateau, to which they closely approach between Cape St. Roque and Cape Frio. In the north-east, between Cape Paria, opposite Trinidad, and Cape St. Roque, the continental shelf attains a considerably greater breadth, while south of Cape Frio it gradually widens, until, in the extreme south, it runs out towards the east in the form of a narrow ridge, upon the top of which rise the Falkland Islands and South Georgia. Excluding from consideration for the present all recent alluvial and Tertiary deposits we may say that the coast lands from Venezuela down to the South of Brazil are composed principally of Archæan rocks; the eastern borders of the continent further south being formed of Quaternary and Tertiary accumulations. So far as we know, igneous rocks are of rare occurrence on the Atlantic sea-board. Palæozoic strata approach the coast lands at various points between the mouths of the Amazons and La Plata, and these, with the underlying and surrounding Archæan rocks, are more or less folded and disturbed, while the younger strata of Mesozoic and Cainozoic age (occupying wide regions in the basin of of the Amazons, and here and there fringing the sea-coast), occur in approximately horizontal positions. It would appear, therefore, that no great axial uplifts have taken place in those regions since Palæozoic times. The crustal movements of later ages were regional rather than axial; the younger rocks are not flexed and mashed together, and their elevation (negative or positive) does not seem to have been accompanied by conspicuous volcanic action.

The varying width of the continental shelf is due to several causes. The Orinoco, the Amazons, and other rivers descending to the north-west coast, carry enormous quantities of sediment, much of which comes to rest on the submerged slopes of the continental plateau, so that the continental shelf tends to extend seawards. The same process takes place on the south-east coast, where the River Plate discharges its muddy waters. South of latitude 40° S., however, another cause has come into play. From the mouth of the Rio Negro to the terminal point of the continent the whole character of the coast betokens a geologically recent emergence, accompanied and followed by considerable marine erosion. So that in this region the continental shelf increases in width by the retreat of the coast line, while in the north-east it gains by advancing seawards. It is to be noted, however, that even there, in places where the shores are formed of alluvia, the sea tends to encroach upon the land.

The Atlantic coast of Africa resembles that of South America in certain respects, but it also offers some important contrasts. As the northern coasts of Venezuela and Colombia must be considered in relation rather to the Caribbean depression than to the Atlantic, so the African sea-board between Cape Spartel and Cape Nun pertains structurally to the Mediterranean region. From the southern limits of Morocco to Cape Colony the coastal heights are composed chiefly of Archæan and Palæozoic rocks, the low shore lands showing here and there strata of Mesozoic and Tertiary age together with still more recent deposits. The existing coast-lines everywhere advance close to the edge of the continental plateau, so that the submarine shelf is relatively narrower than that of Eastern South America. The African coast is still further distinguished from that of South America by the presence of several groups of volcanic islands—Fernando Po and others in the Gulf of Guinea, and Cape Verde and Canary Islands. The last named group, however, notwithstanding its geographical position, is probably related rather to the Mediterranean depression than to the Atlantic trough.

The geological structure of the African coast-lands shows that the earliest to come into existence were those that extend between Cape Nun and the Cape of Good Hope. The coastal ranges of that section are much denuded, for they are of very great antiquity, having been ridged up in Palæozoic times. The later uplifts (negative or positive) of the same region were not attended by tilting and folding of strata, for the Mesozoic and Tertiary deposits, like those of South America, lie in comparatively horizontal positions. Between Cape Nun and Cape Spartel the rocks of the maritime tracts range in age from Palæozoic to Cainozoic, and have been traced across Morocco into Algeria and Tunis. They all belong to the Mediterranean region, and were deposited at a time when the southern shores of that inland sea extended from a point opposite the Canary Islands along the southern margin of Morocco, Algeria, and Tunis. Towards the close of the Tertiary period the final upheaval of the Atlas took place, and the Mediterranean, retreating northwards, became an almost land locked sea.

I need hardly stop to point out how the African coast lines have been modified by marine erosion and the accumulation of sediment upon the continental shelf. The extreme regularity of the coasts is due partly to the fact that the land is nearly coextensive with the continental plateau, but it also results in large measure from the extreme antiquity of the land itself. This has allowed of the cutting back of headlands and the filling up of bays and inlets, a process which has been going on between Morocco and Cape Colony with probably little interruption for a very prolonged period of time. We may note also the effect of the heavy rains of the equatorial region in washing down detritus to the shores, and in this way protecting the land to some extent from the erosive action of the sea.

What now, let us ask, are the outstanding features of the coast lines of the Atlantic Ocean? We have seen that along the margins of each of the bordering continents the last series of great mountain uplifts took place in Palæozoic times. This is true alike for North and South America, for Europe and Africa. Later movements which have added to the extent of land were not marked by the extreme folding of strata which attended the early upheavals. The Mesozoic and Cainozoic rocks, which now and again form the shore-lands, occur in more or less undisturbed condition. The only great linear uplifts or true mountains of elevation which have come into existence in Western Europe and Northern Africa since the Palæozoic period trend approximately at right angles to the direction of the Atlantic trough, and are obviously related to the primitive depression of the Mediterranean. The Pyrenees and the Atlas, therefore, although their latest elevation took place in Tertiary times, form no exceptions to the rule that the extreme flexing and folding of strata which is so conspicuous a feature in the geological structure of the Atlantic sea-board dates back to the Palæozoic era. And the same holds true of North and South America. There all the coastal ranges of highly flexed and folded strata are of Palæozoic age. The Cordilleras of Venezuela are no doubt a Tertiary uplift, but they are as obviously related to the Caribbean depression as the Atlas ranges are to that of the Mediterranean. Again, we note that volcanic activity along the borders of the Atlantic was much less pronounced during the Mesozoic period than it appears to have been in earlier ages. Indeed if we except the great Tertiary basalt-flows of the Icelandic ridge and the Arctic regions, we may say that volcanic action almost ceased after the Palæozoic era to manifest itself upon the Atlantic coast-lands of North America and Europe. But while volcanic action has died out upon the Atlantic margins of both continents, it has continued during a prolonged geological period within the area of the Mediterranean depression. And in like manner the corresponding depression between North and South America has been the scene of volcanic disturbances from Mesozoic down to recent times. Along the African coasts the only displays of recent volcanic action that appertain to the continental margin are those of the Gulf of Guinea and the Cape de Verde Islands. The Canary Islands and Madeira may come under the same category, but, as we have seen, they appear to stand in relationship to the Mediterranean depression and the Tertiary uplift of North Africa. Of Iceland and the Azores I have already spoken, and of Ascension and the other volcanic islets of the South Atlantic it is needless to say that they are related to wrinkles in the trough of the ocean, and therefore have no immediate connection with the continental plateau.

Thus in the geographical development of the Atlantic coast-lines we may note the following stages:—*First*, during Palæozoic times a series of great mountain-uplifts, which were frequently accompanied by volcanic action. *Second*, a prolonged stage of comparative coastal tranquillity, during which the maritime ranges referred to were subject to such excessive erosion that they were planed down to low levels, and in certain areas even submerged. *Third*, renewed elevation (negative or positive) whereby considerable portions of the much denuded Archæan and Palæozoic rocks, now largely covered by younger

deposits, were converted into high lands. During this stage not much rock folding took place, nor were any true mountains of elevation formed parallel to the Atlantic margins. It was otherwise, however, in the Mediterranean and Caribbean depressions, where coastal movements resulted in the formation of enormous linear uplifts. Moreover, volcanic action is now and has for a long time been more characteristic of these depressions than of the Atlantic coast-lands.

I must now ask you to take a comprehensive glance at the coast-lines of the Pacific Ocean. In some important respects these offer a striking contrast to those we have been considering. Time will not allow me to enter into detailed description, and I must therefore confine attention to certain salient features. Examining first the shores of the Americas, we find that there are two well marked regions of fiords and fringing islands—namely, the coasts of Alaska and British Columbia, and of South America from 40° S. L. to Cape Horn. Although these regions may be now extending seawards in places, it is obvious that they have recently been subject to submergence. When the fiords of Alaska and British Columbia existed as land valleys it is probable that a broad land connection obtained between North America and Asia. The whole Pacific coast is margined by mountain ranges, which in elevation and boldness far exceed those of the Atlantic sea board. The rocks entering into their formation range in age from Archæan and Palæozoic, and they are almost everywhere highly disturbed and flexed. It is not necessary, even if it were possible, to consider the geological history of all those uplifted masses. It is enough for my purpose to note the fact that the coastal ranges of North America and the principal chain of the Andes were all elevated in Tertiary times. It may be remarked further, that from the Mesozoic period down to the present the Pacific borders of America have been the scene of volcanic activity far in excess of what has been experienced on the Atlantic sea board.

Geographically the Asiatic coasts of the Pacific offer a strong contrast to those of the American borders. The latter, as we have seen, are for the most part not far removed from the edge of the continental plateau. The coasts of the mainland of Asia, on the other hand, retire to a great distance, the true margin of the plateau being marked out by that great chain of islands which extends from Kamchatka south to the Philippines and New Guinea. The seas lying between those islands and the mainland occupy depressions in the continental plateau. Were that plateau to be lifted up for 6,000 or 7,000 feet the seas referred to would be inclosed by continuous land, and all the principal islands of the Indian Archipelago—Sumatra, Java, Celebes, and New Guinea, would become united to themselves as well as to Australia and New Zealand. In short, it is the relatively depressed condition of the continental plateau along the western borders of the Pacific basin that caused the Asiatic coast lines to differ so strikingly from those of America.

From a geological point of view the differences are less striking than the resemblances. It is true that we have as yet a very imperfect knowledge of the geological structure of Eastern Asia, but we know enough to justify the conclusion that in its main features that region does not differ essentially from Western North America. During Mesozoic and Cainozoic times the sea appears to have overflowed vast tracts of Manchooria and China, and even to have penetrated into what is now the great Desert of Gobi. Subsequent crustal movements revolutionised the geography of all those regions. Great ranges of linear uplifts came into existence, and in these the younger formations, together with the foundations on which they rested, were squeezed into folds and ridged up against the nuclei of Palæozoic and Archæan rocks which had hitherto formed the only dry land. The latest of these grand upheavals are of Tertiary age, and, like those of the Pacific slope of America, they were accompanied by excessive volcanic action. The long chains of islands that flank the shores of Asia we must look upon as a series of partially submerged or partially emerged mountain ranges, analogous geographically to the coast ranges of North and Central America, and to the youngest Cordilleras of South America. The presence of numerous active and recently extinct volcanoes, taken in connection with the occurrence of many great depressions which furrow the floor of the sea in the East Indian Archipelago, and the profound depths attained by the Pacific trough along the borders of Japan and the Kurile and Aleutian Islands—all indicate conditions of very considerable instability of the lithosphere. We are not surprised, therefore, to meet with much apparently conflicting evidence of elevation and depression in the coast-lands of Eastern Asia, where in some places the sea would seem to be encroaching, while in other regions it is retreating. In all earthquake-ridden and volcanic areas such irregular coastal changes may be looked for. So extreme are the irregularities of the sea floor in the area lying between Australia, the Solomon Islands, the New Hebrides, and New Zealand, and so great are the depths attained by many of the depressions, that the margins of the continental plateau are harder to trace here than anywhere else in the world. The bottom of the oceanic trough throughout a portion of the Southern and Western Pacific is, in fact, traversed by many great mountain rides, the summits of which approach the surface again and again to form the numerous islets of Polynesia. But notwithstanding the considerable depths that separate Australia and New Zealand there is geological evidence to show that a land connection formerly linked both to Asia. The continental plateau, therefore, must be held to include New Caledonia and New Zealand. Hence the volcanic islets of the Solomon and New Hebrides groups are related to Australia in the same way as the Riu kiu, Japanese, and Kurile Islands are to Asia.

Having rapidly sketched the more prominent features of the Pacific coast lines, we are in a position to realise the remarkable contrast they present to the coast lines of the Atlantic. The highly folded strata of the Atlantic sea-board are the relics of great mountains of upheaval, the origin of which cannot be assigned to a more recent date than Palæozoic times. During subsequent crustal movements no mountains of corrugated strata were uplifted along the Atlantic margins, the Mesozoic and Cainozoic strata of the coastal regions showing little or no disturbance. It is quite in keeping with all this that volcanic action appears to have been most strongly manifested in Palæozoic times. So many long ages have passed since the upheaval of the Archæan and Palæozoic mountains of the Atlantic sea board that these heights have everywhere lost the character of true mountains of elevation. Planed down to low levels, partially submerged and covered to some extent by newer formations, they have in many places been again converted into dry lands, forming plateaus—now sorely denuded and cut up into mountains and valleys of erosion. Why the later movements along the borders of the Atlantic basin should not have resulted in the wholesale plication of the younger sedimentary rocks is a question for geologists. It would seem as if the Atlantic margins had reached a stage of comparative stability long before the grand Tertiary uplifts of the Pacific borders had taken place; for, as we have seen, the Mesozoic and Cainozoic strata of the Atlantic coast lands show little or no trace of having been subjected to tangential thrusting and crushing. Hence one cannot help suspecting that the retreat of the sea during Mesozoic and Cainozoic ages may have been due rather to subsidence of the oceanic trough and to sedimentation within the continental area than to positive elevation of the land.

Over the Pacific trough, likewise, depression has probably been in progress more or less continuously since Palæozoic times, and this movement alone must have tended to withdraw the sea from the surface of the continental plateau in Asia and America. But by far the most important coastal changes in those regions have been brought about by the crumpling up of the plateau, and the formation of gigantic mountains of upheaval along its margins. From remotest geological periods down almost to the present the land area has been increased from time to time by the doubling-up and consequent elevation of coastal accumulations and by the eruption of vast masses of volcanic materials. It is this long continued activity of the plutonic forces within the Pacific area which has caused the coast-lands of that basin to contrast so strongly with those of the Atlantic. The latter are incomparably older than the former—the heights of the Atlantic borders being mountains of denudation of vast geological antiquity, while the coastal ranges of the Pacific slope are creations but of yesterday as it were. It may well be that those Cordilleras and mountain chains reach a greater height than was ever attained by any Palæozoic uplifts of the Atlantic borders. But the marked disparity in elevation between the coast lands of the Pacific and the Atlantic is due chiefly to a profound difference in age. Had the Pacific coast-lands existed for as long a period and suffered as much erosion as the ancient rocks of the Atlantic sea-board, they would now have little elevation to boast of.

The coast lines of the Indian Ocean are not, upon the whole,

far removed from the margin of the continental plateau. The elevation of East Africa for 6000 feet would add only a very narrow belt to the land. This would still leave Madagascar an island, but there are geological reasons for concluding that this island was at a far distant period united to Africa, and it must therefore be considered as forming a portion of the continental plateau. The great depths which now separate it from the mainland are probably due to local subsidence, connected with volcanic action in Madagascar itself and in the Comoro Islands. The southern coasts of Asia, like those of East Africa, approach the edge of the continental plateau, so that an elevation of 6000 feet would make little addition to the land area. With the same amount of upheaval, however, the Malay Peninsula, Sumatra, Java, and West Australia, would become united but without extending much further seawards. Land connection, as we know, existed in Mesozoic times between Asia, Australia, and New Zealand, but the coast-lines of that distant period must have differed considerably from those that would appear were the regions in question to experience now a general elevation. The Archæan and Palæozoic rocks of the Malay Peninsula and Sumatra are flanked on the side of the Indian Ocean by great volcanic ridges, and by uplifts of Tertiary strata, which continue along the line of the Nicobar and Andaman Islands into Burma. Thus the coast lines of that section of the Indian Ocean exhibit a geographical development similar to that of the Pacific sea board. Elsewhere, as in Hindustan, Arabia, and East Africa, the coast lines appear to have been determined chiefly by regional elevations of the land or subsidence of the oceanic trough in Mesozoic and Cainozoic times, accompanied by the outwelling of enormous floods of lava. Seeing, then, that the Pacific and Indian Oceans are pre eminently regions which, down to a recent date, have been subject to great crustal movements and to excessive volcanic action, we may infer that in the development of their coast lines the sea has played a very subordinate part. The shores, indeed, are largely protected from marine erosion by partially emerged volcanic ridges and by coral islands and reefs, and to a considerable extent also by the sediment which in tropical regions especially is swept down to the coast in great abundance by rains and rivers. Moreover, as the geological structure of these regions assures us, the land would appear seldom to have remained sufficiently long at one level to permit of much destruction by waves and tidal currents.

In fine, then, we arrive at the general conclusion that the coast lines of the globe are of very unequal age. Those of the Atlantic were determined as far back as Palæozoic times by great mountain uplifts along the margin of the continental plateau. Since the close of that period many crustal oscillations have taken place, but no grand mountain ranges have again been ridged up on the Atlantic sea board. Meanwhile the Palæozoic mountain chains, as we have seen, have suffered extensive denudation, have been planed down to the sea-level, and even submerged. Subsequently converted into land, wholly or partially as the case may have been, they now present the appearance of plains and plateaus of erosion, often deeply indented by the sea. No true mountains of elevation are met with anywhere in the coast-lands of the Atlantic, while volcanic action has well-nigh ceased. In short, the Atlantic margins have reached a stage of comparative stability. The trough itself, however, is traversed by at least two well marked banks of upheaval—the great meridional Dolphin Ridge, and the approximately transmeridional Faroe-Icelandic belt—both of them bearing volcanic islands.

But while the coast lands of the Atlantic proper attained relative stability at an early period, those of the Mediterranean and Caribbean depressions have up to recent times been the scenes of great crustal disturbance. Gigantic mountain chains were uplifted along their margins at so late a period as the Tertiary, and their shores still witness volcanic activity.

It is upon the margins and within the troughs of the Pacific Ocean, however, that subterranean action is now most remarkably developed. The coast-lines of that great basin are everywhere formed of grand uplifts and volcanic ranges, which, broadly speaking, are comparable in age to those of the Mediterranean and Caribbean depressions. Along the north-east margin of the Indian Ocean the coast-lines resemble those of the Pacific, being of like recent age, and similarly marked by the presence of numerous volcanoes. The northern and western shores, however (as in Hindustan, Arabia, and East Africa), have been determined rather by regional elevation or by subsidence of the ocean floor than by axial uplifts—the chief crustal disturbances dating back to an earlier period than those of the East Indian Archipelago. It is in keeping with this greater age of the western and northern coast-lands of the Indian Ocean that volcanic action is now less strongly manifested in their vicinity.

I have spoken of the comparative stability of the earth's crust within the Atlantic area as being evidenced by the greater age of its coastal ranges and the declining importance of its volcanic phenomena. This relative stability is further shown by the fact that the Atlantic sea-board is not much disturbed by earthquakes. This, of course, is what might have been expected, for earthquakes are most characteristic of volcanic regions and of those areas in which mountain uplifts of recent geological age occur. Hence the coast lands of the Pacific and the East Indies, the borders of the Caribbean Sea, the volcanic ridges of the Atlantic basin, the lands of the Mediterranean, the Black Sea, and the Aralo Caspian depressions, the shores of the Red Sea, and vast tracts of Southern Asia, are the chief earthquake regions of the globe. It may be noted, further, that shocks are not only most frequent but most intense in the neighbourhood of the sea. They appear to originate sometimes in the volcanic ridges and coastal ranges, sometimes under the floor of the sea itself. Now earthquakes, volcanoes, and uplifts are all expressions of the one great fundamental fact that the earth is a cooling and contracting body, and they indicate the lines of weakness along which the enormous pressures and strains induced by the subsidence of the crust upon its nucleus find relief. We cannot tell why the coast lands of the Atlantic should have attained at so early a period a stage of relative stability—why no axial uplifts should have been developed along their margins since Palæozoic times. It may be that relief has been found in the wrinkling up of the floor of the oceanic trough, and consequent formation of the Dolphin Ridge and other great submarine foldings of the crust. And it is possible that the growth of similar great ridges and wrinkles upon the bed of the Pacific may in like manner relieve the coast lands of that vast ocean, and prevent the formation of younger uplifts along their borders.

I have already remarked that two kinds of elevatory movements of the crust are recognized by geologists—namely, axial and regional uplifts. Some, however, are beginning to doubt, with Professor Suess, whether any vast regional uplifts are possible. Yet the view that would attribute all such apparent elevations of the land to subsidence of the crust under the great oceanic troughs is not without its difficulties. Former sea-margins of very recent geological age occur in all latitudes, and if we are to explain these by sub oceanic depression, this will compel us to admit, as Suess has remarked, a general lowering of the sea-level of upwards of 1,000 feet. But it is difficult to believe that the sea floor could have subsided to such an extent in recent times. Suess thinks it is much more probable that the high level beaches of tropical regions are not contemporaneous with those of higher latitudes, and that the phenomena are best explained by his hypothesis of a secular movement of the ocean—the water being, as he contends, alternately heaped up at the equator and the poles. The strand lines in high latitudes, however, are certainly connected with glaciation in some way not yet understood. And if it cannot be confidently affirmed that they indicate regional movements of the land, the evidence, nevertheless, seems to point in that direction.

In concluding this imperfect outline-sketch of a large subject, I ought perhaps to apologize for having trespassed so much upon the domains of geology. But in doing so I have only followed the example of geologists themselves, whose divagations in territories adjoining their own are naturally not infrequent. From much that I have said, it will be gathered that with regard to the causes of many coastal changes we are still groping in the dark. It seems not unlikely, however, that as light increases we may be compelled to modify the view that all oscillations of the sea level are due to movements of the lithosphere alone. That is a very heretical suggestion, but that a great deal can be said for it anyone will admit after a candid perusal of Suess's monumental work, "Das Antlitz der Erde."

SECTION G

MECHANICAL SCIENCE.

Opening Address by W. Cawthorne Unwin, F.R.S., M.Inst.C.E., President of the Section.

By what process selection is made of a Sectional President of the British Association is to me unknown. I may confess that

it was pleasant to receive the request of the Council to preside at the meetings of Section G, even though much of the pleasure was due to its unexpectedness. I ventured to believe I might accept the honour gratefully, trusting to your kindness to assist me in fulfilling its obligations. Amongst engineers there are many with greater claims than I have to such a position, and who could speak to you from a wider practical experience. Here in Section G, I think it may be claimed that the profession of engineering owes much to some who from circumstances or natural bias have concerned themselves more with those scientific studies and experimental researches which are useful to the engineer, than with the actual carrying on of engineering operations. Here, at so short a distance from the University where Rankine and James Thomson laboured, I may venture to feel proud of being amongst those whose business it has been rather to investigate problems than to execute works.

The year just passed is not one unmemorable in the annals of engineering. By an effort remarkable for its rapidity, and as an example of organization of labour, the broad gauge system has been extinguished. It has disappeared like some prehistoric mammoth, a large limbed organism, perfect for its purpose and created in a generous mood, but conquered in the struggle for existence by smaller but more active rivals. If we recognize that the great controversy of fifty years ago has at last been decided against Brunel, at least we ought to remember that the broad gauge system was one only of many original experiments due to his genius and courage, experiments in every field of engineering, in bridge building, in locomotive design, in ship construction, the successes and failures of which have alike enlarged the knowledge of engineers and helped the progress of engineering.

The past year has seen the completion of the magnificent scheme of water supply for Liverpool, from the Vyrnwy, carried out from 1879 to 1885 by Mr Hawksley and Mr Deacon, and since then completed under the direction of the latter engineer. This is one of the largest and most striking of those works of municipal engineering rendered necessary by the growth of great city communities and made possible by their wealth and public spirit. For the supply of water to Liverpool, the largest artificial lake in Europe has been created in mid Wales, by the construction across a mountain valley of a dam of cyclopean masonry, itself one of the most remarkable masonry works in the world. The lake contains an available supply of over 12,000 million gallons, its size having been determined not only to supply forty million gallons daily for the increasing demand of Liverpool, but also to meet the necessity imposed by Parliament that an unprecedentedly large compensation, amounting to ten million gallons daily and fifty million gallons additional on thirty-two days yearly, should be afforded to the Severn. The masonry dam, though a little less in height than some of the French dams, is of greater length. It is nearly double the length of the great dam at Verviers.[1] Although masonry dams were an old expedient of engineers, it is in quite recent times, and chiefly in consequence of the scientific investigations of French engineers, that they have been revived in engineering practice. Since the completion of the Vyrnwy dam, another very large dam, the Tansa dam, has been completed in Bombay. This dam has a length of two miles and a height of 118 feet, and it is 100 feet thick at the base. The reservoir will supply 100 million gallons per day. In the United States a still greater work of the same kind has been commenced on the Croton river, in connection with the water supply of New York. This dam will have a length of 2000 feet, and a height of 285 feet. Its greatest thickness will be 215 feet. It will be very much the boldest work of its kind.

Returning to the Liverpool supply, the water taken from the lake at the most suitable level into a straining tower provided with very complete hydraulic machinery, passes through the Hirnant tunnel, and thence by an aqueduct, partly consisting of rock tunnels, partly of pipes 39in to 42in in diameter, sixty-eight miles in length, being the longest aqueduct yet constructed. The crossing of the Mersey by an aqueduct tunnel has proved the greatest engineering difficulty to be surmounted. The tunnel has been carried through layers of running sand, gravel, and silt. At first slow progress was made, but later, by the adoption of the Greathead system of shield, with air locks and air-compressing machinery, as much as fifty seven feet of tunnel were driven and lined in one week. The whole work is now complete, and Liverpool has available an extra supply of very pure water, amounting to forty million gallons daily.

A scheme of water supply for Manchester from Lake Thirlemere in Westmoreland, on an equally large scheme, is approaching completion. Birmingham is likely to carry out another work of the same kind. And London, at a greater distance from pure water sources and under greater difficulties from the complexity of existing interests, has come to realize that, within fifty years, a population of 12½ millions will probably have to be provided for. To supply such a population, a volume of water is required ten times as great as the whole available supply from Lake Vyrnwy.

Here in Edinburgh one remembers that the birth place of the steam engine is near at hand. A century and a quarter ago James Watt made an invention which has profoundly influenced all the conditions of social, national, commercial, and industrial life. It is due to the steam-engine more than to any other single cause that the population in this country has tripled since the beginning of the century, and that we have become dependent on steam-power for fuel, for transport, for manufactures, in many cases for water supply, for sanitation, and for artificial light. From some German statistics it appears that there are probably now in the world, employed in industry, steam-engines exerting 49 million horse power, besides locomotives exerting six million horse power. Engines in steam ships are not included. The steam-engine has become a potent factor in civilization, because it places at our disposal mechanical energy at a sufficiently low cost, and the efforts of engineers have been steadily directed to diminishing the cost at which steam-power is produced. Members of one great branch of our profession are much concerned in the production of mechanical energy at a sufficiently cheap rate. They require it in very large quantity for transformation into light and for re-transformation into mechanical energy under conditions more convenient than the direct use of steam-power. Perhaps it will not be inappropriate if in Section G I first discuss briefly some of the causes which have made the steam-engine inefficient and the extent to which we are getting to a scientific knowledge of the methods of evading them. I propose then to consider some of the methods of economizing the cost and increasing the convenience of mechanical power by generating it at central stations and distributing it, and lastly, how far means of transporting energy are likely to make available cheaper sources of energy than steam-power.

Let us go back for a moment to James Watt. The most distinct feature about the invention of the steam engine is that it arose out of studies of such questions as the relation of pressure and temperature of steam, the heat absorbed in producing it, and its volume at different pressures.

Armed with this knowledge, Watt was able to determine that the quantity of steam used in a model atmospheric engine was enormously greater than that due to the volume described by the piston. There was waste or loss. To discover the loss was to get on the path of finding a remedy. The separate condenser, by diminishing cylinder condensation, annulled a great part of the loss. So great was Watt's insight into the action of the engine that he was able to leave it so perfect that, except in one respect, little remained for succeeding engine builders, except to perfect the machines for its manufacture, to improve its details, and to adapt it to new purposes. Now it very early became clear that there were two directions of advance which ought to secure greater economy. Simple mechanical indications showed that increased expansion ought to ensure increased economy. Thermodynamic considerations indicated that higher pressures, involving a greater temperature range of working, ought to secure greater economy. But in attempting to advance in either of these directions, engineers were more or less disappointed. Some of Watt's engines worked with 5 lbs of coal per indicated horse-power per hour. Many engines with greater pressures and longer expansions have done but little better. The history of steam engine improvement for a quarter of a century has been an attempt to secure the advantages of high pressures and high ratios of expansion. The difficulty to be overcome has proved to be due to the same cause as the inefficiency of Watt's model engine. The separate condenser diminished, but it did not annul, the action of the cylinder wall. The first experiments which really startled thoughtful steam engineers were those made by Mr Isherwood,

[1] The length of the dam from rock to rock is 1172 feet. Height from lowest part of foundation to parapet of carriage way, 161 feet. Height from bed of river to overflow sill, 84 feet. Thickness of masonry at base, 120 feet.

between 1860 and 1865 Mr Isherwood showed that in engines such as those then in use in the United States Navy, with the large cylinders and low speeds then prevalent, any expansion of the steam beyond three times led, not to an increased economy, but to an increased consumption of steam Very little later than this M Hirn undertook, in 1871-5, his classical researches on the action of the steam in an engine of about 150 indicated horse-power Experiments of greater accuracy or completeness, or of greater insight into the conditions which were important, have never since been made, and Hirn with his assistants, MM Hallaner and Dwelshauvers Dery, has determined, once for all, the whole method of a perfect steam-engine trial M Hirn was the first to clearly realize that the indicator gives the means of determining the steam present in the cylinder during every period of the cycle of the engine Consequently, superheating in ordinary cases being out of the question, we have the means of determining the heat present and the heat already converted into work The heat delivered into the engine is known from boiler measurements, combined with calorimetric tests of the quality of the steam, tests which Hirn was the first to undertake The balance or heat unaccounted for is, then, a waste or loss due to causes which have to be investigated Hirn originated a complete method of analysis of an engine test, showing at every stage of the operation the heat accounted for and a balance of heat unaccounted for, and the latter proved to be a very considerable quantity

Meanwhile theoretical writers, especially Rankine and Clausius, had been perfecting a thermodynamic theory of the steam engine, based primarily on the remarkable and irrefragable principle of Carnot The result of Hirn's analysis was to show that these theories, applied to the actual steam-engine, were liable to lead to errors of 50 or 60 per cent, the single false assumption made being that the interaction between the walls of the cylinder and the steam was an action small enough to be negligeable

In this country Mr Mair Rumley, following Hirn's method, made a series of experiments on actual engines with great care and accuracy and completeness All these experiments demonstrated the fact of a large initial condensation of steam on the walls of the cylinder, alike in jacketed and unjacketed engines This condensed steam is re evaporated partially during expansion, but mainly during exhaust, and serves as a mere carrier of heat from boiler to condenser, in conditions not permitting its utilization in producing work

It became clear from Hirn's experiments, if not from the earlier experiments of Isherwood, that for each engine there is a particular ratio of expansion for which the steam expenditure per horse-power is least Professor Dery has since deduced from them that the practical condition of securing the greatest efficiency is that the steam at release should be nearly dry In producing that dryness the jacket has an important influence In spite of much controversy amongst practical engineers about the use of the jacket, it does not appear that any trustworthy experiment has yet been adduced in which there was an actual loss of efficiency due to the jacket In the older type of comparatively slow engines it is a rule that the greater the jacket condensation the greater the economy of steam, even when the jacket condensation approaches 20 per cent of all the steam used It appears, however, that as the speed of the engine increases, the influence of the jacket diminishes, so that for any engine there is a limit of speed at which the value of the jacket becomes insignificant

Among steam engine experiments directed specially to determine the action of the cylinder walls, those of the late Mr Willans should be specially mentioned Mr Willans' death is to be deplored as a serious loss to the engineering profession His steam-engine experiments, some of them not yet published, are models of what careful experiments should be. They are graduated experiments designed to indicate the effect of changes in each of the practically variable conditions of working They showed a much greater variation of steam consumption (from 46 to 18 lbs per indicated horse power hour) in different conditions of working than, I think, most practical engineers suspected, and this has been made more significant in later experiments, on engines working with less than full load. The first series showed that in full load trials the compound was superior to the simple engine in practically all the conditions tried, but that the triple was superior to the compound only when certain limits of pressure and speed were passed.

As early as 1878 Prof. Cotterill had shown that the action of a cylinder wall was essentially equivalent to that of a very thin metallic plate, following the temperature of the steam. The exceedingly rapid dissipation of heat from the surface during exhaust especially being due to the evaporation of a film of water initially condensed on its surface In permanent *régime* the heat received in admission must be equal to that lost after cut off In certain conditions it appeared that a tendency would arise to accumulate water on the cylinder surfaces, with the effect of increasing in certain cases the energy of heat dissipation Recently Prof Cotterill has been able to carry much further the analysis of the complex action of condensation and re evaporation in the cylinder, and to discriminate in some degree between the action of the metal and the more ambiguous action of the water film By discarding the less important actions, Prof Cotterill has found it possible to state a semi-empirical formula for cylinder condensation in certain restricted cases which very closely agrees with experiments on a wide variety of engines It is to be hoped that, with the data now accumulating, a considerable practical advance may be made in the clearing up of this complex subject There are, no doubt, some people who are in the habit of depreciating quantitative investigations of this kind They are as wise as if they recommended a manufacturer to carry on his business without attending to his account books Further, the attempt to obtain any clear guidance from experiments on steam engines has proved a hopeless failure without help from the most careful scientific analysis There is not a fundamental practical question about the thermal action of the steam engine, neither the action of jackets or of expansion or of multiple cylinders, as to which contradictory results have not been arrived at, by persons attempting to deduce results from the mass of engine tests without any clear scientific knowledge of the conditions which have affected particular results In complex questions fundamental principles are essential in disentangling the results Interpreted by what is already known of thermodynamic actions, there are very few trustworthy engine tests which do not fall into a perfectly intelligible order There is only one known method, not now much used, by which the cylinder condensation can be directly combated Thirty years ago superheating the steam was adopted with very considerable increase of economy It is likely that it was thought by the inventor of superheating that an advantage would be gained by increasing the temperature range If so, his theory was probably a mistaken one For the cooling action of the cylinder is so great that the steam is reduced to saturation temperature before it has time to do work but the economy due to superheating was unquestionable, and was very remarkable considering how small a quantity of heat is involved in superheating The heat appears to diminish the cylinder wall action so much as almost to render a jacket unnecessary The plan of superheating was abandoned from purely practical objections, the superheaters then constructed being dangerous Recently superheating has been tried again at Mulhouse by M Meunier, and his experiments are interesting because they are at higher pressures than in the older trials and with a compound engine It appears that even when the superheater was heated by a separate fire there was an economy of steam of 25 to 30 per cent and an economy of fuel of 20 to 25 per cent, and four boilers with superheating were as efficient as five without it

It may be pointed out as a point of some practical importance that if a trustworthy method of superheating could be found, the advantage of the triple over the compound engine would be much diminished For marine purposes the triple engine is perfectly adapted But for other purposes it is more costly than the compound engine, and it is less easily arranged to work efficiently with a varying load

There does not seem much prospect of exceeding the efficiency attained already in the best engines, though but few engines are really as efficient as they might be, and there are still plenty of engines so designed that they are exceedingly uneconomical The very best engines use only from 12 to 13 lbs of steam per indicated horse-power hour, having an absolute efficiency reckoned on the indicated power of 16 per cent, or reckoned on the effective power, 13 per cent The efficiency, including the loss in the boiler, is only about 9 per cent But there are internal furnace engines of the gas-engine or oil engine type in which the thermal efficiency is double this

In his interesting address to this Section in 1878, Mr Easton expressed the opinion that the question of water-power was one deserving more consideration than it had lately received, and he

pointed to the variation of volume of flow of streams as the principal objection to their larger utilization. Since that time the progress made in systems of transporting and distributing power has given quite a new importance to the question of the utilization of water-power. There seems to be a probability that in many localities water power will, before long, be used on a quite unprecedented scale, and under conditions involving so great convenience and economy that it may involve a quite sensible movement of manufacturers towards districts where water power is available.

If we go back to a period not very distant in the history of the world, to the middle of the last century, we reach the time when textile manufactures began to pass from the condition of purely domestic industries to that of a factory system. The fly shuttle was introduced in 1750, the spinning jenny was invented in 1767, and Crompton's machine only began to be generally used in 1787. It was soon found that the new machines were most suitably driven by a rotary motion, and after some attempts to drive them by horses, water power was generally resorted to. In an interesting pamphlet on the Rise of the Cotton Trade, by John Kennedy, of Ardwick Hall, written in 1815, it is pointed out that the necessity of locating the mills where water power was available, had the disadvantages of taking them away from the places where skilled workmen were found, and from the markets for the manufactured goods. Nevertheless, Mr. Kennedy states that for some time after Arkwright's first mill was built at Cromford, all the principal mills were erected near river falls, no other power than water power having been found practically useful. "About 1790," says Mr. Kennedy, "Mr. Watt's steam engine began to be understood, and waterfalls became of less value. Instead of carrying the workpeople to the power, it was found preferable to place the power amongst the people."

The whole tendency of the conditions created by the use of steam power has been to concentrate the industrial population in large communities, and to restrict manufacturing operations to large factories. Economy in the production of power, economy in superintendence, the convenience of the subdivision of labour, and the costliness of the machines employed, all favoured the growth of large factories. The whole social conditions of manufacturing centres have been profoundly influenced by these two conditions—that coal for raising steam can be easily brought to any place where it is wanted, and that steam power is more cheaply produced on a large scale than on a small scale. It looks rather, just now, as if facilities for distributing power will to some extent reverse this tendency.

Let me first point out that water power, where it is available, is so much cheaper and more convenient than steam power that it has never been quite vanquished by steam-power.

I find, from a report by Mr. Weissenbach, that in 1876 70,000 horse-power derived from waterfalls were used in manufacturing in Switzerland. According to a census in 1880, it appears that the total steam and water-power employed in manufacturing operations in the United States was 3,400,000 horse power. Of this, 2,185,000 horse power, or 64 per cent., was derived from steam, and 1,225,000 horse power, or 36 per cent., from water. In the manufacture of cotton and woollen goods, of paper and of flour, 760,000 horse power were obtained from water, and 515,000 horse power from steam. If statistics could be obtained from other countries, I believe it would be found that a very large amount of water-power is actually made available. The firm of Escher Wyss and Company, of Zurich, have constructed more than 1800 turbines of an aggregate power of 111,460 horse power.

With a very limited exception all the water power at present used is employed in the neighbourhood of the fall where it is generated. If means were available for transporting the power from the site of the fall to localities more convenient for manufactures, there can be no doubt that a much larger amount of water power would be used, and the relative importance of water and steam power in some countries would probably be reversed. It is because recent developments seem to make such a transport of power possible without excessive cost and without excessive loss, that a most remarkable interest has been excited in the question of the utilization of water power. Take the case of Switzerland for instance. At the present time Switzerland is said to pay to other countries £800,000 annually for coal. But the total available water-power of Switzerland is estimated at no less than 582,000 horse-power, of which probably only 80,000 are at present utilized. I found a year ago that nearly every large industrial concern in Switzerland was preparing to make use of water power, transported a greater or less distance. Besides the great schemes actually carried out at Schaffhausen, Bellegarde, Geneva, and Zurich, where water power is already utilized on a very large scale, there is a project to develop 10,000 horse power on the Dranse near Martigny.

Hence it is easy to see that problems of distribution of power—that is, the transformation of energy into forms easily transportable and easily utilizable—have now a great interest for engineers.

Besides the power required for manufacturing operations, there is a steadily increasing demand for easily available mechanical energy in large towns. For tramways, for lifts, for handling goods, for small industries, for electric lighting, and sometimes for sanitation, power is required. Hitherto steam-engines, or more lately gas engines, have been used, placed near the work to be done. But this sporadic generation of power is uneconomical and costly, especially when the work is intermittent; the cost of superintendence is large, and the risk of accident considerable. Hence attention is being directed to systems in which the mechanical energy of fuel or falling water is first generated in large central stations, transformed into some form in which it is conveniently transportable and capable of being rendered available by simpler motors than steam-engines.

Just as in great towns it has become necessary to supersede private means of water supply by a municipal supply; just as it has proved convenient to distribute coal gas for lighting and heating, and to provide a common system of sewerage, so it will probably be found convenient to have in all large towns some means of obtaining mechanical power in any desired quantity at a price proportionate to the quantity used, and in a form in which it can be rendered available, either directly or by simple motors requiring but little skilled superintendence.

Telodynamic Transmission.—First, then, let me say a few words as to the modes of distributing power which it is possible to adopt. In 1850, at Logelbach in Alsace, M. Ferdinand Hirn used a flat steel belt to transmit power directly a distance of eighty metres. Subsequently a wire rope was used on grooved pulleys. This worked so well that a second transmission to a distance of 240 metres was erected. The details of the system were worked out with great care with a view to securing the least cost of construction, the least waste of energy, and the greatest durability of the ropes. So successful did this system of telodynamic transmission prove that within ten years M. Martin Stein, of Mulhouse, had erected 400 transmissions, conveying 4200 horse power, and covering a distance of 72,000 metres.

Just at this time a very able and far seeing manufacturer at Schaffhausen, Herr Moser, had formed a project for reviving the failing industries of the town by utilizing part of the water-power of the Rhine. Hirn's system of wire-rope transmission rendered this project practicable. The works were commenced in 1863. Three turbines of 750 horse power were erected on a fall which varies from 12 to 16 feet, created by a weir across the river. From the turbines the power is transmitted by two cables, in one span of 392 feet, across the river. Similar cables distribute the power to factories along the river bank. In 1870 the transmission extended to a distance of 3400 feet. Power is sold at rates varying from £5 to £6 per horse power per annum. In 1887 there were twenty three consumers of power paying a rental of £3500 per annum for power. The project has been financially successful, and is still working. At Zurich, Freiberg, and Bellegarde there are similar installations, and a large scheme of the same kind has recently been carried out at Gokak in India. Wire rope transmissions are of great mechanical simplicity, and the loss of power in transmission is exceedingly small. They are extremely suitable for certain cases where a moderate amount of power has to be transmitted a moderate distance, to one or to a few factories. On the other hand, they become cumbrous if the amount of power transmitted exceeds 600 or 1000 horse power. The wear of the ropes, which only last a year, has proved greater than was expected, and is a source of considerable expense.

The practical introduction of a system of distributing power by *pressure water* is due to Lord Armstrong. Such a system involves a central pumping station, a series of distributing mains, and suitable working motors. From its first introduction the peculiar advantages of this system for driving intermittently working machines, such as lifts, dock machinery, railway cranes,

and hauling gear, became obvious But, with intermittent working machines, there rose the need of an appliance for storing energy during periods of minimum demand and restoring it in periods of maximum demand The invention of the accumulator by Lord Armstrong made the system of hydraulic transmission a success, and at the same time fixed its character as a system specially adapted for those cases where intermittent work is required to be done Lord Armstrong's system of hydraulic distribution by water at a pressure of 700 or 800 lbs per square inch, with the use of accumulators for equalizing the variations of supply and demand, has now been widely adopted The most extensive scheme of that kind hitherto executed is the important scheme carried out by the Hydraulic Power Company Over fifty miles of pressure mains have now been laid in the streets of London The Falcon Wharf pumping station contains four sets of compound pumping engines, each of 200 horse power Two additional pumping stations have now been erected, and 1500 lifts are worked from the pressure mains The minimum charge for water is 2s per 1000 gallons This rate of charge is economical for such machines as lifts, but it would be extravagant for machines working continuously It would be equivalent to a charge of nearly £50 per horse power per year of 3000 working hours, apart from interest and maintenance of machines

I shall indicate later on that in some cases where local conditions are favourable, where there is cheap water power, and the possibility of constructing high level storage reservoirs, then hydraulic transmission can be adopted with success for distributing power for ordinary manufacturing purposes But neither telodynamic transmission nor hydraulic transmission have proved suitable as methods for the general distribution of motive power from central stations Distribution by steam and distribution by heated water have both been tried in the United States, but not with very remarkable success Only two other methods are available—distribution by compressed air and distribution by electricity

For many years *compressed air* has been used to distribute power in tunnelling and mining operations to considerable distances It is only recently that it has been used as a general method of distributing power to many consumers In many installations the machinery has been rough and unscientific, and the waste of energy very considerable It is through experience gained and improvements carried out in the remarkable system now at work in Paris, and known as the Popp system, that the great advantages of compressed air distribution have been proved The Paris system has very gradually developed About 1870 a small compressing station was erected to actuate public and private clocks by intermittent pulses of air conveyed along pipes chiefly laid in the sewers In 1889 about 8000 clocks were thus driven Meanwhile the compressed air had also been applied to drive motors for small industries The demand for power thus supplied grew so rapidly that a second compressing station was built in the Rue de Saint Fargeau In 1889 steam air compressors of 2000 horse power were at work, and additional compressors were under construction The pressure at that time was five atmospheres, and the largest air mains were 12 inches in diameter Ingenious and simple rotary machines were used as air motors for small powers, and for larger powers any ordinary steam engine was converted into an air motor Prof Kennedy made tests in 1889, which were communicated to this Association He found that a motor four miles from the compressing station indicated 10 horse power for 20 indicated horse power expended at the compressing station, an efficiency of 50 per cent only There were then 225 motors worked from the air mains

Since 1889 more extended investigations have been made by Professor Riedler, of Berlin, and the chief part of the waste of work has been traced to inefficiency of the air compressors Compound air compressors of much higher efficiency have now been constructed The plant at the Saint Fargeau station has been increased to 4000 horse-power A new station has been erected on the Quai de la Gare, intended ultimately to contain compressors of 24,000 horse power Compressors of 10,000 horse-power are already under construction

Compressed air transmission, whether or not it is the most economical system, is undoubtedly applicable for the distribution of power on a very large scale and to very considerable distances. There is nothing in any of the appliances which is novel or imperfectly understood The air is used in the consumer's premises in machinery of well understood types, and old steam engines can be converted into air motors without difficulty and without alteration of existing transmissive machinery in the factories Not least important, the air can be measured with accuracy enough for practical purposes by simple meters, and charged for in proportion to the power consumed Air compressors and air motors are not as efficient as dynamos and electric motors, but in one respect distribution by air and electricity are similar For distances which are not more than a few miles the loss of energy in transmission is small enough to be insignificant

There is yet one other mode of power distribution which promises to become the most important of all, and which, in the case of transmission to very great distances, if such transmission becomes necessary, has undoubtedly great advantages over every other method

About *electrical distribution* of power I shall not venture to say much, partly because I am not an electrical expert, partly because it has been lately pretty fully discussed In the United States there has been an enormous development of electric tramways, which are essentially cases of electric power distribution In this country we have the South London and some other railways worked electrically There are others also on the Continent But electrical power distribution to private consumers for industrial purposes has not yet made as much progress as might have been expected Perhaps electrical engineers have been so busy with problems of electric lighting that they have had no time to settle the corresponding problems of power distribution

No doubt continuous current distribution presents at the moment the fewest difficulties, or, at any rate, involves the fewest comparatively untried expedients Several continuous current plants for distributing power are in operation, of which perhaps the most interesting is that at Oyonnaz, which was described in Section G last year by Prof G Forbes There 300 horse-power obtained by turbines is transmitted 8 kilometres at 1800 volts It is then let down by motor transformers to a voltage suitable for lighting and driving motors A number of small workshops are driven, the power being supplied at a fixed rent

At the Calumet and Hecla mines on Lake Superior, at the Dalmatia mines in California, and some other places, energy derived from turbines is transmitted distances of a mile or two by continuous electric currents and used in driving mining machinery, and some cases of the use of electrical distribution in mines in this country were mentioned by my predecessor in his address last year

At Bradford a few electric motors are being worked from the electric lighting mains The largest of these is of twenty horse-power The price at which the electricity is supplied is not given, but I believe the cost is high when reckoned for continuous working It would seem that it must be so when the electric current is generated by steam power

At Schaffhausen an electric transmission has now been constructed alongside of the wire rope transmission The power is derived from two turbines, and is transmitted across the Rhine, a distance of 750 yards, at 624 volts The current drives a spinning mill, in which the largest motor is 380 horse power The power is sold, I believe, at £3 per horse power of the motors per annum

Many engineers have now apparently come to the conclusion that alternating currents will be better for power transmission to considerable distances than continuous currents One interesting alternate current transmission, partly for power, partly for lighting purposes, has been for some time in operation at Genoa

On the line of the aqueduct bringing water from the Gorzente rivulet three electric stations are being established The reservoirs are 2050 feet above Genoa, and as this is a much greater fall than is required for water-supply purposes, part can be used to generate about 1600 horse-power

In the first of the power stations erected there are turbines of 450 horse power driving two dynamos A second larger station was completed in November In this there are eight alternate current dynamos of 70 horse power each Six alternators are worked in series, transmitting a current of 6000 volts The current is transmitted sixteen miles by bare copper wires, 8 5 mm diameter, placed overhead The current is used both for lighting and power purposes

Another method of using alternating currents was adopted in the remarkable experiment at Frankfort last year In that case energy obtained by turbines at Lauffen was transmitted to

Frankfort, a distance of 108 miles, and used for lighting and driving a motor The current was obtained at low tension, transformed up to a tension of 18,000 to 27,000 volts for transmission, and then transformed down again for distribution The loss in the conducting wires ranged from 5 horse-power when the turbines worked at 100 horse power, to 25 horse-power when the turbines worked at 200 horse power The efficiency of dynamo, two transformers, and line ranged from 68 to 75 per cent, a remarkably satisfactory result

There can be little doubt that if efficient and durable transformers can be constructed, they do give a considerable advantage to an alternate-current system To an ordinary engineer it appears also that the system of producing current at a low tension in the dynamo, and using it at low tension in the motors, permits the construction of dynamos and motors more mechanically unexceptionable than those worked at high voltage

I have spoken of the growth of a demand for power distributed in a convenient form in towns The power distribution in London, Manchester, Birmingham, and Liverpool by pressure water, and that by compressed air in Paris, shows how rapidly, when power is available, a demand for it arises A striking instance may be found in the small town of Geneva

In 1871, soon after the completion of the earlier system of low-pressure water supply, Col Turrettini applied to the municipal council to place a pressure engine on the town mains for driving the factory of the Society for Manufacturing Physical Instruments The plan proved so convenient that nine years after, in 1880, there were in Geneva 111 water-motors supplied from the low-pressure mains, using 34,000,000 cubic feet of water annually, and paying to the municipality nearly £2000 a year The cost of the power was not low It was charged at a rate equivalent to from £36 to £48 per horse power per year of 3000 working hours But even the high price did not prevent the use of power so conveniently obtainable

Since then a high pressure water service has been established, the water being pumped by turbines in the Rhone From this high pressure service power is supplied more cheaply On the high-pressure system the cost of the power is about 0 7*d* per horse power hour, or £8 per horse-power for 3000 working hours

In 1889 the annual income from water sold for power purposes on the low-pressure system was £2085 and on the high-pressure system £4500 On the high-pressure system the receipts in 1889 were increasing at the rate of £880 per year

In 1889 the motive power distributed, on the high pressure system alone, amounted to 1,500,000 horse power hours, there being seventy-nine motors of an aggregate working power of 1279 horses

In Zurich there is quite a similar system and power, amounting to 9,000,000 horse-power hours in the year, distributed hydraulically to various consumers, who pay a rental of £1200 per annum It will be noted that all this power in Geneva and Zurich is obtained from water which has been pumped, and it is the low cost of the water power which does the pumping which makes this possible

But, further, in both Geneva and Zurich the whole of the dynamos supplying electric light are also driven by turbines using pumped water The convenience of this arises in this way The fall obtainable in the river in both cases is a small one, and varies Large turbines are required, and these cannot work at a constant speed Further, it is expensive to use these large low pressure turbines to drive directly dynamos which only work with a considerable load for a short portion of the day The low pressure turbines in the river are therefore used to pump water to a high level reservoir, and they work with a constant load all the twenty-four hours

From the high level reservoir water is taken as power is required to drive the dynamos, and the turbines driving the dynamos are small high-pressure turbines, working always on a constant fall at a regular speed, and easily adjusted by a governor to a varying load The system seems a roundabout one, but it is perfectly rational, effective, and economical

Few persons can have seen Niagara Falls without reflecting on the enormous energy which is there continuously expended, and for any useful purpose wasted The exceptional constancy of the volume of flow, the invariability of the levels, the depth of the plunge over the escarpment, the solid character of the rocks, all mark Niagara as an ideally perfect water power station, while, on the other hand, the remarkable facilities of transport, both by steam navigation on the lakes and by four systems of railway, afford commercial advantages of the highest importance From a catchment basin of 240,000 square miles, an area greater than that of France, a volume of water amounting to 265,000 cubic feet per second descends from Lake Erie to Lake Ontario, a vertical distance of 326 feet, in 37½ miles

Supposing the whole stream could be utilized, it would supply 7,000,000 horse power This is more than double the total steam and water-power at present employed in manufacturing industry in the United States

Immediately below the Falls the river bends at right angles, and flows through a narrow gorge The town of Niagara Falls on the American side occupies the table-land in this angle

The earliest traders who settled near the Falls erected stream mills in the Upper River in 1725 for preparing timber Later, the Porter family erected factories on the islands in the rapids above the falls It was not, however, till about thirty years ago that any systematic attempt was made to utilize part of the water power of the Falls Then a canal was constructed from Port Day, about three-quarters of a mile above the Falls, to a fore-bay or head-race along the cliff overlooking the lower river In 1874 the Cataract Mill was established, taking power from this canal, and other mills were gradually erected till about 6000 horse-power were utilized These mills have been exceedingly prosperous, but since the growth of a feeling against the disfigurement of the Falls it has become impossible to extend works of the same kind

The idea of a method of utilizing the Falls, capable of greater development, and free from the objections to the hydraulic canal with mills discharging tail water on the face of the cliff, is due to the late Mr Thomas Evershed, Division Engineer of the New York State Canals He proposed to construct head-race canals on unoccupied land some two miles above the Falls From these the water was to fall through vertical turbine pits into tail race tunnels, converging into a great main tunnel, discharging into the lower river Apart from an inappreciable diminution in the volume of flow over the Falls, this plan avoids any disfigurement of the scenery near the Falls, and permits a head of nearly 200 feet to be made available It is, however, essential to such a plan that work should be undertaken on a very large scale In 1886 the Niagara Falls Company was incorporated, and obtained options over a considerable area of land, extending from Port Day for two miles along the Niagara River In 1889 the Cataract Construction Company was formed to mature and carry out the constructional works required

The present plans contemplate the utilization of 100,000 effective horse-power The principal work of construction is a great tunnel 7260 feet long, which is to form a tail race to the turbines, starting from lands belonging to the Company, and discharging into the lower river The tunnel is 19 feet by 21 feet, or 386 square feet in area, inside a brickwork lining 16 inches thick

The base of the tunnel is 205 feet below the sill of the head gate, and permits a fall of 140 to be rendered available at the turbines The brickwork of the tunnel is lined for 200 feet from the mouth with cast iron plates

The tunnel has been excavated with remarkable rapidity with the aid of drills worked by compressed air

The main head-race, about 200 feet wide, will run for about 5000 feet parallel with the river, having entrances from the river at both ends Near the lower reach the Soo Paper Company is already arranging to utilize 6000 horse power, discharging the water from the turbines through a lateral tunnel into the main tunnel Near this lower reach will also be placed two principal power stations, from which power will be distributed, either electrically or otherwise in ways not yet fully determined The first turbines to be erected in these power stations will be twin turbines of the outward flow type of 5000 effective horse power These turbines have a vertical shaft for driving dynamos or other machinery placed above ground

According to Mr Evershed's original plans, it was intended to distribute water by surface canals to different power users, each of whom would sink his own turbine pits, connected below by lateral tunnels to the main discharge tunnel Some of the power at Niagara will undoubtedly be used in this way, and in the case of industries requiring a large amount of power it will be economical to purchase a site and water rights.

Such a plan is, however, not adapted to smaller factories. Obviously for them it would be more economical to develop the power in one or more central stations by turbines of large size

under common management Further, once given the means of distributing power instead of water, an important extension of the project becomes possible

Besides supplying power to industries which may locate themselves at Niagara, the power may be transmitted to the existing factories in Buffalo and Tonawanda

Arrangements are already proceeding to transmit 3000 horse power to Buffalo, a distance of 18 miles, to work an electric lighting station

In 1890, Mr Adams, the President of the Niagara Construction Company visited Europe to examine systems of power distribution It was in consequence of this visit that the important modification of the plans of the Company involved in the substitution, to a large extent, of a system of power distribution, for a system of water distribution came to be adopted The American engineers were anxious to obtain the best European advice as to the methods best suited to the local conditions A commission was formed, consisting of Lord Kelvin, Dr Coleman Sellers, Prof Mascart, and Colonel Turrettini, and an invitation was given to engineers and engineering firms in Europe and America to send in competitive projects for the utilization of the power at Niagara and its distribution to different consumers at Niagara and in Buffalo by electrical or other means Many of the plans sent in were worked out with great care and completeness As to the hydraulic part of the projects there was some approach to general consent as to the arrangements to be adopted, but as to the methods of distributing the power there was an extraordinary diversity

Generally the Commission reported in favour of electrical distribution, with perhaps a partial use of compressed air as an auxiliary method

Generally also they reported in favour of methods of distribution by continuous currents in preference to alternating currents Since the date at which the Commission reported, the Frankfort Lauffen experiment has been made, and in the opinion of some electrical engineers a distinct advance has been achieved in the use of alternating currents at high potential

The Company has not yet decided to adopt any plan for the central stations except in a tentative way One or more turbines of 5,000 horse power are to be erected, and probably at first this power will be distributed to Buffalo by an alternating current system

The cost of a steam horse-power at Buffalo is reckoned at 35 dollars per annum I believe the Company will be able to deliver power at from 10 dollars for large amounts, and a greater price for small amounts, this price being reckoned for twenty-four hour days

The new industry of electric lighting has made necessary the provision of large amounts of motive power Electric traction similarly depends on the supply of motive power New chemical and metallurgical processes are being introduced which entirely depend for their commercial success on the supply of motive power at a low price

Niagara is likely to become not only a seat of large manufacturing operations of familiar types, but also the home of important new industries

NOTES

WE regret to have to announce the death of Sir Daniel Wilson, the President of Toronto University

ALTHOUGH the sixth International Geographical Congress will not assemble in London until June, 1895, arrangements are already being made in connection with it The organizing committee is not quite completed, and the Royal Geographical Society is still adding to it Among those already nominated are the President of the Society (Sir Mountstuart Grant Duff), the honorary Secretaries of the Society (Messrs Douglas Freshfield and Henry Seebohm), Sir George Bowen, Sir Charles Wilson, General J T Walker, Major Darwin, M P, Mr J Scott Keltie, Sir Frederick Abel, Sir Henry Barkley, and General J F D Donnelly This committee is busily engaged in making its arrangements.

THERE has been a recrudescence in the eruption of Etna during the past week We trust that there is a local successor to the lamented Prof Silvestri to give us some day a complete history of the phenomena

THE weather during the past week has been very unsettled, although during the first part the disturbances were mostly confined to the north The anticyclone which had for some time lain to the westward of our islands moved southwards, and shallow depressions appeared off Scotland The prevailing winds were consequently westerly or south westerly, and temperature was rather above the average, except in the north and west, where the daily maxima were frequently below 60°, being some degrees lower than the average On Sunday a rather deep depression from the Atlantic became central over our islands, accompanied by very heavy rainfall in Ireland and Wales, and rainy weather subsequently spread over the whole of the kingdom , while a considerable fall of temperature and strong northerly winds followed the passage of the depression to the eastwards The report issued by the Meteorological Council for the week ending the 6th instant shows that the rainfall only exceeded the mean in the north of Scotland , in all other districts there was a deficit The deficiency was greatest in the south west of England, where it amounted to eight inches since the beginning of the year

PROF LOEFFLER, of the University, Greifswald, has published two articles in the *Centralblatt fur Bakteriologie*, on his discovery of, and experiments with, the *Bacillus typhi murium*, and on the result of its application, at the request of the Greek Government, to arrest a plague of field mice in Thessaly In view of their scientific interest, these articles have been translated under the direction of Mr Harting, and will appear in the next number of *The Zoologist*

VON HELLMUTH PANCKOW contributes an article on the dwarf races in Africa and South India to the recent number of the *Zeitschrift der Gesellschaft fur Erdkunde*

A MOST important report of the sugar cane borers, which do so much harm in the West Indies, from the pen of Mr W F H Blandford (Lecturer on Entomology, Cooper's Hill), appears in the *Kew Bulletin* for July and August

THE *Monthly Weather Review*, of the Dominion of Canada, for April 1892 contains notices of aurora seen on almost every day of the month The most widely-observed display occurred on the 23rd, 24th, and 25th

THE *Abhandlungen* of the Royal Prussian Meteorological Institute (Bd I, No 5) contains a very elaborate investigation, 154 quarto pages, of the aspiration apparatus invented by Dr R Assmann, of Berlin, an instrument intended to determine the true temperature and humidity of the air under any conditions The first apparatus of this kind was invented by Mr John Welsh in 1853, and was used by him and also by Mr Glaisher in their balloon ascents, after which time it appears to have been overlooked, or set aside, until it was again reinvented by Dr Assmann, in a modified form, in 1889 We cannot enter into the construction of the apparatus here, further than stating that by the rotation of discs, the continual renewal of the air in connection with very sensitive thermometers is ensured, by which means sudden changes of temperature which cannot be followed by an ordinary thermometer are indicated. The apparatus is used at the Prussian Institute and at the German colonies in Africa as a standard instrument for the determination of the true temperature and humidity of the air For ordinary stations however, or for observations at sea, we presume that it is not likely to come into general use

THE report of the director of the Hong Kong Observatory for the year 1891 contains a table of the monthly and yearly rainfall value for about forty years The mean yearly value is

90·17 inches, most of which falls between May and September. Dr. Doberck states that there is apparently a little more rain when there are many spots on the sun, but the difference is too slight to be of any practical importance. The east wind is most prevalent at all seasons, the colony being within the region of the trade wind; about 59 per cent. of all winds blow from this quarter, but from June till September there is also a southerly maximum, caused by the monsoon. In winter the temperature is highest with south, and lowest with north wind, and in summer it is highest with south west, and lowest with east winds. During the year, 213 ships' log-books have been examined for data relating to typhoons, and registers have been regularly kept at about forty stations.

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus*, ♂ ♂) from India, presented respectively by Lieutenant H. S. Wilson and Mrs. Dunnington Jefferson; a Ring tailed Coati (*Nasua rufa*) from South America, presented by Mr. C. Carrington; an Angolan Vulture (*Gypohierax angolensis*, juv.), a —— Buzzard (*Buteo* ——) from West Africa, presented by Dr. Ferrier; a Spiny tailed Mastigure (*Uromastix acanthinurus*) from Algeria, presented by Lady Sebright; a Black headed Caique (*Caica melanocephala*) from Demerara, two Spiny-tailed Mastigures (*Uromastix acanthinurus*) from Algeria, deposited; three Short headed Phalangers (*Belideus breviceps*) from Australia, a Hairy Armadillo (*Dasypus villosus*, ♂) from La Plata, a White throated Capuchin (*Cebus hypoleucus*, ♀) from Central America, four Scarlet Ibises (*Eudocimus ruber*) from Para, purchased; a Testaceous Snake (*Ptyas testacea*) froms California, received in exchange.

OUR ASTRONOMICAL COLUMN

NATAL OBSERVATORY.—The superintendent of the Natal Observatory, in his report for the year 1890–91, tenders his obligations to no less than seven ladies, without whose zealous assistance, he says, the greater part of the numerous astronomical computations, &c., would not have been carried out. Although lacking such aid as is consistent with the proper working of an Observatory, a great amount of very useful work has been accomplished. For instance, the entire mass of meridian observations of the moon made at Greenwich during the period 1851–1861 have been reduced and compared with the theoretical basis of Hansen's Lunar Tables, thus completing the whole number of lunar observations up to the year 1890. The work with the transit, magnetic transit, and equatorial have been continued as usual. For the determination of the latitude of the Observatory 1022 observations of thirty five pairs of stars have been obtained. Owing to the close proximity of the equatorial and transit instruments, we are informed that it is impossible to use them both at the same time; this should be at once remedied, for the Observatory does not seem to be supplied with many surplus instruments.

The meteorological observations have been made regularly throughout the year. We hope, now that provision has been made for supplying a rain gauge and set of thermometers for each of the coast magistracies, that the Observatory will still continue to urge the necessity of maintaining and extending the system of weather reports, in the interests of the Colony, for, as is now well known, the value of such observations is only maintained when the stations are *numerous* and well *distributed*.

GEODETIC SURVEY OF SOUTH AFRICA.—Since the issue of the last (Jan. 1891) report by H. M. Astronomer, Dr. Gill, on the Geodetic Survey carried on in South Africa, the work has been progressing very successfully and swiftly, an average of five principal stations being occupied and completed every month by a single observer. On May 31, 1891, the field work as far as Modder River was completed, the site for the base line being reached the following day. Some difficulty was here encountered with regard to the selection of the position for the base, but it was eventually fixed near Kimberley, the permanent camp being fixed about eight miles from this place. The total length of the measured base was 6000 feet, and it was divided into sections of 500 feet, since this seemed "a convenient length for a forward and backward measurement in one day." The figures given in this report, although uncorrected for sea-level, &c., speak well for the accuracy of the undertaking, as will be seen from the following table. Each length of 500 feet was measured both forward and backward, and it is the differences of these measurements that are here shown:—

Section	F – B in feet	Section	F – B in feet
I	+ 0·0025	VII	+ 0·0014
II	– ·0020	VIII	+ ·0011
III	– ·0006	IX	+ ·0014
IV	·0040	X	+ ·0009
V	+ ·0019	XI	+ ·0028
VI	– ·0019	XII	+ ·0015

The probable error of the whole base was ± 0·028 inches. The lengths of the two sections came out as

$$M_{,} = 2999·4445 \text{ feet}$$
$$M_{,,} = 2999·7545 \text{ ,,}$$

The differences between the measured and the computed lengths of Section II through the triangulation were: by the eastern triangles $M - C_1 + 0·0035$ feet; by the western triangles $M - C_1 - 0·0083$ feet.

During the triangulation work several observations for latitude were made at Tafelberg, Hanover, De Put, and Kimberley Camp, the results showing, as Dr. Gill points out, "that the abnormal deviation of the plumb line found along the coast in the neighbourhood of Port Elizabeth had disappeared." The report concludes with the determinations of the observers' personal equations and two diagrams of the triangulation.

THE INTERNATIONAL CONGRESS OF EXPERIMENTAL PSYCHOLOGY

WHEN the first Congress on this subject met in Paris in 1889 under the presidency of Prof. Ribot, and with Prof. Charles Richet for its secretary, it proved a vigorous and most successful attempt to gather together from all parts of the world the students of a difficult branch of learning in which some methods of modern physics are being used in psychology, and these methods, or at least their results, are invading the province of what our ancestors would have preferred to call metaphysics. In the opinion of many of the most thoughtful students of the subject it has been considered an important point to keep up the connection between the physiological and the psychological sides of the questions under discussion, and the present Congress under the careful and admirable presidency of Prof. Henry Sidgwick, has proved very successful on this point, and has led to much pleasant acquaintanceship between those whose general work lies in different branches of learning. At Paris the full number at the Congress was about 150, and very little notice was taken of it in England; but at this recent Congress in London there have been nearly twice as many members, and it has received 70 or 80 visitors from all parts of Europe and from the United States and Canada. The vice presidents have been Prof. A. Bain, Prof. Baldwin, Prof. Bernheim, Prof. Ebbinghaus, Prof. Ferrier, Prof. Preyer, Prof. Delboeuf, Prof. Liégeois, Prof. Preyer, Prof. Richet, and Prof. Schafer. Among the other well-known names of the visitors there were those of Helmholz, Binet, Ribot, Henschen (Upsala), Munsterburg (Freiburg), and among the English names Herbert Spencer, Francis Galton, Prof. Oliver Lodge, Prof. Victor Horsley, Dr. Lauder Brunton, and Dr. Hughlings Jackson. The honorary secretaries were Prof. James Sully and Mr. F. W. H. Myers. The rooms of University College were kindly lent to the Congress by Mr. Erichsen for its use during the four days of the meeting (Aug. 1-4). Prof. Sidgwick's address attracted a large audience. He expressed himself as feeling it his first duty to apologize for the choice of England as the place of meeting, inasmuch as England could not be said to be the country which had done most for experimental psychology which, in the common meaning of the terms, had been most advanced in German and French laboratories, and was making recent and rapid progress in America. However, in a slightly different sense of the word the English school of psychologists from Locke and Hume down to Bain and Herbert Spencer had been for the most part experimentalists or at least empiricists. They had before them at this Congress a very wide range of subjects, too extensive he thought on the whole to be covered

by the term "Psychologie Physiologique," which had been used at Paris as the name of their first Congress, and he thought "Experimental Psychology" more appropriate. In laboratory work the leadership was taken by Germany; in hypnotism France was our master and Germany our colleague. He was glad to see some of the leaders of the Nancy School with them that day, as he thought they were taking the broader lines in the subject, and that Europe was certainly not inclined on the whole to narrow the subject. He would not attempt to discuss the larger questions at that time, but would confine himself to the harmless task of explaining the arrangements that were proposed. In the morning meetings the Congress would be divided into two sections, of which Section A would be devoted to neurology and psycho-physics, and Section B to hypnotism and cognate questions; in the afternoon there would be general meetings.

The address was very warmly received, and Prof. A. Bain, in reading the first paper took the opportunity of expressing his gratitude to Prof. Sidgwick and the secretaries for the energy they had shown in bringing together such a large group of men who were glad to make each other's acquaintance. He went on to read an interesting paper on the advantages in psychology of introspection on the one side and experiment on the other, and the ways in which one could help the other. Prof. Charles Richet went on to discuss some of the possible prospects of psychology, and to express a hope that some of the most difficult subjects, such as thought transference and clairvoyance, might be helped by the minute study of the process of development of the human mind. Prof. Gruber (of Roumania) then gave a very vivid sketch of the remarkable association of colour with sound, which he had spent many years in observing. To a very small number among his best educated patients the sound of the vowel "e" was accompanied by a sensation of yellow colour, of "i" by blue, of "o" by black, and so on through the long list of the Roumanian vowels and diphthongs, and also to some extent with numbers. The same colour was not always induced by the same sound in different patients but the observations had been carefully tested. Prof. Pierre Janet related in detail a long case of complete loss of memory for present events and complete incapacity for any decision (*Aboulie*) which had been suddenly brought about by the foolish jest (on August 28, 1891) of telling her what was not true, viz. that her husband was dead. The most curious points were that the loss of memory extended backwards as far as July 14, 1891, *i.e.* of what had happened during the six weeks before the accident, though the natural memory was complete up to July 14, and the patient's sub-conscious memory of all that had happened after that could be easily demonstrated by her automatic writing and by unconscious speech in a normal or hypnotic sleep. Prof. Ebbinghaus, in criticizing the paper, remarked that the woman's state seemed best explained as a condition of such complete distraction by things without that she had no power to attend to things within. Mr. Myers cited a case described by the elder Despine in 1830, in which there was a description of double memory and double personality such that the woman in the second state could eat and drink like a drayman, but soon reverted with no memory to her first state, and asked pitifully for her usual four teaspoonfuls of arrowroot.

Next day Section A and Section B went to work separately. In Section A Prof. Henschen (Upsala) read a paper which attracted considerable attention and consisted in a very careful examination of the exact tract of the visual path in man through the brain from the eye to the visual centre in the cortex of the calcarine fissure. It was admitted that it was not in accordance with the results of physiological experiments on animals; but the arguments for its proof in man were considered quite sufficient. Prof. Horsley followed with a paper on the degree of Localization of movements and correlative sensations, which roused some discussion; and then Prof. Schafer brought forward careful experiments to show that there was no valid reason to attribute any intellectual powers to the prefrontal lobes of the brain; and Dr. Waller ended the work of the morning by illustrating the difficulties of accurately defining the functional attributes of the cerebral cortex.

In Section B Prof. Liégeois read a paper which M. Liébeault, of Nancy, had written along with him describing a case of suicidal monomania, which they had succeeded in curing by hypnotic suggestion. The President expressed himself much interested in the paper, and regretted that they could not see Liébeault among them, for he was a man who, after twenty-five years of contempt, had succeeded in making the world realize some new methods. Dr. Frederic van Eeden (Amsterdam) read a careful report of his five years' experience of the medical cases of hypnotism along with Van Renterghem in Amsterdam. He laid stress on the care which should be taken to avoid the distrust and prejudice caused by the abnormal facts of hypnotism in public exhibitions. With the upper classes he thought hypnotism more difficult than with the lower, for they objected, rightly, to a tone of command. Psycho therapy with them must guide and support, but not command, and that it would do so even to the extent of curing some organic disease he regarded as well proved. Virchow's cellular pathology had neglected the psychical forces of the living cell. Now that these were acknowledged some principles of the old vitalism must revive. Prof. Bernheim read another more technical paper on hysterical amaurosis, explaining it as a purely psychical state brought about by suggestion, with which Dr. Bérillon could not agree, but Prof. Bernheim replied that there was nothing abnormal in hypnotism; there was no difference between normal and hypnotic sleep, though the two states were produced by different means. Further, there was not necessarily any sleep in hypnosis. It was a pity for that reason that the word had been chosen, for hypnotism meant simply suggestibility. Prof. Delboeuf took a similar view; to hypnotize a man was only to persuade him that he could do something that he thought he could not do. Supposing the man thought he had a pain, to hypnotize him was to make him sure he had not. Dr. Bérillon preferred to define hypnotism as the psychical state in which the cerebral control had been taken away artificially, and the patient became an automaton for any use. Such automatism was not in any way necessarily injurious to the subject, and was certainly useful in some diseases.

In the general afternoon meeting there were elaborate theories of colour perception well explained to the Congress both by Prof. Ebbinghaus and by Mrs. C. L. Franklin; and Prof. Lloyd Morgan attempted the difficult task of defining the limits of animal intelligence, chiefly as shown by the dog, whom he was sorry not to be able to credit with as much power of introspection as many of his friends. After some slight discussion on this, Dr. Bramwell (of Goole) brought forward four subjects from Yorkshire, on whom he showed some of the common phenomena of hypnotism and related some of his experiences in recent medical practice, which he had been able to show to doctors in Leeds and elsewhere, *e.g.* that he had been able in a few cases to produce by hypnotism, at a time when the patient seemed fully awake and normal, a state of local anæsthesia to allow a dentist to extract seven double teeth without any pain to the patient.

On Wednesday morning, in Section A, Prof. Heymans (of Copenhagen) read a paper on the relation of Weber's law to the phenomena of the inhibition of presentations; Dr. Mendelssohn (St. Petersburg) on the parallel law of Fechner; Dr. Verriest (Louvain) on the physiological basis of rhythmic speech; and M. Binet (Paris) on the psychology of insects, showing that in the Coleoptera the dorsal nervous centres were motor and the ventral sensory. In Section B Prof. Delboeuf pointed out the remarkable power of the somnambulist in judging of the length of passing time without any watch or instrument. He had found some simple Belgian countrywomen when hypnotized able to carry out suggestions at any time he liked to name from 300 to 3000 minutes, and he thought the subject deserved further inquiry. Prof. Hitzig (Berlin) brought forward a minute and careful physiological study of some attacks of sleep which had some resemblance to hypnotic conditions.—Mr. F. W. H. Myers showed from the reports drawn up by Mr. Kenlemans, Mrs. Verrall, and two other experimenters of some experience that in some cases, though probably only in a few, it was possible to induce hallucinations by such an experiment as crystal vision, *i.e.* the purely empirical process of looking steadily into a crystal or other clear depth or at a polished surface. These externalized images or quasi-percepts illustrated some little known points in conscious and sub-conscious memory. Prof. Pierre Janet corroborated Mr. Myers's results by some of his own, in which, for instance, dreams which had been manifest to the onlooker but unknown to the sleeper were brought within the sleeper's knowledge by gazing on a bright surface or by the essentially similar process of automatic writing. In the afternoon the President presented a very long report of careful detail of a census of hallucinations which had been agreed upon at the Congress in Paris in 1889, and which had been carried out in England by himself, in America by Professor William James, and in France

by M Marillier The question asked in England had been, "Have you ever, while in good health, and believing yourself to be awake, seen the figure of a person or heard a voice which was not in your view referable to any external cause?" In England 17 000 answers had been obtained, and about 1 in 10 persons (taken at random) who had answered had had some such hallucination in their lives The great majority of these hallucinations consisted of realistic appearances of living men, a small minority of dead persons, and a still smaller group of grotesque objects. A remarkable class was that of hallucinations of several persons at one time—collective hallucinations, and a still more remarkable class was of those coincidental with some distant event unknown to the percipient, such as the death of the person whose figure appeared The President came to the conclusion that after careful allowance for all sources of error, the probability against these coincidences being chance was enormous, and if the hypothesis that they were not casual was to be accepted, the assumption of the inaccuracy of the informants and inquirers must be strained to an extreme pitch M Marillier explained that it had been very difficult to get any large number of answers in France because of the dislike shown by the French to answer any psychological questions about themselves

On Thursday morning, in Section A, Dr Donaldson gave an interesting account of the minute investigation of the brain of Laura Bridgeman, the well known blind deaf mute, who died in 1889 in Boston There was depression of the motor speech centre, with slender sensory nerves and somewhat thin cortex over the areas of the defective senses In Section B Dr Berillon raised a lively debate by describing the good effects he had brought about by hypnotism in the education of about 250 children, who were suffering from many childish discomforts, such as night-terrors, insomnia, somnambulism, or faults, such as kleptomania, idleness, cowardice, &c After this Mrs H Sidgwick gave a summary of some experiments in thought-transference she had made, with the help of Miss A Johnson and Mr G A Smith as hypnotiser By thought transference she meant the communication from one person whom they called the agent to another, whom they called the percipient, otherwise than through the recognized channels of sense The successful percipients were seven in number, and had generally been hypnotised They had succeeded in transferring numbers, mental pictures, *i e* mental pictures in the agent's mind, and induced hallucinations given by verbal suggestion to one hypnotic subject, and transferred by him to another In the total number of experiments the number of failures was much larger than of successes, but as the antecedent probability could in most cases be accurately determined, the proportion of successes was amply sufficient to show that the result was not due to chance The many precautions necessary to such experiments were described in detail One percipient succeeded in the experiments with numbers when divided from the agent by a closed door at a distance of about 17 feet Attention was called to the great variability of results with the same percipients and agents for which they had not been able to discover any reason An account was added of some experiments in producing local anæsthesia under conditions apparently excluding all suggestion other than mental The President wished to remark that he thought it important in such experiments that all the failures should be recorded as well as the successes In the afternoon, after papers by Dr Lightnar Witmer, Dr Wallaschek, and Prof von Tschisch, the President put several questions to the vote as to matters of future organization, and it was decided to hold the next international Congress in Munich in 1896, with Prof Stumpf as President and Baron von Schrenck as secretary A suggestion was also made that there should be an extraordinary meeting in America next year, and a small American committee was appointed to consider this After a hearty vote of thanks to the President and Secretaries, and a brief reply, the Congress was dissolved

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 1.—M. de Lacaze-Duthiers in the chair —On boron pentasulphide, by M Moissan If the tri-iodide of boron, instead of being treated with sulphur in the dry way at a low red heat, as in the preparation of boron trisulphide, be mixed with sulphur and dissolved in carbon bisulphide at the ordinary temperature, boron pentasulphide is obtained It fuses at 390°, and does not pass through the pasty state In contact with water it forms boric acid, sulphuretted hydrogen, and a precipitate of sulphur Mercury and silver reduce it to the trisulphide, forming metallic sulphides Heated to fusion in a vacuum it decomposes into sulphur and the trisulphide Its density is 1 85 It is very difficult to obtain free from iodine, but in all the preparations the ratio between the boron and the sulphur has indicated the formula B_2S_5. -On the stripped plants of autumn, and their utilization as green manure, by M P P Dehérain It has been found that by planting the ground with vetch or mustard, and digging it in during the autumn, the amount of nitrogen retained in the soil was nearly doubled —Remarks on alimentation in the Ophidia, by M Léon Vaillant —A report on the great anaconda of Central America kept in the reptile menagerie Since 1885 the snake has eaten on the average five times per annum, its nourishment consisting of goats, three rabbits, and one goose The interval between two meals was in one instance 204 days —On symmetric tetrahedral curves, by M Alphonse Dumoulin —On Stokes' law, its verification, and interpretation, by M G Salet —A spectrum, given by a spectroscope with quartz prisms, is received on the fluorescent substance contained in a Soret eye piece It is then projected transversally on to the slit of a second spectroscope Through this the diagonal spectrum of Stokes' classical experiment is seen with perfect definition, no ray exceeding the theoretical limit The law thus verified can also be deduced from thermodynamic considerations According to Stokes' law, "the rays emitted by a fluorescent substance always have a smaller refrangibility than the exciting rays." If it were possible to transform yellow into violet light by fluorescence, many chemical reactions would become possible which only occur at the higher temperature at which violet appears in the spectrum This would be equivalent to the passage of heat from a colder to a hotter body, in contradiction to the second law of thermodynamics —Constitution of pyrogallol, by M de Forcrand —On Cascarine, by M Leprince —Physiological examination of four cyclists after a run of 397 km, by MM Chibret et Huguet This distance, which was covered by the youngest of the party, an Englishman of 18, in seventeen hours, was that between Paris and Clermont Ferrand It was found that the temperature was at the finish rather below than above the normal, that the coefficient of utilization of urinary nitrogen varied inversely as the degree of fatigue, and that therefore a decided waste of nitrogen is a concomitant of excessive fatigue The nutriment taken during the course consisted of much alcohol, champagne, beef-tea, and Kola solution in the case of the Englishman He and the next in speed both took Kola. The winner was extremely fatigued at the finish, the next man, a Frenchman of 28, not at all His pulse was beating at 60, that of the former at 84 The coefficients of utilization of nitrogen were 76 32 and 58 27 per cent respectively —On the properties of the vapours of formol or formic aldehyde, by MM F Berlioz and A Trillat —Subcutaneous grafting of the pancreas its importance in the study of pancreatic diabetes, by M E Hédon —On the habits of *Clinus argentatus* Cuv and Val, by M Frédéric Guitel —On a Permian Alga, with its structure preserved, found in the boghead of Autun *Pila Bibractensis*, by MM C Eg Bertrand and B Renault —The chalk of Chartres, by M A de Grossouvre

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THURSDAY, AUGUST 18, 1892

A DEBATABLE LAND—PLANTS OR ANIMALS?

A Monograph of the Myxogastres By George Massee (London Methuen and Co, 1892)

THIS work is much in advance of any book in the English language treating of the perplexing group of organisms that forms its subject The author has been in peculiarly favourable circumstances for the preparation of such a monograph, having enjoyed full access to "the splendid collection of Myxogastres in the Royal Herbarium, Kew, rich in types, and with numerous annotations by Rostafinski," as well as had "the loan or gift of valuable, and in some instances unique, specimens" from other workers in the same field in different countries He has fully acquainted himself with the literature of the subject, and has made many personal observations on the structure, and, in some cases, on the life-history, of various types He is thus able to bring to bear on the discussion of the problems that claim consideration a wide and varied knowledge, with the result that the book is indispensable to every student of the Myxogastres The introductory portion will be found worth perusal by others besides specialists, as it discusses the arguments for and against the vegetable nature of the group While accepting the view that the origin of the Myxogastres is to be found among the *Flagellatæ*, he comes to the conclusion that the sum of the characters presented by them in the reproductive phase manifests a tendency "in the direction of the vegetable kingdom, and more especially in the direction of the Fungi" But he is unable to establish strict homologies with the latter, since the Myxogastres are "a terminal group, and permit no comparisons with higher forms of the same type" In the discussion of this vexed question, Mr Massee shows none of the virulence to which it has given rise in former times, and he endeavours to do justice in his statement to the views of De Bary, and of other supporters of the view that the organisms in question should be regarded as animals After all, to an evolutionist at least, the distinction would appear more of verbal than of real importance

Accepting the view that there are certain forms, of a very primitive structure, from which the animal and vegetable kingdoms have been developed in ever-increasing specialization, there is cause to expect the existence of more or less intermediate types, in which the characters at one period of their life-history are more those of animals, and at another period more plant-like It matters little under which kingdom we agree to place them. Here, as elsewhere, Nature refuses to be bound down by rigid classification, and we must accept facts as they are, not as any *a priori* system might wish to make them. That the Myxogastres are not Fungi may be admitted, though they show a considerable similarity in various points in the course of development—a similarity clearly stated by Mr. Massee in his discussion of the whole question.

The term *Myxogastres* is employed, we infer, on the ground of priority. It possesses, however, the incidental advantage of not implying any positive view on the nature of the group, in the same way as do the terms *Myxomycetes* and *Mycetozoa*. The limits of the group are taken in this monograph in the sense employed by Rostafinski It thus does not include the *Acrasieæ* and *Ceratium*, admitted as Mycetozoa by De Bary, nor does it make any reference to the numerous forms of the *Monadineæ*, which Zopf discusses in his "Schleimpilze" in Schenck's "Handbuch der Botanik" Thus limited, the group is more homogeneous, though the definition is, perhaps, somewhat arbitrary, and omits forms that are undoubtedly related to the more specialized types, and an English work on which would be welcome

The author enters on somewhat slippery ground in the endeavour to explain the line of development of the Myxogastres, and also to illustrate his ideas of the relationship between the several orders He holds that four orders can be distinguished by the presence or absence of lime in the sporangial wall, and by the presence and nature of the capillitium

> "In each order we find the special characteristic idea evolving through a sequence of genera, the terminal one not connected with any higher order, hence the special feature terminates abruptly within the order where it originated, and it is invariably in some comparatively undifferentiated genus near the initial point of each order, that we meet with the suggestion of a new line of evolution, which, at its maximum of development, constitutes the characteristic feature of the order immediately in advance of the one from which it emanated in an incipient condition"

Turning now to the systematic portion of the work, we find that it gives abundant proofs of care and of familiarity with the several forms, based on personal examination of each The method of description is clear, the more important characters being printed in italics Mr Massee recognizes fully the difficulties of determining the limits of species and of the larger groups "while the life-history of the majority of forms is still unknown," saying plainly that

> "all attempts at classification, as also the conception as to what constitutes a species, must be considered as tentative When we are better acquainted with the main lines of development and lines of variation, also the conditions determining these variations, it is certain that the main factor in the discrimination of species will not be a one-twelfth oil-immersion objective"

Basing his acquaintance with the Myxogastres on personal examination of large numbers of examples, fresh and dried, many of the latter being authentic types, Mr Massee does not hesitate to unite species and genera hitherto kept as distinct, but shown to be connected by fuller material. Thus several familiar names become sunk as synonyms; *e g* *Licea*, Schrad., and *Lindbladia*, Fr., are ranked under *Tubulina*, Pers (emended) Under the generally accepted rules of nomenclature, this leads to Massee standing as the authority for many species, transferred by him, in reality, to another genus. But, besides such cases of apparent novelties, there are also a good many descriptions of *new* species in the usual sense of the term. The synonyms are carefully given under each group and species A wise reticence has been observed in the endeavour to recognize the species meant by most of the older writers who mention the Myxogastres The

synonymy previous to Rostafinski's monograph is borrowed as a whole from that work, "without any attempt at corroboration" Mr Massee says —

"I feel certain that nearly one-third of Rostafinski's work would not have been sacrificed to synonyms unless they mean something more than I have been able to discover, hence I have not felt justified in ignoring them altogether"

The geographical distribution has been worked out from the extensive collections already referred to as at the author's command

The twelve plates, bearing 313 coloured figures by Mr Massee himself, call for special mention as a valuable assistance to students of the Myxogastres They deserve high praise for their accuracy and execution The printing and get-up of the book are very satisfactory A review would scarce be complete did it not find fault with some point or other, and we may do that part of our duty very briefly by taking exception to the rather inconvenient size (large octavo), and to the tendency in the introductory pages to let the sentences run to an inconvenient length One, taken at random, we found to occupy twenty-five lines There is no ground for this charge, however, as regards the descriptive portion of the monograph

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE *No notice is taken of anonymous communications]*

The Apodidæ—a Reply

PROF LANKESTER's review of my book in NATURE (p 267) contains, as is usual with "candid opinions," a considerable number of misstatements These compel me to ask space for a reply

Prof Lankester commences by stating very authoritatively that my account of the hermaphroditism of Apus is erroneous This question, being purely a matter of evidence, can wait My account of it in "The Apodidæ" is "meagre" because, as is clear to any one who reads the preface, I was constrained to put aside for the present all questions which did not directly bear upon the line of argument embodied in my book

These points, however, are not serious Let us turn, then, to the main charges which are intended to deprive my book of all claim to be a real contribution to zoological science Prof Lankester, after himself dethroning my title, "The Apodidæ," says that I "pose as the discoverer of a new and unsuspected agreement between the Crustacea and the Chætopoda, and that I bring forward arguments as new which have "long been effectively used" for the same purpose It is difficult here not to accuse Prof Lankester of deliberate misrepresentation If he will allow me to keep my title and will read my book, he will find that I go beyond this general standpoint, and specialize the Apodidæ as the particular Phyllopods which are to be deduced from a Chætopod Without, I believe, a single page of digression, my book discusses from beginning to end the relation of the Apodidæ to the Annelids, of the Apodidæ to Limulus, to the Trilobites, and so on All the well-known arguments in favour of the more general proposition which deduces the Phyllopods from Annelids I have naturally adopted, adding, however, many new arguments of more or less weight in favour of my special point Not one of these arguments does Prof Lankester attempt to meet The only one he refers to he wishes to claim as his own, as, indeed, he does everything else in the book "which will bear examination"! This charge of wholesale plagiarism from Prof Lankester's articles on Apus and Limulus is the more remarkable, because my own investigations compelled me either to modify or to reject almost every position therein adopted by him This may account for his "candid opinion," but hardly for his charge of plagiarism The only evidence he adduces to support this charge can merely be meant to throw dust in the eyes, it is as follows —

In describing the absence of articulations in the limbs of Apus I admitted that Prof Lankester had noted the point (which, however, is not absolutely correct), but I added that he had failed to see its significance Prof Lankester resents this statement, and cites himself to show that he agreed with Claus in holding that the limbs of the Arthropoda were homologous with the parapodia of the Chætopods This acquiescence in a general proposition does not in any way prove that he applied it to explain the special conditions of the limbs of Apus

While I do not at all share his jealousy in matters of priority, and will gladly yield the point to him if he can base his claim on something more definite than the passage he cites, the fact that he wishes to claim this argument for his own is specially interesting There is far more meaning in this than in his use of such expressions as "fanciful conceptions, crude speculations, and dogmatic assertions," because, if this particular argument holds —and Prof Lankester would not claim it unless he acknowledged its validity—it goes far to show that my theory can hardly be called a "fanciful conception" The reviewer's statement that "there is no evidence" that I "made use of well-preserved material," looks as if he had not taken the trouble to read the book, and further as if he did not understand the importance of the issues at stake, the histological points, which are the only ones likely to be affected by the state of preservation of the material, are insignificant as compared with the main argument

If, instead of indulging in such loose charges, Prof Lankester had endeavoured to show where, in his opinion, my argument breaks down, and what are some of the more glaring misstatements in my book, which cause him to "regret" that he cannot recommend it as "a repository of fact," he would have done science (and perhaps (?) myself personally) much better service I should also personally have been grateful to him had he himself set an example to the more "inexperienced" zoologist of "how morphological problems should be attacked" I did not, in my speculations as to the relation of Apus to the Annelids, feel inclined to follow the example set by Prof Lankester in his own speculations as to the relations of Limulus to the Arachnids I was especially recommended to ripen my ideas, and to publish them together in book-form Would Prof Lankester have advised me to publish my speculations, as he did his, in separate articles, occasionally, perhaps, advancing theories and arguments in one article which have to be withdrawn in the next? This plan may be convenient for the writer, but is most annoying to all who have to work over the same ground again

To conclude, my book is an argument from beginning to end, the argument may be absurd, but it must be met by argument In the meantime, until Prof Lankester demolishes it, I have the good fortune to know that several leading zoologists, among whom Prof Haeckel kindly permits me to mention his name, think it—well, to say the least—*not* absurd

August 2 HENRY M BERNARD

Calculation of Trajectories of Elongated Projectiles

(Additional Note)

IT has been already pointed out (NATURE, March 1892, p 474) that the range table of the 4 inch B L gun, selected by the authorities, afforded a more satisfactory test of the value of the coefficients of resistance than the results of the special experiments carried out with that gun in 1887 This range table was based on practice of 17/5/83, 7/3/84, and 21,23/4/84. The muzzle velocity was 1900f s, the weight of the shot 25lbs., and the diameter of the shot 4in But no information is given respecting the height of the barometer or thermometer In this table the elevations are given at which the gun must be laid to obtain ranges of 100, 200, 300 7600, 7700 yards, and also the time of flight for each range, expressed to the $\frac{1}{100}$th of a second for ranges below 5000 yards, and to the $\frac{1}{10}$th of a second for ranges 5000 to 7500 yards

In calculating the ranges for elevations of 1°, 2°, 3° 20°, the temperature was supposed to be 62° F, and height of the barometer 30in., at the level of the gun The coefficient κ was supposed to be 0·97 to adapt the tables to a head struck with a radius of two diameters

By the use of the range table it was found what was the experimental elevation and time of flight for each of the ranges obtained by calculation

The results of calculation and experiment are given in the following table In column 1 the calculated ranges are specified. In columns 2 and 3 the calculated and experimental corresponding times of flight are given, and in column 4 the differences of these quantities In columns 5 and 6 the calculated and the experimental elevations are given, and in column 7 their differences, which are due to the "jump" of the gun and to the "vertical drift" of the elongated shot The calculated horizontal remaining velocity (column 8) is given in each case in yards per second to facilitate the expression of the small errors in time, given in column 4, in yards of range

By the use of the general tables the time of flight over each range and the horizontal remaining velocity have been calculated (see columns 10 and 9), supposing the shot in each case to start with the horizontal muzzle velocity, and to move through air of a density corresponding to the mean height to which the shot actually rises

Range	Time of flight			Elevation			Calculated horizontal remaining velocity	General tables	
	Calc	By R T	Diff	Calc	By R T	Diff		Rem vel	Time
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Yards	Secs	Secs	Secs	°	° ′	′	y s	y s	Secs
1053	1 92	1 90	+0 02	1	0 52	+ 8	479	478	1 92
1831	3 72	3 77	−0 05	2	1 56	+ 4	391	390	3 73
2433	5 36	5 44	0 08	3	2 58	+ 2	343	345	5 38
2937	6 86	7 00	−0 14	4	3 56	+ 4	322	322	6 89
3386	8 30	8 41	−0 11	5	4 53	+ 7	305	304	8 33
3797	9 64	9 77	−0 13	6	5 51	+ 9	293	289	9 73
4148	10 95	11 04	−0 09	7	6 44	+16	278	278	10 98
4467	12 21	12 23	−0 02	8	7 35	+25	265	268	12 15
4813	13 46	13 57	0 11	9	8 36	+24	258	258	13 48
5110	14 66	14 74	−0 08	10	9 33	+27	249	250	14 66
5384	15 84	15 84	0 00	11	10 28	+32	242	242	15 81
5664	17 01	16 95	+0 06	12	11 25	+35	234	235	16 98
5924	18 14	18 10	+0 04	13	12 20	+40	227	228	18 12
6170	19 29	19 18	+0 11	14	13 12	+48	220	222	19 24
6398	20 40	20 29	+0 11	15	14 5	+55	214	217	20 30
6632	21 53	21 46	+0 07	16	15 0	+60	208	212	21 41
6821	22 58	22 51	+0 07	17	15 40	+74	203	207	22 34
7003	23 62	23 52	+0 10	18	16 33	+87	198	203	23 26
7221	24 75	24 71	+0 04	19	17 33	+87	192	199	24 38
7483	25 94	26 10	−0 16	20	18 47	+73	188	193	25 75

The very small differences in column 4 between the calculated and experimental times of flight for the full extent of the range table afford conclusive evidence of the accuracy of the coefficients of resistance derived from my experiments of 1867, 1868, and 1878–80

F BASHFORTH

A Plea for an International Zoological Record

BEING now for the second year one of the Recorders for our English "Zoological Record," I should like to offer a few remarks upon the disadvantages of the system of recording that prevails at present in England and abroad

The first point to be noticed is the number of independent Records that are published Chief among these are our *Zoological Record* and the *Zoologischer Jahresbericht*, published by the Zoological Station at Naples Besides these there are several minor semi private records which it does not concern us to enumerate

The disadvantage of so many records is obvious In the first place they are expensive, as the result of competition is to decrease the number of purchasers of each record, since comparatively few zoologists are able to purchase more than one of them Secondly they are all in some way incomplete. Thus without going into great details it may be pointed out that the *Zoological Record* specializes upon systematic zoology, and as a result the portions devoted to animal morphology and embryology are all but useless, as a rule, to those interested in these subjects Moreover, the systematic portion, being often undertaken by zoologists who are not professed systematists, does not appear always to give satisfaction to those it is intended to benefit On the other hand the *Zoologischer Jahresbericht* leaves out systematic zoology entirely, which in many groups of animals cannot well be separated from other branches of study, and from the fact that it does not record palæontological papers, there are often omitted, at least in my two groups—sponges and echinoderms—many works of great morphological importance

Some years ago a proposal was made by Dr Dohrn and the staff of the Naples Zoological Station to unite the two records into one The English part was to be entirely systematic, the Naples part was to be entirely morphological and physiological, and both were to be published together as parts of one record. This most excellent proposal was refused by the British zoologists, owing, apparently, to a desire to gain exclusive honour for British nationality

I wish now to propose that this long delayed project should be carried out, and that in future one International Zoological Record should be published Such a record should fall into two natural parts (1) a morphological and physiological part, and (2) a systematic part, each with its own chief editor Seeing now that Naples is a recognized centre for zoological research, and that a modern zoologist's education is scarcely complete until he has studied there, the first part of the Record could best be done there much on the lines of the present *Jahresbericht* On the other hand London, with the greatest systematic collection in the world and the addition of a perfect library, would naturally be the centre for the systematic part The total result could be published in one volume, perhaps best at Leipzig, and the systematic part would be in English, while the morphological part could be in English, French, German, or whatever might be the language of the recorder, as it is now in the Naples *Jahresbericht*

I think the advantages of such a scheme are obvious By the combination the labour of recording would be enormously lessened, and the combined record need not be much more expensive than either one of the two now existing At the same time authors could be encouraged to send in abstracts of their own works to one of the two editors This would be an advantage in every way. In the first place authors would be sure of seeing a proper abstract of their papers published I am sure it must be the experience of many who have published a memoir and afterwards read the abstract of it, that the abstract often gives a shockingly mutilated account of the results set forth in the original paper By the omission of a qualifying phrase or sentence, an author's results are often made to appear in abstracts as absolute rubbish I speak as one who has suffered

On the other hand, the work of the recorder would be still further lightened by authors sending abstracts of their own works It might be left to the editors' discretion to cut down an abstract if it was too long

I feel confident that a scheme of combined records such as I have sketched out would cheapen the production of the Record to such an extent, that, amongst other things, it would be possible to pay a special recorder of the literature, that is to say, a person whose business it would be to go through all the periodicals and sort out the papers amongst the different recorders, as is actually done by the editor of the *Naples Jahresbericht* In the present system of the English *Zoological Record* each recorder has to go through the whole of the periodicals, and if the group be a small one, *e g* sponges, the labour of searching for papers is out of proportion to the task of recording them Moreover, it necessitates a longer or shorter residence in London near the British Museum Library, which may cost a recorder *more than he is paid* for his share of the Record The duties of a recorder of the literature would be best undertaken by some one residing near the British Museum, as he could then get all the periodicals During my residence in Naples last year I was unable to obtain all the periodicals in the enormous list of the *Zoological Record*, and thus I was obliged to leave out of my *Sponge and Echinoderm Record* for 1890 a great many papers which I am recording now for 1891

A great need at the present moment is the intelligent organization of scientific research, and I venture to suggest the above

scheme as an improvement upon the present organization as far as the recording of zoological literature is concerned. Perhaps in the far distant future a record of geology and botany might further be incorporated in the above scheme, to make an "International Record of the Progress of Biological Science." It is scarcely to be hoped, however, that we are within a measurable distance of such a convenience. Would it not be a reasonable thing that the Royal Society of London should initiate such a progress in the recording of scientific literature as that here advocated?

E. A. MINCHIN

University Museum, Oxford, August 2.

Pilchards and Blue Sharks

YOU may like to know that the pilchards in coming in on the Cornish coasts this season are followed by great quantities of blue sharks (*Squalus glaucus*) from four to nine feet in length.

Just now they are hanging about four or five miles from land, and evidently are disturbing the pilchards in their feeding very much, as they are not scattering and playing on the surface of the sea in the evening twilight as they usually do, but are keeping in closely-packed schools throughout the night, hence our fishermen are having a very uncertain time of it as the consequence, some boats having rather heavy catches, and others only a few hundred of fish. And all are complaining of the damage done to the nets by the sharp teeth of these monsters, as in attacking the pilchards in the fishermen's nets, there is no hesitancy on the part of the sharks, for the net is bitten through and carried off with the pilchards. Last Friday morning the fishing boat *Wave* landed seven of these sharks, and the master said, had he desired it, he could have caught a dozen, or more.

MATTHIAS DUNN

Mevagissey, Cornwall, August 16.

Aurora Borealis

STANDING by the Hampstead Heath flagstaff last Friday evening (12th), a few minutes before ten, I witnessed a feeble but characteristic display of the Aurora Borealis. Looking to the north-west, and midway between Ursa Major and the horizon, was a speck of pale bluish-green luminousness. While wondering as to the cause, a flickering shaft of crimson tinted light shot upward in the direction of the "Pointers." This was followed by other streamers and "glows," sometimes white, sometimes slightly coloured. Occasionally patches of hazy light would be formed, through which the stars could be seen, and once a number of horizontal bands or waves passed upward from the horizon in quick succession, travelling almost to the star G in Ursa Major before they faded away. At 10.20 p.m., when I left the spot, the streamers had apparently ceased, but the sky was still luminous. Throughout the display was very faint and the colours very weak—mere tints.

A. BUTCHER

ON Friday evening, August 12th, between the hours of nine and ten p.m., there was visible here a magnificent display of the aurora borealis. The streamers were very bright at times, and those on each extreme were more or less reddish. I think it worth recording because of the unusual time of year for such a display. It was doubtless seen over a wide region, and the telegraph system may have had some experience of earth currents.

EDMUND MCCLURE.

Mundesley, Norfolk, August 13.

AN active aurora of great brilliancy was visible here on Friday night from nine till ten p.m. The whole realm of the sky from north-west to north-east and from horizon to zenith was filled with a vaporous and highly luminous mass with streamers and rays, the light sufficing for reading moderately large type. The streamers and rays were projected from the upper edge of an arch of dark coloured vapours resting on the northern horizon. The sky space occupied by the points of the streamers covered the constellation Ursa Major on the west, Cassiopea on the east, and the intermediate region. Among the brilliant sheaf of white streamers an occasional dark coloured ray shot upwards from the generating arch.

J. LLOYD BOZWARD

Worcester, August 13.

Aurora Australis

A FRIEND (Mr. Hamilton S. Dove) who has resided for several years in Tasmania having sent me a full account of an unusually splendid aurora recently observed by him, but which met with little notice even locally, I enclose a condensed description of it, thinking it worthy of record in your columns. In previous occurrences of Southern Aurora he had observed "only a greenish yellow light, and was very much surprised at the grand fiery-red cloud-like patches, which formed so striking a feature in this phenomenon."

WILLIAM WHITE

The Ruskin Museum, Sheffield.

"On the night of Wednesday, May 18th, 1892, a grand display of aurora was witnessed by us in the Calder district, near the township of Wynyard, Table Cape, North west Tasmania. The sun had set at about ten minutes to five, and the night was very clear and cold—no clouds were to be seen—with a keen frosty wind blowing from the south west. Shortly after seven o'clock a bright light was visible above the southern horizon, somewhat similar to the light preceding sunrise. Then two broad zones of greenish light appeared, extending from the south-east to the south west, in the form of a depressed arch, one zone being a short distance above the other, like the bands of a rainbow. At times parts of these bands faded, whilst other parts became brighter. Presently some patches of a dark red colour, as of illuminated sunset clouds, began to appear above the zones of greenish light, spreading along, but with intervals between, the whole expanse of the zones—one specially large and deep red patch being conspicuous in the extreme south-west. These patches glowed and faded alternately in the same manner as the zones of greenish light.

"After continuing for the space of about half an hour the coloured lights gradually faded, leaving the strong whitish light which appeared at first. Towards nine o'clock, however, a further manifestation occurred, beginning with a brilliant red light in the south east, and extending from the horizon to a considerable distance upward, resembling the glow from a huge fire. This also paled and brightened, till presently the two broad zones of greenish light again appeared, this time, however, confined chiefly to the south and south east heavens, very little reaching south west. After this reappearance of the zones some broad white stripes commenced to radiate from the horizon, crossing the zones more than half the way upwards to the zenith. The stripes began to appear near the red glow in the south-east, and several others occurred south-east by south, only two rather faint ones being to the west of south.

"Almost directly one of the white stripes appeared one of the red cloud-like patches came to the east of it, and gradually extended towards it, so that the sky above the zones of greenish-yellow light was eventually covered with red glowing patches and pale vertical stripes, which similarly paled and brightened.

"The later appearances, like the first, lasted for about half an hour and then disappeared, the moon rising soon afterwards.

"H. S. DOVE.

"G. W. EASTON."

Units Discussion at British Association

REFERRING to the preliminary memorandum printed in your issue of August 4th, page 334, I wish to correct a slip in the statement about the fall between two surfaces joined by a "weber." I ought to have added, "If their area is one square centimetre." Enlargement of the area to a metre would diminish the pull to 40 tons. Also I may observe that at the meeting I did not press all the proposed resolutions, but withdrew Nos. 4, 5, 6, and 8.

OLIVER J. LODGE.

THE VARLEY TESTIMONIAL

AN important Committee, containing among others, Lord Kelvin, Prof Ayrton, Prof G Forbes, Dr Gladstone, Prof D E Hughes, Dr J Hopkinson, Prof Kennedy, Prof O Lodge, Prof J Perry, Messrs W H Preece, A Siemens, A Stroh, J W Swan, and Prof S Thompson, has been formed, to give effect to the feeling amongst some of the older members of the electrical profession that the life-long labours in electrical research of Mr S A. Varley should be recognised by some substantial testimonial befitting his reputation as a scientific investigator

A brief sketch of Mr Varley's career will serve to show what signal services he has rendered to the cause of electrical science and the honour his discoveries have conferred upon this country

Mr Samuel Alfred Varley was born in London in 1832, and was the third son of the late Mr Cornelius Varley, an active man of science and an artist In 1858, when the Atlantic cable was being constructed, he wrote a paper, read before the Institute of Civil Engineers, "On the Electrical Qualifications requisite in Long Submarine Cables," and was shortly afterwards elected an Associate Member of that Institution

In the paper referred to above, Mr Varley opposed the views of the electrical advisers of the company Faraday, who had publicly supported their opinions, endorsed Mr Varley's ideas immediately after receiving a copy of his paper Mr Varley followed this up by reading a second one before the Society of Arts in 1859, "On the Practical Bearing of the Theory of Electricity to Long Submarine Telegraphy" In this paper he suggested, among other things, the use of artificial lines, which have since proved of such value in connection with duplex working In 1866 Mr Varley discovered for himself the re-action or self-exciting principle, and at that early date constructed his first machine of the pure dynamo type, which is now in the Museum at South Kensington His dynamo of 1866 was exhibited at the Inventions Exhibition of 1885, and for this he was awarded a gold medal

The controversy which subsequently arose on this invention may be held to have been fitly summed up by the late Robert Sabine, C E (son-in-law of Sir Charles Wheatstone), in the following words —"Professor Wheatstone says he was the first to complete and try the reaction machine Mr S A Varley was the first to put the machine officially on record in a provisional specification, dated December 24, 1866, which was, therefore, not published until July, 1867 Dr Werner Siemens was the first to call public attention to the machine in a paper read before the Berlin Academy on the 17th January, 1867" (See *Engineering*, November, 1877)

In 1866 he introduced needle telegraph coils, in which soft-iron magnetically-induced needles were substituted for tempered steel needles These induced and consequently undemagnetisable needles entirely superseded the old form introduced by Wheatstone and Cooke, and were largely adopted by the Postal Department In the same year (1866) he designed a system of electric train inter-communication

In the year 1875 Mr Varley became assistant-manager of the works of the late British Telegraph Manufactory, Limited, and as the first Gramme machines constructed in England were manufactured by this firm, he had ample opportunities of studying the characteristics of both series wound machines and those having a seperate armature for excitation of the field magnets There is scarcely a doubt that Mr. Varley's investigations at this period led to the invention of compound winding, for in 1876 he patented a series-shunt or compound-wound dynamo, and, in three legal suits, the claim that this specification first described a system of compound winding has been fully sustained. Mr Varley has from time to time contributed papers read at the meetings of the British Association, among which may be mentioned one "On the Mode of Action of Lightning on Telegraph Circuits," wherein he described a lightning bridge designed by himself, a number of which are now doing duty, although fitted up more than twenty years ago

But Mr Varley's *magnum opus* is the important part which he took in the invention and perfecting of the dynamo, perhaps the most striking invention of the century, and upon this his fame as a patient, conscientious, and earnest scientific investigator of the Faraday school will permanently rest His researches were undertaken in the true spirit of science, and no thought of self-emolument has ever caused him to deviate from the path which he has pursued throughout an eventful, although eminently simple and blameless life, a life in which self-denial and self sacrifice have had no small share Like many men of genius he was far ahead of the times, and has lived to see others reap the benefit of his great discoveries His nervous and retiring disposition has for years kept him from the busy haunts of men, and to the younger generation of electricians he exists only in name, a name, however, that will live as long as the dynamo is employed in the service of man

Subscriptions will be gladly received by the hon treasurer, Mr Stroh, 8 Haverstock Hill

NOTES

THE *Electrician* for August 5 contains an article on Lord Rayleigh, which is accompanied by a steel portrait

AT a recent meeting of the Berlin Geographical Society, the chairman, Baron von Richthofen, announced that the society was about to publish, in commemoration of the 400th anniversary of the discovery of America, a work descriptive of the ancient manuscripts and maps in the Italian libraries relating to the history of this event The German Emperor has promised a contribution of 15,000 marks towards the expense of the undertaking, and it is to be edited by Dr Kretschmer The accompanying atlas will contain thirty-five large maps, of which thirty-one are new, and will be published for the first time.

AT the lunch in the Library Hall, St Andrews, on the 11th, to the party from the British Association, Prof McIntosh announced that Mr Charles Henry Gatty, of East Grinstead, had presented £1,000 for the purpose of establishing a Marine Laboratory at St Andrews, which sum he further increased to £2,000 before the close of the day The name of Mr Gatty is sufficiently familiar to marine zoologists, were it only in connection with the accomplished lady (Mrs Alfred Gatty), the favourite correspondent of Dr George Johnston, of Berwick-on Tweed Mr Gatty's munificent donation will enable St. Andrews to have a substantial and comfortable laboratory instead of the wooden building (formerly a fever hospital), which has hitherto been used for marine work since the period of the Trawling Commission under Lord Dalhousie St. Andrews Marine Laboratory is the oldest permanent station in the country, and, as it has pre eminent advantages in regard to varied and very rich marine fauna and flora, easy access to a fine University Library, and a University Museum—unique in certain departments, a new future is opened to it through Mr Gatty's handsome gift. At the same meeting it was stated that the Fisheries prize of £20 given annually to the best student of Zoology (hitherto from an anonymous donor) was the gift of Mr J W Woodall, of Scarborough Both Mr Gatty and Mr Woodall were present

DURING the past week the weather has been fine generally over the southern portion of the kingdom, but somewhat unsettled The anticyclonic conditions which prevailed for a day or two

in the middle of last week gave place on Friday, the 12th inst, to a south westerly current, with showery weather, the rainfall being rather heavy in the north and west, while the low pressure over the north of Scotland caused rather strong gales and heavy seas on Saturday and Sunday During the early part of the present week a depression advanced from the southward, occasioning unsettled weather and fog or mist in places, while exceptionally heavy rains occurred in parts of Ireland and Scotland, the amount measured at Parsonstown on Monday morning being 1 24 inches During the week the maximum temperatures have nearly reached 80° in some parts of England and in the east of Scotland For the week ending the 13th inst temperature was below the mean in all districts, except the Channel Islands, where it just equalled it The absolute minima, which were registered on the 11th, were exceedingly low for the time of year, and at many of the more inland stations frost was experienced on the grass

THE fifth annual report of the National Association for the Promotion of Technical and Secondary Education has just been published, and satisfactory progress is shown During the year a bi-monthly journal has been issued under the title of the *Record of Technical and Secondary Education*, in which detailed accounts of the work done by the County Councils have been given from time to time The *Record* has to some extent relieved the pressure on the space of the report, which is shorter than its predecessors

THE *Ceylon Observer* for July 21 has an editorial on "Marine Biological Stations," and while sympathising with the decision of the meeting which was called together a short time ago to take steps to establish a station in the island of Jamaica, ventures the hope that Ceylon, too, may have its marine biological station, and points out how particularly well situated that island is for such an undertaking

WE refer elsewhere to Prof Forel's report on the present extension of the Alpine glaciers, to which, whatever the *modus operandi*, the disaster of St Gervais was due A letter in Tuesday's *Times* refers to Mr Douglas Freshfield's warning that there may still be an excess of water ready to discharge itself in the neighbourhood of the Aiguille du Goûté, and states that the view has received a remarkable confirmation While a party was breakfasting at the Pierre Pointue, which overhangs the stream that drains the eastern wing of the Glacier des Bolsons, a tremendous noise suddenly brought them all—visitors and *employés* of the chalet—out upon the platform to see the violent flood of opaque brown fluid which tore down the bed of the stream which had been flowing so quietly before No great damage seems to have been done, but certainly the occurrence will strengthen the view that careful scientific studies should be made so that complete warning may in all cases be given

AN address on "Geological Chronology," which Prof Young delivered to the Physical Society of Glasgow University in February last, has been published in pamphlet form by Messrs Carter and Pratt, Glasgow

A PRELIMINARY draft prospectus of a new physical atlas, which Messrs J Bartholomew and Co, Edinburgh, have in preparation, has reached us The work will be based upon Berghaus's "Physikalischer Atlas," published by Justus Perthes, of Gotha, 1889–92, but will, we understand, be much larger and more extensive, and contain a great deal of entirely new and original matter. According to the present intentions of the compilers, the work will be issued in five separate sections as follows (1) Geology, (2) Orography and Hydrography, (3) Meteorology and Magnetism, (4) Botany and Zoology, (5) Ethnography and Geographical Demography, and when complete may be obtained either in one complete volume, or in five smaller volumes. The joint authors will be Mr J G Bartholomew and Dr H R Mill, and the various sections will be revised and edited by, amongst others, Prof Bayley Balfour, Dr A Buchan, Sir Archibald Geikie, Prof James Geikie, and Dr John Murray

THE *Times* of Tuesday states that Lieutenant Bower has discovered in Chinese Turkestan the remains of a subterranean city, in one of the excavations near which he found a curious birch-bark manuscript, which he took with him back to India for the investigation of scholars The manuscript is described as having been dug out of the foot of one of the curious old erections just outside a subterranean city near Kuchar These erections are said to be about 50 feet to 60 feet high, in shape like a huge cottage loaf, built solid with sun dried bricks, with layers of beams now crumbling away Dr Hoernle, who undertook the examination of the manuscript, thinks that these erections are Buddhist stupas, which often contain a chamber enclosing relics and other objects These chambers are generally near the level of the ground, and are often excavated by persons in search of hidden treasure There is no reason why a birch bark manuscript, thus preserved from the chances of injury, should not last for an almost indefinite period, especially if the chamber is air-tight Dr Hoernle has now communicated to the Asiatic Society of Bengal the result of his examination of the manuscript It is written in Sanscrit of a very archaic type, not in the Sarada character of Cashmere, as was at first surmised, but in the Gupta character, which is a much earlier form Separate portions of it were written by different scribes and at different dates, and the latest portion must, he thinks, be ascribed to a period not later than the second half of the fifth century—say 475 A D—while the earlier portion must be referred to a date half a century earlier The manuscript is therefore the oldest Indian manuscript, and one of the oldest manuscripts existing in the world The manuscript consists of fifty five leaves, all of which have now been transcribed and the greater part translated by Dr Hoernle, and both will be published in instalments by the Asiatic Society of Bengal

THE *Times* India correspondent gives us some important intelligence regarding Mr Conway's exploring party in the Hindu Kush The party has arrived at Askoleya after making the first definitely recorded passage of the Hispar Pass—the longest glacier pass in the world The party left Nagar on June 27, spent ten days exploring the vast system of glaciers not marked on any map which covers the north slopes of the main Hindu-Kush range in that neighbourhood Mr Conway ascended a difficult rock peak of 17,000 feet, and attempted the ascent of the Great Nagar Mountain, but he was driven back by a hundred yards of ice fall, that proved to be absolutely impassable On July 11, after a day's halt at Hispar, Mr Conway started up the great glacier and reached the foot of Nushik in three short marches The next day being cloudy he did not go to the top of Nushik, as he had intended, but he sent a party under Mr Rondebush to cross that pass They took all the spare baggage and conveyed it by the Braldo Valley to Askoleya. Meanwhile Mr Conway and Mr M'Cormick with an Alpine guide, Zurbuggen, continued three more marches up the great Hispar glacier to the pass, which they actually crossed on July 18 The view from the pass is said to be superb, over a vast lake of snow some 300 miles in area, quite flat, surrounded by a ring of giant peaks and with a row of peaks rising like islands in the midst of it They camped just below the pass on the east side and were overtaken by a severe snowstorm They descended two marches down the Biafo glacier to the level of grass, whence they sent Zurbuggen to Askoleya, which he reached in one long day's march. Mr. Conway spent six days on the way, chiefly occupied in surveying, which the continued bad weather rendered difficult The whole party re united at Askoleya on July 26 The length of

the pass from the foot of the Hispar Pass to the foot of the Biafo glacier is about ninety miles. The mercury on the pass stood at 15.85 in. No one suffered perceptibly from the rarefaction of the air.

THE latest news from Etna is that Monte Gemmellaro has broken out afresh, and the great lava current that has been flowing from it has now been divided into two arms, both of which are rapidly advancing in the direction of Serra Pizzuto and Pedova, completely covering *en route* the lavas of 1886. The deluges of molten rock that have been emitted during the last month have destroyed one of the finest and most fertile districts in Sicily.

PROF. FOREL has recently prepared a table (*Arch. de Sci.* July 15) showing the behaviour of the small lake at the Great St. Bernard in regard to cold since 1817. This lake is at a height of about 8000 feet, is about 24 acres in surface, and of small depth. It appears the mean duration of the frozen state is about 268 days; for nearly two thirds of the year the lake is imprisoned "under a carapace of ice and snow." This justifies only too well the remark of the monk, "Nine months of winter and three months of bad weather." Between the earliest date of freezing (September 30) and the latest (November 6) are 36 days, the mean date being October 20. The earliest date of thawing is June 12, and the latest September 15; difference 95 days (the mean date being July 13). By grouping the dates in a series of decades (approximately) Prof. Forel finds maxima of duration of the frozen state in 1840–49 and in 1880–91, and a minimum in 1860–69. This corresponds fairly, he points out, with the phases of Bruckner's cycle, according to which a maximum of cold occurred about 1850, a maximum of heat about 1860, and a maximum of cold about 1880.

BY the election of the present holder—Mr. A. A. Kanthack—to the Medical Tutorship of the Liverpool University College Medical School, the John Lucas Walker Studentship in Pathology at Cambridge will shortly become vacant. The studentship is of the annual value of £250, and is tenable for three years. Candidates should send in their applications and testimonials by October 25, to Prof. Roy, F.R.S., New Museum, Cambridge.

WE learn from the *British Medical Journal* that the Library of the British Medical Association has been presented with a valuable gift of a series of important works, bearing chiefly on hygiene and public medicine, from the library of the late Dr. Alfred Carpenter. The books number upwards of 250 volumes, and are the gift of Mrs. Carpenter.

AN interesting account of a visit by Mr. E. Satow to the ruins of Sukkhothai and Sawankhalôk, Siam, appears in the Journal of the Society of Arts, for August 12.

A NEW edition—the sixth—of "The Electric Light popularly explained," by A. Bromley Holmes, has just been brought out by Messrs. Hemrose and Sons, Limited.

"PAPERS and Proceedings of the Royal Society of Tasmania for 1891" has just reached us, and we learn from the report that during the year six meetings were held and thirteen papers were read; the income amounted to £393, and the expenditure to £235 1s. 1d.

A CATALOGUE of Standard English and Foreign Books on Chemistry and the Allied Sciences has just been issued by Mr. W. F. Clay, Edinburgh.

THE Annual Report of the Superintendent, Mr. J. H. Hart, on the Royal Botanic Gardens, Trinidad, for 1891, has lately been published, and much good work seems to have been accomplished during the year.

WE have received from the Australian Museum, Sydney, Parts I. (Cephalopoda) and II. (Pteropoda) of the Catalogue of the Marine Shells of Australia and Tasmania, which Mr. John Brazier is compiling.

A PAMPHLET on "The Dairy and its Equipment, with Practical Management of Milk and Cream," which has been written by Dr. H. J. Webb (the Principal of the Aspatria Agricultural College) in conjunction with Mrs. Edward Moul, and recently issued, is full of information likely to be of use to those engaged in dairy-work.

IN the *American Naturalist* for August, Dr. S. Lockwood gives a geological reason "Why the Mocking Birds Left New Jersey," and the report of Prof. Osborn's lectures on "Heredity and the Germ-Cells" is continued.

Naturae Novitates for July has reached us from the publishers, R. Friedländer & Sohn, Berlin.

THREE new volumes have been added to the excellent series entitled "Encyclopédie Scientifique des Aide-Mémoire" (Gauthier-Villars)—"Notions de Chimie Agricole," by J. Schlœsing, Fils; "Les Divers Types de Moteurs à Vapeur," by E. Sauvage; "La Bière," by L. Lindet.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. H. D. Bowditch; a Puma (*Felis concolor*), a Tayra (*Galictis barbara*) from Brazil, presented by Mr. J. F. Wolfe; three Martineta Tinamous (*Calodromus elegans*) from Bahia Blanca, Argentina, presented by Mr. F. W. Horn; a Slender-billed Cockatoo (*Licmetis tenuirostris*) from Australia, presented by Dr. J. C. Victor Sapp; a Californian Sea Lion (*Otaria stelleri*) from the North Pacific, an Indian Chevrotain (*Tragulus meminna*, ♀) from India, deposited; an Indian Oriole (*Oriolus kundoo*), two —— Himalayan Tree Pies (*Dendrocitta himalayensis*) from India, five Black-necked Tanagers (*Euphonia nigricollis*), six Thick-billed Tanagers (*Euphonia laniirostris*), a Violet Tanager (*Euphonia violacea*), a Greenish Tanager (*Euphonia chlorotica*), a Lead-coloured Tanager (*Hypophaea chalybea*) from Brazil, purchased; a Magellanic Goose (*Bernicla magellanica*) bred in Holland, six Himalayan Tree Pies (*Dendrocitta himalayensis*) from India, received in exchange.

OUR ASTRONOMICAL COLUMN

THE PERSEIDS.—Mr. Denning, in the August number of *The Observatory*, remarks, with reference to the radiant point of the Perseids, that "the agreement of observation and theory is not perfect, especially as regards the shower at its earlier stages and at its termination, when the displacement appears to be somewhat greater than theory requires." From observations made on August 16, 1877, the radiant he deduced was $60° + 59°$, the theoretical position, according to Dr. Kleiber, being $54° + 59°$. In 1886, on the same date, from the path of a very bright Perseid, Mr. Denning obtained a radiant point of $53° + 59°$, a value closely approaching the theoretical one. As Mr. Denning has reason to believe that the Perseids will continue to fall until the 22nd of this month, and as the suspected radiant for this date is about $77° + 56\frac{1}{2}°$, our readers will have an opportunity of either verifying this position or obtaining one more accurate.

THE observations of the August meteors seem to have been sadly interfered with by the weather. So far we have received no communication respecting them.

"HIMMEL UND ERDE."—The August number of *Himmel und Erde* contains much that will be read with interest. Herr J. Plassmann contributes an article, which will be continued in the next issue, on variable and new stars, in which, after referring to the peculiar features of the late nova, he discusses the light curves of many well-known variables. A supplement to the note on the great February spot includes an illustration

showing the movement in the line of sight of the F line caused by the presence of a protuberance in the region of the spot "The Length of our Earth-days," "A Lost Comet," and "Paris Scientific Undertakings" are titles of other communications, the last of which is a brief general survey of recent additions to our knowledge about the construction and movement of the visible universe

ASTRONOMY AT THE COLUMBIAN EXPOSITION —Arrangements are about to be made for organizing a series of congresses or conventions to be held next year during the progress of the World's Exposition The preliminary address of the General Committee on Mathematics and Astronomy points out that such a congress should take advantage of the presence of the leading scholars of the world for the mutual interchange of ideas by presenting and considering investigations in special lines of research

The sections dealing with Astronomy and Astro Physics are eight in number and are as follows —

Astronomy

a History of Astronomy
b Astronomical Instruments
c Methods of Observation
d Physical Astronomy
e Observatory Buildings

Astro Physics

a Spectrum Analysis
b Astronomical Photography
c Stellar Photometry

The address further states that advice and suggestions with regard to the general conduct of the convention are earnestly invited, while special stress is laid on the scientific questions for future discussion The Chairmen of the Special Committees of the several subjects under the charge of the General Committee are as follows —

Pure Mathematics —Prof E H Moore, Chicago University

Astronomy —Prof G W Hough, Dearborn Observatory, North western University, Evanston

Astro-Physics —Prof George E Hale, Kenwood Astro Physical Observatory, Chicago

Among the names in the partial lists of the Advisory Councils on these two subjects we notice those of Prof A Cayley and Prof J J Sylvester for mathematics, and S Copeland (Astronomer Royal for Scotland), Prof R S Ball, Prof Gill, Mr Norman Lockyer, the Earl of Rosse, Prof Liveing, Prof Dewar, and Dr Huggins

LUNAR ECLIPSE, MAY 11, 1892 —With reference to the lunar eclipse that occurred last May, *Astronomische Nachrichten* No 3106 contains a series of accounts, which include the times of immersion and emersion of the objects on the moon's surface, gathered from the following observatories —Bonn, Heidelberg, Breslau, Christiania, Prag, Kiel, and Kalocsa.

NUMERATION OF ASTEROIDS —The *Astronomical Journal* No 271 contains the announcement that an arrangement had been agreed upon by which the numeration of asteroids will in future be put on a sound basis For the present Prof Krueger will assign to these bodies the notation 1892 A, B, C in the order in which their announcement is sent to the Telegraphische Central-Stelle, Prof Tietzen, Director of the Rechen Institute in Berlin, in the meantime undertaking their definite numeration This arrangement will be found to avoid all such confusion as has been experienced with regard to those asteroids about which sufficient information is not available for their orbital determinations Although they will not now receive their numbers, they can easily be recognized by their lettering in the annual series

THE BRITISH ASSOCIATION

SECTION C

GEOLOGY

OPENING ADDRESS BY PROF C. LAPWORTH, LL D., F R.S., F G S, PRESIDENT OF THE SECTION

IT has, I believe, been the rule for the man who has been honoured by election to the chair of President of the Geological Section of the British Association to address its members upon the recent advances made in that branch of geology in which he has himself been most immediately interested It is not my intention upon the present occasion to depart from this time honoured custom, for it has both the merit of simplicity and the advantage of utility to recommend it In this way each branch of our science, as it becomes in turn represented, not only submits to the workers in other departments a report of its own progress, but presents by implication a broad sketch of the entire geological landscape, seen through the coloured glasses, it may be, of divisional prejudice, but at any rate instructive and corrective to the workers in other departments, as being taken from what is to them a novel and an unfamiliar point of view

Now every tyro in geology is well aware of the fact that the very backbone of geological science is constituted by what is known as stratigraphical geology, or the study of the geological formations These formations, stratified and unstratified, build up all that part of the visible earth crust which is accessible to the investigator Their outcropping edges constitute the visible exterior of our globe, the surface of which forms the physical geography of the present day, and their internal characters and inter relationships afford us our only clues to the physical geographies of bygone ages Within them lies enshrined all that we may ever hope to discover of the history and the development of the habitable world of the past

These formations are to the stratigraphical geologist what species are to the biologist, or what the heavenly bodies are to the astronomer It was the discovery of these formations which first elevated geology to the rank of a science In the working out of their characters, their relationships, their development, and their origin, geology finds its means, its aims, and its justification Whatever fresh material our science may yield to man's full conception of nature, organic and inorganic, must of necessity be grouped around these special and peculiar objects of its contemplation

When the great Werner first taught that our earth-crust was made up of superimposed rock-sheets or formations arranged in determinable order, the value of his conclusions from an economic point of view soon led to their enthusiastic and careful study, and his crude theory of their successive precipitation from a universal chaotic ocean disarmed the suspicions of the many until the facts themselves had gained such a wide acceptance that denial was no longer possible But when the greater Hutton asserted that each of these rock formations was in reality nothing more nor less than the recemented ruins of an earlier world, the prejudices of mankind at large were loosed at a single stroke Like Galileo's assertion of the movement of the globe, this demanded such an apparently undignified and improbable mode of creation that there is no wonder that, even down to the present day, there still exist some to whom this is a hard saying, to be taken, if taken at all, in homœopathic doses and with undisguised reluctance

Hutton, as regards his philosophy, was, as we know, far in advance of his time With all the boldness of conviction he unflinchingly followed out these ideas to their legitimate results He claimed that as the stratified formations were composed of similar materials—sands, clays, limestones, and muds—to those now being laid down in the seas around our present coasts, they must, like them, have been the products of ordinary natural agencies—of rain, rivers, and sea waters, internal heat and external cold—acting precisely as they act now And further as these formations lie one below the other, in apparently endless downward succession, and all are formed more or less of these fragmentary materials, so the present order of natural phenomena must have existed for untold ages Indeed, to the commencement of this order he frankly admits, "I see no trace of a beginning or sign of an end"

The history of the slow acceptance of Hutton's doctrines, even among geologists, is, of course, perfectly familiar to us all. William Smith reduced the disputed formations to order, and showed that not only was each composed of the ruins of a vanished land, but that each contained in its fossils the proof that it was deposited in a vanished sea inhabited by special life creation Cuvier followed, and placed it beyond question that the fossilized relics of these departed beings were such as made it absolutely unquestionable that these creatures might well have inhabited the earth at the present day Lyell completed the cycle by demonstrating stage by stage the efficiency of present natural agencies to do all the work required for the degradation and rebuilding of the formations Since his day the students of

stratigraphical geology have universally acknowledged that in the study of present geographical causes lies the key to the geological formations and the inorganic world of the past

In this way the road was paved for Darwin and the doctrine of descent The aid which had been so ungrudgingly afforded by biology to geology was repaid by one of the noblest presents ever made by one science to another For the purposes of geology, the science of biology had practically completed a double demonstration first, that the extinct life discernible in the geological formations was linked inseparably with the organic life of the present, and, second, that every fossil recognized by the geologist was the relic of a creature that might well have existed upon the surface of the earth at the present time Geology repaid its obligation to biology by the still greater twofold demonstration first, that in the economy of nature the most insignificant causes are competent to the grandest effects, if only a sufficiency of time be granted them, and, second, that in the geological formations we have the evidences of the actual existence of those mighty eons in which such work might be done

The doctrine of organic evolution would always have remained a metaphysical dream had geology not given the time in which the evolution could be accomplished The ability of present causes to bring about slow and cumulative changes in the species is, to all intents and purposes, a biological application of Hutton's ideas with respect to the original geological formations Darwin was a biological evolutionist, because he was first an uniformitarian geologist Biology is pre eminent to day among the natural sciences, because its younger sister, Geology, gave it the means

But the inevitable consequence of the work of Darwin and his colleagues was that the centre of gravity, so to speak, of popular regard and public controversy was suddenly shifted from stratigraphical geology to biology Since that day stratigraphical geology, to its great comfort and advantage, has gone quietly on its way unchallenged, and all its more recent results have, at least by the majority of the wonder loving public, been practically ignored

Indeed, to the outside observer it would seem as if stratigraphical geology for the last thirty years had been practically at a standstill The startling discoveries and speculations of the brilliant stratigraphists of the end of the last century and first half of the present forced the geology of their day into the very front rank of the natural sciences, and made it perhaps the most conspicuous of them all in the eyes of the world at large Since that time, however, their successors have been mainly occupied in completing the work of the great pioneers The stratigraphical geologists themselves have been almost wholly occupied in laying down upon our maps the superficial outlines of the great formations, and working out their inter relationships and subdivisions At the present day the young stratigraphical student soon learns that all the limits of our great formations have been laid down with accuracy and clearness, and finds but little to add to the accepted nomenclature of the time

Our palæontologists also have equally busied themselves in working out the rich store of the organic remains of the geological formations, and the youthful investigator soon discovers that almost every fossil he is able to detect in the field has already been named, figured, and described, and its place in the geological record more or less accurately fixed

In France, in Germany, in Norway, Sweden, and elsewhere, in Canada and in the United States, work as thorough and as satisfactory has been accomplished, and the local development of the great stratified formations and their fossils laid down with detail and clearness

Many an unfledged, but aspiring geologist, alive to these facts, and contrasting the well mapped ground of the present time with the virgin lands of the days of the great pioneers, finds it hard to stifle a feeling of keen regret that there are nowadays no new geological worlds to conquer, no new systems to discover and name, and no strange and unexpected faunas to unearth and bring forth to the astonished light of day The youth of stratigraphical geology, with all its wonder and freshness, seems to have departed, and all that remains is to accept, to commemorate, and to round off the glorious victories of the dead heroes of our science

But to the patient stratigraphical veteran, who has kept his eyes open to discoveries new and old, this lull in the war of geological controversy presents itself rather as a grateful breathing time, the more grateful as he sees looming rapidly up in front the vague outlines of those oncoming problems which it will be the duty and the joy of the rising race of young geologists to grapple with and to conquer, as their fathers met and vanquished the problems of the past He knows perfectly well that Geology is yet in her merest youth, and that to justify even her very existence there can be no rest until the whole earth-crust and all its phenomena, past, present, and to come, have been subjected to the domain of human thought and comprehension There can be no more finality in Geology than in any other science, the discovery of to day is merely the stepping-stone to the discovery of to-morrow, the living theory of to-morrow is nourished by the relics of its parent theory of to-day

Now if we ask what are these formations which constitute the objects of study of the stratigraphical geologist, I am afraid that, as in the case of the species of the biologist, no two authorities would agree in framing precisely the same definition The original use of the term *formation* was of necessity lithological, and even now the name is most naturally applied to any great sheet of rock which forms a component member of the earth crust, whether the term be used specifically for a thin homogeneous sheet of rock like the Stonesfield slate, ranging over a few square miles, or generically, for a compound sheet of rock, like the Old Red Sandstone, many thousands of feet in thickness, but whose collective lithological characteristics give it an individuality recognizable over the breadth of an entire continent

When Werner originally discovered that the "formations" of Saxony followed each other in a certain recognizable order, a second characteristic of a formation became superposed upon the original lithological conception—namely, that of determinate "relative position" And when William Smith proved that each of the formations of the English Midlands was distinguished by an assemblage of organic remains peculiar to itself, there became added yet a third criterion—that of the possession of "characteristic fossils"

But these later superposed conceptions of time succession and life type are far better expressed by dividing the geological formations into zoological *zones*, on the one hand, and grouping them together, on the other hand, into chronological *systems* For in the experience of every geologist he finds his mind instinctively harking back to the bare lithological application of the word "formation," and I do not see that any real advantage is gained by departing from the primitive use of the term

A *zone*, which may be regarded as the *unit of palæontological succession*, is marked by the presence of a special fossil, and may include one or many subordinate formations A *system*, which is, broadly speaking, the *unit of geological succession*, includes many "zones," and often, but not always, many "formations" A *formation*, which is the *unit of geological stratigraphy*, is a rock sheet composed of many strata possessing common lithological characters The formation may be simple, like the Chalk, or compound, like the New Red Sandstone, but, simple or compound, local or regional, it must be always recognizable, geographically and geologically, as a lithological individual

As regards the natural grouping of these lithological individuals as such, fair progress has been made of late years, and our information is growing apace We know that there are at any rate three main groups 1st The stratified formations due to the action of moving water above the earth-crust, 2nd The igneous formations which are derived from below the earth crust, 3rd The metamorphic formations which have undergone change within the earth-crust itself We know also that of these three the only group which has hitherto proved itself available for the purpose of reading the past history of the globe is that of the stratified formations

Studying these stratified formations therefore in greater detail, we find that they fall naturally in their turn into two sets—viz, a mechanical set of pebble beds, sandstones and clays formed of rock fragments washed off the land into the waters, and an organic set of limestones, chalk, &c, formed of the shells and exuviæ of marine organisms

But when we attempt a further division of these two sets our classification soon begins to lose its definiteness We infer that some formations, such as the Old Red and the Triassic, were the comparatively rapid deposits of lakes and inland seas; that others, like the Coal Measures, London Clay, &c, were the less rapid deposits of lagoons, river valleys, deltas, and the like, that others, like our finely laminated shales and clays of the Silurian and Jurassic, were the slower deposits of the broader

seas, and finally, that others, like our Chalk and Greensand, were possibly the extremely slow deposits of the more oceanic deeps

Nevertheless, after looking at the formations collectively, there remains no doubt whatever in the mind of the geologist that their mechanical members are the results of the aqueous degradation of vanished lands, and that their organic members are the accumulated relics of the stony secretions of what once were living beings Neither is there any possibility of escape from the conclusion that they have all been deposited by water in the superficial hollows of the sea bottoms and ocean floors of the earth crust of their time

In the life of every individual stratified formation of the mechanical type we can always distinguish three stages first, the stage of erosion and transportation, in which the rock fragments were worn off the rocks of the higher ground and washed down by rain and rivers to the sea second, a stage of deposition and consolidation below the surface of the quiet waters, and third, a final stage in which the completed rock formation was bent and upheaved, in part at least, into solid land In the formations of the organic type three corresponding stages are equally discernible first, the period of mineral secretion by organized beings, second, the period of deposition and consolidation, and third, the final period of local elevation in mass But one and all, mechanical and organic alike, they bear in their composition, in their arrangement, and in their fossils, abundant and irresistible evidences that they *were* the products, and that now they *are* the memorials of the physical geography of their time

Guided by the principles of Hutton and Lyell, geologists have worked out with great care and completeness the effects of those agencies which rule in the first of these three life stages in the history of a mechanical formation No present geological processes are better known to the young geologist than those of denudation, erosion, and transportation, so familiar to us in the eloquent works of our President They form together the subject-matter of that most wonderful fascinating chapter in geology, which from its modest opening among the quiet Norfolk sandhills sweeps upwards and onwards without a break to its magnificent close on the brink of the gorge of the Colorado But our knowledge of the detailed processes of deposition and consolidation which rule in the second stage is still exceedingly imperfect, although a flood of light has been thrown upon the subject by the brilliant results of the *Challenger* expedition And we are compelled to admit that our knowledge of the operations of those agencies which rule in the processes of upheaval and depression is as yet almost nil, and what little we have already learnt of the effects of those agencies is the prey of hosts of conflicting theories that merely serve to annoy and bewilder the working student of the science

But not one of the formative triad of detrition, deposition, and elevation can exist without the others No detrition is possible without the previous upheaval of the rock-sheet, from which material can be removed, no deposition is possible without the previous depression of the rock sheet, which forms the basin in which the fragmentary material can be laid down

Our knowledge, therefore, of the origin and meaning of any geological formation whatever, can at most be only fragmentary until this third chapter in the life history of the geological formation has been attacked in earnest

Now all the rich store of knowledge that we possess respecting the first stage in the life of a geological formation has been derived from a comparison of certain phenomena which the stratigraphical geologist finds in the rock formations of the past, with correspondent phenomena which the physical geographer discovers on the surface of the earth of the present And all that we know of the second stage again has been obtained in precisely the same way Surely analogy and common sense both teach us that all which is likely to be of permanent value to us as regards the final stage of elevation and depression must first be sought for in the same direction

Within the last twenty years or so many interesting and vital discoveries have been made in the stratigraphy of the rock formations, which bear largely upon this obscure chapter of elevation and depression And I propose on this occasion that we try to summarize a few of these new facts, and then, reading them in conjunction with what we actually know of the physical geography of the present day, try to ascertain how such mutual agreement as we can discover may serve to aid the stratigraphical geologist in his interpretation of the true meaning of the geological formations themselves We may not hope for many years to come to read the whole of this geological chapter, but we may perhaps modestly essay an interpretation of one or two of the opening paragraphs

In the physical geography of the present day we find the exterior of our terraqueous globe divided between the two elements land and water We know that the solid geological formations exist everywhere beneath the visible surface of the lands, but of their existence under the present ocean floor we have as yet no absolute certainty We know both the form of the surface and the composition of the outer layers of the continental parts of the lithosphere, we only know as yet even in outline the form of the surface of its oceanic portions The surface of each of our great continental masses of land resembles that of a long and broad arch-like form, of which we see the simplest type in the New World The surface of the North American arch is sagged downwards in the middle into a central depression which lies between two long marginal plateaux, and these plateaux are finally crowned by the wrinkled crests which form its modern mountain systems The surface of each of our ocean floors exactly resembles that of a continent turned upside down Taking the Atlantic as our simplest type, we may say that the surface of an ocean basin resembles that of a mighty trough or syncline, buckled up more or less centrally into a medial ridge, which is bounded by two long and deep marginal hollows, in the cores of which still deeper grooves sink to the profoundest depths This complementary relationship descends even to the minor features of the two Where the great continental sag sinks below the ocean level, we have our gulfs and our Mediterraneans, seen in our type continent as the Mexican Gulf and Hudson Bay Where the central oceanic buckle attains the water line, we have our oceanic islands, seen in our type ocean as St Helena and the Azores Although these apparent crust-waves are neither equal in size nor symmetrical in form, this complementary relationship between them is always discernible The broad Pacific depression seems to answer to the broad elevation of the Old World—the narrow trough of the Atlantic to the narrow continent of America

Every primary wave of the earth's surface is broken up into minor waves, in each of which the ridge and its complementary trough are always recognizable The compound ridge of the Alps answers to the compound Mediterranean trough, the continuous western mountain chain of the Americas to the continuous hollow of the Eastern Pacific which bounds them, the sweep of the crest of the Himalaya to the curve of the Indo-Gangetic depression Even where the surface waves of the lithosphere lie more or less buried beneath the waters of the ocean and the seas, the same rule always obtains The island chains of the Antilles answer to the several Caribbean abysses, those of the Ægean Archipelago answer to the Levantine deeps

Draw a section of the surface of the lithosphere along a great circle in any direction, the rule remains always the same crest and trough, height and hollow, succeed each other in endless sequence, of every gradation of size, of every degree of complexity. Sometimes the ridges are continental, like those of the Americas, sometimes orographic, like those of the Himalaya, sometimes they are local, like those of the English Weald But so long as we do not descend to minor details we find that every line drawn across the earth's surface at the present day rises and falls like the imaginary line drawn across the surface of the waves of the ocean No rise of that line occurs without its complementary depression, the two always go together, and must of necessity be considered together Each pair constitutes one of those *geographical units of form* of which every continuous direct line carried over the surface of the lithosphere of our globe is made up This unit is always made up of an arch-like rise and a trough like depression, which shade into each other along a middle line of contrary curvature It resembles the letter S or Hogarth's line of beauty, and is clearly similar in form to the typical wave of the physicist Here, then, we reach a very simple and natural conclusion, viz the surface of the earth crust of the present day resembles that of a series of crust waves of different lengths and different amplitudes, more or less irregular and complex, it is true, but everywhere alternately rising and falling in symmetrical halves like the waves of the sea

Now this rolling wave like earth-surface is formed of the outcropping edges of the rock formations which are the special

objects of study of the stratigraphical geologist. If, therefore, the physiognomy of the face of our globe is any real index of the character of the personality of the earth crust beneath it, these collective geographical features should be precisely those which answer to the collective structural characters of the geological formations.

In the earlier days of geology one of the first points recognized by our stratigraphists was the fact that the formations were successive lithological sheets, whose truncated outcropping edges formed the present surface of the land, and that these sheets lay inclined at an angle one over the other, or as William Smith quaintly expressed it, like a tilted "pile of slices of bread and butter." But as discovery progressed the explanation of this arrangement soon became evident. The formations revealed themselves as a series of what had originally been deposited as horizontal sheets, lying in regular order one over the other, but which had been subsequently bent up into alternating arches and troughs (*i.e.* the anticlines and synclines of the geologist). Their visible parts, which now constitute the surface of our habitable lands, were simply those parts of the formations which are cut by the irregular plane of the present earth's surface. All those parts of the great arches and troughs formerly occurring above that plane have been removed by denudation; all those parts below that plane lie buried still, out of sight within the solid earth crust.

Although in every geological section of sufficient extent it was seen that the anticline or arch never occurred without the syncline or trough—in other words, that there was never a rise without a corresponding fall of the stratum, yet it is only of late years that the stratigraphical geologist has come clearly to recognise the fact that the anticline and syncline must be considered together, and must be united as a single crust wave. For the arch is never present without its complementary trough, and the two together constitute the *tectonic*, *structural*, or *orographic unit*, namely, *The Fold*, the study of which, so brilliantly inaugurated by Heim in his "Mechanismus der Gebirgsbildung," is destined, I believe, in time, to give us the clue to the laws which rule in the local elevation and depression of the earth crust, and furnish us with the means of discovery of the occult causes which lie at the source of those superficial irregularities which give to the face of our globe its variety, its beauty, and its habitability.

We have said already that this wave or fold of the geologist resembles that of the wave of the physicist. Now we may regard such a wave as formed of two parts, the arch-like part above and the trough-like part below. The length of the wave is naturally the length of the axial line joining the outer extremities of the arch and trough, and passing through the centre, node, or point of origin of the wave itself, which bisects the line of contrary curvature. The amplitude of the wave is the height of the arch added to the depth of the trough. The arch part of such a wave, if perfectly symmetrical, may clearly be regarded as belonging either to a wave travelling to the right, in which case the complementary trough is the one in that direction, or it may be regarded as belonging to a wave travelling to the left, in which case its trough must be the one in that direction. But as in the case of the shore wave, the advancing slope of the wave is always the steeper, and the real centre of the wave must lie half way down this steeper slope; so there is no difficulty in recognizing the centre of a geological fold and fixing the real direction of movement.

The fold of the geologist differs from the ordinary wave of the physicist, essentially in the fact that even in its most elementary conception, as that of a plate bent by a pressure applied from opposite sides, it necessarily includes the element of thickness. And this being the case, the rock sheet which is being folded and curved has different layers of its thickness affected differently. In the arch of the fold the upper layers of the rock sheet are extended, while its lower layers are compressed. On the contrary in the trough of the fold the upper layers are compressed and the lower layers are extended. But in arch and trough alike there exists a central layer, which, beyond taking up the common wave-like form, remains practically unaffected.

But the geological fold has in addition to length and thickness, the further element of breadth, and this fact greatly complicates the phenomena.

Many of the movements which take place in a rock sheet which is being folded, or in other words those produced by the bending of a compound sheet composed of many leaves, can be fairly well studied in a very simple experiment. Take an ordinary large note book, say an inch in thickness, with flexible covers. Rule carefully a series of parallel lines across the edges of the leaves at the top of the book, about ¼ of an inch apart, and exactly at right angles to the plane of the cover. Then, holding the front edges loosely, press the book slowly from back and front into an S-like form until it can be pressed no further. As the wave grows, it will be noticed that the cross lines which have been drawn on the upper edge of the book remain fairly parallel throughout the whole of the folding process, except in the central third of the book, where they arrange themselves into a beautiful sheaf-like form, showing how much the leaves of the book have sheared or slidden over each other in this central portion. It will also be seen when the S is complete that the book has been forced into a third of its former breadth.

It is clear that the wave which the book now forms must be regarded as made up of three sections, viz. a section forming the outside of the trough on the one side, and a section forming the outside of the arch on the other, and a central or common section, which may be regarded either as uniting or dividing the other two.

As this experiment gives us a fair representation of what takes place in a geological fold, we see at a glance that the geologist is forced to divide his fold into three parts—an arch limb, a trough limb, and a middle limb—which last we may call the *copula* or the *septum*, according as we regard it as connecting or dividing the other two. Our note book experiment shows us also that in the trough limb and the arch limb the leaves or layers undergo scarcely any change of relative position beyond taking on the growing curvature of the wave. But the layers in the central part, or *septum*, undergo sliding and shearing. It will be found also, by gripping the unbound parts of the book firmly and practising the folding in different ways, that this *septum* is also a region of warping and twisting. This simple experiment should be practised again and again until all these points are apparent, and the various stages of the folding process become clear; the surface of the book being forced first into a gentle arch-like rise with a corresponding trough-like fall; then stage by stage the arch should be pushed over on to the trough until the surfaces of the two are in contact and the book can be folded no further.

In the structure of our modern mountain ranges we discover the most beautiful illustrations of the bending and folding of the rocky formations of the earth crust. The early results of Rogers among the Alleghanies, of Lory and Favre in the Western Alps, have been greatly extended of late years by the discoveries of Heim and Baltzer in the Central Alps, of Bertrand in Provence, of Margerie in Languedoc, of Dutton and his colleagues in the western ranges of America, and of Peach and Horne and others in the older rocks of Britain. The light these researches throw upon the phenomena of mountain structure will be found admirably summarized and discussed in the works of Leconte, of Dana, of Daubrée, of Reade, of Heim, and finally in the magnificent work of Suess, the "Antlitz der Erde," of which only the first two volumes have yet appeared.

Looking first at the mountain fold in its simplest form as that of a bent rock plate, composed of many layers which have been forced into two similar arc-like forms, the convexities of which are turned, the one upwards and the other downwards, we find in the present mountain ranges of the globe every kind represented. We commence with one in which the arch is represented merely by a gentle swell of the rock sheet, and the trough by an answering shallow depression, the two shading into each other in an area of contrary flexure. From this type we pass insensibly to others in which we see that the sides of the common limb or septum are practically perpendicular. From these we pass to folds in which the twisted common limb or septum overhangs the vertical, and so on to that final extreme, where the arch limb has been pushed completely over on to the trough limb, and all three members, as in our note book experiment, are practically welded into one conformable solid mass.

Although the movements of these mountain folds are slow and insensible, and only effected in the course of ages, so that little or no evidence of the actual movement of any single one of them has been detected since they were first studied, yet it is perfectly plain that when we regard them collectively, we have here crust folds in every stage of their existence. Each example in itself represents some one single stage in the lifetime of a single fold. They are simply crust folds of different ages. Some are, as it were, just born; others are in their earliest youth. Some have attained their majority, some are in the prime of life, and some

are in the decrepit stages of old age Finally, those in which all three members—arch limb, trough limb, and septum—are crushed together into a conformable mass, are dead Their life of individual movement is over If the earth pressure increases the material which they have packed together may of course form a passive part of a later fold, but they themselves can move no more

In many cases, due partly to the action of longitudinal pressures, the septum becomes reduced to a *plane* of contrary motion, namely—the over-fault, or thrust plane, and the arch limb and the trough limb slide past each other as two solid masses But here we have no longer a fold, but a fault

We see that every mountain fold commences first as a gentle alternate elevation and depression of one or more of the component sheets of the geological formations which make up the earth-crust This movement is due apparently to the tangential thrusts set up by the creeping together, as it were, of those neighbouring and more resistant parts of the earth-crust which lie in front of and behind the moving wave Yielding slowly to these lateral thrusts the crest of the fold rises higher and higher, the trough sinks lower and lower, the central common limb or septum grows more and more vertical and becomes more and more strained, sheared, and twisted As this middle limb yields, the rising arch part of the fold is forced gradually over on to the sinking trough, until at last all three members come into conformable contact and further folding as such is impossible Movement ceases, the fold is dead

We see also from our note-book experiment that the final result of the completion of the fold is clearly to strengthen up and consolidate that part of the crust plate to the local weakness of which it actually owed its origin and position The fold has by its life action theoretically trebled the thickness of that part of the earth plate in which its dead remains now lie If the lateral pressure goes on increasing and the layers of the earth crust again begin to fold in the same region, the inert remains of the first fold can only move as a passive part of a newer fold either as a part of the new arch limb, the new trough limb, or the new septum As each younger and younger fold formed in this way necessarily includes a more resistant, and therefore a thicker, broader, and deeper sheet of the earth crust, we have here the phylogenetic evolution of a whole family of crust folds, each successive member of which is of a higher grade than its immediate predecessor

But it very rarely happens that the continuous plate in which any fold is imbedded is able to resist the crust creep until the death of the first fold Usually, long before the first simple fold is completed, a new and a parallel one rises in front of it on the side of the trough limb, and the two grow, as it were, henceforward side by side But the younger fold, being due to a greater pressure than the older, must of necessity be of a higher specific grade, and the two together form a generic fold in common

Our present mountain systems are all constituted of several families of folds, all formed in this way, of different gradations of size, of different dates of origin, and of different stages of life evolution, and in each family group the members are related to each other by this natural genetic affinity

Sometimes the new folds are formed in successive order on one side of the first fold, and then we have our unilateral (or so-called unsymmetrical) mountain groups, like those of the Jura and the Bavarian Alps Sometimes they are formed on both sides of the original fold, and then we have our bilateral (or so called symmetrical) ranges, like the Central Alps In both cases the septa of the aged or dead folds are of necessary all directed inwards towards the primary fold If, therefore, they originate only on one side of the fold, our mountain group looks unsymmetrical, with a very steep side opposed to a gently sloping side If they grow on both sides of the original fold, we have the well known "fan structure" of mountain ranges. In this case the whole complex range is seen at a glance to be a vast compound arch of the upper layers of the earth-crust, keyed up by the material of the dead or dying folds, which by the necessities of the case constitute mighty wedges whose apices are directed inwards towards the centre of the system But a complete arch of this kind is in reality not a single fold, but a double one, with a septum on both sides of it, and it requires two troughs, one on each side of it, as its natural complement. The so-called unsymmetrical ranges, therefore, which are constituted merely of arch limb, trough limb, and septum, are locally the more natural and the more common

It is clear that in the lifetime of any single fold its period of greatest energy and most rapid movement must be that of middle life In early youth the lateral pressure is applied at a very small angle, and the tangential forces act therefore under the most disadvantageous circumstances In the middle life of the fold the arch limb and the trough limb stand at right angles to the septum, and the work of deformation is then accomplished under the most favourable mechanical conditions and with the greatest rapidity That is to say, the activity of the fold and the rate of movement of the septum, like the speed of the storm wind, varies directly as the gradient

In our note-book experiment we observed that little or no change took place in the arch limb and trough limb, while the septum became remarkably sheared and twisted The same is the case in nature, but here we have to recollect that these moving mountain folds are of enormous size, indeed actual mountains in themselves These great arches, scores of miles in length, thousands of feet in height and thickness, must of necessity be of enormous weight, capable of crushing to powder the hardest rocks over which they move, while the thrust which drives them forward is practically irresistible It is plain, therefore, that while the great arch limb and the trough limb of one of these mighty folds move over and under each other from opposite directions, they form together an enormous machine, composed of two mighty rollers or millstones, which mangle, roll, tear, squeeze, and twist the rocky material of the middle limb or septum, which lies jammed in between them, into a laminated mass This deformed material, which is the characteristic product of the mountain making forces, is, of course, made up of the stuff or the original middle limb of the fold, and whether we call it breccia, mylonite, phyllite, or schist, although it may be composed of sedimentary stuff, it is certainly no longer a *stratified* rock, and though it may have been originally purely igneous material, it is certainly no longer *volcanic* It is now a manufactured article made in the great earth mill

These mountain folds, however, are merely the types of folds and wrinkles of all dimensions which affect the rock formations of the earth crust Within the mountain chains themselves we can follow them fold within fold, first down to formations, then to strata, then to laminæ, till they disappear at last in microscopic minuteness beyond the limits of ordinary vision Leaving these, however, for the moment, let us travel rather in the opposite direction, for these mountain folds are by no means the largest known to the stratigraphical geologist Look at any geological section crossing the continent of North America, and it will be found that the whole of the Rocky Mountain range on its western side and the Alleghany range on the east are really two mighty compound geological anticlines, while the broad sag of the Mississippi Basin is actually a compound geological syncline made up of the whole pile of the geological formations That is to say, the continent of North America is composed of a pair of geological folds, the two arches of which are represented by the Rockies on the one side and the Alleghanies on the other, while the intermediate Mississippi syncline is the common property of both Here, then, we reach a much higher grade of fold than the orographic or mountain-making fold, viz the plateau making fold or the semi-continental fold, which, because of its enormous breadth, must include a very much thicker portion of the earth crust than the ordinary orographic fold itself

But which must be the real middle limbs of these two American folds, those septal areas where most work is being done and the motion is greatest?

Taught by what we have already learned of the mountain wave the answer is immediate and certain They must be on the steeper sides of each of the two folds, namely, those which face the ocean How perfectly this agrees with the geological facts goes without saying It is on the steep Pacific side of the western fold that the crushing and crumpling of its rocks is the greatest It is on the Atlantic side of the eastern fold that the contortion and the metamorphism of its rocks are at their maximum, while in the common and gently sloping trough of both folds, namely, the intermediate Mississippi Valley, the entire geological sequence remains practically unmodified throughout

Again, which of these two American folds should be the more active at the present day? Taught by our study of the mountain wave the answer again is immediate and conclusive. It must be that fold whose septum has the steeper gradient. Geology and geography flash at once into combination. The steeper Pacific septum of the western fold from Cape Horn almost to

Alaska is ablaze with volcanoes, while the gently inclined Atlantic septum of the eastern fold from Greenland to Magellan Straits shows none, except on the outer edge of the Antilles, in the very region where the slope of the surface is the steepest. We see at a glance that the vigour of these two great continental folds, like those of our mountain waves, varies directly as the surface gradient of the septum.

But the geographical surface of North America, considered as a whole, is in reality that of a double arch, with a sag or common trough in the middle. We have seen already that this double arch must be regarded as the natural complement of the equally double Atlantic trough. Here, then, if the path of analogy we have hitherto so triumphantly followed up to this point is still to guide us, the basin of the Atlantic must be, not only in appearance, but in actuality, formed of two long minor folds of the same grade as the two that form the framework of America, but with their members arranged in reverse order. If so, their submarine septa ought also to be lines of movement and of volcanic action. And this is again the case. The volcanic islands of the Azores and St. Helena lie not exactly on the longitudinal crests of the mid oceanic *Challenger* ridge, but upon its bounding flanks.

But we have not yet, however, finished with our simple fold. If we draw a line completely round the globe, crossing the Atlantic basin at its shallowest, between Cape Verde to Cape St. Roque, and continued in the direction of Japan, where the Pacific is at its deepest, as the trace of a great circle we find that we have before us a crust fold of the very grandest order. We have one mighty continental arch stretching from Japan to Chili, broken medially by the sag of the Atlantic trough, and this great terrestrial arch stands directly opposed to its natural complement, the great trough of the Pacific, which is bent up in the middle by the mightiest of all the submarine buckles of the earth-crust, on which stand the oceanic islands of the central Pacific.

But if this be true, then the septum of all septa on our present earth crust must cross our grandest earth fold where the very steepest gradient occurs along this line, and it must constitute the centre point of the moving earth fold, and of greatest present volcanic activity. And where is this most sudden of all depressions? Taught once more by our geological fold, the answer is instantaneous and incontrovertible. It is on the shores of Japan, the region of the mightiest and most active of all the living and moving volcanic localities on the face of our globe.

But the course of the line which we indicated as forming our grandest terrestrial fold returns upon itself. It is an endless fold, an endless band, the common possession of two sciences. It is geological in origin, geographical in effect. It is the *wedding-ring* of geology and geography, uniting them at once and for ever in indissoluble union.

Such an endless fold, again, must have an endless septum, which, in the nature of things, must cross it twice. Need I point out to the merest tyro in these wedded sciences that if we unite the Old and New Worlds and Australia, with their intermediate sags of the Antarctic and Indian Oceans, as one imperial earth arch, and regard the unbroken watery expanse of the Pacific as its complementary depression, then the circular coastal band of contrary surface flexure between them should constitute the moving master septum of the earth crust. This is the "Volcanic girdle of the Pacific," our "Terrestrial Ring of Fire."

Or, finally, if we rather regard the compact arch of the Old World itself as the natural complement of the broken Indo Pacific depression, then the most active and continuous septal band of the present day should divide them. Again our law asserts itself triumphantly. It is the great volcanic and earthquake band on which are strung the Festoon Islands of Western Asia, the band of Mount St. Elias, the Aleutians, Kamtchatka, the Kuriles, the band of Fusijama, Krakatoa, and Sangir. The rate of movement of the earth's surface doubtless everywhere varies directly as the gradient.

We find, therefore, that even if we restrict our observations to the most simple and elementary conception of the rock fold as being made up of arch-limb, trough-limb, and twisting but still continuous septum, we are able to connect, in one unbroken chain, the minutest wrinkle of the finest lamina of a geological formation with the grandest geographical phenomena on the face of our globe.

We find, precisely as we anticipated, that the wave-like surface of the earth of the present day reflects in its entirety the wave-like arrangement of the geological formations below. On the land we find that the surface arches and troughs answer precisely to the grander regional anticlines and synclines of the subterranean sedimentary sequence; and it may, I believe, be regarded as certain that the submarine undulations have a similar or complementary relationship. We find in the new geology, as Hutton found in the old, that geography and geology are one. We find, as we suspected, that the physiognomy of the face of our globe is an unerring index of the solid personality beneath. It bears in its lineaments the characteristic family features and the common traits of its long line of geological ancestors.

Such, it seems to me, is an imperfect account of the introductory paragraphs of that great chapter in the New Geology now in course of interpretation by geologists of the present day; and we have translated them exactly in the old way by the aid of the only living geological language, the language of present natural phenomena, and I doubt not that sooner or later the rest of this great chapter will be read by the same simple means.

I have confined myself to-day to the discussion of the characteristics of the simple geological fold as reduced to its most elementary terms of arch, trough, and unbroken septum; for this being clearly understood, the rest naturally follows. But this twisted plate is really the key which opens the entire treasure house of the New Geology in which lie spread around in bewildering confusion facts, problems, and conclusions enough to keep the young geologist and other scientific men busily at work for many a long year to come.

Into this treasure house I often wander myself, in the few leisure hours that I can steal from a very busy professional life; and out of it I bring now and again heresies that sometimes amuse and sometimes horrify my geological friends. As you have so patiently listened to what I have already said, perhaps you will permit me in a few final sentences to indicate in brief some of those novelties which I see already more or less clearly, and a few of those less novel points on which it appears to me that more light is wanted. My excuse is twofold—first, to furnish material for work and controversy to the young geologists; and second, to obtain aid for myself from workers in other walks of science.

The account of the simple rock-fold I have already given you is of the most elementary kind. It presupposes merely the yielding to tangential pressure from front and back, combined with effectual resistance to sliding. But in the layers of the earth crust there is always, in addition, a set of tangential pressures theoretically at right angles to this. The simple fold becomes a *folded fold*, and the compound septum twists not only vertically but laterally. On the surface of the globe this double set of longitudinal and transverse waves is everywhere apparent. They account for the detailed disposition of our lands and our waters, for our present coastal forms, for the direction, length, and disposition of our mountain ranges, our seas, our plains, and lakes. The compound arch becomes a dome, its complementary trough becomes a basin. The elevations and depressions, major and minor, are usually twinned, like the twins of the mineralogist, the complementary parts being often inverted, and turned through 180° (compare Italy with the Po-Adriatic depression). Every upward swirl and eddy has its answering downward swirl. The whole surface of our globe is thus broken up into fairly continuous and paired masses, divided from each other by moving areas and lines of mountain making and crust movement, so that the surface of the earth of the present day seems to stand midway in its structure and appearance between those of the sun and the moon, its eddies wanting the mobility of those of the one and the symmetry of those of the other. In the geology of the earth-crust, also, the inter crossing of the two sets of folds, theoretically at right angles to each other, gives rise to effects equally startling. It lies at the origin of the thrust-plane or overfault, where the septal region of contrary motion in the fold becomes reduced to, or is represented by, a *plane* of contrary motion. It allows us to connect together under one set of homologies folds and faults. The downthrow side of the fault answers to the trough, the upthrow side to the arch, of our longitudinal fold; while the fault plane itself represents the septal area reduced to zero. The node of the fault, and the alternation and alteration of throw, are due to the effects of the transverse folding.

These transverse folds of different grades, which affect different layers of the earth crust differentially, account also for the formation of laccolites, of granitic cores, and of petrological provinces, and they enable us also to understand many of the phenomena of metamorphism.

Of the folds of the third order I shall here say nothing, but I must frankly admit that the primal cause of all this tangential movement and folding stress is still as mysterious to me as ever. I incline to think that it is due to many causes—tidal action, sedimentation, and many others. I cannot deny, however, that it may be *mainly* the result of the contraction in diameter of our earth, due to the loss of its original heat into outer space? For everywhere we find evidences of symmetrical crushing of the earth-crust by tangential stresses. Everywhere we find proofs that different layers of that crust have been affected differentially, and the outer layers have been folded the most. We seem to be dealing not so much with a solid globe as with a globular shell composed of many layers.

Is it not just possible after all that, as others have suggested, our earth is such a hollow shell, or series of concentric shells, on the surface of which gravity is at a maximum, and in whose deepest interior it is non existent? May this not be so also in the case of the sun, through whose spot eddies we possibly look into a hollow interior? If so, perhaps our present nebulæ may also be hollow shells formed of meteorites, on the surfaces of these shells the fiery spirals we see would be the swirls which answer to the many twisting crustal septa of the earth. Our comets, too, in this case might be elongated ellipsoids, whose visible parts would be merely interference phenomena or sheets of differential movement.

In this case we have represented before us to day all the past of our earth as well as its present. Uniformity and evolution are one.

Thus from the microscopic septa of the laminæ of the geological formations we pass outwards *in fact* to these moving septa of our globe, marked on land by our new mountain-chains, and on our shores by our active volcanoes. Thence we sweep, *in imagination*, to the fiery eddies of the sun, and thence to the glowing swirls of the nebulæ, and so outwards and upwards to that most glorious septum of all the visible creation, the radiant ring of the Milky Way.

Prof. George Darwin, in his address to the section of mathematical and physical science at the meeting of the British Association at Birmingham in 1886, with all the courage of genius, and the authority of one of the sons of the prophets, acknowledged that it seems as likely that "meteorology and geology will pass the word of command to cosmical physics as the converse." Behind this generous admission I shelter myself. But I feel absolutely confident that long after the physicists may have swept away these provisional astronomical suggestions as "the baseless fabric of a vision," there will still remain in the treasure house of the geological fold a wealth of abundant material for the use of the mathematician, the physicist, the chemist, the mineralogist, and the astronomer, of the deepest interest and of the highest value.

SECTION H

ANTHROPOLOGY

OPENING ADDRESS BY ALEXANDER MACALISTER, M.D., F.R.S., PROFESSOR OF ANATOMY IN THE UNIVERSITY OF CAMBRIDGE, PRESIDENT OF THE SECTION.

ON an irregular and unfenced patch of waste land, situated on the outskirts of a small town in which I spent part of my boyhood, there stood a notice board bearing the Inscription, "A Free Coup," which, when translated into the language of the Southron, conveyed the intimation, "Rubbish may be shot here." This place, with its ragged mounds of unconsidered trifles, the refuse of the surrounding households, was the favourite playground of the children of the neighbourhood, who found a treasury of toys in the broken tiles and oyster-shells, the crockery and cabbage stalks, which were liberally scattered around. Many a make-believe house and road, and even village, was constructed by these mimic builders out of this varied material, which their busy little feet had trodden down until its undulated surface assumed a fairly coherent consistence.

Passing by this place ten years later I found that its aspect had changed; terraces of small houses had sprung up, mushroom-like, on the unsavoury foundation of heterogeneous refuse. Still more recently I notice that these in their turn have been swept away, and now a large factory, wherein some of the most ingenious productions of human skill are constructed, occupies the site of the original waste.

This commonplace history is, in a sense, a parable in which is set forth the past, present, and possible future of that accumulation of lore in reference to humanity to which is given the name Anthropology, and for the study of which this Section of our Association is set apart. At first nothing better than a heap of heterogeneous facts and fancies, the leavings of the historian, of the adventurer, of the missionary, it has been for long, and alas is still, the favourite playground of *dilettanti* of various degrees of seriousness. But upon this foundation there is rapidly rising a more comely superstructure, fairer to see than the original chaos, but still bearing marks of transitoriness and imperfection, and I dare hazard the prediction that this is destined in the course of time to give place to the more solid fabric of a real Science of Anthropology.

We cannot yet claim that our subject is a real science in the sense in which that name is applied to those branches of knowledge, founded upon ascertained laws, which form the subjects of most of our sister Sections, but we can justify our separate existence, in that we are honestly endeavouring to lay a definite and stable foundation, upon which in time to come a scientific Anthropology may be based.

The materials with which we have to do are fully as varied as were those in my illustration, for we as anthropologists take for our motto the sentiment of Chremes, so often quoted in this Section, *humani nihil a nobis alienum putamus*, and they are too often fully as fragmentary. The bones, weapons, and pottery which form our only sources of knowledge concerning prehistoric races of men, generally come to us as much altered from their original forms as are the rusty polyhedra which once were the receptacles for biscuits or sardines. The traditions, customs, and scraps of folk lore which are treasures to the constructive anthropologist, are usually discovered as empty shells, in form as much altered from their original conditions as are those smooth fragments of hollow white cylinders which once held the delicate products of the factory of Keiller or Cairns.

I have said that Anthropology has not yet made good its title to be ranked as an independent science. This is indicated by the difficulty of framing a definition at the same time comprehensive and distinctive. Mr. Galton characterizes it as the study of what men are in body and mind, how they came to be what they are, and whither the race is tending; General Pitt Rivers, as the science which ascertains the true causes for all the phenomena of human life. I shall not try to improve upon these definitions, although they both are manifestly defective. On the one side our subject is a branch of biology, but we are more than biologists compiling a monograph on the natural history of our species, as M. de Quatrefages would have it. Many of the problems with which we deal are common to us and to psychologists; others are common to us and to students of history, of sociology, of philology, and of religion; and, in addition, we have to treat of a large number of other matters æsthetic, artistic, and technical, which it is difficult to range under any subordinate category.

In view of the encyclopædic range of knowledge necessary for the equipment of an accomplished anthropologist, it is little wonder that we should be, as we indeed are, little better than smatterers. Its many-sided affinities, its want of definite limitation, and the recent date of its admission to the position of an independent branch of knowledge, have hitherto caused Anthropology to fare badly in our Universities. In this respect, however, we are improving, and now in the two great English Universities there are departments for the study of the natural history of man and of his works.

Out of the great assemblage of topics which come within our sphere, I can only select a few which seem at present to demand special consideration. The annual growth of our knowledge is chiefly in matters of detail which are dull to chronicle, and the past year has not been fertile in discoveries bearing on those great questions which are of popular interest.

On the subject of the antiquity of man there are no fresh discoveries of serious importance to record. My esteemed predecessor at the Leeds meeting two years ago, after reviewing

the evidence as to the earliest traces of humanity, concluded his survey with the judgment, "On the whole, therefore, it appears to me that the present verdict as to tertiary man must be in the form of 'Not Proven'" Subsequent research has not contributed any new facts which lead us to modify that finding The most remarkable of the recent discoveries under this head is that of the rude implements of the Kentish chalk plateau described by Professor Prestwich, but while these are evidently of archaic types, it must be admitted that there is even yet room for difference of opinion as to their exact geological age

Neither has the past year's record shed new light on the darkness which enshrouds the origin of man What the future may have in store for us in the way of discovery we cannot forecast, at present we have nothing but hypothesis, and we must still wait for further knowledge with the calmness of philosophic expectancy

I may, however, in this connection refer to the singularly interesting observations of Dr Louis Robinson on the prehensile power of the hands of children at birth, and to the graphic pictures with which he has illustrated his paper Dr Robinson has drawn, from the study of the one end of life, the same conclusion which Mr Robert Louis Stevenson deduced from the study of his grandfather, that there still survive in the human structure and habit traces of our probably arboreal ancestry

Turning from these unsolved riddles of the past to the survey of mankind as it appears to us in the present, we are confronted in that wide range of outlook with many problems well nigh as difficult and obscure

Mankind, whenever and however it may have originated, appears to us at present as an assemblage of tribes, each not necessarily homogeneous, as their component elements may be derived from diverse genealogical lines of descent It is much to be regretted that there is not in our literature a more definite nomenclature for these divisions of mankind, and that such words as *race*, *people*, *nationality*, *tribe*, and *type* are often used indiscriminately as though they were synonyms

In the great mass of knowledge with which we deal there are several collateral series of facts, the terminologies of which should be discriminated In the first place there are those ethnic conditions existing now, or at any other point in time, whereby the individuals of mankind are grouped into categories of different comprehension, as *clans* or families, as *tribes* or groups of allied clans, and as *nations*, the inhabitants of restricted areas under one political organization This side of our subject constitutes Ethnology

In the second place, the individuals of mankind may be regarded as the descendants of a limited number of original parents, and consequently each person has his place on the genealogical tree of humanity As the successive branches became in their dispersion subjected to the influences of diverse environments, they have eventually differentiated in characteristics To each of these subdivisions of the phylum thus differentiated the name *race* may appropriately be restricted, and the sum of the peculiarities of each race may be termed *race characters* This is the phylogenetic side of Anthropology, and its nomenclature should be kept clearly separate from that of the ethnological side The great and growing literature of Anthropology consists largely of the records of attempts to discover and formulate these distinctive race-characters *Race* and *tribe* may be terms of equal extension, but the standpoint from which these categories are viewed is essentially different in the two cases

There is yet a third series of names in common use in Descriptive Anthropology The languages in use among men are unfortunately numerous, and as the component individuals in each community usually speak a common language, the mistake is often made of confounding the tribal name with that of the tribal language Sometimes these categories are co extensive, but it is not always so, for it is a matter of history that communities have been led to adopt new languages from considerations quite independent of phylogenetic or ethnic conditions. These linguistic terms should not be confounded with the names in either of the other series, for, as my learned predecessor once said in a presidential address, it is as absurd to speak of an Aryan skull as it would be to say that a family spoke a brachycephalic language

In the one clan there may be, by intermarriage, the representatives of different races, in the one nation there may be dissimilar tribes, each derived by composite lines of ancestry from divergent phyla, yet all speaking the same language

We have an excellent illustration of the confusion resulting from this disregard of precision in the case of the word *Celtic*, a term which has sometimes been employed as an ethnic, sometimes as a phylogenetic, and sometimes as a linguistic species In the last named sense, that to which I believe the use of the name should be restricted, it is the appropriate designation of a group of cognate languages spoken by peoples whose physical characters show that they are not the descendants of one common phylum in the near past There are fair-haired, long headed families in Scotland and Ireland, fair, broad-headed Bretons, dark-haired, round headed Welshmen, and dark-haired, long-headed people in the outer Hebrides, McLeans, "Sancho Panza type"—men obviously of different races, who differ not only in colour, stature, and skull form, but whose traditions also point to a composite descent, and yet all originally speaking a Celtic tongue The use of the word *Celtic* as if it were the name of a phylogenetic species has naturally led to hopeless confusion in the attempts to formulate race-characters for the Celtic skull—confusions of a kind which tend to bring physical anthropology into discredit Thus Retzius characterizes the Celtic crania as being dolichocephalic, and compares them with those of the modern Scandinavians Sir Daniel Wilson considers the true Celtic type of skull as intermediate between the dolichocephalic and the brachycephali, and Topinard figures as the typical Celtic skull that of an Auvergnat, extremely brachycephalic, with an index of 85 !

Our traditional history tells that we, the Celtic-speaking races of Britain, are not of one common ancestry, but are the descendants of two distinct series of immigrants, a British and a Gaelic Whatever may have been the origin of the former, we know that the latter are not homogeneous, but are the mixed descendants of the several Fomorian, Nemedian, Firbolg, Tuatha de Danaan, and Milesian immigrations, with which has been combined in later times a strong admixture of Scandinavian blood. It is now scarcely possible to ascertain to which of these component strains in our ancestry we owe the Celtic tongue which overmastered and supplanted the languages of the other tribes, but it is strictly in accordance with what we know of the history of mankind that this change should have taken place We have instances in modern times of the adoption by conquered tribes of the language of a dominant invading people For example, Mr Hale has lately told us that the speech of the Hupas has superseded the languages of those Californian Indians whom they have subdued In like manner, nearer home, the English language is slowly but surely supplanting the Celtic tongues themselves

We may here parenthetically note that what has been observed in the case of language has also taken place in reference to ritual and custom Observances which have a history and a meaning for one race have, in not a few instances, been adopted by or imposed upon other races to whom they have no such significance, and who in incorporating them give to them a new local colour These pseudomorphs of the earlier cultures are among the most perplexing of the problems which the student of comparative religion or folk lore has to resolve

But we want more than a perfect nomenclature to bring Anthropology into range with the true sciences We need a broader basis of ascertained fact for inductive reasoning in almost all parts of our subject, we want men trained in exact method who will work patiently at the accumulation, verification, and sorting of facts, and who will not prematurely rush into theory We have had enough of the untrained writer of papers, the jerry-builder of unfounded hypotheses whose ruins cumber our field of work

The present position of our subject is critical and peculiar, while on the one hand the facilities for anthropological research are daily growing greater, yet in some directions the material is diminishing in quantity and accessibility We are accumulating in our museums treasures both of the structure and the works of man, classified according to his distribution in time and space, but at the same time some of the most interesting tribes have vanished, and others are rapidly disappearing or becoming fused with their neighbours. As these pass out of existence we, with them, have lost their thoughts, their tongues, and their traditions, for even when they survive, blended with other races, that which was a religion has become a fragmentary superstition, then a nursery tale or a child's game, and is destined finally to be buried in oblivion. The unifying influences of commerce, aided by steam and electricity, are effectually effacing the landmarks

between people and people, so that if we are to preserve in a form fit for future use the shreds which remain of the myths, folk-lore, and linguistic usages of many of the tribes of humanity, we must be up and doing without delay. It is on this account that systematic research such as that which Mr. Risley has advocated with regard to the different races of India is of such pressing and urgent importance. It is for this reason likewise that we hail with pleasure the gathering of folk lore while yet it survives, and welcome such societies for the purpose as the Folk lore Congress recently inaugurated.

I have said that in the department of Physical Anthropology our facilities for research are increasing. The newly-founded anthropometric laboratories are beginning to bring forth results in the form of carefully compiled statistical tables, embodying the fruits of accurate observations, which are useful as far as they go. Were these extended in their scope the same machinery might easily gather particulars as to the physical characters of the inhabitants of different districts, which would enable the anthropologist to complete in a systematic manner the work which Dr. Beddoe had so well begun. I would commend this work to the consideration of the provincial university colleges, especially those in outlying districts.

Of all the parts of the human frame, the skull is that upon which anthropologists have in the past expended the most of their time and thought. We have now, in Great Britain alone, at least four collections of skulls, each of which includes more than a thousand specimens, and in the other great national and university museums of Europe there are large collections available for study and comparison.

Despite all the labour that has been bestowed on the subject, craniometric literature is at present as unsatisfactory as it is dull. Hitherto observations have been concentrated on cranial measurements as methods for the discrimination of the skulls of different races. Scores of lines, arcs, chords, and indexes have been devised for this purpose, and the diagnosis of skulls has been attempted by a process as mechanical as that whereby we identify certain issues of postage stamps by counting the nicks in the margin. But there is underlying all these no unifying hypothesis, so that when we, in our sesquipedalian jargon describe an Australian skull as microcephalic, phænozygous, tapeino dolichocephalic, prognathic, platyrhine, hypselopalatine, leptostaphyline, dolichuranic, chamæprosopic, and microseme, we are no nearer to the formulation of any philosophic concept of the general principles which have led to the assumption of these characters by the cranium in question, and we are forced to echo the apostrophe of Von Torok, "Vanity, thy name is Craniology."

It was perhaps needful in the early days of the subject that it should pass through the merely descriptive stage, but the time has come when we should seek for something better, when we should regard the skull not as a whole complete in itself, nor as a crystalline geometrical solid, nor as an invariable structure, but as a marvellously plastic part of the human frame, whose form depends on the co operation of influences, the respective shares of which in moulding the head are capable of qualitative if not of quantitative analysis. Could measurements be devised which would indicate the nature and amounts of these several influences, then, indeed, would craniometry pass from its present empirical condition, and become a genuine scientific method. We are yet far from the prospect of such an ideal system, and all practical men will realize the immense, but not insuperable, difficulties in the way of its formulation.

In illustration of the profound complexity of the problem which the craniologist has to face, I would ask your indulgence while I set out a few details to show the several factors whose influence should be numerically indicated by such a mode of measurement.

The parts composing the skull may be resolved into four sets: there is, first, the brain case; secondly, the parts which subserve mastication and the preparation of the food for digestion; thirdly, the cavities containing the organs of the senses of hearing, sight, and smell; and fourthly, those connected with the production of articulate speech. If our measurements are to mean anything, they should give us a series of definite numbers indicating the forms, modifications, and relative size of these parts, and their settings with regard to each other and to the rest of the body.

To take the last point first, it needs but a small consideration to show that the parts of the skull are arranged above and below a certain horizontal plane, which is definite (although not easily ascertained) in every skull, human or animal. This is the plane of vision. The familiar lines of Ovid—

> Pronaque cum spectent animalia cetera terram,
> Os homini sublime dedit cœlumque tueri
> Jussit, et erectos ad sidera tollere vultus—

are anatomically untrue, for the normal quadruped and man alike, in their most natural position, have their axis of vision directed to the horizon. Systems of measurement based upon any plane other than this are essentially artificial. There are at the outset difficulties in marking the plane accurately on the skull, and it is to be deplored that the anthropologists of different nations should have allowed themselves to be affected by extraneous influences, which have hindered their unanimous agreement upon some one definite horizontal plane in craniometry.

The Frankfort plane drawn through the upper margins of the auditory foramina and the lowest points of the orbital borders has the advantage of being easily traced and differs so little from the plane of vision that we may without substantial error adopt it.

The largest part of the skull is that which is at once the receptacle and the protector of the brain, a part which, when unmodified by external pressure, premature synostosis, or other adventitious conditions, owes its form to that of the cerebral hemispheres which it contains. Speaking in this city of George and Andrew Combe, I need not do more than indicate in this matter that observation and experiment have established on a firm basis certain fundamental points regarding the growth of the brain. The study of its development shows that the convolutioning of the cerebral hemisphere is primarily due to the connection, and different rate of growth, of the superficial layer of cells with the underlying layers of white nerve fibres; and that so far from the shape being seriously modified by the constraining influence of the surrounding embryonic skull, the form of the soft membranous brain case is primarily moulded upon the brain within it, whose shape it may however be, to some extent, a secondary agent in modifying in later growth. We have also learned that, although in another sense from that of the crude phrenology of Aristotle, Porta, or Gall, the cerebrum is not a single organ acting as a functional unit, but consists of parts, each of which has its specific province; that the increase in the number of cells in any area is correlated with an increase in the size and complexity of pattern of the convolutions of that area; and that this in turn influences the shape of the enclosing shell of membrane and subsequently of bone.

The anatomist and the physiologist have worked hand in hand in the delimitation of these several functional areas, and pathology and surgery have confirmed what experimental physiology has taught. The topography of each part of the cerebrum, so important to the operating surgeon, should be pressed into the service of the anthropologist, whose measurements of the brain-case should have definite relation to these several areas. In the discussion which is to take place on this subject, I hope that some such relationships will be taken account of. This is not the place to work out in detail how this may be done; I only desire to emphasize the fundamental principle of the method.

The second factor which determines the shape of the individual skull is the size of the teeth. That these differ among different races is a matter of common observation; thus the average area of the crowns of the upper-jaw teeth in the male Australian is 1,536 sq. mm., while in the average Englishman it is only 1,286 sq. mm., less than 84 per cent. of that size.[1]

It is easy to understand how natural selection will tend to increase the size of the teeth among those races whose modes of feeding are not aided by the cook or the cutler; and how, on the other hand, the progress of civilised habits, assisted by the craft of the dentist, interferes with the action of selection in this matter among the more cultured races.

For larger teeth a more extensive alveolar arch of implantation is necessary; and as the two jaws are commensurately developed, the lower jaw of the macrodontal races exceeds that of the meso- or microdontal races in weight. Thus that of a male Australian exceeds that of the average Englishman in the proportion of 100 : 91.

To work this heavier jaw more powerful muscles are needed.

[1] These and the succeeding averages are from my own measurements, taken from never less than ten individual cases.

In the average well developed Englishman with perfect teeth the weight of the fleshy portion of the great jaw-muscles, masseters and temporals, is 60 grammes, while the weight of those as ascertained in two Australians was 74 grammes

Correlated with this greater musculature a sharper definition of the areas for the attachments of the jaw-muscles is required The muscular fascicles are approximately of uniform size in both microdonts and macrodonts, as the range of motion of the jaw differs little in different races, but when the skull is smaller on account of the smaller size of the brain which it contains, the temporal crest ascends higher on the side-wall In the average Englishman the temporal crests at their points of greatest approximation interiorly across the brows are 112 mm apart, but in the Australian they are only separated by 103 mm the interstephanic distances in these two are respectively 132 and 114 mm

The more powerful stroke of the mandibular teeth upon the anvil of the upper jaw teeth in macrodonts renders necessarily a proportionally stronger construction of the bases of support for the upper alveolar arch In any skull this arch requires to be solidly connected to the wall of the brain case to which the shock of the impact is ultimately transmitted, and in order to protect from pressure the delicate intervening organs of sight and smell, the connection is accomplished by the reversed arches of the infraorbital margins with their piers, malar and maxillary, founded on the frontal angular processes These foundations are tied together by the strong supraorbital ridge, so that the whole orbital edge is a ring, made up of the hardest and toughest bone in the skeleton

A twofold modification of this arrangement is required in the macrodont skull The bony circum orbital ring becomes stronger, especially along its lateral piers, and also as the alveolar arch is longer, and consequently projects further forward, its basis of support must be extended to meet and bear the malar and maxillary piers But macrodonts are often microcephalic, and therefore the frontal region of the skull must be adjusted to form a foundation for this arch In the average English male skull, held with its visual axes horizontal, a perpendicular dropped from the anterior surface of the fronto nasal suture will cut the plane of the alveolar arch between the premolar teeth or through the first premolar In an Australian skull the perpendicular cuts the horizontal plane at the anterior border of the first molar teeth

It is obvious, therefore, that to ensure firmness, the piers of the arches must be obliquely set, hence the jaw is prognathous, but it is also needful that the supra orbital arcade should be advanced to meet and bear these piers, as the mandibular stroke is always vertical

But the inner layer of the skull is moulded on the small frontal lobes of the brain, so this forward extension must affect only the much thicker and tougher outer table of the skull, which, at the period of the second dentition, here separates from the inner table, the interval becoming lined by an extension of the mucosa of the anterior ethmoidal cell In this way an air space, the frontal sinus, is formed, whose development is thus directly correlated to the two factors of brain development and size of the teeth If the frontal lobes are narrow in a macrodont skull, then the foundations of the outer or malar piers of the orbital arch must be extended outwards as well as forwards, the external angular process becoming a prominent abutment at the end of a strong low-browed supraorbital arch, whose overhanging edge gives to the orbital aperture a diminished vertical height

The crania of the two most macrodont races of mankind, Australian and African, differ in the relation of the jaw to the frontal bone In the microcephalic Australian, the maxillæ are founded upon the under side of the shelf-like projection of the outer table of the frontal, which juts out as a buttress to bear it On the other hand the nasal processes of the mesocephalic negro ascend with greater obliquity to abut on the frontal, and have, by their convergence, crushed the nasal bones together, and caused their coalescence and diminution

The crania of the two most microcephalic races present distinctive features of contrast along the same lines The Bushman's skull is usually orthognathous, with a straight forehead and a shallow frontonasal recess, while the Australian skull is prognathous with heavy overhanging brows These conditions are correlated to the mesodontism of the Bushman and the macrodontism of the Australian respectively.

In the course of the examination of the relations of brain development to skull growth, some interesting collateral points are elicited The frontal bone grows from lateral symmetrical centres, which medially coalesce, union taking place usually between the second and sixth years of age It has been noticed by anthropologists that metopism, as the anomalous non union of the halves of this bone has been termed, is rare among microcephalic races, occurring only in about 1 per cent among Australian skulls Increased growth of the frontal lobes as the physical accompaniment of increased intellectual activity interposes an obstacle to the easy closure of this median suture, and so in such races as the ancient Egyptian, with a broader forehead, metopism becomes commoner, rising to 7 per cent In modern civilised races the percentage ranges from 5 to 10 In following out the details of this enumeration, I have spoken as if the microdontal condition had been the primary one, whereas all the available evidence leads to show that the contrary was the case The characters of all the early crania, Neanderthal Engis, and Cromagnon, are those of macrodonts The progress has been from the macrodont to the microdont, as it probably was from the microcephalic to the macrocephalic

The effects of the variations in size of the teeth are numerous and far-reaching The fluctuation in the weight of the jaw depending on these variations has an important influence on the centre of gravity of the head, and affects the set of the skull on the vertebral column This leads to a consequent change in the axes of the occipital condyles, and it is one of the factors which determines the size of the neck muscles, and therefore the degree of prominence of the nuchal crests and mastoid process

As the teeth and alveolar arches constitute a part of the apparatus for articulate speech, so these varieties in dental development are not without considerable influence on the nature of the sound produced The necessarily larger alveolar arch of the macrodont is hypseloid or elliptical, more especially when it has to be supported on a narrow frontal region, and this is associated with a more extensive and flatter palatine surface This in turn, alters the shape of the mouth cavity, and is associated with a wide flat tongue, whose shape participates in the change of form of the cavity of which it is the floor The musculature of the tongue varies with its shape and its motions, upon which articular speech depends, become correspondingly modified For example, the production of the sharp sibilant S requires the approximation of the raised flexible edge of the tongue to the inner margins of the teeth behind the canines, and to the palatine margin close behind the roots of the canine and lateral incisor teeth This closes the vocal tube laterally, and leaves a small lacuna about 5 mm wide anteriorly, through which the vibrating current of air is forced A narrow strip of the palate behind the medial halves of the median incisors bounds this lacuna above, and the slightly concave raised tongue tip limits it below

With the macrodont alveolar arch, and the correspondingly modified tongue, sibilation is a difficult feat to accomplish, and hence the sibilant sounds are practically unknown in all the Australian dialects

It is worthy of note that the five sets of muscular fibres, whose function it is to close laterally the flask like air space between the tongue and the palate, are much less distinct and smaller in the tongues of the Australians which I have examined than in the tongues of ordinary Europeans

There is a wide field open to the anatomical anthropologist in this investigation of the physical basis of dialect It is one which requires minute and careful work, but it will repay any student who can obtain the material, and who takes time and opportunity to follow it out The anatomical side of phonology is yet an imperfectly known subject, if one may judge by the crudeness of the descriptions of the mechanism of the several sounds to be found even in the most recent text books As a preliminary step in this direction we are in urgent need of an appropriate nomenclature and an accurate description of the muscular fibres of the tongue The importance of such a work can be estimated when we remember that there is not one of the 260 possible consonantal sounds known to the phonologist which is not capable of expression in terms of lingual, labial, and palatine musculature.

The acquisition of articulate speech became possible to man only when his alveolar arch and palatine area became shortened and widened, and when his tongue, by its accommodation to the modified mouth, became shorter and more horizontally flattened, and the higher refinements of pronuncia-

tion depend for their production upon more extensive modifications in the same directions.

I can only allude now very briefly to the effects of the third set of factors, the sizes of the sense organs, on the conformation of the skull. We have already noted that the shape and the size of the orbital opening depend on the jaw as much as on the eye. A careful set of measurements has convinced me that the relative or absolute capacity of the orbital cavity is of very little significance as a characteristic of race. The microseme Australian orbit and the megaseme Kanaka are practically of the same capacity, and the eyeballs of the two Australians that I have had the opportunity of examining are a little larger than those of the average of mesoseme Englishmen.

The nasal fossæ are more variable in size than the orbits, but the superficial area of their lining and their capacity are harder to measure, and bear no constant proportion to the size of their apertures, because it is impossible without destroying the skull to shut off the large air sinuses from the nasal fossæ proper for purposes of measurement. Thus the most leptorhine of races, the Esquimaux, with an average nasal index of 437 has a nasal capacity of 55 c.c.m., equal to that of the platyrhine Australian, whose average is 54.5, and both exceed the capacity of the leptorhine English, which average about 50 c.c.m. There is an intimate and easily proved connection between dental size and the extent of the nasal floor and of the pyriform aperture.

These are but a few of the points which a scientific craniometry should take into consideration. There are many others to which I cannot now refer, but which will naturally occur to the thoughtful anatomist.

In this rapid review of the physical side of our subject the study of these race characters naturally suggests the vexed question as to the hereditary transmission of acquired peculiarities. This is too large a controversy for us now to engage in, but in the special instances before us there are grounds for the presumption that these characters of microdontism and megacephaly have been acquired at some stage in the ancestral history of humanity, and that they are respectively correlated, with diminution of use in the one case, and increase of activity in the other. It is a matter of observation that these qualities have become hereditary, and the point at issue is not the fact, but the mechanism, of the transmission. We know that use or disuse affects the development of structure in the individual, and it is hard to believe that the persistent disuse of a part through successive generations does not exercise a cumulative influence on its ultimate condition.

There is a statement in reference to one of these characters which has gained an entrance into the text-books, to the effect that the human alveolar arch is shortening, and that the last molar tooth is being crowded out of existence. I have examined 400 crania of men of the long, and round-barrow races, Romano-British and early Saxon, and have not found among all these a single instance of absence of the third molar or of overcrowded teeth. On the other hand, out of 200 ancient Egyptian skulls, 9 per cent. showed displacement or disease, and 1½ per cent. show the want of one molar tooth. Out of 200 modern English skulls there was no third molar tooth in 1 per cent. So far this seems to confirm the current opinion.

Yet the whole history of the organism bears testimony to the marvellous persistence of parts in spite of contumely and disuse. Take, for example, the present position of the little toe in man. We know not the condition of this digit in prehistoric man, and have but little information as to its state among savage tribes at the present day, but we do know that in civilised peoples, whose feet are from infancy subjected to conditions of restraint, it is an imperfect organ—

Of every function shorn
Except to act as basis for a corn.

In 1 per cent. of adults the second and third joints have ankylosed, in 3 per cent. the joint between them is rudimentary, with scarcely a trace of a cavity, in 20 per cent. of feet the organ has lost one or more of its normal complement of muscles. But though shorn of some of its elements, and with others as mere shreds, the toe persists, and he would be a bold prophet who would venture to forecast how many generations of booted ancestry would suffice to eliminate it from the organization of the normal man.

Nevertheless, although it is difficult to demonstrate, in the present imperfect state of knowledge, the method whereby race-characters have originated, I think that the most of our anthropologists at least covertly adopt the philosophy of the ancient proverb, "The fathers have eaten sour grapes and the children's teeth are set on edge."

But there are other branches of anthropology of far greater interest than these simple problems upon which we have tarried so long. The study of man's intellectual nature is equally a part of our subject, and the outcomes of that nature are to be traced in the tripartite record of human progress which we call the history of culture. It is ours to trace the progress of man's inventions, and their fruits in language and the arts, the direct products of the human mind. It is also ours to follow the history of man's discovery of those secrets of nature to the unfolding of which we give the name of science. The task is also ours to inquire into that largest and most important of all sections of the history of culture which deals with the relation of human life to the unseen world, and to disentangle out of the complex network of religion, mythology, and ritual those elements which are real truths, either discovered by the exercise of man's reason, or learned by him in ways whereof science takes no account, from those adventitious and invented products of human fear and fancy which obscure the view of the central realities. In this country it matters less that our time forbids us to wander in these fascinating fields wherein the anthropologist loves to linger, as the munificent benefaction of Lord Gifford has ensured that there shall be an annual fourfold presentation of the subject before the students of our Scottish universities. There is no fear that interest in these questions will flag for want of diversity in the method of treatment or of varieties in the standpoints of the successive Gifford lecturers.

From the ground of our present knowledge we can but faintly forecast the future of Anthropology, when its range is extended by further research, and when it is purged of fancies, false analogies, and imperfect observations. It may be that there is in store for us a clearer view of the past history of man, of the place and time of his first appearance, of his primitive character, and of his progress. But has this knowledge, interesting as it may be for its own sake, any bearing on the future of mankind? Hitherto growth in knowledge has not been accompanied with a commensurate increase in the sum of human happiness, but this is probably due to the imperfection which characterises even our most advanced attainments. For example, while the medical and sanitary sciences, by their progress, are diminishing the dangers which beset humanity, they have also been the means of preserving and permitting the perpetuation of the weaklings of the race, which, had natural selection exercised its unhindered sway, would have been crushed out of existence in the struggle for life.

It is, however, of the essence of true scientific knowledge, when perfected, that it enables us to predict, and if we ever rise to the possession of a true appreciation of the influences which have affected mankind in the past, we should endeavour to learn how to direct these influences in the future that they shall work for the progress of the race. With such a knowledge we shall be able to advance in that practical branch of Anthropology, the science of education, and so to guide and foster the physical, intellectual, and moral growth of the individual that he will be enabled to exercise all his powers in the best possible directions. And lastly, we shall make progress in that kindred department, Sociology, the study of which does for the community what the science of education does for the individual. Is it a dream that the future has in store for us such an Anthropological Utopia?

PHYSICS AT THE BRITISH ASSOCIATION

THE mathematicians and physicists of the British Association could not have had better accommodation than that which was placed at their disposal in Edinburgh. The physics lecture-room of a University, with its appropriate fittings and appliances, is their ideal environment. Almost all the leading British physicists were present, the chief absentee of note being Lord Rayleigh, and foreign men of science were well represented by such men as Profs. von Helmholz, Wiedemann, Ostwald, and Du Bois, from Germany; M. Guillaume, from France; Schoute, from Holland; and Michelson, from America.

The *Discussion on a National Physical Laboratory* was one of the most important.

The speakers were Oliver Lodge, Glazebrook, von Helmholz, Lord Kelvin, Rucker, Dr. John Ince, Fitzgerald, Stokes, Carey Foster, Ayrton, and the President.

Prof. Lodge opened the discussion by giving an outline of the work which might be done in such a laboratory. The work should include the accurate determination of physical constants, the maintenance of standards, and the issue or verification of certified copies, the continuous recording of certain special phenomena, the conduction of certain special experimental inquiries, more particularly such as might have to be carried on years or even centuries, the taking up and completing of lines of research already developed by amateurs (or even in well-equipped laboratories) to that point at which it was impossible for them, unaided, to proceed farther.

Mr. Glazebrook described the work done at the Cavendish Laboratory. A part of this work consists in the testing of units of electrical resistance and electromotive force. In many cases it is quite impossible (in view of the more proper work of the laboratory) to give the necessary time for the proper carrying out of this work—which should be undertaken by a National Laboratory.

Prof. von Helmholz stated that one of the chief causes for the setting up of the National Physical Laboratory at Berlin was the desire of the Government that mechanicians should be assisted in their work by means of properly conducted scientific research and superintendence. It was necessary also that proper headquarters should exist for the construction and control of standards. The directors are entirely free from any duties of teaching, no systematic instruction being given in the laboratory. A large part of the work done consists in standardizing of thermometers. In the first year of the institution 90,000 were tested. Electrical apparatus, steam engine indicators, and standard lights for gas and electric companies, are also tested; and a considerable amount of thermodynamical work is undertaken with a view to practical improvements. £2500 are spent annually upon apparatus and work alone, exclusive of salaries.

Lord Kelvin said that it was a matter of great importance to the nation that its artizans should have as good scientific direction for their work as the artizans of Germany have for theirs.

Prof. Rucker said that it was by no means gratifying that it was necessary to send thermometers to Paris in order that they should be compared with the air thermometer. It would be of great advantage to have a national institution worked largely in connection with the Royal Society.

Prof. Fitzgerald, among other things, said that he doubted if the House of Commons was sufficiently educated to understand that the advance of scientific work was of national value.

The Discussion on Nomenclature of Units was opened by Prof. Oliver Lodge on lines recently indicated in NATURE.

Dr. Hopkinson and Dr. Preece criticized the proposed changes, maintaining that the time had not yet arrived when they could be advantageously introduced, even if they were satisfactory, which was very questionable except in one or two cases.

Dr. du Bois also spoke in opposition to the proposed changes, remarking that, even if accepted in Britain, they certainly would not be favoured in Germany. The discussion then dropped.

The Report on Underground Temperature dealt with observations made in a boring at Wheeling, West Virginia. The well had been sunk by a company to a depth of 4500 feet. The company decided to abandon it at this stage; but on request the boring was continued to a much greater depth for the purpose of the scientific observations. During last summer observations of temperature were made at successive depths of 125 feet down to the bottom. The surface temperature being 51°, at a little more than 1000 feet below the surface, 68°·75 were registered. At 3000 feet and 4000 feet respectively, 87 and 102° were observed; and at the bottom of the well the temperature was 110°·15. The rate of increase grows with the depth. Between 1590 feet and 1835 feet, the average rate was 1° per 92 feet; between 1835 feet and 2486 feet it was 1° per 84·5 feet. This increased until at the foot the rate was 1° per 58 feet. The average rate was 1° per 72 feet.

Report on the Discharge of Electricity from Points.—As the result of the experiments made it was found that disturbing influences, which had little or no effect at the cathode, had a powerful effect when applied to the anode, so as even to prevent the passage of sparks. Experiments were also made with the view of determining the quantity of gas concerned in the passage of a given quantity of electricity.

Report on Electrical Standards.—The committee which submitted this report had a meeting at Edinburgh, which was attended by a number of foreigners. As a result of this meeting they agreed to the following resolutions:—(1) That the resistance of a specified column of mercury be adopted as the practical unit of resistance; (2) That 14·4521 grammes of mercury in the form of a column of uniform cross section, 106·3 cm. in height, at 0° C., be the specified column; (3) That standards in mercury, or solid metal having the same resistance as this column, be made and deposited as standards of resistance for industrial purposes; (4) That such standards be periodically compared with each other, and also that their values be redetermined at intervals in terms of that of a freshly set up mercury column. It was further agreed that these resolutions be communicated to the Electrical Standards Committee of the Board of Trade. It was agreed that the number 0·001118 should be adopted as the number of grammes of silver deposited per second from a neutral solution of nitrate of silver by a current of one ampere, and that the electromotive force of a Clark cell at 15° C. should be taken as 1·434 volts.

Prof. von Helmholz remarked that a column of mercury was much preferable to alloys, in which small fissures might exist or come into existence. He alluded also to the manner in which the difficulties of setting up such a mercury column, arising from the want of proper contact between the mercury and the glass, may be overcome. The British and German tests agreed so closely as to show that the results might be used for commercial purposes, possibly for centuries; though, for scientific purposes, some change might be needed. He and others had been sent here by their Government with the object of coming to an agreement on this subject with Great Britain, and it was hoped that America and France would also adopt the resolutions.

Wire Standards of Electric Resistance, by Dr. Lindeck, of Berlin.—The author described experiments on this subject. Alloys containing manganese seem to be the best for the purpose. Those containing zinc are the most objectionable because of impurities. Changes of resistance depending on the process of winding the coils were also investigated. The best results were got with the alloy manganin. Changes of resistance, apparently due to oxidation from contact with the air, take place; but these can be avoided by varnishing the wire. The resistance rises slowly with temperature, reaches a maximum, and then decreases rapidly.

Prof. Sylvanus Thomson said that, in working with manganin, he had found that it could not be relied upon if too strong a current were sent through it. He agreed that no alloy containing zinc should be used.

On the Clark Cell, by Dr. Kahle, Berlin.—Dr. Kahle gave details of experiments made on Clark cells. He found that they furnished a very trustworthy standard of electromotive force, and that they were very suitable for practical work.

Prof. Carhart said that he had found cells, made by different persons at different times, gave practically the same result when used under the same conditions.

Mr. Glazebrook said that he had come to the conclusion that differences amongst the results given by different cells were due to the fact that the time taken to reach the equilibrium condition differed in different cells.

Preliminary Account of Oceanic Circulation, based on the Challenger Observations, by Dr. A. Buchan.—In communicating this account, Dr. Buchan remarked that the enquiry had so far advanced that the chief results could be stated. The *Challenger* observations have been supplemented by those of Mohn, Agassiz, J. T. Buchanan, Belknapp, and Capt. Wharton. The surface winds of the globe have a special bearing on the subject of ocean temperature. The surface winds of the Atlantic generate currents which have the effect of raising the temperature on the west side of the Atlantic, at depths from 100 to 500 fathoms, about 10 degrees above the temperature at these depths on the east side. At 500 fathoms the temperature is nearly the same at both sides of the Atlantic, but at lower depths the effects are reversed. At these depths the west side is more under the influence of the Arctic currents along the American coast, and the east side is more under the influence of the under currents from the Mediterranean and the equatorial regions of the Atlantic. This high temperature distribution extends northwards even beyond the Wyville Thomson ridge between Shetland and Iceland. At 700 fathoms the temperature just south of this ridge is five or six degrees higher than it is over the Pacific, Indian, and

South Atlantic Oceans at that depth At 200 fathoms the temperature of the Mediterranean is about 56°, and is practically constant down to the bottom (1500 fathoms in some places) Similar conditions hold in the Gulf of Mexico, where the temperature at 700 fathoms is 25° 5, with no change at lower depths On the other hand, north of the Wyville Thomson ridge in the North Atlantic, there is a uniform temperature of about 29° 5 at all depths below 700 fathoms—that temperature being about two or three degrees higher than the freezing point of the water This undercurrent of warm salt water from the Mediterranean, extending even beyond the North Cape of Norway, seems to explain why there is no instance of an iceberg appearing off the west coast of Europe

Physical Condition of the Waters of the English Channel, by Mr H V Dickson —The constitution of the samples of water agreed, on the whole, with that of the *Challenger* samples, coinciding entirely with that of the Atlantic water The tidal currents are sufficiently strong to keep the water thoroughly mixed from the top to the bottom, except off Start Bay, where a vortex is formed—the water being colder in summer, and warmer in winter, than the surrounding water, and this spot is one of the best fishing grounds in the Channel

On Primary and Secondary Cells in which the Electrolyte is a Gas, by Prof Schuster —When an electric discharge passes through a part of the gas filling a tube, all the gas is brought into a state in which it readily conducts electricity Prof Schuster has studied the laws of this conduction If we assume that the primary phenomena of discharge depend on dissociation of the molecules, he remarked that it must often have appeared peculiar to experimenters that no phenomena of polarization appear When an elementary gas is used no such phenomena appear When compound gases are used only slight polarization appears, but Prof Schuster has found that the phenomena become very marked when hydrocarbons are used The law of decrease of polarization in this case resembles that which is observed when liquid electrolytes are used This points to the performance of work of the nature of electrolysis The magnitude of the effect depends on the nature of the electrodes It is small when copper and iron are used, but is very large when aluminium or magnesium are used When a latter metal was employed, a direct current being passed for a long time, a reverse electromotive force of 35 volts was got from a single cell This shows that the action is similar to that of a secondary cell Prof Reinold has already described cases in which gases act as an electrolyte in a primary circuit when under the influence of a discharge Prof Schuster has found that, in such cases, the employment of aluminium electrodes gives very strong effects

On Leaky Magnetic Circuits, by Dr du Bois —It appears from the experiments described that the leakage decreases when the magnetization is increased

Experiments on the Electric Resistance of Metallic Powders, by Dr Dawson Turner —It is well known that metallic powders have very great electric resistance This can be reduced to an extraordinary degree by the passage of an electric spark in their neighbourhood Amongst other substances Dr Turner has tried powdered aluminium, copper, annealed selenium, iron filings, small shot, mixtures of aluminium and resin fused into a solid mass, etc The best results were obtained with the first two A short glass tube, filled with powdered aluminium, is placed in circuit with one or two cells and a galvanometer No current passes until a spark discharge occurs in the neighbourhood, when a fairly large effect becomes visible. The powder continues to conduct for a short time unless it be shaken or disturbed, when the effect ceases In the case of the rod of aluminium and resin, mere shaking does not destroy the effect, though the application of heat does When the resistance has once been lowered in this way, the powder becomes very sensitive, a spark at a great distance produces the effect, and a very slight jar destroys it

On the Stability of Periodic Motions, by Lord Kelvin —The mathematical investigation of this subject was illustrated by an experiment in which a simple harmonic vertical motion was given to the point of support of a pendulum When the period of the superposed motion was one half of that of the natural motion of the pendulum, the equilibrium became unstable, and the slightest disturbance caused the vertical motion of the bob to be changed into transverse motion of increasing amplitude If the superposed period were now lessened, the vertical motion again became stable Similarly a rod poised vertically in unstable equilibrium could become stable by having its point of support moved with simple harmonic motion, of proper period, in a vertical line

Prof Osborne Reynolds remarked that it was well known to practical engineers that a revolving shaft, when driven at a certain speed, began to bend, and might even break, though at higher speeds it would again become straight Lord Kelvin had now explained this effect

On the Specific Conductivity of Thin Films, by Profs Reinold and Rucker —When the film was an aqueous soap solution containing a considerable portion of glycerine and a small proportion of a metallic salt, the specific conductivity was the same, whether the liquid was in mass or was drawn out into a film not exceeding 1-200,000 in in thickness When the liquid consisted of an aqueous soap solution alone, the specific conductivity increased when the thickness became small, until, in the thinnest film observed, it was seven times as great as at first The effect seemed to be due to a breaking down of equilibrium when the tenuity was extreme

A Contribution to the Theory of the perfect Influence Machines, by J Gray, B Sc —The theory of the perfect influence machine has been shown by Clerk Maxwell to be analogous to Carnot's theory of the perfect heat-engine Maxwell points out that there is a loss of energy in the ordinary influence machine through sparking at the contacts, which would render the machine inefficient, even though losses from leakage and the like were done away with Maxwell has described a machine in which sparking and the loss due to it is eliminated This is done by causing the carrier of electricity always to make contact with charging and discharging conductors when the former is at the same potential as the latter In the case of the discharging conductor, this is done by prolonging the contact springs to meet the carrier, in the case of the charging conductors this is not sufficient, it is necessary to surround the ends of their contact springs by two additional conductors charged to an equal and opposite potential, and of such capacity as will just reduce to zero the potential of the small quantity of electricity left from the previous discharge These additional conductors were called by Maxwell regenerators, as being analogous to regenerators in the heat-engine

The object of the author is to investigate the efficiency of an influence machine constructed according to Maxwell's design, and other designs less perfect This is done by drawing a QV (quantity-potential) energy diagram for one revolution of the carrier The results obtained are as follows —

	Theoretical efficiency
Maxwell's machine	1
,, ,, without regenerators	$\frac{Q}{Q+\frac{1}{2}av}$
,, ,, without long contacts on receivers	$\frac{1}{2}$
,, ,, without regenerators and without long contacts on chargers	$\frac{Q}{Q+\frac{1}{2}aV}$

where Q = quantity received or discharged by a carrier in each revolution,
V = the potential (numerical value) of the positive or negative receiver,
v = the potential of the residual charge to be reduced to zero by the regenerator,
a = the part of the carrier's capacity due to its not being completely surrounded by the discharging conductor

The conclusion is that the regenerators are of much less importance than the long contacts in adding to the efficiency of an influence machine

Experiments with a Ruhmkorff Coil, by Messrs Magnus Maclean and A Galt —The quantity of electricity induced in a secondary circuit by a make in a primary circuit is equal to the quantity induced in the same secondary by a break in the primary If, however, there is a non-metallic gap in the circuit, the *break* impulse causes a flow in one direction, and the *make* causes either no flow, or a much less flow in the opposite direction, because the short intense impulse of the former breaks down the resistance, while the comparatively long and less intense impulse of the make either does not break down the resistance at all or only does so to a slight extent, so that the effective resistance is much greater in one direction than in the

other To obtain the average difference of the quantity of electricity set in motion in one direction over that in the other, an electrolytic cell and a vacuum tube were placed in the secondary circuit of a small Ruhmkorff coil The solution in the cell was sulphate of copper of density 1 7 with ½ per cent of commercial sulphuric acid added The mean of seven experiments, lasting from two to four hours, gave the average electrolytic current calculated from the gain of the cathode, as ⅓ of a milliampere A similar experiment, in which the vacuum tube was replaced by a very large liquid resistance, led to no result

The Application of Interference Methods to Spectroscopic Measurement, by Prof A Michelson —Prof Michelson's "wave-compiler" consists essentially of a small plane sheet of glass with parallel surfaces and two mirrors The mirrors are set at right angles to each other and the central plane of the glass passes through their line of intersection, making an angle of 45° with each of them Rays of light from the source under examination fall upon the glass surface at an angle of 45°, and are partly reflected, partly transmitted, so as to suffer normal reflection at the mirrors, and finally proceed from the other surface of the glass, at an angle of 45, to the eye Normal displacement of one of the mirrors parallel to itself causes a difference of path which produces interference If the source of light emits radiation of two wave-lengths (as in the case of incandescent sodium), or of more, the brightness of the interference bands—regarded from the centre outwards—exhibits periodic variation, which can be accurately observed The law of variation can be calculated when the distribution of light in the source, as regards wave-length and intensity, is known Conversely, the method can be used to determine the nature of this distribution Mr Michelson has examined various sources of light—oxygen, hydrogen, zinc, cadmium, mercury, &c —and has found that lines which in the most powerful spectroscope appear single, are really double, triple, or even more complex In examining hydrogen at different pressures and temperatures the results indicated that the widths of the component lines decreased as the pressure decreased, but not without limit Investigations made on a large number of substances give strong confirmation of the kinetic theory of gases

On a Periodic Effect which the Size of Bubbles has on their Speed of Ascent in Vertical Tubes containing Liquid, by Dr F T Trouton —The chief peculiarity observed when a bubble of air ascends in water is that the speed of ascent is a periodic function of the size of a bubble The form of the curve obtained by plotting the volumes of the bubbles as abscissæ and the corresponding speeds as ordinates showed that at first, as would be expected, increase in size diminishes the speed, but afterwards the speed increases in value, then reaches a maximum at about twice the minimum speed, and so on two or three times, depending on the diameter of the tube employed The oscillations in the curve die out in much the same fashion as those of a pendulum in a viscous medium The form of the bubbles was almost spherical at the first minimum, after this the bubble is pointed at the top until the second minimum is reached, when it is again rounded at the top, but has a dumb-bell shape, and so on, presenting in this way similarities to the breaking up of a liquid column through surface tension Liquids which do not mix with water were used instead of air, and air bubbles in other liquids were also used

On a Method of Determining Thermal Conductivities, by Mr C H Lees —The method has more direct application to the determination of the conductivity of a liquid than previous methods have It consists in measuring the amount of heat conducted, under given conditions, through a film of liquid placed between two copper cylinders It was found most convenient to keep the upper cylinder at the temperature of the surrounding air, while the lower one was kept cool by water from the mains Precautions were taken against errors from radiation, &c.

A Magnetic Curve Tracer, by Prof Ewing —The apparatus is designed to plot mechanically the ordinary magnetization curve The curve is traced on a screen by a spot of light reflected from a mirror, which is subjected to two motions—one proportional to the magnetizing force, the other to the magnetization These motions are communicated by means of the sagging of wires placed in air-gaps in magnetic circuits In the one case, the wire carries a steady current in a varying field, in the other the wire carries the varying current in a steady field The curves may be traced on sensitized paper, and the instrument should be of much use to engineers for testing purposes In working with the instrument Prof Ewing has observed true effects of magnetic time lag in the inward penetration of magnetization

On a Magnetic Balance and its Practical Use, by Prof du Bois —A test bar of standard size is placed within a magnetizing coil Over this is placed an iron yoke, balanced on a knife edge, and having attached to it a graduated scale with sliding weights. When a current passes through the coil the equilibrium is disturbed, and it is restored by sliding the weight along the scale The position of the weight then gives the magnetization in absolute measures in c g s units The position of the yoke is one of unstable magnetic and mechanical equilibrium

On Earth Current Storms in 1892, by Mr W H Preece —In communicating this paper, Mr Preece spoke of the great importance of observers at all parts of the globe contriving to collect data regarding electric storms

On the Dielectric of Condensers, by Mr W H Preece —The author pointed out that in the condensers used by him there was evidence of work done upon the insulating material, which necessarily retarded the rate of propagation of signals

On Polarizing Gratings, by Prof du Bois —The author has constructed minute gratings with silver wire scarcely visible to the naked eye Radiant heat and long light waves are polarized by these gratings in the same way as electromagnetic radiations are polarized by larger wire gratings

The Volume Effects of Magnetism, by Dr C G Knott —The results for iron tubes have been already described in NATURE In one case a steel tube, of given bore and thickness of wall, gave increase of internal volume in all fields used Usually the volume diminishes in low fields and increases in high The effects were shown to the audience by projection upon a screen

An Estimate of the Rate of Propagation of Magnetization in Iron, by Prof Fitzgerald —Assuming that the iron is constituted of a system of little magnets, and with possible assumptions as to the size of these magnets and their strength, it is found that their natural rate of vibration may be one hundred millions per second Unless the period of the vibration propagated through the iron approximates to this the wave lengths would be very small, while quicker vibrations, with periods like those of light, would not be propagated at all

Experimental Proof that the Coefficient of Absorption is not affected by Density of Illumination, by Dr W Peddie —When parallel rays of light pass through a uniform absorbing medium, the intensity of the light diminishes according to a certain law The assumption which, on this point, is made the basis of the theory of radiation is that the fractional diminution of intensity, at any stage, per unit of thickness traversed (called the coefficient of absorption), is independent of the intensity of the light Sir G Stokes has indicated a method of testing the point by the reflection of light, at nearly perpendicular incidence, from the surface of glass—part of the absorbing medium being placed in the path of half of the light before reflection, and a similar part being placed in the path of the other half after reflection Both portions, being then projected on a screen, could be directly compared in respect of colour and intensity No test seems to have been made by this or any other method. In Dr Peddie's method light is passed through two double image prisms and a plate of quartz Four rays are thus produced, coloured alike in pairs, the colour of one pair being complementary to that of the other The colour of one pair can be made to match as nearly as possible the colour most readily absorbed by the medium, similar portions of which are placed at different distances from the points from which these rays are made to diverge by means of a lens The light being projected on a screen, a direct comparison is obtained The media used were pieces of surface-coloured glass In no case was any difference observed, although the intensity varied from 1 to 1000, and the eye could have observed the difference of one per cent in the brightness of the two discs thrown on the screen, without the additional help of change of colour

On Dispersion in Double Refraction due to Electric Stress, by Dr John Kerr —The fact of dispersion has been established, and it is found that the optical effect depends upon the wave-length, being the inverse ratio of the square root of the wave-length.

On a Delicate Calorimeter, by Messrs J A. Harker and P J Hartog This is essentially a Bunsen ice-calorimeter, with solid acetic acid instead of ice, so being much more delicate, and capable of being used at ordinary temperatures

On Graphic Solutions of Dynamical Problems, by Lord Kelvin —The method of drawing meridional curves of capillary sur-

faces of revolution, described in "Popular Lectures and Addresses," vol. i., 2nd edition, pp. 31-42, suggests a corresponding method for the solution of dynamical problems.

Reduction of every problem of Two Freedoms in Conservative Dynamics, to the drawing of Geodetic Lines on a Surface of given Specific Curvature, by Lord Kelvin.

1. Any conservative case of two-freedom motion is proved to be reducible to a corresponding case of the motion of a material point in a plane.

2. In plane conservative dynamics, with any given value for the energy constant, E, the resultant velocity, q, at any point (x, y) is a known function of (x, y), being given by the equation

$$q^2 = 2(E - V) \qquad (1)$$

where V denotes the potential at (x, y); and every problem depends on drawing lines for which $\int q ds$ (the Maupertius "action") is a minimum.

3. Considering any part, S, of the infinite plane, find a surface, S', such that any infinitesimal triangle A'B'C' drawn on it has its sides q/q_0 of those of a corresponding triangle ABC in the field, S, of our plane problem: q_0 denoting the value of q at any particular point (x_0, y_0) in the plane. By the principle of least action we see instantly that the lines on S' corresponding to paths on S, are geodetic. Thus the *adynamic* case of motion of a particle on S', is found as a perfect and complete representative of the motion on the plane surface S, under force with any arbitrarily given function V, for its potential, and any particular given value, E, for the total energy of the moving particle.

4. It is easily proved that the surface S', to be found according to §3, exists; and that its specific curvature (Gauss's name for the product of its two principal curvatures) at any point, is equal to

$$\frac{q^2_0 \, \Delta^2 \log q}{q^2}$$

5. Examples are given of the finding of S'. As one example, illustrating the practical usefulness of this method in dynamics, the problem of the parabolic motion of an unresisted projectile is reduced to the drawing of geodetic lines on a certain figure of revolution of which the explicit equation is expressed in terms of elliptic functions.

THE PERIODIC VARIATIONS OF ALPINE GLACIERS

THIS twelfth Report, dealing with the Alpine glaciers and their changes, by Dr. Forel, comes in the nick of time, and will be generally welcomed, for it announces that the question of glacier changes in the Alps will in future be studied systematically; and, further, we learn in a postscript that the State Council of the Canton of Le Valais have, on the proposition of M. Maurice de la Pierre, head of the Home Department, decided to take under its efficient direction the studies of observation and control of the variations of glaciers. These observations are confided to the charge of the Cantonal Administration of Forests, the head of which is M. Antoine de Torrenté at Sion. M. Forel records this act of intelligent and prudent administration with keen satisfaction and true gratitude, and would gladly see it imitated by other cantons possessing glaciers. M. Forel publishes also the report, which, in compliance with the wishes of M. de la Pierre, he had addressed to the Home Department of Le Valais. It is equally applicable to the glaciers of other cantons in Switzerland, and we therefore print it *in extenso*.

M. de la Pierre, Councillor of State, head of the Home Department, Sion.

SIR,—Referring to the interview you granted me on January 31, and in reply to your question, I have the honour to give you the following particulars:—

Glaciers in general, and particularly those of Le Valais, are subject to variations in shape, which, according to an irregular periodicity, cause them sometimes to grow in length, in breadth, in thickness, sometimes to decrease, often in very considerable proportions. These variations, which in recent centuries have attracted the attention of the populations interested and of naturalists, have in this century been the subject of direct study, especially during the last twenty years.

It has been recognized that most of the great catastrophes which have ravaged the region of the high Alps, have been caused by these glacial variations. It is when the glacier extends, lengthens, arrives at its maximum, that it not only invades the fields and destroys Alpine chalets, but barricades the valleys, arrests the flow of rivers, and creates temporary lakes, the evacuation of which ravages the country; or else, surpassing its usual dimensions, it forms an avalanche, the destructive power of which is terrible. Taking my examples from Le Valais, I attribute to forces of this kind: the catastrophes of the Valley of Saas, 1633, 1680, 1772, caused by the overflow of the lake Mattmarck, due to the stoppage of the Viège by the glacier of Allalin; the catastrophes of the valley of Bagne, 1545, 1605, 1818, caused by the formation of a temporary lake behind the barricades of the glacier of Giétroz; the catastrophes of Randa, 1636, 1819, caused by the fall of the glacier of Bies, which had assumed extraordinary dimensions; perhaps we might also attribute to the same source the inundations of St. Bartholomew, 1560, 1635, 1636, 1835, which may have been due to the excessive increase and fall of the terminal extremity of the glacier of Plan-névé of La Dent du Midi.

Since these variations of glaciers are the cause of great catastrophes in mountainous regions, they are deserving of attentive study; there is scope to form theories and to recognize the rhythm of their periodicity; it is very necessary to be able to foresee their development, in order to ward off threatening events.

Now, the preparatory study which we have made within the last few years has shown us that the periodicity of glacial variations is much longer than was formerly believed to be the case; the popular dictum that the increase in the size of glaciers recurs every seven years is certainly incorrect. We cannot yet give definite figures, but probably the cycle of glacial variation is as much as 35 to 50 years. The latter period alone has been studied attentively; if 1850 or 1855 be fixed upon as the epoch of maximum of glaciers, they have been steadily decreasing in past years, so that from 1870 to 1875 we were not aware of a single one on the increase. In 1875 the Glacier des Bossons du Mont Blanc gave the signal for a new period by commencing to lengthen out; it was followed in 1878 and 1879 by the glaciers of Trient and Zigiorenove, then successively by some thirty glaciers in different valleys of Le Valais; but the phase of increase is not yet general in your canton; a number of large glaciers, Arolla, Otemma, Corbassière, Le Gorner, Le Rhone, are still decreasing or stationary. It is only of the Mont Blanc group that the increase can be said to be general; in Le Valais it is in process of development, and we are still very far from the maximum stage of glaciers. If, as is probable, the maximum only arrives at the commencement of next century, the actual period of glaciers will have lasted more than fifty years.

Thus this is a phenomenon, whose cycle is equal or superior to that of the average human life; one generation of men witnesses only one of the glacial variations. It is a phenomenon of such majestic slowness that its study is exceptionally difficult.

A phenomenon of which a man can, in his whole life, see but one manifestation, surpasses in its amplitude the powers of initiative individual study. To observe the facts of so prolonged a period, organizations are required of a superior duration. Shall we address ourselves, therefore, to learned societies, which, being continually renewed, may be supposed to have sufficient continuance? We fear that, even in the most powerful of these societies, Societies of Naturalists and the Alpine Clubs, a sufficiently keen interest in observations, which can only be utilized after the lapse of some generations will not be felt for the observations to be organized and carried out with the necessary perseverance. It seems to us that the State alone, by virtue of the indefinite continuance it enjoys, is in a position to follow out this study with a sufficiently long grasp. However much we may be in favour of private individual or collective initiative action in researches and scientific work, in this special case we believe it advisable to have recourse to the State administration, considering it the only institution of sufficient duration to proceed to the study of phenomena of such extreme slowness.

We therefore take the liberty of addressing ourselves very respectfully to the Government of the Canton of Le Valais, and begging it to introduce the study and observation of the variations of glaciers, which have so great an influence on the prosperity of mountain populations.

It seems to us that the State department best fitted for such a

study would be that of the Administration of Forests. The forest inspectors and their agents are called upon by their functions to travel over the high valleys of the Alps; they would thus be able, without great additional labour, to undertake the observation of glaciers.

As to the programme on which they should work, we would simplify it as much as possible, and reduce it to two points:—

1. To attentively survey the glaciers in order to fix for each one the year of maximum and the year of minimum extent in their successive variations.

2. To specially watch the dangerous glaciers, and warn the Administration of the danger they may cause by assuming exaggerated dimensions during their phase of development.

In order to carry out this double programme, the Government should charge each inspector of forests to study the glaciers of his district, and to inscribe on a register *ad hoc* the state of growth and decline of each glacier every year. For important glaciers, interesting or dangerous, he should have measurements made from fixed marks, and state in exact figures the changes in the dimensions of the glaciers; for little, uninteresting, or unimportant glaciers, occasional inspection and the reports of the mountaineers would suffice to ascertain their state of growth or decrease.

M. Antoine de Torrent, Inspector General of the Forests of Le Valais, has long been occupied in collecting observations on the glacial variations of our Alps; it is from him that we have obtained all the facts recorded by science in this field of research in Le Valais; it is for him, not for us, to give instructions as to the way in which the observations should be organized.

This study is not an expensive one: it calls for no great outlay on the part of the State, nor does it make great demands on the powers and the time of the observers. It may lead to important and useful results. It can only be successfully carried out by the State, since that alone has the necessary persistence to continue it long enough. I therefore venture to recommend these studies on the variation of glaciers to your great benevolence, and to the enlightened solicitude with which you follow all questions interesting to the public welfare. Men of science, who consecrate their lives to the study of the phenomena of nature, are ready to help you to the best of their ability to study these questions from a theoretic point of view. But it is necessary, in order to arrive at practical results, to have a collection of materials of observation which the State alone seems to us capable of bringing together with success.

Accept, M. le Conseilleur de l'État, the expression of my very respectful and devoted consideration.

F. A. FOREL.

Morges, February 10, 1892.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 8.—M. de Lacaze-Duthiers in the chair.—The "Pythonomorphs of France," by M. Albert Gaudry. Announcing the discovery of the snout of one of the great chalk reptiles termed pythonomorphs by M. Cope, on account of their similarity to the sea serpent as imagined by the ancients. The specimen is from a pythonomorph 10m. long, and was found in the upper chalk of Cardesse, near Pau. It is similar to the *Mosasaurus giganteus* of Maestricht, and has been termed *Liodon mosasauroides*. A smaller and somewhat similar specimen was also found, and was termed *Liodon compressidens*. These and a few minor fragments are the first representatives of the pythonomorphs found in France.—On the production of sugar in the blood at the expense of the peptones, by M. R. Lépine.—On the lava of July 12, 1892, in the torrents of Blonnasay and Bon-Nant (catastrophe of Saint Gervais, Haute Savoie), by M. P. Demontzey. After describing the probable course of the catastrophe, the writer comes to the following general conclusion:—That the lava of July 12 has behaved exactly like those which have been observed before in the torrents of the Alps and the Pyrenees. That its energy was all the more disastrous as the transport in masses commenced in the most elevated regions of the torrent basin after the sudden bursting forth of a large body of water concentrated more rapidly even than in the most violent hailstorms in the upper basins of torrents without glaciers. That the volume of the deposited materials of all sorts—estimated at about one million cubic metres—presents no anomaly in comparison with the relatively small amount of water, which effected the transport by a series of successive bounds, with alternate momentary accelerations and retardations of speed. That this torrent phenomenon has substituted for a simple and hitherto harmless rivulet a torrent whose activity can be mastered with a relatively short delay. That both in the Alps and the Pyrenees similar cases of the transformation of peaceful rivulets into formidable torrents can be cited, aggravated by the fact of their being caused by rain, which is even more difficult to predict and ward off than the dangers presented by a glacier. And lastly, that this great disaster could not have been provided against, since nobody had had the idea even of exploring the glacier of Tête-Rousse.—On a property of lamellar bimetallic conductors submitted to electromagnetic induction, by MM. Ch. Reignier and Gabriel Parrot. An arrangement recalling Faraday's disc is obtained by substituting for the ordinary copper conductors thin plates composed, along their thickness, of a very magnetic and a highly conducting metal, so placed that the lines of force are perpendicular to their thickness. The flow of induction emanating from the north pole is divided into several sheets of parallel lines very close together, which only traverse the magnetic portions of the bimetallic conductors, and the tubes of force become cylindrical. The available energy in such an arrangement increases at a rate which is sensibly proportioned to the height of the conductors. An apparatus constructed on this principle gave, with a weight of 750 kg. and a velocity of 500 revolutions, 32,000 watts, giving an output of 42 watts per kg. of the machine.—The application of the measurement of density to the determination of the atomic weight of oxygen, by M. A. Leduc. The composition of water by volume, and thence its composition by weight, were determined by finding the density of a mixture of hydrogen and oxygen produced by the electrolysis of an alkaline solution. After an electrolysis of several days, during which the superfluous gas was allowed to escape through mercury, the liquid and the platinum poles were saturated with gas, and the density obtained by the method previously described did not vary by more than 0.0001 gr. The value within $\frac{1}{100}$ per cent. was 0.41423. The volume ratio between hydrogen and oxygen was 2.0037 at 0°, and the atomic volume of oxygen 1.9963. The atomic weight of oxygen by this method is 15.877, and by the synthetic method 15.882, so that 15.88 must be taken for the mean atomic weight. Hence the molecular weight of water vapour is 17.88, and its theoretical density 0.622.—On the general form of boiling-point curves for central substitution compounds, by M. G. Hinrichs.—Note on the existence in the earth of an acid mineral substance as yet undetermined, by M. Paul de Mondesir. If all the carbonic acid contained in lime be driven off by a strong acid, and the ratio of lime to carbonic acid be carefully measured, the lime is found to exceed the quantity necessary for saturation. The earth remains always acid and capable of decomposing carbonate of lime in the cold. That this acid residuum cannot be humic acid or free silica is proved by the total destruction of the organic substances by ignition or potassium permanganate, which leaves the property in question unaffected. The quantity of acid matter varies from 2 to 1 per cent. of the earth. It is very stable, and its composition has not yet been determined.—Calcareous soap and boiler explosions, by M. A. Vivien.—Pupine, a new animal substance, by M. A. B. Griffiths. This is extracted from the skin of the chrysalis of several lepidoptera.—On the colouring matter of *Micrococcus prodigiosus*, by the same.—On the coccoid state of a nostoc, by M. C. Sauvageau.—On an alga living in the roots of the *Cycadeæ*, by M. P. Hariot.—On the presence of fossils in the azoic formations of Bretagne, by M. Charles Barrois.—On the discovery of cut flints in the quaternary *Rhinoceros Mercki* alluvium of the Saone valley at Villefranche, by M. Ch. Depéret.

ROME.

R. Accademia dei Lincei, June 5.—The 289th annual meeting, honoured by the presence of H.M. King Umberto I.—The President introduced the two committees charged with the examination of the works in competition for the two royal prizes of 10,000 lire each, one for social and economic sciences, the other for mathematical sciences. Senator Lampertico, reporting for the first committee, said that, although two essays, one on "Ancient Socialism," by Salvatore Cognetti de Martiis, and another on the laws of the distribution of wealth, bearing the motto, "Laboremus," had shown considerable merit, the committee had not felt justified in awarding the prize to either

Professor Cerruti, on behalf of the second committee, reported that two candidates had been found equally deserving of the mathematical prize, viz., Professor Luigi Bianchi by his essays on the triple orthogonal systems of Weingarten and allied subjects, and Professor Salvatore Pincherle in virtue of his various works on the general theory of functions. It was therefore decided to divide the prize equally among these two candidates.—The last of the ministerial prizes for professors of secondary classical and technical schools, amounting to a total of 9000 lire for philological, and 9000 lire for physical and chemical subjects, were distributed among thirteen candidates, prizes of 3000 lire being obtained by Professors Nasini and Costa for their work "On the Variation of Refractive and Dispersive Power of Sulphur in its Compounds," and by Dr. Enrico Salvioni for his contribution "On the Construction of the Legal Ohm."—General Ferrero then addressed the meeting on the subject of scientific measuring instruments. Although, he said, the human eye, that natural model of the telescope, the microscope, and the photographic camera, can distinguish within a few hundredths of a millimetre whether two points are in contact, although the ear can appreciate sounds ranging from 32 to 70,000 vibrations per second, and is able, while following the rhythm of a full orchestra, to discover the slightest dissonance, yet the power of our senses is limited to a comparatively small portion of the infinite variety of external phenomena, that portion which is of more immediate value for our merely animal life. The errors which the unaided senses are liable to lead us into are mainly due to their subjectivity, which renders the impressions of one individual incomparable with those of another, or with his own under different conditions. The use of instruments enables us to submit these impressions to measurement, to compare them amongst themselves, and immensely to extend our field of investigation towards the infinitely great and the infinitely small. The progress made in this direction during the last few hundred years justifies the hope that the time is not far distant when the results of observation will be as far as possible beyond the personal influence of the observer. The disciple of science will read the truth in the book of nature, traced out by the phenomena themselves. The universe, which has always remained inaccessible to metaphysics, will willingly disclose its secrets to the researches of modern science. This owes its great progress during the last century mainly to the perfection and delicacy of its measuring instruments, which has made modern astronomical observations a thousand times more accurate than those of the Chaldees, and has, by making very minute differences of temperature appreciable and measurable, enabled biology to enter the ranks of the exact sciences. The accuracy of measurements of length and mass is ensured by the arrangements in connection with the International Office of Weights and Measures at Breteuil. Some recent comparisons of standards gave a probable error in length of 1/20,000mm., while that for mass was 1/1000 mgr. The determination of weight has been carried to such a pitch of accuracy, that it has been found possible, at Breteuil, at Monaco, and at Rome, to measure the slight differences of weight produced by varying the height above the ground by a few metres. For the measurement of time there has been no necessity of fixing a conventional standard. The marvellous invention of the pendulum has made it possible to subdivide almost indefinitely the natural fundamental unit, the duration of the rotation of the earth. In the determination of longitudes the error has been reduced to one or two hundredths of a second. Hipp's chronoscope, which may be called a microscope for time, enables the observer to subdivide time to a thousandth of a second. The impulse given to biological research by such instruments has been astonishing. The time of reaction to the various sensory stimuli has been fixed at 136 thousandths of a second for sound, at 150 for light, 133 for touch, 359 for taste, and 443 for smell, while the velocity of propagation of a nervous impulse has shown itself to be 37m per second. In artillery, the chronoscope has been utilized for the study of the initial velocities of projectiles, and for the tracing of diagrams expressing the relations between spaces, times, and explosive pressures. Errors of observation may be due to the imperfection of the senses, to unavoidable faults in the construction of the instruments, and to external influences. These may be classified according as they are constant or accidental, or better as periodical or otherwise. Most of the errors due to the observer, and of those due to external influences, are periodical, and may be eliminated by repeating the observations under varying conditions. The calculus of probabilities shows that the precision of results, so far as the elimination of purely accidental errors is concerned, increases with the square root of the number of observations. But experience shows that beyond a certain number of observations the increase of precision is illusory. This is probably due to the existence of other errors of a constant character which escape analysis, and from which it is not possible to protect the observations. Experiment also proves that for all kinds of work the maximum error does not exceed a certain limit, which is a function of the mean error. For angular measurements, this does not exceed three times the mean error, so that according to Gauss's law of errors it would be safe to lay 1000 to 1 against the chance of an error greater than 3.2 times the mean error. The observer himself must above all have physical qualities enabling him to use his senses under the best possible conditions. In addition to well-trained senses and facility in managing his instrument, he must have a clear mind, a correct judgment, and a sound scientific preparation for the research he undertakes. Concentrated upon his research, he must abstract himself from the surroundings among which he lives, and possess a spirit unimpassioned enough to subject himself to a purely objective criticism. In concluding, the speaker pointed out that there is at present no science which treats of measurement in general, as a preparation to all the sciences which aim at quantitative results. Many treatises on astronomy, on geodesy, on physics are prefaced by theories of instruments and the compensation of errors. But even those works which profess to treat of the art of measuring are usually limited to geodetic and topographic measurements. It is to be hoped that this important vacancy may soon be filled up, and that a *Science of Measurement* will unite the elements dispersed among the various sciences in one compact and harmonious whole.

CONTENTS.

THURSDAY, AUGUST 25, 1892

BRAMWELL'S CLINICAL ATLAS

Atlas of Clinical Medicine By Byrom Bramwell, M D Vol I (Edinburgh. Constable, 1892)

THIS large and handsome volume is highly creditable to the author and to the Extramural School of Edinburgh, in which he is a lecturer It consists of a series of thirty admirably coloured plates, mostly portraits of patients, with about an equal number of woodcuts, and descriptive letterpress The account of the several diseases illustrated is so full and good that it almost makes the work a collection of illustrated monographs

The diseases described and portrayed in this first volume are myxœdema and sporadic cretinism, Addison's disease, Hodgkin's disease, unilateral atrophy of the face, bulbar paralysis, Ophthalmoplegia externa, Molluscum fibrosum, Kaposi's disease, variola, melancholia, and mania

There are also reports of cases of Friedreich's disease and of a few other rare morbid conditions

The plan adopted by the author is to give a detailed account of the case or cases illustrated, and then a discussion of the disease under the heads of anatomy, diagnosis, and treatment, concluding with minute hints (such as one would give to intelligent ward-clerks) as to the points of clinical investigation. No order is observed in the sequence of subjects, and as the work is without a preface (though not, we are glad to say, without an index), it is not clear whether the author has formed any other plan than publishing interesting cases as they may come under his notice The words "Volume I" on the title-page encourage the hope that Dr Bramwell contemplates an additional series, and in that case it might be desirable to arrange the completed work in alphabetical or some other convenient order

To take the first subject treated—Myxœdema—as a specimen

There is first a brief notice of the first patient whose portrait is given, then an account of the original description of this remarkable disease by Sir William Gull in 1873, next a discussion of its geographical distribution and incidence on sex and age, the symptoms and pathology follow, and the author agrees with the conclusion of most who have studied the question, that this peculiar condition is in some way dependent on atrophy of the thyroid body, finally, the treatment is discussed, and the method of transplantation or grafting of a portion of the healthy thyroid of an animal into the patient's body is mentioned, with the results so far obtained by Bircher and Kocher.

Three portraits of patients afflicted with myxœdema follow, each with a full clinical history of the case They are all three excellent, the colouring as well as the design being as good as chromo-lithography can produce.

This monograph is followed by one on sporadic cretinism, which Dr Bramwell regards as "infantile myxœdema," another way of stating the true relation which Gull's remarkable insight led him to detect when he called the disease he discovered "a cretinoid condition in the adult" The paper is illustrated by seven uncoloured lithographs

The two plates which belong to Addison's disease are the most artistic in the book, the difficulties are, of course, much less than in the case of myxœdema Some of the other portraits are reproductions of photographs, very good in their way, but with the defects inseparable from this mode of illustration

The three coloured plates of the singular affection described by Kaposi under the ill-chosen title of xeroderma pigmentosum are again excellent, particularly No xviii The illustrations of mental disease, although they display considerable power in draughtsmanship, are perhaps open to the objection of showing such fully developed and extreme aspects of the several states delineated, that they do not much help the recognition of less marked and typical examples

We should, indeed, advise Dr Bramwell, if, as we hope, he is encouraged to continue this valuable series of plates, to choose for illustration rather such infrequent morbid conditions as the diseases associated with the names of Graves, Addison, Raynaud, and Friedreich than the more familiar maladies which can be always studied at first hand

It would also be well, perhaps, if in a scientific work of importance like this the catechetical method of instruction were omitted, which here and there interrupts the course of a paper For instance, the following conversation, though no doubt an excellent paradigm of one method of class teaching, seems out of place where it stands (p 30)

Dr B (to the students) The case, gentlemen, is exactly what I suspected It is, in fact, an absolutely typical example of the disease Such are the leading facts, I shall now be glad to hear any suggestions you may have to make as to the diagnosis

A Student Tumour of the cerebellum.

Dr B No, it is not a case of tumour of the cerebellum

And so on

Here and there an inelegant word or sentence strikes the eye Thus Dr Bramwell pertinently remarks that Addison's discovery was not merely "a happy hit," but spoils the phrase by adding "it was no mere fluke" A more important error of omission is, that in quoting the interesting quotation which follows from Addison's original work, Dr Bramwell makes no clear distinction between the graphic and marvellously accurate account of idiopathic Anæmia, and the description of Melasma suprarenale, as the discoverer named it, which begins "It was while seeking in vain to throw some additional light upon this form of anæmia that I stumbled upon the curious facts which it is my more immediate object to make known to the profession." The fact is that Addison, in a few pages, made known the existence and clinical features of *two* rare and remarkable diseases—idiopathic (since called grave or pernicious) anæmia and Melasma suprarenale (since called Morbus Addisonii) Dr. Bramwell is well aware of these facts, but it would have been useful if he had fully stated them, particularly as so much confusion on the subject still prevails both in this country and in Germany

In conclusion, we must repeat that the present volume is most creditable to the author, to his artist, and to the

publishers It is remarkably moderate in price, and we trust that it will be so well supported by societies and private purchasers that Dr Bramwell will be encouraged to continue so admirable an enterprise

MODERN DEVELOPMENTS IN NORWAY

Handbook for Travellers in Norway Eighth Edition, Revised (London Murray, 1892)

NORWAY now shares with Switzerland the privilege of being "the playground of Europe," and would even take precedence were it not for the sea voyage there and back The recent progress of tourist invasion is curiously displayed by reference to the various editions of Murray's Handbooks

We have before us the tattered remnants of our old travelling companion and oracle—Part I of the "Handbook for Northern Europe," including Denmark, Norway, and Sweden (1849) We are there told that by the last census in 1835 the population of Christiania was 33,000 The last edition tells us that its population is now 156,000 This is good progress for a capital city, but that of the chief town of Arctic Norway is still more remarkable Tromso (lat 69° 38′ N) had in 1816 only 300 inhabitants Its present population is above 5,700, in spite of the fact that for more than two months the sun is continuously below the horizon On the 22nd January, when it makes its first appearance over a crag to the south of the town, there is much jubilation, general holiday, and gun firing In the old handbook the journey from Tromso to the North Cape is described as an adventurous expedition demanding special preparations, which are described, and ladies are warned not to attempt it Now it is as easy as a trip from London Bridge to Ramsgate, in steam packets incomparably superior to those which carry passengers down the Thames

In the old handbook the Skjeggedalsfos, justly described in the present edition as "more grand and picturesque than any other waterfall in Europe," is unnoticed, as also in the next edition (1858) It was then unknown to the outer world, including Norway itself, until a solitary English pedestrian—the writer—ventured to explore the valley of the Tyssedal, to climb further on, and sojourn for a night in the Ringedal It was first described in 1859 in "Through Norway with a Knapsack" Now it is one of the primary "lions" of Norway, there is a regular passenger boat on the lake, so solitary and desolate before 1859, professional guides, and an hotel in course of erection The other grand region of Norway—the wildest of all—the *Jotunhjem*, which in the early editions of the Handbook was merely referred to in a single paragraph of a few lines, and in 1874 in two paragraphs bracketed as a side route, was made the subject of a special section of fifteen pages in the edition of 1880, illustrated by a special map of the district This is continued in the present edition

The Norwegian Tourist Club has strong claims upon the gratitude of all Norwegian tourists Besides publishing in its transactions the record of explorations which have opened up many interesting districts, it has erected huts for refuge in the Jotunhjem, rendered a visit to the foot of the Voringfos and many similar places possible, and set up many useful sign-boards indicating paths to waterfalls, points of view, &c The assistance thus freely given to tourists in Norway contrasts very remarkably with the twopenny tricks of British landlords, who, for a consideration, permit their tenants to put up gates and charge admission to so many of our little dribbles designated waterfalls, and other natural objects of interest

The present Handbook is brought up to date, and improved in many respects, notably by being printed on thinner paper than heretofore, and by setting the bye routes in smaller type, as Baedekker does There is a valuable feature altogether new, viz, a Guide to Cycling Routes in Norway The old accounts of the old hilly roads—which are now greatly improved or wholly superseded—led to false impressions on the subject The writer delivered a lecture on "Cycling in Norway" to the Society of Cyclists some years ago which corrected these impressions, and induced many cyclists to do Norway, this appendix to Murray's Handbook will doubtless have still greater effect In one important respect Norway offers the cyclist unrivalled advantages, viz, its admirable national organization of "Stations" for bed and board at regular intervals of about eight miles apart, and the annual publication of an authorized guide to all the roads and all the stations thereon, of which Mr Bennett publishes an English translation with additions and maps, which render it a very valuable handbook

An ideal handbook of Norway is, however, still demanded The country being a narrow strip extending from 58° to 72° of latitude, it lends itself to a scheme of simple mapping, in horizontal strips of one degree each, which would require no cross folding Each degree on the scale of Munck's map would occupy only the depth of one of Murray's pages The scale of this map is sufficient for pedestrians, cyclists, and carriole tourists With such a series of maps and a small key map, the only handbook reference demanded would be designation of latitude In 1880 the writer constructed such a series from Munck, and suggested its adoption by the publishers, but the suggestion was not carried out The development, or rather creation, of hotels in Norway is marvellous. The night before last we stopped at the Stalheim Hotel, dined in a magnificent salon, with roomy seats for 300 guests, music at dinner, concert in capacious smoking-room every evening, several drawing-rooms and 200 beds, all the salons lighted by electricity Formerly—at the time of our first visit—the only provision here for travellers was a very inferior "station," a little hut with two or three questionable beds, no such luxury as white bread Much of this is due to the modern development of cruising in what may be called cooperative yachts, such as the *Ceylon* and the larger vessels of the Orient Company and others, which carry about a hundred passengers on each cruise, visit the finest fjords, and halt for inland trips, thus rendering a short holiday available for Norway, so far as the outer fringe of its grand scenery is concerned W M. W.

Odde, August 13, 1892

OUR BOOK SHELF

Ostwald's Klassiker der Exacten Wissenschaften (Leipzig: Verlag von Wilhelm Engelmann.)

It is extremely important that every student of science should as far as possible make himself familiar with the history of discovery in the various subjects in which he is interested. He can hope to understand thoroughly the present position of any department of science only if he understands the stages of development through which it has passed. And by far the most effective way in which this knowledge can be attained is by the study of the memoirs in which the great masters of research have recorded their discoveries and described the methods by which their results have been reached. These documents bring the student into contact with the finest intellects which have been devoted to original inquiry; and he will be surprised to find how much freshness is often given to an old doctrine when it is apprehended precisely in the way in which it presented itself to the investigator by whom it was first brought to light. Judged from the point of view of later thinkers, the achievements of even the most illustrious workers belonging to past times may be in some ways found wanting; but the mistakes of great men, when properly understood, may sometimes be almost as instructive as those of their conclusions which have stood the test of the closest and most prolonged examination.

Important as it is that the classics of science should be widely and carefully studied, they have hitherto, unfortunately, been accessible only to a comparatively small class. It was therefore an excellent idea to issue a series of them in a convenient form and at a moderate price, so that they might be brought within easy reach of all to whom the study of science is either a duty or a source of interest and pleasure. Upon the whole, those who planned the present series may be congratulated upon the manner in which their scheme is being executed. Dr. W. Ostwald is acting as general editor, while particular departments have been entrusted to specialists—astronomy to Dr. Bruns, mathematics to Dr. Wangerin, crystallography to Dr. Groth, physiology to Dr. G. Bunge, the physiology of plants to Dr. W. Pfeffer, physics to Dr. A. von Oettingen. The only serious fault we have to find is that memoirs in foreign languages have not been printed in their original form, but have been translated into German. This cannot but diminish the usefulness of the series from an international or cosmopolitan point of view; and we may doubt whether it is really the best plan even for German students. So far, at least, as English and French memoirs are concerned, there are probably few serious students in Germany who would not have preferred to have before them the actual words used by the authors themselves.

The memoirs are not being issued in chronological order. The series opens with Helmholtz's paper on the conservation of energy (1847). This is followed by papers by Gauss, Dalton, Wollaston, Gay-Lussac, Galileo, Kant, T. de Saussure, Laplace, Huyghens, Woehler, Liebig, Bunsen, Pasteur, and many other famous men of scientific light and leading.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Aurora Borealis.

THE auroral display of Friday, the 12th inst., referred to in last week's issue of NATURE, would seem to have been visible over a wide area. Between 9.30 and 10 p.m. I observed it at Boppard, on the Rhine, a few miles above Coblence. The streamers were clearly defined, but presented no unusual features, being merely rays of whitish light which slowly dissolved as the moon rose above the crest of the range of hills running along the right bank of the river. On the previous evening I was at Strassburg where, owing, I suppose, to the gas and electric lights, I took the greyish appearance of the northern horizon to be nothing more than the usual light in that quarter at this season. Further south, in Switzerland and Austria, auroræ were seen on both nights. As to "the unusual time of year for such a display," I may mention that on Sunday, August 2, 1891, I witnessed a brilliant aurora from the Deck of the R.M.S. *Teutonic*, in latitude 48½° N., longitude 30° W. It varied considerably in intensity, and continued to do so for half an hour up to 10 p.m. HY. HARRIES.

Bayswater, August 20.

An Unusual Sunset.

THIS evening (July 29th) we were treated to a sunset of rare type, one which is unique at least in the experience of the writer.

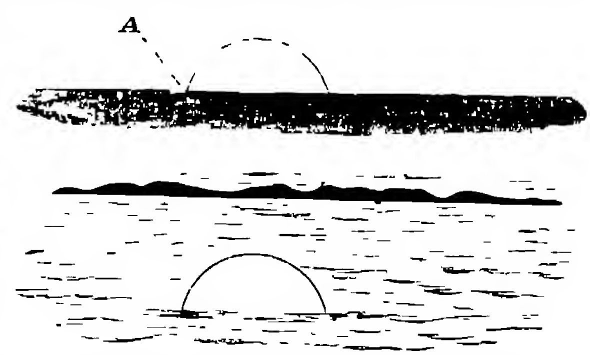
The fog was apparently *forming* round about the outer range of the mountains which lies between Mount Hamilton and the coast of the Pacific. Ordinarily, about this time of day, one can see the fog drifting over the tops of these mountains, and pouring into the valley on this side.

To-day, however, the crest of this range was barely visible above a sea of fog, which was unusually level and flat, as seen from above. Just over and along the crest was stretched a slender, thin, cloud which obscured the lower half of the sun's disc. Suddenly there formed underneath this semi-disc another of the same shape and size, and similarly placed, but not quite so bright as the true solar disc.

The accompanying figure shows essentially what was seen. The lower image I take to be that of the lower limb of the sun, shining down (from behind the upper strip of cloud) upon this quiet lake of fog and there reflected. But this amount of reflecting power in a fog if that be the true explanation, is very surprising, the image formed being not only bright and sharp, but very free from the usual glare of what are known as "brilliant" sunsets.

Another phenomenon, certainly not frequent in this country, showed itself on the limb of the sun at the point indicated by the dotted line A.

Here twice, just before the disc disappeared, the deep red colour of the solar surface turned to a bright blue, the change in



colour being just about what one would experience in examining a prominence first through the C line and then through the F. Then again at the last moment, when all had disappeared but a narrow strip at the eastern limb, this flashed out into the same light blue, an effect apparently due to the greater refrangibility of the blue rays, combined with a very steady atmosphere.

Mr. Barnard says that for half an hour after sunset he observed "a small bright spot of light" at the point where the sun had disappeared. HENRY CREW.

Lick Observatory, July 29.

The Red Spot on Jupiter.

ON August 19, at 14h. 40m., I began observing Jupiter with my 10-inch reflector, power 252. The red spot was seen slightly east of the central meridian, and it looked decidedly fainter and

less definite than during the last opposition. The spot was estimated to be precisely central at 14h. 46m., and this is 14.3 minutes in advance of the time given in Mr. Marth's ephemeris (*Monthly Notices*, May, 1892). The motion of the spot has therefore shown a considerable acceleration during recent months. Between August 2, 1891, and February 2, 1892, the mean rotation period was 9h. 55m. 42.2s., but between February 2 and August 19, 1892, it was only 9h. 55m. 39.3s. This is a difference of 3 seconds, and it clearly proves that the motion of the spot is affected by some remarkable variations. A very decided retardation set in at the end of August, 1891, and continued to operate until February, 1892, but since that time the spot has exhibited an expected celerity of movement.

A large number of interesting details are now visible on the planet, but the bright equatorial spots which were so conspicuous about twelve years ago have virtually disappeared. During my observation on August 19 I saw the third satellite projected on the southern limb of the planet as a bright spot.

Bristol, August 20. W. F. DENNING.

Numbering the Hours of the Day.

WITH reference to Dr. Mill's recent interesting article on "Time Standards of Europe," I beg leave to emphatically take exception to the remark on p. 176, that "the system of numbering the hours of the day from 0 to 24 has failed to hold the popular fancy," as I maintain that the public has had no opportunity of testing the convenience of such a reckoning. The ordinary standard used in this country being railway time, so long as *Bradshaw* is printed on the old system of numbering the hours only up to 12, it is out of the question to expect the public to adopt any other. Any number of clock faces numbered otherwise, either at Greenwich or all over the country, would not lead people to adopt the new system; the railway tables must first be altered, and as *Bradshaw* is compiled from the tables of separate companies, probably it would be necessary to approach the numerous railway companies with a view to their considering the subject and deciding upon a common plan. They would have to discuss not only the question of printing the time tables on the new plan, but also whether it would be necessary, as well, to alter all the clock-faces at every station. I am given to understand that one railway company (in the Isle of Wight) for some time printed its tables—if it does not still—with the afternoon hours numbered from 12 to 23; though its example, because, I presume, it was of a small and uninfluential line, was not copied by any other company.

A further difficulty in the way of the public making any change is that the highest authoritative book on time matters—the *Nautical Almanac*, compiled and published by the British Government—still reckons the hours from noon. As a civil day commencing at noon is not suggested, would not the railway authorities have a ready objection to urge, and decline to alter their time tables while time bearing the name of the national observatory, and used in the national ephemeris, were reckoned on a different plan from that which it is suggested they should adopt?

As regards the existing mode of reckoning time, the art of the printer is sometimes called in to show at once, without having to refer to the tops of columns or the sides of pages, which half of the day is meant; thus in the Midland Railway's, and part of the North-Eastern Railway's time-tables thick and thin type show this, and in some other tables a short vertical line appears between the figures of the hours and those of the minutes.

If the lists of places (p. 176) at which the time of the national standard is kept and not kept are intended to be complete, may I ask if Jersey has yet adopted Greenwich time? It had not up to 1887, although Guernsey had done so.

Sunderland, August 1. T. W. BACKHOUSE.

Propagation of Magnetic Impulses along a Bar of Iron.

IF at one end of an iron bar an alternating current be passed through a coil, will there be a wave propagation of magnetism along the bar?

Mr. Trouton (NATURE, vol. xlv., p. 42) hoped to find an answer to this question by searching after nodes, when two coils are placed one at each end of the bar, and the same alternating current is passed through both coils, or when one coil is employed on a closed iron ring. The search was conducted by a secondary coil connected with a telephone. Mr. Trouton found some places of minimum, but ascertained that these were not the nodes sought for.

Mr. Trowbridge (*Phil. Mag.* [5] 33, p. 374, 1892) made use of his phasemeter; two secondary coils, each connected with a telephone, could slide along the ring on which two large primary coils were placed. Two mirrors on the diaphragms of the telephones permitted to study change of phase by Lissajous's figures.

From his experiments, Mr. Trowbridge infers that there was no wave-motion along the iron ring; he believes that the propagation of magnetic disturbances produced by forced oscillations on iron bars is closely analogous to the propagation of heat over these bars.

Though I agree with Mr. Trowbridge in his conclusions, it seems to me that neither the experiments of Mr. Trouton nor those of Mr. Trowbridge could give any but embroiled results.

In collaboration with Mr. N. G. van Huffel, Phil. Nat. Cand. at this University, I have made some preliminary experiments on this question. Firstly, it became obvious that care must be taken against direct induction of the primary coils on the secondary. Only when the secondary coil which was connected with the telephone was embedded in a mass of copper everywhere 2.5 cm. deep, with a narrowly closing aperture for the iron bar, these direct effects were eliminated if the distance of the secondary from the primary coil were not too small. I have found no indication that similar precautions were taken in the quoted experiments.

But secondly, the telephone proved to be not the proper instrument for conducting the research. In most cases the variation of the magnetic intensity goes too slow to be perceptible by the telephone.

At one end of an iron bar (5 meters long, 1.5 cm. diameter), a primary coil A was placed; along the bar the secondary coil B (within a mass of copper, and connected with a telephone) could slide. A magnetic impulse was given by sending a current through A. If B were near A, a single tick was heard in the telephone; if the distance between B and A were greater, nothing was perceived in the telephone. However, if the circuit composed of B and the telephone were interrupted by a tuning-fork P, a sound was heard during somewhat one second and a half of the same pitch as the tone of the tuning fork P, every time the primary current was sent through A, or broken. The intensity of this sound diminished as the distance of B from A increased, but was still perceptible wherever B was placed on the bar.

Thereupon the primary circuit to which belongs the primary coil A was interrupted by a tuning fork Q. If no tuning-fork were in the circuit of B and the telephone, then only when B was near A a sound was heard of the pitch of Q; at a greater distance nothing was heard in the telephone. But if now a tuning-fork P interrupted the circuit of B and the telephone, a continuous sound was heard, even at much greater distances of B from A. When the pitch of P differed slightly from that of Q, beats were perceived, also when the frequency of P was nearly half that of Q. The interpretation of these facts is so apparent, that I need not dwell upon it. But these facts illustrate the principle on which Van Rysselberghe based his method of simultaneously sending telegraphic and telephonic signals along the same line.

I believe that the propagation of magnetic impulses along a bar of iron has to be studied in an entirely different way. We intend to make an attempt in this direction ere long.

Utrecht, July, 1892. V. A. JULIUS.

"The Limits of Animal Intelligence."

CLOSELY in connection with an observation I made the other day with respect to an argument of Prof. Pearson's, I should like to say a few words about a paper read by Prof. Lloyd Morgan before the International Congress of Experimental Psychology, on "The limits of animal intelligence." The first proposition he advanced, "That human psychology is the only key to animal psychology," and the deductions he subsequently drew, all implied that our knowledge of human psychology differed not only in degree, but in kind, from our knowledge of that of animals. Of course it is true that my knowledge of *my own* psychology does differ in kind from my knowledge of that

of animals, but it differs in exactly the same way from my knowledge of that of all other men. If in no case is "an animal activity to be interpreted as the outcome of the exercise of a higher psychical faculty, if it can be fairly interpreted as the outcome of one which stands lower on the psychological scale," the same rule should be applied to the interpretation of human activities, for the only reason for distinguishing between human and animal psychology is that their activities do, as a matter of fact, differ. Human beings are of course distinguished from animals in other ways, in the structure of their limbs, for example; but there is no *a priori* ground for inferring from such differences any, and certainly not any particular, difference in psychological powers. And so far from its being permissible to infer such a difference from greater or less complexity of brain-structure, it is only because animals which when alive displayed great activities proved, on dissection, to have possessed complex brain structure, that we can infer any connection whatever between the two phenomena. As no man has ever dissected his own brain he cannot say that any particular structure is associated with those psychological powers of which alone he has any more direct knowledge. If, for example, I say "Morality involves a perception of the relation between the actual and ideal, and is based on introspection," I say this in consequence of my personal experience. I can only infer morality, introspection, and so on, in other beings, whether animals or men, by judging from their activities. And if "most cases of so called morality in the dog can be otherwise interpreted," so also can most cases in other men. A fundamental distinction between the psychological powers of animals and men could only be established by showing a fundamental distinction between animal and human activities, as observed from outside by a third person. And though it is easy to show that there is a difference in degree, Prof. Morgan did not adduce any cases which even tended to show that there is any difference in kind. The cases he did adduce all tended the other way; and though this was doubtless because he only adduced difficult cases in order to show that his theory was capable of explaining them away, his explanations seemed to me, for the reasons I have given, insufficient.

Note.—The quotations are from a printed *précis* of his paper distributed by Prof. Lloyd Morgan at the meeting.

EDWARD T. DIXON.

12, Barkston Mansions, South Kensington, August 5.

Tropical Cyclones.

A FEW years ago I drew up some simple mathematical rules to aid the Jamaica Weather Service when in doubt as to the indications, and thinking that these rules may be of some use to other isolated or nearly isolated stations in the Tropics, I state them here, and give an example or two as to their application.

At the time and place of observation let

p = Reading of bar in inches and decimals of an inch, corrected for instrumental error, reduced to 32° F. and sea level, and further corrected for diurnal variation.

p_m = Mean value of p for the time of the year.

$\Delta p = p_m - p$ = fall of pressure below the mean.

v = Velocity of the wind in miles per hour.

r = Distance of the centre of the cyclone in miles.

$\frac{dp}{dr}$ = Bar gradient, or the fall of p per mile towards the centre at the place of observation.

$\frac{dp}{dt}$ = Rate of fall, or the fall of p per hour.

$\frac{dr}{dt}$ = Rate of approach of the centre in miles per hour.

Now let us suppose that the centre is moving towards the place; in this case we have

$$\frac{dr}{dt} = \frac{\frac{dp}{dt}}{\frac{dp}{dr}} = \frac{\text{Rate of fall}}{\text{Gradient}} \qquad (1)$$

In Jamaica $\frac{dp}{dr}$ is found by an exchange of telegrams between Kingston and Kempshot, these places being on the line of usual approach, and 77 miles apart.

The next equation is based upon the results of observation:—

$$r = \frac{\Delta p}{2\frac{dp}{dr}} = \frac{\text{Fall below mean}}{\text{Twice the gradient}} \qquad (2)$$

This equation must not be pressed; it is intended to be used when the centre is still a long way off.

Thus we have

$$\text{Time of arrival of the centre} = \frac{r}{\frac{dr}{dt}} = \frac{\text{Fall below mean}}{\text{Twice the rate of fall}} \qquad (3)$$

This is an important equation, for it shows that the direct approach of a cyclone may be ascertained by the constancy in the computed time of arrival.

As an example, let us take the cyclone which passed over Kingston, Jamaica, August 18, 1880. This was before the Weather Service was established, and the indications of the advancing cyclone were confused by the existence of a small cyclone to the north-east of Kingston; there was no wind in Kingston until 8 p.m., and rain fell quietly in showers all that afternoon from a sky covered with stratus.

Kingston, Jamaica, August 18, 1880.

	p	Δp	$\frac{dp}{dt}$	Time of arrival
7 a.m.	29.845			
9 ,,	.807	0.178	0.0170	2 p.m.
11 ,,	.777	.208	.0142	6 ,,
1 p.m.	.750	.235	.0120	11 ,,
3 ,,	.729	.256	.0225	9 ,,
5 ,,	.660	.325	.0595	8 ,,
7 ,,	29.491	0.494	0.1808	8.30 ,,
9 ,,	28.937			

From the last column it appears that from 7 a.m. to 1 p.m. the cyclone was not directly approaching, and from the logs of vessels and other information it is certain that the cyclone was passing south of Jamaica on a westerly course, and that between 1 and 3 p.m. it turned on its course and advanced directly towards Kingston. The centre arrived at about 9.15 p.m., lowest p = 28.917.[1] A warning notice was posted at 3 p.m., but had these rules been in existence, a better notice could have been posted at 5 p.m.

Now if the gradient be not known at an isolated station, it may sometimes be deduced from the theoretical equation—

$$\frac{dp}{dr} = 0.00007v \qquad (4)$$

This equation is only to be used for considerable distances from the centre; and if v be small, or variable, or if it be mixed up with the sea-breeze, it cannot be used at all.

If $\frac{dp}{dr}$ be known, r is known from (2), and then some idea may be formed as to the magnitude of the coming disturbance. The following rule may prove useful:—

Let Δp_c be the fall below the mean at the calm centre of the cyclone; then, roughly—

$$\Delta p_c = \frac{\Delta p\sqrt{r}}{6}\left(1 + \tfrac{3}{4}\Delta p\sqrt{r}\right) \qquad (5)$$

Now $\frac{dp}{dr}$ is unknown in the example above; but if we take $\frac{dr}{dt}$ = 18 from the subsequently known circumstances, (1) gives $\frac{dp}{dr}$ = 0.0012 at 3 p.m.; (2) gives r = 106 at the same hour, which happens to be right; and (5) gives Δp_c = 1.3, which is a little too large, the observed fall at the centre being about 1.1.

As another example, let us take the great hurricane in Mauritius on April 29 this year. Some valuable notes by Dr. Meldrum are published in NATURE, June 9, but unfortu-

[1] See "Jamaica Meteor. Obs.," vol. 1 (Introduction).

nately the readings of the barometer are not corrected for diurnal variation, although the given values of $\frac{dp}{dt}$ are so corrected, and I can only apply approximate corrections, and so obtain approximate values of Δp

Mauritius, April 29, 1892

	p	Δp	$\frac{dp}{dt}$	Time of arrival
6 a.m	29 668	0 282	0 018	2 p m
8 ,,	597	353	029	2 ,,
9 ,,	536	414	061	1 ,,
10 ,,	440	510	094	1 ,,
11 ,,	29 304	0 646	0 131	1 30 ,,

The computed time of arrival is therefore 1 30 p m , and the agreement in the last column shows that the centre was directly approaching the place of observation, and it really arrived there at 2, or 2 30 p m

Now at 6 a m the wind was 22 4 miles an hour (4) gives $\frac{dp}{dt}$ - 0 0016, (2) gives r = 104, and (5) gives Δp = 1 5, which is a little too small, the observed fall at the centre being about 2 0 If, however, we compute Δp, for 9 a m , we get 2 4, which is a little too large , and as in the case of time of arrival, we should be guided by a series when possible

Jamaica, July 29 MAXWELL HALL

A Sparrow's Antipathy to Purple

I HAVE but just seen your number for March 10 About five years ago I knew a tame sparrow with a great antipathy for purple It was brought up in a room, but not, or seldom, caged It lived four or five months A piece of blue paper placed over its food would cause it to hesitate, though if hungry it would eventually draw the paper aside , a person coming into the room wearing a blue dress would make it quite wild, and a habit of mischievously pecking at a certain part of the wall of the room was successfully stopped by hanging a piece of blue paper there This sparrow was taught to be cleanly in its habits I had put off writing this to you in hopes that others who saw more of the sparrow would have written a more detailed account, but trust this letter may not be too late for any one interested to get a young sparrow from the nest this year and rear it Sparrows have not yet reached Borneo G D HAVILAND

Sarawak, June 17

Bumping in the Lane Fox Mercurial Pump.

CAN any reader of NATURE favour me with a method by which the bumping in the Lane Fox pump may be obviated? I find that when exhaustion is pressed to a certain point, the bumping becomes so violent, in spite of the utmost care in lowering the reservoir, that the bulb of the pump is constantly cracked D G

Lahore, July 25

CARL SCHORLEMMER, LL D , F R S

CARL SCHORLEMMER having been my friend and colleague in Owens College for more than thirty years, it is with a sad pleasure that I take up my pen to record in the columns of NATURE some few details of his character and work He had not, like his predecessor Dittmar, been a fellow student with me in Heidelberg, but had worked at chemistry in Darmstadt, where he was born, and at Giessen In 1858 Dittmar, who up to that year had been my private assistant, obtained the College appointment of Demonstrator, and he strongly urged me to offer his vacant post to his friend Schorlemmer, a young man of great promise From the time of his arrival in Manchester until the day of his death I do not recollect that in all the intercourse of those years Schorlemmer and I ever had a single serious difference Whilst my private assistant he and I examined the relation which the aqueous acids exhibit as regards boiling point and composition, and I remember well the difficulties we had to contend with in distilling fuming nitric and hydrofluoric acids under pressure, and I also remember how successfully he met them Once, I know, he got some fuming hydrofluoric acid on his hand, and he bore the scar of the serious burn to the end This work with me was his apprenticeship In a short time Dittmar left us, and Schorlemmer took his place as the official Laboratory Assistant, and as we had not many students at that time, he had leisure to begin the hydrocarbon work which has placed his name high in the list of organic chemists of the century In 1861 the late Mr John Barrow, of the Dalton Chemical Works, Gorton, brought me a sample of the light oils which he had obtained in the distillation of cannel coal At that time our knowledge of the chemical composition of the low-boiling coal-oils was very incomplete, and I urged Schorlemmer to undertake the investigation This was the beginning of the work which led to a result which altogether modified the existing ideas concerning the constitution of the paraffin hydrocarbons, and paved the way for the sound foundation upon which the organic portion of our science has since been successfully laid In order to appreciate Schorlemmer's results let us for a few moments glance at the position of the question when he commenced work Before 1848 the only known member of the paraffin series of hydrocarbons, was methane CH_4 In the above year the researches of Kolbe on the electrolysis of the fatty acids, and of Frankland on the isolation of the alcohol-radicals, opened out new fields yielding a rich harvest Each molecule of these latter hydrocarbons was supposed to contain two molecules of the radical methyl being represented as $\left.\begin{matrix}CH_3\\CH_3\end{matrix}\right\}$, whilst together with these a second series of hydrides was believed to exist, $\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}$ ethyl hydride standing in the same relation to the radical as an alcohol does to an ether The truth of this view seemed confirmed by Wurtz's discovery of the existence of the so-called mixed radicals in which two molecules of different hydrocarbons, such as ethyl and amyl $\left.\begin{matrix}C_2H_5\\C_5H_{11}\end{matrix}\right\}$ occurred How was this question to be settled? Schorlemmer at once seized upon the correct method of solution and carried it out successfully If, said he, the radical methyl $\left.\begin{matrix}CH_3\\CH_3\end{matrix}\right\}$ is identical with hydride of ethyl $\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}$ not only must these two bodies possess the same properties, but both bodies must yield the same product, viz., ethyl chloride, on treatment with chlorine This identity he proved, not only in the above—the most simple case—but in the more complicated cases of ethyl-amyl $\left.\begin{matrix}C_2H_5\\C_5H_{11}\end{matrix}\right\}$ and of di-amyl $\left.\begin{matrix}C_5H_{11}\\C_5H_{11}\end{matrix}\right\}$ as these hydrocarbons yielded respectively chloride of heptyl and chloride of decatyl, $C_7H_{15}Cl$ and $C_{10}H_{21}Cl$ It is difficult to overrate the importance of this apparently simple discovery It laid for ever the ghost of the existence of two sets of isomeric hydrocarbons of the paraffin series, and paved the way for Kekulé's theory of carbon combination, upon which the whole modern theory of organic chemistry is based So to Schorlemmer belongs the credit of placing in position the foundation-stone of our science And at once his name became known as a master wherever chemistry is studied , so that in 1871 the Council of the Royal Society admitted him to the Fellowship at once, an honour conferred nowadays on few

But it was not only as an expert experimentalist that Schorlemmer excelled, and his thirty-two papers catalogued in the Royal Society list prove that he was a successful one. He possessed an exhaustive knowledge, un-

common amongst chemists, of the literature of his special science in all its varied departments. If any of our men wanted a quick reference to either recent or ancient work, it was always "Go and ask Schorlemmer," and they seldom came empty away. But his acquaintance with other sciences was also considerable. If he had not been a distinguished chemist he would have made an equally distinguished botanist. He likewise possessed in full measure that dogged power of work which distinguishes the German. I was especially fortunate in securing his co-operation as co-author of the Treatise. The success of my little book—as to which no one was more surprised than myself—induced me to set about the task of writing a larger and more complete work. I soon found that the other very various and pressing duties of my position rendered it impossible for me to do all the work myself, and my friend Schorlemmer joined me in this somewhat laborious business. To him the organic part almost entirely owes its being, whilst in the inorganic portion his assistance and suggestions were most valuable. We published the book simultaneously in Germany and England, and it is not too much to say that in both countries the work has become a standard one. For the last few years of his life this was his main work. Only those few men who have lately attempted the task of writing even a moderately complete treatise on modern organic chemistry can know what serious labour such work entails. Several distinguished chemists have given up the task as hopeless, and have not completed what they had begun. If Schorlemmer's life had been spared he would have brought his work to a conclusion, cost what it might. Our consolation—and it is but a poor one—at his early death (for he was only fifty-eight), must be that, so far as the chemistry of the hydrocarbons and their derivatives are concerned, his manuscript is complete, and in the hands of Messrs. Vieweg. A mass of material he has gathered together for the remaining organic compounds in which nitrogen occurs as a constituent element. It will be my task to see whether this last portion of the work is complete, and if not, how it can best be brought up to the level of the day.

As a historian of our science, I think that the designation of him by his German friends as the "English Kopp" is a just one. Only a few weeks before his death he talked to me with pleasure of the results of his work on an introduction to the history of chemistry, which had engaged his attention for many months past. Fortunately, he had the rare power of writing so that his manuscript was at once ready for press. Hence, although a fragment, his history so far as it goes—and I believe it goes as far as the end of the eighteenth century—is complete. We shall all look with interest to its speedy publication, and from what I know of the author's works and ways, I shall be disappointed if this fragment does not throw a new light on many dark pages in the early history of our science. One word more as to his character. I have said that we never had a difference, and I believe from what I know of his other friends that they would say the same. He was of a retiring, most modest, and unassuming disposition. To only a few of his intimates, German and English, were his true colours visible. As a laboratory teacher he was excelled by few, merely as a lecturer by many. But although, like some other eminent lecturers, his diction may have been faulty, the staple article was there, and I never met a real student amongst all those who passed through his hands who did not express his admiration for the man, and his sense of the obligation which he felt for the masterly instruction which the Professor always and most readily gave, whilst the long list of honours which his men gained in organic chemistry, both at London and afterwards at Victoria, proved that his teaching was not in vain. True to his science, he valued chiefly the respect and affection of his colleagues and pupils. In society he did not shine, nor did he take any leading part in the government of the College or in the foundation of the University, although those of us who were more active in these matters could always count upon his support in all questions in which the interests of science were concerned, and if he usually preferred to be at his own desk rather than to spend his time listening to the often tedious discussions of the Senate meetings, he was always at hand when a vote was needed to carry out some measure of scientific reform. Although for many years a naturalized Englishman, and enjoying and appreciating English freedom and English ways, he retained more than is usual, a lively interest in the welfare of the "Vaterland." I knew but little of his political views, for these he did not obtrude on his friends, though he held decided ones. He believed in popular freedom and popular rights, and was a strong supporter of the German Social Democratic party, many of the leaders of this movement, both in Germany and in England, being his intimate personal friends. But with these matters we have here little to do. We here have to recognize the scientific work which he has done amongst us, to record our appreciation of that work, and to express the regret of all interested in science at his untimely death.

H. E. ROSCOE.

SCIENTIFIC INVESTIGATIONS OF THE SCOTTISH FISHERY BOARD.

THE Fishery Board for Scotland has issued its Tenth Annual Report (for the year 1891). It is divided into two parts—the general report, and the report on salmon fisheries. We reprint from the general report the passage relating to the scientific investigations carried on since the Board was reconstituted ten years ago:—

The following is a statement of the sums which have been sanctioned during each of the following years and spent by the Board on scientific investigations:—

Year	Sanctioned	Spent
1883-84	£300	£300 13 7
1884-85	1600	1430 0 11
1885-86	1500	1500 0 0
1886-87	2000	1647 5 3
1887-88	2000	1843 4 5
1888-89	2000	1804 4 3
1889-90	2000	2026 10 0½
1890-91	1800	1792 13 4
	(With £200 for travelling expenses.)	
1891-92	£1800	Do.

In addition a sum of £2500 was applied in 1886-87 for the purchase of the steamer *Garland*, and £500 per annum allowed for its maintenance, which was increased first to £900, and afterwards to £1200 a year.

When the Board commenced its operations, it was a new departure in State administration. The Fisheries Commission of the United States was only established in 1871, and we were without the experience which has since been gained in America, Germany, Norway, and other countries bordering on the North Sea. The directions of the Act of Parliament creating the Board were very general. We were appointed to "take cognisance of everything relating to the coast and deep sea fisheries of Scotland, and take such measures for their improvement as the funds under their administration not otherwise appropriated might admit of, but without interfering with any existing authority or private right." Hitherto the fisheries had been practically left to take care of themselves. During the administration of the old Board, which had existed from 1809 under the name of the Commissioners of the British White Herring Fishery, scientific investigations had indeed been made from time to time into special points, such as the spawning of the herring, the capture of immature herrings by sprat fishermen, and the action of the beam trawl on herring spawning beds. These inquiries were, however, limited both in character and

extent, and were merely incidental to certain questions prominent for the time being. The absence of definite scientific knowledge relating to the fisheries had been felt and commented upon by Royal Commissions appointed to enquire into fishing questions, and when the new Board came into existence in 1882, it was found that, without further information as to the habits and life history of the food-fishes, it would be impossible to submit satisfactory reports to Parliament either as to the improvement or the regulation of the fisheries. It was accordingly resolved that scientific investigations should be instituted under a committee, consisting of Prof. Ewart (Convener), Sir James Maitland, Sheriff Forbes Irvine, and Mr. Maxtone Graham. This committee acted until 1886, when it was dissolved, and, in 1887, another committee was formed, consisting of Prof. Ewart (Convener), Sir James Maitland, Mr. William Boyd, and Mr. W. Anderson Smith, which continued till 1889. Since the dissolution of this committee the scientific work has been under the immediate control of the Board, with Dr. T. Wemyss Fulton as scientific secretary, but all the members feel, and desire specially to acknowledge, the valuable assistance which has been rendered by Sir James Maitland and Mr. Anderson Smith.

Before describing the investigations undertaken, a word must be said as to the means which have been at the disposal of the Board. In 1884 a marine laboratory was established at St. Andrews, with the co-operation of Prof. McIntosh, F.R.S., who was at the time engaged in making scientific investigations for the Royal Commission on Beam-Trawling, under the late Lord Dalhousie, and this laboratory has continued in active operation ever since under Prof. McIntosh's charge. In 1885 another laboratory was erected at Tarbert, Lochfyne, which was placed under the charge of Mr. George Brook, F.L.S., and was occupied until 1887. During 1886-87 a portion of Rothesay Aquarium was made use of, and from 1884 until 1889 part of the scientific work was carried on at the Natural History Department of the University of Edinburgh, under the charge of Prof. Ewart. Subsequently a marine laboratory was built at Dunbar, which has since been added to, and in connection with which the Board are now erecting a large hatchery for the propagation of sea fish. In addition to the laboratories mentioned, the fishery cruisers have occasionally been engaged in aiding the scientific inquiries, as have also the staff of Fishery Officers around the coast. Since 1886 the small steam vessel *Garland*, although not at all sufficient for the work, has also rendered important services.

At the time when the scientific investigations were begun very little was known regarding the habits of sea-fishes. Fishermen, who presumably ought to know something of the life-history of the fishes they catch, knew, as Prof. Huxley has remarked, very little beyond the best way to catch them. Yet from the earliest period until comparatively lately, the practice has been to shape fishery legislation in accordance with local desires or the popular opinion prevailing at the time, and not upon ascertained conditions. A study of the statutes dealing with sea fisheries, especially those passed by Parliament from the middle of last century to about the middle of this, shows that vast sums of money have been expended uselessly, and injurious restrictions imposed for reasons which scientific investigations have now proved were illusory. About thirty years ago, however, an important change in this system was effected. Van Beneden on the continent, and Prof. Huxley, Mr. Spencer Walpole, Mr. Shaw Lefevre, and others in this country made a stand against haphazard regulations, and in Great Britain their action found practical expression in the liberating Act of 1868 (31 and 32 Vict. c. 45), which repealed or amended sixty-four fishery statutes, and restored liberty of fishing. The Royal Commissioners who brought about this reform (the late Sir James Caird, Prof. Huxley, and Mr. Shaw Lefevre) refer in their report to the absence of knowledge about the habits of sea fishes, their reproduction, spawning-places, and conditions of existence which is essential to effective regulation of the fisheries.

An indication of the lack of accurate knowledge on these subjects as lately as 1883 was afforded at the London International Fishery Exhibition in 1883, when a high authority thus described the condition of things at that time: "It is a very striking fact that the one point on which all speakers at the conferences held during the past summer at the Exhibition were agreed was this—that our knowledge of the habits, time and place of spawning, food, peculiarities of the young, migrations, &c., of the fish which form the basis of British fisheries, is lamentably deficient, and that without further knowledge any legislation or attempts to improve our fisheries by better modes of fishing, or by protection or culture, must be dangerous, and indeed unreasonable."

It is a source of satisfaction to the Board that their labours in this field of fishery work, even for the comparatively short time over which they have extended, have yielded successful results, and have contributed materially to the advancement of that knowledge of fishery problems, the want of which was felt and deplored by the Royal Commissioners of 1866. The scientific work carried on by the Board, the chief results of which have been described from year to year in their annual report to Parliament, may be summarized briefly as follows:—

(1) Inquiries into the influence of beam-trawling on the fish supply, especially within the territorial waters; the capture and destruction of immature fish by various modes of fishing; the condition of the inshore fisheries for shell fish and the supplies of mussels and other bait for line fishermen; surveys and examination of the fishing grounds, &c.

(2) Investigations into the food, fecundity, reproduction, habits and migrations of the food fishes, the location of their spawning grounds, and of the nurseries of young fish, the time and duration of spawning, &c.

(3) The study of pelagic and demersal ova, and of the development of the food fishes and edible molluscs from the egg onwards.

(4) Inquiries into the micro-organisms in river waters, and associated with salmon disease, and into the food of fishes in inland waters.

(5) Observations on the temperature, salinity, and physical conditions of the sea around the coast.

(6) The artificial propagation of sea fish and shell fish to re-stock depleted grounds.

The investigations into the influence of beam trawling, which have been carried on with great regularity and care, have furnished a mass of scientific and statistical evidence unexampled in the history of any fishery, and have been followed by the prohibition of this mode of fishing within the territorial seas. As stated in former reports, various portions of the inshore grounds were for experimental purposes closed against beam trawling, and by the Herring Fishery (Scotland) Act of 1889, the territorial waters were included in the prohibition, certain powers being reserved to the Fishery Board. Closely related to beam trawling is the capture and destruction of immature fish, which is generally regarded as the most important of the fishery problems awaiting solution in the immediate future. In certain foreign States and English fishery districts the landing or sale of immature fish under certain sizes has already been made penal, and in 1890 an International Fishery Conference was specially convened in London to consider this subject so far as it affected the diminution of the fish supply from the North Sea. Extensive observations have been made by the Board as to the distribution of immature fish on the east coast of Scotland at various distances from shore and in water of different depths, the minimum size at maturity of the different species and the proportions captured by various modes of fishing, with especial reference to the mesh of trawl nets, have been ascertained, as has also the action of the beam-trawl in destroying immature fish according to the time the net is down and the nature of the bottom. The results were embodied in a report which was prepared by Dr. Fulton, under directions of the Board, and was described (we believe with perfect accuracy) by the vice-president at the Conference "as one of the most important, if not the most important, document that had up to the present been contributed to the Fishery literature of this country."

The inquiries into the food and propagation of the edible fishes have been also prosecuted on an extensive scale. The food-material of nearly 20,000 specimens caught at various parts of the coast and at all seasons of the year has been examined, and this research has yielded valuable results both in regard to the protection and regulation of the fisheries and the increase of the fish supply by artificial means. The fecundity of nearly all the food fishes has been determined, the nature of pelagic and demersal ova has been carefully studied, and the distribution of the former in the waters over the breeding grounds and along the coasts investigated. The development from the egg onwards, and the characteristics of the young of the majority of the edible fishes have been described—including the herring, haddock, whiting, cod, ling, turbot, plaice, lemon sole, flounder, &c., and also of the most valuable forms of bait, the mussel and the clam. The spawning of the herring and of the other food-

fishes has received special attention. Since 1888 upwards of 30,000 white fish—such as cod, turbot, plaice, &c —have been individually examined By this means the time and duration of the breeding season has been determined, and the important fact has been proved that on the east coast of Scotland, where the investigation was mainly carried on, the spawning grounds of the valuable food-fishes (cod, haddock, plaice, turbot, &c) generally lie outside the territorial limit—contrary to the belief formerly held—and that only forms of comparatively little value, such as the flounder, dabs, and gurnards, &c , spawn within the three mile limit The importance of these facts cannot be over-estimated They bear directly both on the question of establishing a close time and the measures proper to be taken for the regulation of fishing on the breeding grounds The trawlers, driven outside the inshore waters, generally take to the breeding-grounds, for there the hauls are most abundant The significance of this fact, in connection with the falling off in the inshore fisheries, is becoming too grave to be longer overlooked The growth of population has been followed by an increase in the demand for fresh fish, the extension of the means of distribution has ministered to this demand, and if the floor of the ocean is to be swept without public regulation, the ordinary fishing-grounds will prove inadequate to maintain the supply The destruction of spawning fish is proving a serious evil In Germany, where this matter has been carefully examined, it is now held to be more important to protect the spawning banks, than to prevent the destruction of immature fish Some of our fisheries are, in fact, in danger of being exhausted unless judicious regulations are rigidly enforced

During the last three years experiments have been carried on to determine the migratory movements of fish, and nearly 3000 have been labelled and returned to the sea A percentage of these has been recovered, and steps are now being taken to apply the same method on a large scale to the herring The experiments are not sufficiently advanced to justify any final conclusion as regards all fish, but undoubtedly as regards many of them the facts already ascertained prove that until they reach a certain size they do not leave the territorial waters

The means of increasing the diminishing fisheries for shell-fish have received careful attention Surveys have been made of the more important mussel beds on the east coast, the extensive clam-bed in the Firth of Forth, the cockle beds at Barra, and a detailed examination of the great mussel-growing area in the Clyde is at present in progress The French system of growing mussels on wattled bouchots has been tested side by side with the bed system, and a series of experiments have been made on board the *Garland* to test the comparative efficiency of different natural baits, and of various artificial substitutes A physical and biological investigation has also been made of a number of sea lochs on the west coast, in order to ascertain their suitability for the growth and culture of oysters (the Scottish oyster having sunk to a very low point), and a special lobster pond has been constructed at Brodick, Arran, in which about 200,000 young lobsters were hatched last year

The physical observations into the temperature and salinity of the sea have been carried on on board the *Garland* and the fishery cruisers, and at ten fixed stations daily—five on the east coast and five on the west By the courtesy of the Northern Lighthouse Board, observations are allowed to be taken daily at the Bell Rock and Oxcar Lighthouses, the lightship at the North Carr, and also at the mouth of the Tay Many thousands of observations are thus made every year, and several valuable reports have already been published.

From this brief summary of part of the work done, it will be seen that considerable progress has been made since 1883 in extending the knowledge of the habits and life-history of the food-fishes, and it is gratifying to learn that the results obtained by the Board have been gratefully acknowledged by high authorities, and found useful in other countries.

In recent years the attention of the authorities of various maritime States, especially those around the North Sea, but also in the Mediterranean and in America, has been forcibly called to the diminution of the fish-supply within the territorial seas and on much frequented fishing banks off shore The falling off in the supply of valuable flat fishes, such as turbot, sole, and plaice, from the North Sea, has led to various conferences of those engaged in the fishing industry At the International Fishery Conference held in London in 1890, at which representatives were present from Germany, Denmark, Holland, France, Belgium and Spain, it was resolved that scientific investigations should be carried on by each country, particularly into the capture and destruction of immature fish by the beam trawl, prior to the assembling of an official International Conference to deal with the subject by international agreement , and at a conference of representatives of the fishing industry held in London last February resolutions were passed, that in view of the diminution of the valuable food fishes, the hatching of sea-fish should be undertaken on a large scale, and measures adopted to prohibit the sale of immature flat fishes under a certain size The decrease in the fish supply from the off shore banks has not yet become so marked off the Scottish coast as is the case further south , but from the statistics given below as to the yearly increasing number of Scottish beam trawlers , the flocking northwards of English vessels from their own depleted grounds , and the actual diminution in the quantity of flat fish landed there is reason to apprehend that in the course of very few years a similar result will be brought about here As has been stated above, the Board are at present having erected at Dunbar, by means of the ordinary vote for scientific investigation, on a site granted by the War Office and the Council of the Burgh, a large hatchery for sea fish, with the necessary tanks and pumping apparatus, which, when complete, will permit of several hundreds of millions of the food fishes being hatched every season and planted on the fishing-grounds It will therefore be possible for the first time in this country to adopt active measures to directly add to the fish supply, as has already been done in the United States, Norway, Canada, and Newfoundland

NOTES

AMONG the honours announced at the change of Ministry the Privy Councillorship conferred upon Prof Huxley not only establishes a precedent, but affords an indication that the neglect of the claims of men of science, whether they be servants of the Crown or not, to the ordinary national distinctions is not likely to be so marked in the future as it has been in the past Six years ago or thereabouts, Prof Huxley was allowed to leave the public service without the slightest recognition of the value of the work he had done in many capacities during some forty years No better way of making the so called "honours" ridiculous can be found than in generally omitting to confer them upon persons of distinction --persons known to the nation as devoting their lives to the national welfare in some walk or other

WE have learned with regret a rumour to the effect that th Admiralty has declined to render the assistance in carrying observers and instruments for which the Royal Society made application some time ago to further the observations of the total solar eclipse in Senegambia next April If this be confirmed, the expedition will in all probability be abandoned. Such a state of things requires no comment of ours

A MEETING of the Swiss Society of Natural History is announced to take place at Basle, from September 4 to 7, under the Presidency of Prof Hagenbach-Bischoff, and the following communications have been arranged for —"The Origin of Swiss Lakes," Prof A Heim, Zurich , "The Thermal Conditions of the Lake of Geneva," Prof F A Forel, Morges "The Biological Conditions of the East-African Steppe," Prof C Keller, Zurich , "The Metamorphosis of Alpine Rocks," Prof C Schmidt, Basle , "The Evolution of Human and Animal Physiognomy," Prof W His, Leipzig ; "Studies on the Veddahs, the Aboriginals of Ceylon," Dr Fr Sarasin, Berlin A special invitation is given to foreign students to join the meeting

ACCORDING to the *Times* a telegram has been received from Tromso announcing that the *Manche* which left Leith on July 20, for Jan Mayen Island, in the Greenland Sea, reached its destination on the 27th The island had not been visited for ten years The vessel went round it and then proceeded to Spitzbergen, where it made important collections of reindeer, foxes, birds, and fossils in Ja Fiord and Bel Sound

MR RISELY GRIFFITHS, the Administrator of the Seychelles, visited the Island of Aldabra in May last. In a report to the Colonial Office communicated to Kew, he gives the following particulars respecting the gigantic land tortoises —"The following morning I went on shore to visit Mr Spurs' establishment, and observe some of the natural peculiarities of this extraordinarily formed island, which, except here and there, appears to be one mass of very ancient coral, which has been washed for so many centuries by the sea that all the softer portions have been washed out, and the remainder is hard and ragged, and therefore is difficult to walk over Curious to state, small trees, shrubs and vines flourish over it, and in these inextricable places, which are of vast extent, do the enormous land tortoises find a genial and apparently prolific existence When Mr Spurs first went to Aldabra he was of opinion there were very few of them left, but he now states that there cannot be less than one thousand in all the island I made him repeat this statement more than once, as I was sceptical about so large a number, but he assured me that a few hundreds would not accurately describe their number"

THE Tuesday evening lectures at the Royal Victoria Hall, Waterloo Bridge Road, will be resumed in September, and on the evenings of September 6, 13, and 20, respectively, Prof H J Malden will lecture on "The Wonders of the World," "A Holiday in Sweden and Denmark," and "Australia"

ACCORDING to the *North British Agriculturalist* the plague of voles from which farmers in the Border districts have for some time past suffered much inconvenience and loss, is, notwithstanding the strenuous efforts put forward for the abatement of the plague, on the increase The grass lands are so thickly set with the nests of the voles that much difficulty is experienced in cutting them, and the vermin are now making their abode in the corn-fields, which are in consequence also being destroyed

CÁNOVAS AND TRAYNOR, 3 Calle de Santa Catalina, Madrid invite subscriptions to a facsimile reproduction of the first geographical chart of America (1500), by Juan de la Cosa, Columbus's sailing-master in his first and second voyages It will be printed in the original colours, from which black, by the way, is absent The work will be published in three forms, one—the popular—at 12s, another in vellum at 20s, and the third in parchment at £20 The parchment edition will be hand coloured

PROF FLUCKIGER has sent to the President of the Pharmaceutical Society, as representing the British subscribers to the Fluckiger testimonial, a bronze replica of the medal which was presented to him, and expresses the hope that it will be accepted as a sign of his gratitude and a slight proof of his appreciation of the friendship and encouragement he has always met with in England

WE extract from the *Bollettino Mensile*, of the Meteorological Observatory of Riposto, the following details respecting the recent eruptions of Mount Etna The crater had shown extraordinary activity from the beginning of July, and on the night of the 8th–9th, a severe shock in all the surrounding region announced the probability of an approaching eruption At 1 20 p m. on the 9th the south slope of the mountain burst open, at about 5000 feet above the sea, forming at once several mouths emitting lava, stones, and incandescent masses, as well as enormous quantities of sand and black smoke. At times large blocks were hurled to a height of about 1300 feet Several of the mouths united, and formed three craters in an almost direct line from north to south, from two of which the lava encircled Monte Nero like an enormous river, while the third emitted masses of stones and cinders The eruption continued with more or less intensity all the month, but showed signs of diminishing on the 31st The lava devastated much fertile country, but fortunately its course was checked by the deposits of former eruptions, if this had not been the case several of the villages would have been in great danger This eruption was noteworthy for the enormous quantities of smoke and sand emitted, and for the scarcity of seismic motions, the lava resembled physically that emitted in the eruptions of 1883 and 1886

THE thirty ninth Report of the Department of Science and Art of the Committee of Council on Education is now ready, as is also the Directory (revised to June 1892), with regulations for establishing and conducting science and art schools and classes

MESSRS GIBBONS, of Liverpool, have issued a small handbook respecting the Department of Engineering in connection with University College, Liverpool, which should prove of much service to intending students, who will find in it all the information they are likely to require with reference to fees, subjects, evening lectures and classes, scholarships, certificates, &c., &c

THE twenty fifth annual report of the Peabody Institute of the City of Baltimore has been issued, and seems in every respect highly satisfactory Incandescent electric lamps and appliances have been placed in the large hall and reading-room during the year, accessions to the library have been numerous and valuable, and the lectures were attended by larger audiences than in the preceding year Another encouraging item in the report is that there was an increase in the number of applications for books relating to science, amongst the subjects which appear to have grown in favour being anatomy, astronomy, chemistry, mathematics, medicine, and natural history

THE annual announcement of Courses of Instruction in the Colleges at Berkeley, Cal, for the academic year 1892–93 has recently been issued

THE Calendar of University College, Bristol, for the Session 1892–93, has just been issued

THE second edition of Mr W F Kirby's "Elementary Text-Book of Entomology" has been published within the last few days by Messrs Swan Sonnenschein and Co The author has not thought it necessary to make any extensive alterations in the text or plates, but the following additions have been made to the work —An appendix, giving further particulars respecting many of the insects mentioned or figured, and a complete index

IN the *Board of Trade Journal* for August are to be found articles on "Chemical Industry in Germany," the "Sicilian Sulphur Industry," and "Cinchona and Indigo Cultivation in India"

THE current number of the *Journal of the Society of Arts* is, in the main, devoted to the publication of Prof George Forbes' first lecture on "Developments of Electrical Distribution"

THE June number of the *Agricultural Gazette of New South Wales* contains the continuation of two articles by Mr P Turner, on "The Grasses of Australia," and "New Commercial Crops for New South Wales," "Notes on Economic Plants," "The Sugar Cane Disease on the Richmond and Clarence Rivers," and many other items of interest

THE *Korean Repository* for June, which has just come to hand, has an interesting article by Rev D L Gifford on "Ancestral Worship as practised in Korea."

MESSRS CROSBY LOCKWOOD AND SON announce for early publication a new work by Mr J E. Gore, entitled "The Visible Universe, Chapters on the Origin and Construction of the Heavens"

British Rainfall for 1891, compiled by Mr. G. J. Symons and Mr. H. T. Wallis, has been published, and in consequence of the exceptional character of the year of which it treats, is rather later in making its appearance than its predecessors have been. The Devonshire blizzard was the cause of much work, and praise is due to those observers who were brave and persevering enough to take their observations, notwithstanding the very exceptional difficulties by which they were confronted. One observer was barricaded with five feet of snow against every door, and another—a lady—finding that the wind had swept the grass clean all round the rain gauge and piled the snow more than five feet deep near the entrance gates to her house, wrote to enquire what she was to enter as the depth of the snow.

Symons's Monthly Meteorological Magazine for August contains a summary of the climate of the British Empire for the year 1891, compiled from sixteen representative stations. The highest shade temperature occurred at Melbourne, 103°, in January. This is the first occasion since the publication of these interesting tables in 1884, that the temperature of Melbourne has exceeded both Adelaide and Calcutta. In connection with high temperature, attention is drawn to the record at Alice Springs in the centre of Australia, which shows an absolute shade maximum of 117° in December, and an average maximum of above 100° for the month. The extreme maximum in the sun 165°, and the lowest mean humidity 57 per cent., were recorded at Adelaide. Winnipeg, as usual, had the lowest shade temperature, -34°.5, in February, as well as the greatest total range 128°.1, and greatest mean daily range 22°.0. Ceylon recorded the highest mean temperature, 80°.7, and also the least range in the year, there being only 24°.3 between the maximum of the hottest day and the minimum of the coldest night. Malta usually has the smallest rainfall or the least cloud; this year, however, Adelaide had the least rainfall, 14 inches, and Bombay the least cloud, the average amount being 3. The greatest rainfall was at Colombo, Ceylon, 119 inches. It is unfortunate that both the West Indian returns have had to be omitted owing to incompleteness.

ABOUT the middle of last week the low pressure areas which advanced over this country from the south-westward caused a rapid rise of temperature in England, the maximum shade temperatures reaching 83° in the south and east. These conditions were accompanied by violent thunderstorms over the southern, midland, and eastern counties on Thursday and Friday, the area embraced by the storm extending from Devonshire in the west to Norfolk in the north-east, while the rainfall was very heavy, amounting to 1.4 inch in several parts. During the early part of the present week the temperature continued high over the greater part of England, being about 10° above the mean for the time of year, but was much lower in Scotland and Ireland. Conditions were again unsettled on the 23rd, and about 1.5 inch of rain was measured in the south-west of Ireland on that morning, while areas of low pressure lay over our south-west coasts, and severe thunderstorms occurred in the evening over all the southern half of England. The heat on the Continent has been excessive, the thermometer in the shade registering 100° and upwards at many stations, and even reaching 108° at Biarritz and Bilbao. During the last few days, however, the weather has become somewhat cooler over Europe, although very high temperatures were still maintained. During the week ended the 20th inst. the rainfall exceeded the mean in Ireland and Scotland, but in most of the English districts there was a considerable deficit (except in the south and east, where there was an excess, owing to the thunderstorms). There still exists a deficiency in all districts from the beginning of the year amounting to 5 inches in the south and to 8.6 inches in the south-west of England.

THE firm of P. J. Kipp and Sons, Delft, have constructed a new form of their electrodynamometer for the measurement of telephonic currents, in which several improvements have been introduced. As in the old form, in accordance with the suggestion of M. Bellati (Atti del R. I. Ven. 1883), a cylinder of soft iron wires takes the place of the usual movable bobbin. The cylinder becomes magnetized under the action of the current in the fixed coil, its magnetization being proportional to the strength of the current when sufficiently weak, and becoming reversed on the reversal of the current. The instrument is therefore eminently suitable for the measurement of weak alternating currents. The coil is wound in two parts, which may be used in series or in multiple arc, the resistance of each being about 250 ohms. A damping arrangement, similar to that employed in Thomson's quadrant electrometer, can be used. When the vibrations are not damped, speaking in a low voice into a Siemens telephone in connection with this instrument produces a deflection of 180mm. on a scale placed at the proper distance from a mirror which is attached to the iron cylinder. If one speaks at the distance of three or four metres from a microphone placed in the primary circuit of a small induction coil—the electrodynamometer being in the secondary circuit—a deflection of 48mm. is obtained. The price of the instrument is 225 or 240 francs, according as a concave, or a plane, mirror is supplied. A guard ring of soft iron can be supplied for twenty-two francs additional. The firm believe that the instrument will be of great use to physiologists. It is largely used in continental laboratories.

REPORTING lately to the Société d'Encouragement on the industrial preparation of carbonic acid in France, commenced by M. Gall, M. Troost points out that in Germany, which preceded France in this matter, what greatly stimulated the work was the consumption of beer, as it was found that by pressure of carbonic acid on beer, the latter could be brought up from cellars to bars in excellent condition, while compressed air spoiled the beer. In France, on the other hand, success has been due to the large quantities of salicylic acid used in medical treatment, this substance being largely produced by the reaction of liquid carbonic acid on sodium phenol. The *Compagnie générale des produits antiseptiques* has works near Hermes (Oise), directed by M. Gall. Pure carbonic acid is there produced very economically by combustion of coke; is collected in a gasometer, from which it is drawn, to be dried and compressed with pressures of 5, 25, and 70 atmospheres, and stored in iron bottles. Most of the acid is used for making salicylic acid, but other applications occur, and M. Gall is increasing the power of manufacture. At present 300 kilogrammes are produced daily, but it will be possible ere long to produce 1000 kilogrammes. The liquid is now supplied in Paris at 60 c. the kilogramme (say 6d. for 2¼ lbs.). Thus the French production is in a condition to compete with the German. Among other uses besides those already mentioned are the manufacture of aerated waters, the filtering of wine, cooling by virtue of the great absorption of heat in vaporizing, and solidification of fused metals under high pressure (which greatly improves the quality).

FROM a recent report on the telephone system in Belgium (which has grown rapidly since 1883) we learn that the State has considerably supplemented the work of the companies constructing and working various small lines, and using on all of them the double wire (while the companies have mainly continued the single one). The material used is the phosphorus bronze of Montefiore. The subscription varies largely, from 250 fr. in a radius of 3 km. in Brussels and Antwerp, to 125 fr. in Louvain and Malines. One interesting feature of the Belgium lines is that they are all connected with the principal telegraph offices, so that subscribers can send to these, by telephone, any telegrams they wish sent, and similarly they can receive tele-

phonically any telegrams addressed to them A copy of the telegram is sent at the same time The number of telegrams thus sent by telephone in 1889 was 371,000, in 1890 it grew to 440,000 To facilitate the development of telephonic relations the country is divided by Government into a number of circles, containing several towns provided with central offices communicating with each other by means of a double wire Thus the inhabitants of a small town like Heyst are able to speak with Bruges, Blankenburgh, Ostend, Middlekerke, and Nieuport The system is being extended wherever clients are probable, and the telephone now enters largely into Belgian habits

IN the south east of the valley of Mont Dore (Puy de Dôme is a curious natural formation in the basalt, called the Creux-de-Souci A crater shaped depression about 80 ft wide communicates by a central hole with a larger circular cavern, 170 ft diameter, the bottom of which is occupied by a small lake with about 10 ft of water The shape is like that of two cups with bases opposed, the lower one the larger From an examination of the place this summer by M Martel and some friends (*La Nature*), it appears that carbonic acid is plentiful in the cavern Several times they went down by rope ladder, hoping to use a boat lowered previously, but they could not get below about 13 ft from the water (which was about 70 ft from the orifice), they experienced headache, progressive suffocation, &c, while matches and candles went out The cavern is probably closed, there is no sign of a stream, nor are there any stalactites The lake is merely fed by water filtering through the basalt, after heavy rain this is considerable The temperature is exceptionally low, which M Martel explains thus Snow lies several months on the neighbouring ground, and when this melts in spring its water penetrates into the Creux-de-Souci at a temperature near 0°C Thus the air is cooled, and, being denser than that outside it, accumulates below, it is not renewed from above No air-current was observed The accepted view that there is water communication with Lake Pavin (about 270 ft lower) is considered a mistake It would be interesting, M Martel says, to make methodical observations, in different seasons, both as to the carbonic acid and the temperature

MR. C DAVIES SHERBORN asks us to state that the grant from the British Association, stated by us as being made towards "Index to Plants," &c, was really towards "Index Generum et Specierum Animalium," a work which has already been referred to on two occasions in NATURE—May 15, 1890, and July 2, 1891

THE additions to the Zoological Society's Gardens during the past week include a Japanese Ape (*Macacus speciosus*, ♂) from Japan, presented by Mr H. H. Jacobs, two Rhesus Monkeys (*Macacus rhesus*, ♂ ♀) from India, presented by Mr R Dodman and Mr. C. W Emlyn respectively, a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Mr R. Rocca, two Crowned Lemurs (*Lemur coronatus*) from Madagascar, purchased, a Common Cormorant (*Phalacrocorax carbo*), British, presented by Capt Salvin, two Spotted-sided Finches (*Amadina lathami*) from Australia, purchased, twenty five Cambayan Turtle Doves (*Turtur senegalensis*) from East Africa, deposited by General Mathews, three Cambayan Turtle Doves (*Turtur senegalensis*) from East Africa, presented by General Mathews, three Hardwickes Mastigures (*Uromastix hardwicki*) from India, purchased, a Robben Island Snake (*Coronella phocarum*) from South Africa, presented by Miss M Rutherford, a Nilotic Monitor (*Varanus niloticus*) from East Africa, presented by Gen Mathews, a Nilotic Monitor (*Varanus niloticus*) from East Africa, presented by Mr. Frank Finn, F Z.S.; two Smooth-clawed Frogs (*Xenopus laevis*) from East Africa, presented by Mr Frank Finn, F Z S, a Common Boa (*Boa constrictor*) from South America, presented by Messrs F Sander and Co, four Indian Wild Swine (*Sus cristatus*), born in the menagerie

OUR ASTRONOMICAL COLUMN.

NOVA AURIGÆ —In *Wolsingham Observatory Circular*, No 33, it is stated that Mr H Corder having informed the Rev T E Espin that the Nova Aurigæ had increased, it was examined August 21, and found to be 9 2, spectrum mono chromatic, one intense line (500 ?)

THE OPPOSITION OF MARS —At the Lick Observatory, up to the middle of August, many of the supposed canals on Mars discovered in 1877 by Schiaparelli were mapped, but none of them seemed to be double On the night of the 17th inst, however, Profs Schaberle, Campbell, and Hussey made three entirely independent drawings, each showing the canal marked Ganges on Schiaparelli's map to be distinctly double, and thus confirming in 1892 Schiaparelli's discovery of 1877

THERMAL ABSORPTION IN THE SOLAR ATMOSPHERE —In *Astronomische Nachrichten*, Nos 3105-06, Mr E B Frost sets forth the results of his observations with reference to thermal absorption in the solar atmosphere As the paper is of considerable length, we will only concern ourselves with the broad results, leaving our readers to look up the details for themselves The instrument—made by Mr Frost himself, and used throughout the experiments—was a double thermopile, or, rather, two thermopiles, of considerable length, and the back junctions, after being carefully insulated and imbedded in sealing-wax, were inserted in the two ends of a brass U-shaped tube, the front faces of the piles projecting a little out of the tube, while their back parts were in contact in the middle To ensure an equality of temperature at the two back junctions, this part of the tube was enveloped in a cylinder filled with water, thus eliminating practically accidental thermo effects in the metals of the thermopiles Mr Frost's original intention was to employ both these piles, one for receiving the projected image of the sun, and the other for the direct rays, but, as he became acquainted with the "disproportionately greater intensity of the latter," he was obliged to employ as a screen a thin silk gauze, thus using this pile as a counterpoise to eliminate such effects as air currents, reflected radiations, &c

Let us deal first with the photosphere The following table shows the differences between observation and theory The column headed O is obtained from a curve based on the observations, that of C is the result of theory and gives the values of $I\ I_0$ as obtained from the ratio $\frac{I}{I_0} = \frac{e - f\sec\theta}{e - f}$. ρ represents the distance of the point observed from the centre of the sun (radius = 100), and θ the angle at the sun's centre between the line to the observer and the radius to the point observed

ρ	θ	O	C	C-O
0	0	100.0	100.0	0.0
10	5.7	99.9	99.8	−0.1
20	11.5	99.4	99.3	−0.1
30	17.5	98.4	98.4	0.0
40	23.6	96.3	97.1	+0.8
50	30.0	93.6	95.1	+1.5
60	36.9	89.8	92.2	+2.4
70	44.4	84.6	87.8	+3.2
80	53.1	77.9	80.6	+2.5
90	64.2	68.0	65.6	−2.4
100	90.0	(39)	—	—

The differences in the last column might, as Mr Frost says, be somewhat reduced by the introduction of another constant in the formula, but even then sufficient difference would remain to indicate the inability of the formula to cope with the present conditions.

In the attempt to ascertain whether there was a difference in the thermal conditions for the poles and the equator, taking points equidistant from the centre of the sun's disc, the conclusion Mr. Frost draws is that there is none The difference between the two hemispheres also he finds "to be exceeding small, if real" With regard to the spots he says, "A rather surprising result of these observations was that spots are occasionally relatively warmer than the surrounding photosphere." Whether the position of the spot on the disc had anything to do with it is

uncertain, but where the observations were referred to it was found that "the two spots with the highest relative temperature were very near the sun's edge" He further suggests that if further observation should establish this fact, viz, that spots suffer less absorption than the neighbouring photosphere, we might consider them "to be in a higher stratum than the photosphere."

HYDROGEN SPECTRUM IN THE SOLAR ATMOSPHERE — M Deslandres, in the *Comptes Rendus* for July 25, communicates a brief note concerning the spectrum of hydrogen that was photographed by him in a prominence on the 4th of May last This spectrum, besides containing many metallic lines, shows also ten ultra violet radiations of hydrogen and five other new ones, the latter of which, as he says, follow so regularly the former series that one is led to consider them as due to hydrogen It may be remembered that Mr Balmer indicated a simple function of whole numbers which represented exactly the series of 14 radiations of hydrogen This function, which is applicable to most of the metals, is $N = A - \frac{B}{n^2}$, where N is the number of vibrations, A and B two constants, and n a whole number In the following table we give the result of M Deslandres' measures with regard to the new addition to this series, to show how close an agreement exists between the calculated and observed values —

Whole Nos of the formula n	No of vibrations		
	Deslandres.	Ames	Calculated
12	266 565	266 575	266 566
13	296 685	267 715	267 694
14	268 585	268 615	268 586
15	269 310	269 330	269 309
16	269 890	—	269 898
17	270 385	—	270 387
18	270 795	—	270 797
19	271 140	—	271 142
20	271 460	—	271 448
21	271 700	—	271 694

REFRACTION IN MICROMETRIC AND PHOTOGRAPHIC MEASURES —A very simple method by which the effect of differential refraction may be eliminated from the results of micrometric observations or from the measures of photographic plates is given by Dr S C Chandler in the *Astronomical Journal*, No 271 The principle underlying this method is the position of the plate about to be measured, which here is inclined at a certain angle in the vertical direction to the focal plane of the telescope In the measurement of distances this inclination necessitates the application of a small correction, but this is soon accomplished by the aid of a simple formula, which can be considerably modified by determining the screw revolution directly from the plate One might at first think that by this means the stellar images would be slightly affected, but Dr Chandler informs us that he thinks that "attentive examination will show that the difference of definition will be inappreciable"

THE RECENT EARTHQUAKES

THE first of the earthquake shocks felt on the 18th inst in Ireland, Wales, and the West of England was evidently one of unusual strength for this country, and it is very desirable that both it and the subsequent slighter shocks should be thoroughly investigated, with a view to discovering their origin and their relations to one another As I have been engaged for several years in working at our British earthquakes, and am now occupied in studying these recent shocks, I should be greatly obliged if you would allow me to ask your readers who felt the shocks for assistance in obtaining the necessary materials

It would be of great service to know simply the names of as many places as possible where one or more of the shocks were felt and the accompanying sounds heard With this knowledge the boundaries of the disturbed area and the sound-area of each shock may be determined—points of considerable importance But for a complete study of the shock it is desirable to have further details, such as would be given by answers to the questions printed below, especially to those numbered 3, 4, 6, and 7 I shall be most glad and thankful to receive accounts of the earthquakes from any place whatever, and I may add that no account, however scanty the information given, can fail to possess some value or to help in throwing light on the nature and origin of the shock

(NOTE —If more than one shock was felt it is important that the notes relating to each should be kept separate)

(1) Name of place where the shock was felt

(2) Situation of the observer (*a*) Whether indoors (and on which floor of the house) or in open air (*b*) How occupied at the moment of the shock

(3) Time at which the shock was felt, if possible, to the nearest minute

(4) Nature of the shock, description of the (*a*) The number of vibrations (*b*) Their relative intensity (*c*) Whether there was any tremulous motion before or after the principal vibrations (*d*) Whether any vertical motion was perceptible, and if so, whether the movement was first upward and then downward, or first downward and then upward

(5) Duration of the shock in seconds, not including that of the accompanying sound

(6) Intensity of shock Was it strong enough (*a*) to make windows, doors, fire-irons, &c, rattle. (*b*) To cause the chair or bed on which the observer was resting to be perceptibly raised or moved (*c*) To make chandeliers, pictures, &c, swing, or to stop clocks (*d*) To overthrow ornaments, vases, &c, or cause plaster to fall from the ceiling (*e*) To throw down chimneys or make cracks in the walls of buildings?

(7) Sound-phenomena (*a*) If any unusual rumbling sound was heard at the time of the shock, what did it resemble? (*b*) Did the beginning of the sound precede, coincide with, or follow, the beginning of the shock, and by how many seconds? (*c*) Did the end of the sound precede, coincide with, or follow, the end of the shock, and by how many seconds? (*d*) Did the sound become gradually louder and then die away? (*e*) Were the principal vibrations felt before, at, or after the instant when the sound was loudest?

(8) The names of any other places where the earthquake was noticed would be most useful, together with answers for each place (if possible) to the following questions —(*a*) Was the shock felt? (*b*) Was it strong enough to make doors, windows, fire irons, &c, rattle? (*c*) Was any unusual rumbling sound heard at the time of the shock? CHARLES DAVISON.

38, Charlotte Road, Birmingham, August 23

CHEMISTRY AT THE BRITISH ASSOCIATION

AFTER the President's address, the first paper was read by Prof Crum Brown on "Electrolytic Synthesis," descriptive of work carried out in conjunction with Dr J Walker

He showed how, by an extension of the electrolytic methods which had been already fully worked out in relation to potassium acetate, the higher fatty acids of other series could be synthesised Thus, starting from the ethyl potassium malonate the ether of succinic acid was obtained in considerable quantity and with great readiness Similarly adipic, sebacic and other ethers had been obtained Secondary products were formed which in the higher members of the series accumulated in inconveniently large quantities.

Professor Ramsay gave a communication on the "Impurities in Chloroform" He found that when the purest chloroform that could be prepared was exposed to light between the months of March and July, it emitted an acrid odour when opened, due to the formation of phosgene gas The reaction by which this had been brought about was —

$$2CHCl_3 + O_2 = 2\ COCl_2 + 2\ HCl$$

The second day of the meeting was devoted almost entirely to the consideration of the phenomena accompanying the combustion of gases Messrs Lean and Bone gave an account of the results obtained in exploding ethylene with less than its own volume of oxygen They had found that there was always a considerable rise of pressure, and that the resulting products contained, in addition to hydrogen and carbon monoxide, small percentages of carbon dioxide, unsaturated hydrocarbons, and some saturated hydrocarbon, presumably marsh gas.

The unsaturated hydrocarbons consisted largely, if not entirely, of acetylene. Carbon is also formed as a product of the reaction, due in all probability to the decomposition of heavy hydrocarbons into marsh gas and carbon at high temperatures The experiments show that oxygen combines with carbon in preference to hydrogen

Prof Lewes, in his paper on the "Luminosity of Hydro-

carbon Flames," described the results of the analyses of the gases drawn from an ordinary coal gas flame at different heights He had found that the heavy hydrocarbons which occur in the non luminous part of the flame are almost entirely converted into acetylene before they reach the luminous zone The luminosity of the flame is, in his opinion, brought about by dissociation of the acetylene, the temperature required for this dissociation varing with the degree of dilution of the acetylene Under the circumstances already described, where the amount of acetylene present was 1·1 to 1 3 per cent, the temperature was 1200°, whilst in the flame of a paraffin lamp, where about double the amount of acetylene was present, the temperature was found to be 1000°

On passing ethylene through a heated tube at different temperatures he found that at 900° the chief products were methane and acetylene, at 1000° there was still no hydrogen and no carbon, but more oil and heavy hydrocarbons, whilst at a still higher temperature hydrogen and carbon appeared amongst the products, above 1200 there was much carbon and little or no hydrocarbons The actual temperature of the gas flame used was 500° at a distance of half an inch above the burner, 1279° at the top of the non luminous zone, and 1370° at the top of the luminous zone

Prof Smithells followed with a number of very beautiful "Experiments on Flame" He held that the ordinary candle flame showed four and not three zones as usually described He considered that the phenomena of combustion in flames ought to be studied by using gases of simple and definite composition rather than a variable and complex mixture such as coal gas

He showed, by means of experiments, the two distinct zones in the non luminous Bunsen flame, and how these could be separated, and their character varied according to the amount of air admitted, and similar illustrations were given by burning a jet of air laden with benzene vapour Under the conditions of the Bunsen flame he had found that whatever hydrocarbon was used the products withdrawn from the inner cone consisted of carbon monoxide, carbon dioxide, hydrogen, and water vapour, whilst in the case of the benzene flame described, when the air supply was so regulated as to produce a luminous zone between the inner and outer zones, acetylene was found amongst the gases withdrawn from that zone

His experiments had led him to conclude that when the hydrocarbon is starved of oxygen the carbon burns preferentially to the hydrogen

Prof Smithells then introduced a spray of cupric chloride solution into the gas, and showed that the inner flame remained unaltered in appearance, whilst the outer flame became green

He is of opinion that the decomposition of the salt takes place in the inner flame, and that the colouration of the outer flame is due to the projection of the products of decomposition through the outer flame A discussion followed these papers, in which Sir G G Stokes described the experiments he had performed with a view to determine whether the luminosity of the flame was due to carbon or to hydrocarbons He was not in favour of the idea that the colouration of the flame was due to chemical reactions taking place within it Sir Henry Roscoe thought it due to the separation of metal in the flame, and not to the oxide Prof Liveing quoted the results of his observations on the spectrum of oxygen, and expressed his adherence to the hydrocarbon theory of luminosity Prof Ramsay supported Prof Smithells' contention The discussion came to a conclusion with the replies of the authors of the papers

Dr J A Harker then followed with a description of "The Reaction of Hydrogen with Mixtures of Hydrogen and Chlorine" He finds that as had been previously observed by Horstmann, Bunsen, and others, the hydrogen combines partly with the oxygen and partly with the chlorine, but that the reaction varies with the quantities of the constituent gases present, and takes place in accordance with the law of Guldberg and Waage

Prof Clowes gave the results of the investigations which he had taken up in order to produce a safety lamp which should indicate with greater accuracy the presence of inflammable gases and vapours in air In confirmation of previous observations he had found hydrogen to be by far the most sensitive flame, and he described a means by which hydrogen could be burnt in an ordinary oil safety lamp with greater convenience than had hitherto been possible

A discussion which was to have been held in conjunction with Section D on the "Chemical Aspects of Bacteriology," fell through

Prof Roberts Austen gave a paper on the "Effect of Small Quantities of Foreign Matter on the Properties of Metals" The addition of two tenths per cent of lead or bismuth to gold was found to render it quite brittle, whilst extremely small quantities of phosphorus, magnesium, and zinc made nickel malleable Such phenomena had no doubt been of great interest in ancient times to the alchemist, but to-day they constituted all important questions for the engineer. Experimenting on gold, which could be obtained more readily than most other metals free from impurities, either solid or gaseous, he found that the tenacity was decreased by the addition of small quantities of elements whose atomic volumes were greater than that of gold, whilst those elements whose atomic volume was the same or smaller than that of gold, increased its tenacity Lithium and aluminium acted in an exceptional manner Furthermore, whilst the addition of 10 per cent of aluminium gave an alloy melting at 400° lower than gold, 23 per cent. of the admixture yielded a brilliant alloy having a higher melting point than gold He pointed out also that gold during the process of cooling showed abnormalities similar to those shown by iron, which, however, disappeared when the operation was carried out under pressure Prof Hartley had found that iron required to be slightly oxidised before it could be melted, even at a temperature which sufficed to melt platinum He had always found that silver and copper, unless prepared with special precautions which he described, contained gold

Dr Gladstone submitted a communication on the "Molecular Refraction and Dispersion of Metallic Carbonyls and of Indium, Gallium and Sulphur" The observations made on a sample of the iron pentacarbonyl supplied to him by Mond indicated an extreme dispersion for iron, even taking the highest value for carbonyl previously recorded He attributed, however, a still higher value (11 2) to carbonyl, and assigned a chemical formula in accordance therewith With regard to sulphur he had found that the values obtained varied only slightly, whether the sulphur was in the liquid, solid or gaseous condition Prof Liveing found that the same thing held for oxygen and nitrous oxide in the liquid and gaseous conditions, and considered that this pointed to the continuity of the gaseous and liquid states

Dr G H. Bailey gave a paper on "Impurities of Town Air" He pointed out that the amount of air taken into the system daily greatly exceeded that of the liquid and solid food, whilst according to Tyndall expired air was very free indeed from solid particles, and that air was undoubtedly the medium by which many diseases were propagated, and that in towns, as a matter of fact, the death rate rose to very abnormal proportions during those periods when the air was most polluted Under these circumstances it was a matter of surprise that so little attention had been devoted in recent years to the determination of the impurities in air A very large amount of information had, it was true, been obtained relating to the carbonic acid in air, and this had led to valuable results, but with the exception of Dr Russell's extremely interesting reports, hardly anything had been done in the direction of determining the sulphurous acid and organic matter with which town air, especially at certain seasons, was laden He then described the methods which had been adopted by the Air Analysis Committee of Manchester for determining these impurities, showing how it was not only possible to arrive at a measure of the amount of suspended organic matter, but also to ascertain proximately how far it was of a noxious character Such analyses may appropriately be supplemented by a bacteriological examination of air Some hundreds of analyses of the air of London, Manchester, and Liverpool had been made, and the following conclusions were drawn from them —(1) That in clear breezy weather the amount of sulphurous acid in town air does not exceed one milliogramme per 100 cubic feet of air (2) That in anticyclonic periods, and especially in times of fog, diffusion is seriously interfered with, and the quantity has been found as high as 50 milligrammes (3) That the organic impurities in air also increase under similar conditions to those which promote the accumulation of sulphurous acid to 40 or 50 times their normal amount at least.

In the discussion which followed Sir Douglas Galton expressed himself well satisfied with the enquiry, and hoped that the work would be continued He called attention to the tendency for decaying matter to collect, especially in certain areas of large towns and the danger of allowing such accumulations. Mr A. E. Fletcher, Chief Inspector of Alkali Works thought the

house fire was a large contributor to the evil and a most difficult one to contend against He suggested filtering the air for the house through cotton wool filters and had found that it could be applied with great success Mr Warrington criticised the methods of analysis and would like to see the determinations extended so as to show in what quantity the respective sulphur compounds existed in the air Dr Rideal had found the method of determining sulphurous acid most reliable and preferable to the Gas Referee's test used for the estimation of sulphur in coal gas Messrs Hartog, Fairley, Thomas, Dr Clowes and the President also spoke on the paper, and Dr Bailey replied to various points which had come up in the discussion

Subsequently, Prof W H Perkin described methods of synthesis with the aid of butane and pentane tetra carboxylic ethers the constitution of the methylene ring compounds being illustrated by Prof Crum Brown by means of a very ingenious set of models

A number of papers were carried over to the last day of the meeting mainly dealing with atomic weights and analytical work Amongst these Prof Ramsay and Miss Aston contributed the atomic weight of boron (*a*) by determination of the water of crystallization in borax (*b*) by conversion of anhydrous sodium borate into sodium chloride The value obtained was 10 966 Mr Hartog drew attention to the results just published of a determination of the atomic weight of boron by the late Dr Abrahall

Prof Ostwald read a communication on the assumed potential difference between metals in the solid and in the molten state His experiments failed to detect any such difference of potential, it is at any rate below $\frac{1}{1000}$ of a volt Prof McLeod showed that the iodides of sulphur, SI_6 and S_2I_2, if they existed at all as chemical compounds, were of a most unstable nature, the only evidence of definite combination having taken place in S_2I_2 was that it melted at a lower temperature than either of its constituents

BIOLOGY AT THE BRITISH ASSOCIATION

SO many important and interesting papers were submitted to the Organizing Committee of D this year that it was found necessary to divide the section into the three departments of Zoology, Botany, and Physiology The plan of adjourning for lunch at half past one, and resuming work again at two, with some attractive papers for the afternoon, was tried and found a success Practical demonstrations and exhibitions were also given in the afternoons in the laboratories above the lecture-room

On Thursday, August 4, after the president's address, the following series of reports by committees appointed at the Cardiff meeting was submitted (1) The Zoology and Botany of the West India Islands, (2) the Naples *Zoological* Station, (3) Zoology of the Sandwich Islands, (4) Botanical Laboratory at Ceylon, (5) Migration of Birds, (6) Plymouth Laboratory, (7) Deep Sea Tow-net, (8) Protection of Wild Birds' Eggs All of these committees have this year been re-appointed with or without grants Three papers were then taken in the afternoon, viz (1) Renewed experiments on the modification of the colours of Lepidopterous larvæ, with exhibition of specimens, by E B Poulton, F R S, (2) Prof Preyer, of Berlin, on the physiology of protoplasm, and (3) Prof Hartog on the alleged personality of the segments of the nucleus, and Weismann's "Idant" theory of heredity Prof Preyer attributed an important part to the absorption of oxygen by the protoplasm in the formation of pseudopodia Prof Hartog contended, from previously ascertained facts, and from his own recent researches, that the view that the segments that constitute the young nucleus persist during its maturity is untenable, and that Weismann's "Idant" theory of heredity being founded thereon must necessarily fail.

On Friday, in the Botanical Department, important papers were read by Dr Scott (on Secondary Tissues in Monocotyledons), Prof Goebel (on the Simplest Form of Mosses), Prof Errera (Physiological Action at a Distance), Prof Bower (Morphology of Spore-bearing Members in Vascular Cryptogams), and others, these will be noticed elsewhere

In the Department of Physiology there were the following —

(1) Prof. Waymouth Reid gave a paper on Vital Absorption, in which he showed that the older views of Dutrochet and others as to the process being a physical one due to osmosis must be modified in the direction of showing that the vital activity of the cells composing the absorbing membrane must be taken into account We know that changes are wrought upon substances during the process of absorption, such as the regeneration of serum-albumen from peptone In the case of the intestine of the rabbit in full digestive activity, one can get evidence of a stream passing from within outwards so long as the tissues are alive Scraping off the epithelium diminishes the transfer or puts a stop to it By the addition of pilocarpine to the fluids used, it is possible to reverse the direction of the stream

(2) Prof Rosenthal, of Erlangen, read a paper on Animal Heat and Physiological Calorimetry The apparatus he made use of has an air calorimeter In fever, produced by injection of putrid matter, he finds that heat production is not augmented, although in a few experiments he made on man he found a small augmentation of heat production

(3) Dr Lockhart Gillespie communicated a paper on Proteid-hydrochlorides, in which he stated that all proteids have an affinity for hydrochlorides, and the lower proteids combine with a greater percentage of HCl than the higher These results were supported by the amount of silver which is contained in a series of the different proteid salts of silver, the ratio of silver to albumen being highest, and that of silver to peptone being lowest The different stages of gastric digestion of a meal he finds to be —1, the amylolytic stage—no free HCl being present, but some combined proteids—duration about ten minutes, 2, combined hydrochloric acid (proteid hydrochloride)—acidity considerable, no free HCl, small amount of lactic acid present—duration about half an hour, 3, free HCl stage—some free HCl, but mostly combined, lactic acid disappearing, 4, the chief absorption stage—acidity falling, but proportion of free to combined HCl rising—from three to four or five hours, 5, evacuation—propulsion of contents of stomach into duodenum at fourth or fifth hour

(4) Dr E W Carlier gave an account of the hibernating gland of the hedgehog, which is situated along the cervico dorsal and in the axillary regions, and attains its maximum dimensions in October—*i e*, just at the commencement of hibernation—and its minimum shortly after the animal has awakened from winter sleep Histological examination shows that towards the close of hibernation many of the cells change The chromatin in the nucleus diminishes, the fat stored in the cell gradually disappears, and finally the whole cell breaks up Dr Carlier considers that the hibernating gland is not merely a storehouse for fatty matter but actually secretes some nutritive material of great service to the animal during its winter sleep

(5) Dr G Mann read a paper on the Functions, Staining Reactions, and Structures of Nuclei, in which he endeavoured to prove that the achromatic elements of a cell are the most important, and that the nuclear chromosomes are organs for the assimilation of food, while the centrosome is a trophic centre for the nucleus

In the Department of Zoology, the following papers were read —

(1) Dr Henry C McCook (Philadelphia), on the Social Habits of Spiders This paper considered the claims of certain species of the Araneæ to possess in some degree the communal tendencies of the Social Hymenoptera The eminent French araneologist, M Eugène Simon, in his studies of South American spiders, finds a temporary sodality among certain orb-weavers (*Epeira Badeliert*) at the cocooning season, which Dr McCook thought might be explained by the well-known fact that female spiders when cocooning often choose the same locality and mass their egg bags, the one mother overlaying the cocoon of another But this is quite incidental, and occurs with species which are known to be solitary The close grouping of Simon's *Uloborus republicanus* was regarded as no proof of a sodality, but simply showed an assemblage of snares in proximity which is not uncommon The gathering of males in groups on the outer lines of the webs is quite what one sees in other species with which there is no departure from the solitary habit The third example of supposed social spiders (*Anelosimus socialis*) shows characteristics closely resembling those of young spiders of various genera, who will weave around themselves upon the foliage where they lodge a tent of delicate spinning work within which they dwell for a short space, and then scatter, every individual at once assuming the solitary habit. If Simon's observations be here confirmed, we shall have the transfer of this trait of young spiders in many species to the adult period of at least one species The fact

would revolutionize our ideas of the universal prevalence of the solitary habit The paper was illustrated with a number of large painted figures

(2) Prof A. Crum Brown, F R S, on a Use of the External Ear The form of the external ear enables us to find the altitude of the source of sound by rotating the head about a horizontal right and left axis

(3) Prof Lloyd Morgan, the Method of Comparative Psychology The object of this communication was to show that our interpretation of animal intelligence is necessarily based on a double or two fold process of observation 1st, the activities of animals have to be carefully observed as objective phenomena, 2nd, our own mental processes have to be carefully observed and cautious inductions drawn from them Finally the objective phenomena reached by the first process have to be interpreted in terms of conclusions obtained through the second In the higher animals there is abundant evidence of ability to sense or feel relations, but little or none of the perception or cognition of the relations of introspection or of reflection, and possibly herein we have a limit to animal intelligence

(4) Mr J. E S Moore, on the Relationships and Rôle of the Archoplasmic Body during Mitosis in the larval Salamander The author has extended the discovery of the archoplasmic body in the spermatocyte of the salamander to the somatic cells of both the larva and adult, and especially to the cells of the germinal blastema and the leucocytes He demonstrated for this vertebrate a distribution and functional activity of the archoplasmic body identical with that recorded by Platner for the invertebrate *Helix*, and concluded that the archoplasmic body is the sole agent in the formation of the achromatin spindle fibres

(5) Prof J C Stewart exhibited with remarks an abnormal fore foot of a horse, in which two large digits and vestiges of others were present

(6) Dr G Mann read a paper on the Origin of Sex, in which he contended that any sexual cell might be transformed into either a male or female cell, according to the facilities of acquiring and assimilating food material

(7) Dr J Beard, on Larvæ and their Relations to Adult Forms. The author attempted to show that all metazoa above cœlenterata developed through the intermediation of a larva (often disguised by the presence of food yolk), and, in fact, upon the latter He urged that the recapitulation theory was no explanation of the phenomena of embryology, at best it held good to a limited extent for the ontogeny of certain organs The views of the author led him to regard metazoon development as a sort of alternation of generations

(8) Professor W A Herdman, F R S, on the Exploration of the Irish Sea to the south of the Isle of Man now being carried on by the Liverpool Marine Biology Committee

On Saturday, August 6th, the section did not break up into departments The following papers were read —

(1) Prof McKendrick, F R S, demonstrated by means of a new form of myograph a method of recording and projecting simultaneously upon a screen, through the aid of lime light, curves of muscular contraction He also showed a method of measuring and recording the time occupied by short voluntary movements, such as those of the fingers in writing, or the movements of the tongue

(2) Prof G Fritsch (Berlin), on the Origin of the Electric Nerves in the *Torpedo*, *Gymnotus*, *Mormyrus*, and *Malapterurus* Prof Fritsch pointed out that there are two kinds of electric organs found, the one being modified muscles, as is the case in *Torpedo*, *Gymnotus*, *Mormyrus*, and *Raia*, while the other belongs to the cutaneous system, and is probably transformed gland cells of the skin, as in *Malapterurus* In electric organs originating from muscles there are many ganglion cells, but in those derived from skin organs there are only two ganglionic cells, one on each side, and only one nerve fibre belonging to each cell, which fibre is formed by a combination of protoplasm-processes at a certain distance from the gigantic ganglion cell

(3) Prof. Miall, F R S, gave an account of the leaf of the water plant *Victoria regia*, illustrated by lantern slides, in which he described the peculiarities of its structure, and the way in which it is modified to suit its special environmental conditions.

(4) Dr. J Musgrove, the Blood-vessels and Lymphatics of the Retina. The author pointed out that the distribution of the vessels in the retina was as regular as that occurring in the arm or the leg. The blood-vessels of the retina of the ox may be divided into three sets. There are upper and lower sets of branches of large vessels, and there is an intermediate zone entirely free from large vessels except in so far as it is traversed by the main stems of artery and vein in their course to the upper part of the retina This intermediate zone the author regards as the homologue of the yellow spot found in the human retina The capillary vessels on a transverse section of the retina are seen to lie chiefly in the nerve cell layer, the inner molecular layer, and the inner nuclear layer Only rarely are capillaries found beyond the inner nuclear layer, and they never extend as far as the outer nuclear layer, so that the outer layers (the rods and cones, &c) are entirely free from vessels

(5) Mr H. O Forbes exhibited a recently discovered series of sub fossil bones of extinct birds of New Zealand and the Chatham Islands, and made remarks upon the localities where they had been found and upon their distribution From the Chatham Islands the specimens were in a remarkably fine state of preservation, and included the species described under the names of *Aphanapteryx hawkinsi*, *Fulica newtoni*, and *Corvus moriorum*, along with portions of *Nestor* and *Harpa* From New Zealand, *Biziura*, *Cereopsis*, *Cygnus*, and the type specimens of *Cnemiornis gracilis*, Forb, were exhibited, and also the larger part of the skull of *Harpagornis moorei*, Haast

(6) Dr J Clark, on the Natural Relations between Temperature and Protoplasmic Movements The author showed that the minimum temperature for protoplasmic movements depended on the nature, habits, and natural surroundings of the plants, and that change of conditions of growth induced change of minimum

(7) Dr J Clark, Experimental Observations on the Functions of the Nucleus in the Vegetable Cell By divesting the vegetable cell of its wall, and also by mechanically separating the protoplasmic contents of a cell into two equal parts, the author tried to show the relations between the nucleus and cell wall formation, and between mechanical stimulus and nuclear activity

(8) Dr Francis Warner, Co ordination of Cellular Growth and Action by Physical Forces The facts accumulated in a report on 50,000 children observed by the author appear to show that defects in development of the body are largely co-related with defects of the nerve system in its power of co-ordination and mental function

(9) M Louis Olivier, La Canalisation des Cellules et la Continuité de la Matiere vivante chez les Végétaux et les Animaux The author has for some time recognized, even in highly differentiated tissues, the canalization of the cell wall and the free passage of protoplasm, and lately he has obtained evidence, photographic and otherwise, that in highly organized forms, such as Dicotyledons, the protoplasm is continuous from the extremity of the roots to the tips of the leaves

(10) Dr John H Wilson, some Albucas and their Hybrids The author has formed crosses between hybrids and the parent forms in several species of the African liliaceous genus *Albuca*

On Monday, Section D was occupied in the forenoon by a discussion on "Sea-Fisheries" —

(1) Prof McIntosh, F R S, opened the discussion by a paper entitled "A Sketch of the Scotch Fisheries, chiefly in their scientific aspects, during the past decade, 1882-92," in which he gave an interesting account of the condition of the fisheries, and of the investigations which have been carried on by the Fishery Board of Scotland, and at the St Andrews Marine Laboratory, and elsewhere

(2) Prof Ewart followed with a general paper on our sea fisheries, in which he showed that some of our valuable fishes are becoming scarce, and discussed various remedial measures which have been suggested He considered that fish-hatching was not of much practical use if the young were merely returned to the sea when hatched

(3) Mr E W L. Holt read a paper, drawn up by himself and Messrs W L Calderwood and J T Cunningham, of the Marine Biological Association, on the Destruction of Immature Fish, and a discussion of remedial measures In this paper the authors dealt chiefly with the protection of immature fish by the imposition of a size limit It was contended that the size limits proposed at the conference at Fishmongers' Hall last February are altogether too small, and that no limit can be useful which is not based upon the size at which a fish is for the first time able to reproduce its species Tables were given showing the variation which exists in this respect in the different districts. The authors gave figures showing the immense destruction of immature fish on certain grounds lying on the east side of the North Sea, and the opinion was expressed by Mr Holt, who has had

charge of the Association's work in that district, that the imposition of a reasonable size-limit for plaice alone would do more to cause the trawlers to leave these grounds unmolested than could be effected by any scheme of closing based on international agreement

Various zoologists and fishing experts, including Prof Ray Lankester, Prof McIntosh, Prof Ewart, Dr Fullerton, Mr Olsen, Mr Stebbing, Mr Walker, and Prof McKendrick, took part in the discussion which followed

(4) Dr W Ramsay Smith, The Food of Fishes This statistical paper gives the result of observations made by the naturalists of the Fishery Board for Scotland on over 10,000 food fishes collected in the Firth of Forth and St Andrews Bay during the last four years The author considers the statistics so extensive as to reduce the limit of the errors of observation to such an extent as to allow general conclusions of a trustworthy character to be drawn now for the first time

(5) Mr E W L Holt, Notes on Teleostean Development

(6) Mr. A P Swan, The Effect of Sea-water on the Vitality of the Salmon Fungus The author showed that immersion in sea water even diluted with any lesser proportion than three parts of fresh water is fatal to the fungus, and from the continuous nature of the hyphæ it is certain that the disease is destroyed on the stay of the fish in the sea, and that the recurrence of the disease on the return to fresh water must be due to re infection In the discussion that followed Mr George Murray expressed his acceptance of the author's results

(7) Prof E G Prince, on the Formation of Argenteous Matter in the Integument of Teleosteans The fibrillated substance to which the integument of many fishes owes its silvery lustre is formed in a layer of granular plasma which belongs to the mesoderm

(8) Prof E E Prince, The Development of the Pharyngeal Teeth in the Labridæ The grinding plates in the pharynx of wrasses are developed from rounded dental sacs formed from the cells of the mucous layer

(9) Dr Carlier, on the Skin of the Hedgehog The skin of the dorsal surface is very thick, and very rugose The spines spring from depressions between the rugosities On section the mucosa is very thick, and devoid of blood vessels except beneath Sweat and sebaceous glands are absent radiation of heat is thereby almost prevented The spines which are morphologically hairs, are fixed in the cutis vera by a broad base, near which is a rich capillary plexus The spines, consist of cuticle, cortex, and medulla The cortex is strengthened internally by twenty-two or more longitudinal septa The medulla is divided into loculi by transverse imperforate septa, which divide at their margins into secondary septa, which again divide into tertiary, enclosing respectively secondary and tertiary loculi The erector pili is very large, and somewhat fan-shaped The skin of the ventral surface is much thinner, and is covered with soft hairs between which and the spines there is a gradual transition on the flanks Sebaceous and sweat glands are present, and also much adipose tissue, and a thin skin muscle

(10) Rev Alex S. Wilson, on the Industry and Intelligence of Insects in relation to Flowers

(11) The following demonstrations were also given —Dividing Pollen Mother Cells, by Prof M Hartog, Hibernating Gland of Hedgehog, by Dr Carlier, Variations in Arrangement of Feathers in Wings of Birds, by Mr Goodchild, Embryo sac of Angiosperms, by Dr G. Mann

On Tuesday, Aug 9, the Section again separated into Departments. In the Botanical Department, papers were read by Prof Schmitz (Knollchen am Thallus einiger Florideen), Mr Carruthers (on the Structure of the Stem of a typical Sigillaria), Mr T. Hick (on Calamostachys Binneyana), Mr A C. Seward (on Myeloxylon from Millstone Grit and Coal Measures), Prof Hillhouse (Disappearance of native Plants from their local Habitats), and others which will be noticed elsewhere

Mr G. Murray drew attention to a comparison of the Marine Floras of the warm Atlantic and Indian Ocean, his remarks being illustrated by a printed table of statistics. He dealt with the question whether since the last period of a warm climate at the Cape when the two tropical marine floras mingled, the genera and species had had time to vary much, or remained the same in the warm Atlantic and Indian Oceans now separated by the colder flora at the Cape.

Mr Harold Wager read a paper on the Structure of *Cystopus candidus*, a fungus found parasitic on the shepherd's purse He pointed out that the nuclei are similar in structure in many respects to the nuclei of higher plants In the formation of the oospore a number of nuclei are restricted to the periplasm, and at a late stage a number of nuclei are found in the oospore surrounding a large central oil globule During fertilization the protoplasm and nuclei contained in the antheridium pass over into the fertilizing tube, but whether any of the contents pass into the oospore was not determined

A paper, by Mr James Britten, was read protesting against certain proposed changes in Botanical nomenclature

Two papers were given by Prof G Gilson (Louvain), on the Affinity of Nuclein for Iron and other substances, and a Method of Staining Nuclei by Chemical Means It is now certain that dead nuclein, as well as other substances found in the cell, have a strong affinity for the various compounds of iron and of other metals and negative chemical bodies Thus the difficult question arises, Is the presence of iron in the nuclear elements constant and normal during life, and is this metal necessary for the chemical activity of the nucleus?

Dr C H Bailey, Manchester, discussed the conditions affecting plant life in a town atmosphere, especially the falling off in the amount of light received, and the increase in sulphurous acid Finally, a paper was read by Dr G Mann, which contended that the view first put on record by the author, viz, that the embryo-sac of Angiosperms corresponded to a sporocyte, and not a macrospore, was confirmed by the observations of Guignard, Dodel, and Overton, and that the eight cells within the embryo sac were eight female sexual cells corresponding to the eight male sexual cells derived from a pollen mother-cell

In the Department of Zoology the following papers were read —

(1) Baron Jules de Guerne, Présentation de Planches inédites de Zoologie concernant les Recherches du Yacht *l'Hirondelle*

(2) Baron Jules de Guerne, Crustacés Copepodes des Eaux sursaturés de Sel de la France et des Canaries

(3) Dr Arthur Robinson, Observations on the Development of the Posterior Cranial and Anterior Spinal Nerves in Mammals At an early stage (eleven protovertebral somites) a continuous cord of nerve cells extends backwards from just within the posterior part of the auditory depression along the dorso lateral angle of the medulla and spinal cord At the time of formation of the secondary optic-cup this cellular cord loses a connection it had with the dorsal extremity of the neural tube, thickens between auditory vesicle and first somite, remains relatively small from first to fourth somite, and beyond the fourth somite gives origin to a series of swellings, the spinal ganglia The ganglionic enlargement in the presomitic region becomes the root ganglia of the glosso-pharyngeal and vagus nerves An enlargement in relation with the fourth somite becomes the first cervical ganglion Other enlargements in second and third somites become connected either with spinal accessory or (in cat) with posterior root of hypoglossal nerve

(4) Prof J C Ewart, on the Cranial Ganglia. The author discussed chiefly the ganglia of the glossopharyngeal and facial nerves in elasmobranch fishes, and their relations to the branches of the cranial nerves

(5) Prof W A Herdman, F R S, gave two short notes, one on the Geographical Distribution of Ascidians, in which he drew attention to the great predominance of species and individuals, and also of gigantic specimens in Arctic and in Antarctic seas, the other on the Presence of Atrial Tentacles in various genera of Tunicata, with a suggestion as to their function The various forms in which up to now atrial tentacles have been found are phylogenetically rather closely related, and most of them are species in which the animals are in the habit of living closely aggregated together Possibly under these crowded conditions it is an advantage to the animals to have the power (as some have) of reversing the usual current of water, or of using the atrial for a time as the inhalent aperture, when the atrial tentacles would have important functions to perform

(6) Mr E B. Poulton, F.R S, gave two interesting exhibitions of series of specimens, the one illustrating renewed experiments on the modifications of the colours of Lepidopterous pupæ, and the other being an observation bearing on the non transmission of characters acquired by certain pupæ

(7) Dr J Symington, on the Cerebral Commissures in the Marsupialia and Monotremata The author held that in these two divisions of the Mammalia the Corpus Callosum was absent, the only transverse fibres that exist being those known as the

hippocampal commissure and the anterior commissure These results support the conclusions of Owen, and are opposed to those of Flower

(8) Prof J Playfair McMurrich, the Early Development of the Isopods The author described the structure and mode of segmentation of the typical centrolecithal ovum of the Isopod *Jæra*, calling attention to the early differentiation of the germ layers, which may be traced back to the eight celled stage The mesoderm forms at first a band of cells surrounding the embryo, and later concentrates towards the ventral surface to form the blastodisc, behind which is the endoderm, these two layers becoming later enclosed by the ectoderm, which grows back over them by teloblastic proliferation

(9) Dr J Beard gave some notes on Lampreys and Hagfishes

(10) Prof G B Howes and Mr J Harrison, on the Skeleton and Teeth of the Australian Dugong The authors described the process of vertebral epiphysis formation, showing that epiphyses, so far as represented, are formed late, and are rapidly merged into the substance of the vertebral body They described the formation of structures which might, perhaps, be regarded as anticipatory of supernumerary phalanges, and pointed out that their observations lent no support to Kukenthal's view of the epiphysial nature of such phalanges Five mandibular teeth were found to be present in the anterior region of each ramus in the manatee, and one of these they claimed as a canine They recorded the discovery of milk predecessors to the first upper and the four lower incisors (?) of the dugong, and of the two anterior mandibular cheek teeth of the manatee, and discussed the bearings of these facts on the inter-relationships and affinities of the order Sirenia

(11) Dr H C McCook—Can Spiders Prognosticate Weather Changes? Dr McCook first stated briefly the widespread popular opinion that spiders fairly indicate the weather by ceasing to spin before foul weather, and weaving freely before fine weather He then gave a few extracts from his journal of observations on this point extending over six years, the tenor of which is that the popular opinion has no basis in fact Many species of orb weavers, which were colonized and kept under close observation, made snares freely before rains and storms, frequently even in the intervals between heavy rains

(12) Mr G Swainson, some Notes on Marine and Freshwater *Chironomus*

(13) Rev Hilderic Friend, on British Earthworms The author distinguishes between the four genera—*Lumbricus*, *Allolobophora*, *Allurus*, and *Dendrobæna*—to which British earthworms belong, and gives an account of the different species, some of which are new to science

(14) Mr H Newman Laurence, the Human Body as a Conductor of Electricity

(15) Prof J B Haycraft, Fertilization of the Eggs of the Stickleback

The two following papers, also on the programme, were taken as read —

(16) Prof Emile Yung, la Fonction Dermatoptique chez le Ver de Terre, and

(17) M J Richard, Note sur l'Œil Lateral des Copepodes du genre Pleuromma The lateral eye in *Pleuromma* is variable in position, but is more often on the right side than on the left, and seems more constant in males than in females

The following demonstrations were also given during the afternoon —The Formation of Pearls (by Mr Albert F Calvert), Interesting British Food Fishes (by Mr E W L Holt), and the Structure of *Myeloxylon* (by Mr A C Seward)

GEOGRAPHY AT THE BRITISH ASSOCIATION

THE work of the Geographical Section was overtaken in four meetings, the large attendance at which was evidence that the papers read met at least with popular approval It is more satisfactory to gather from the opinions expressed by specialists that many of the papers were solid and original, and that from the scientific standpoint the average work was of high excellence Without doubt the most important of the new results announced to the Section was Dr Schlichter's admirable development of a photographic process for determining longitude by the almost disused method of lunar distances The practical value of the invention is very great, especially with regard to the mapping of partially known continents.

Like all other departments of the Association, Section E owed much of its success to the distinguished foreigners who took part in its proceedings The papers by the Prince of Monaco and the occasional remarks of Baron von Richthofen were much appreciated Two ladies read papers, Mrs Bishop recounting her adventures on the borders of Tibet with her well-known literary grace, and Mrs Grove giving a short, bright account of the rainless regions of Chile

Prof James Geikie's presidential address, although based entirely on geological reasoning, was truly geographical in so far as it utilized geology only for the purpose of explaining the origin of the existing surface conditions of the globe As presenting the only sound basis of physical geography, this opening address proved to be one of the best and most original with which Section E has ever been favoured Unfortunately, Prof Geikie was prevented by illness from presiding at all the meetings, but his place was taken by the vice presidents, Colonel Godwin Austen, Mr H J Mackinder, Mr E G Ravenstein, and Mr Coutts Trotter

The First Ascent of Oraefa Jökull—In the absence of the author, Mr J Coles read an account by Mr F W W Howell of the first ascent of Oraefa Jokull in Iceland Mr Howell succeeded in making the ascent on August 12 last year, after several previous failures Although only 6550 feet in height the mountain presented remarkable difficulties on account of the irregularity of the ice

Place Names—Dr J Burgess, in the course of a paper on place names, urged a uniform system of transliteration from Oriental alphabets as more scholarly and more satisfactory than any attempt to represent the sound of names phonetically In no other way could uniformity of spelling be arrived at, and the diverse spellings now in use made the study of Asiatic geography in particular very toilsome and irritating With regard to Gaelic names there were several serious errors in spelling on the ordnance map, but at the suggestion of Sir Charles Wilson a Committee of the Royal Scottish Geographical Society had taken the matter up, and aided by local committees were introducing important corrections. A lively discussion followed the reading of this paper, in which Sir Charles Wilson, Mr Mackinder, Prof Thomas Smith, and others took part A Committee of the Association was formed to co operate with the Scottish Society, and received a small grant to aid in the thorough revision of the orthography of Gaelic place names

Effects of Rainfall in Formosa—Mr John Thomson, of London, gave an account of the effect of rainfall on the scenery of Formosa, illustrated by a number of fine photographs The situation of the island and its mountainous structure conspire to give prominence to the effect of rain action, the wind blowing in from the warm current of the *Kuro Siwo* strikes against a mountainous ridge which runs the whole length of the island and culminates in a summit 12,000 feet high The mountain side to windward is scored with deep ravines, and the streams choked with huge boulders in course of transport to the coast plains, which are deeply covered by fine alluvium washed down from the heights

The Windings of Rivers—Mr J Y Buchanan, in a short paper, discussed the windings of rivers from the standpoint of hydrodynamics

Lesser Tibet—Mrs Bishop (Miss Isabella Bird) described a journey undertaken in 1889, on the borderland of Tibet, which she approached from Leh, in Kashmir The intensity of radiation at great altitudes, giving very hot days and cold nights, was observed to lead to a very rapid disintegration of the rocks, resulting in the formation of immense fields of gravel Although presenting a vivid picture of the topography and scenery of the trans Himalayan borderland, Mrs Bishop entered more fully into the characteristics of the people, contrasting the false, suspicious, and cringing natives of Kashmir with the truthful, trustful, and independent people of Tibet, who always welcomed her warmly and dealt with her fairly.

The North Atlantic—The Prince of Monaco read two papers on his oceanographical work, the first bearing on his experiments with floats on the surface circulation of the Gulf Stream, and its associated system of currents About 10 per cent of the floats thrown over from the Prince's yacht have been recovered, and by taking into account the position in which they were found and the date, important confirmation of the theoretical system of circulation was obtained The current was found to be a circular whirl, with its centre a short distance south-west of the Azores. Floats thrown over near the centre were not re-

covered for many years, but those launched to the north or the south were thrown ashore more speedily on the coast of France, Spain, Portugal, North Africa, or in the West Indies The only escape from the whirl was the Gulf Stream drift towards Norway and the Arctic Sea The mean rate of circulation was calculated as about 4½ miles per day, and the rate of movement was found to be more rapid in the western than in the eastern half of the whirl The Prince's second paper set forth the advantages which would accrue to meteorology and to navigation if the atmospheric conditions of the North Atlantic could be observed and telegraphed daily to Europe He pointed out that the Bermudas, the Azores, Madeira, the Canaries, and the Cape Verd Islands were, or would very soon be, in telegraphic communication with Europe If high and low level observatories were established in these islands it would be possible to construct very fair synoptic charts of the North Atlantic, and vastly improve upon the useful Pilot Charts now compiled by the Washington Weather Bureau The Prince was willing that all observations should be collected at Monaco, where the Government of the Principality would discuss and publish the data, and he suggested that the Governments most interested should send delegates to a conference to be held next winter at Monaco in order to discuss the feasibility of the scheme Dr A Buchan, in commending the Prince's suggestions, said that the surface temperature of the North Atlantic had been proved to have an influence on the direction of cyclones crossing it, and consequently on the weather of the British Islands and western Europe He thought a properly equipped low level station on the Bermudas was the first desideratum, then a similar station on the Azores, to be followed by a high level observatory The results at Ben Nevis warranted the expectation of great advances, not only in knowing the weather of the Atlantic, but in forecasting weather for Western Europe, if the Prince's scheme received the encouragement which it deserved

Detailed Oceanography and Meteorology —Mr J Y Buchanan described his observations on the temperature and density of the water in the Gulf of Guinea in connection with the counter-equatorial current Dr H R Mill gave a brief account of the physical geography of the Firth of Forth, dwelling particularly on the relation between tidal and solar variations of temperature in the water The puzzling fact that in the Firth of Forth the water at high tide is saltest when that phase occurs in the afternoon was explained by the high water of spring tides occurring at that hour Mr H N Dickson, in a short paper, urged the claims of meteorology as a subject of instruction with special regard to its place in physical geography

The Desert of Atacama —Mrs Lilly Grove, of Oxford, gave a vivid description of a journey through the Atacama desert, including a trip by rail from Antofagasta to Uyuni at an elevation of 13,000 feet in the Andes

Photography and Surveying —Colonel Tanner explained the system of photographic surveying which he has developed on the Himalayan survey By the use of a finely ruled grating the angular intervals between prominent objects could be estimated, and in cases where detailed triangulation was impracticable very fair maps could be compiled from photographs taken from several prominent centres

Determination of Longitude by Photography —Dr H Schlichter communicated a most important paper, summing up a long series of experiments, and an investigation of the mathematical formulæ required in calculating longitude from lunar distances His method enables him in favourable circumstances to fix the longitude to within 6′, an approximation hitherto only possible by telegraphic time comparisons His summary is as follows —

"Lunar distances as a means for the strictly accurate determination of geographical longitudes have been little used of late, partly on account of the splendid chronometers with which ships are now provided, and partly owing to the inaccuracies of the instruments commonly employed for lunars For exploring expeditions on land, however, chronometers are of little value, and the other astronomical phenomena which may be used besides lunar distances are either too difficult for accurate observation by the majority of travellers, or occur too seldom, or are not accurate enough The author therefore introduces a new method of observation and measurement of lunar distances, viz by obtaining a parallel series of photographs of the moon and a fixed star or planet on one plate, and afterwards measuring the distances on the plate For the elimination of all possible inaccuracies of the photographic film or of the lens, the lunar distances thus registered are checked by repeatedly photographing on the same plate two fixed stars, the positions of which are given in the *Nautical Almanac*, and the angular distances of which can easily be computed therefrom The angular distances of the photographic lunars are then found by a simple proportion The time for taking a set of eight photographic lunars on one plate does not exceed three or four minutes, and micrometric measurements show with perfect accuracy the change of the lunar distances (owing to the movement of the moon) during each interval of the eight observations The minute accuracy of the method is hereby established The micrometric measurements on the plate are made by means of the same *réseau* which is employed by the principal observatories for stellar photography, and the measurements may therefore be regarded as absolutely correct Results thus obtained give the correct longitude of the place of observation The author proposes to use this method for scientific expeditions into the interior of continents, &c, as well as for the further determination and correction of secondary meridians in navigation For both purposes it is especially adapted on account of its minute accuracy and great simplicity"

African Travels —The whole of one day was devoted to the reading of papers bearing on Africa, almost all having reference to South Africa. Mr I Wilkinson described two journeys which he had made in the Kalahari Desert Mr Theodore Bent summarized in an interesting manner the results of his explorations at Zimbabwe, a paper on the orientation of which was also read by Mr Swan In the report of the committee appointed to assist in the exploration of Zimbabwe, it was announced that Mr and Mrs Bent intended to pursue their investigations into African ruins of the Zimbabwe type in Abyssinia Mr John Buchanan gave an account of the industrial resources of Nyasaland, which his long experience there enabled him to do with authority The fertility of the soil, and the intelligence and willingness to work of the people, were advantages common to few parts of tropical Africa A staple commodity was still wanting, but there were unmistakable signs that this would before long be found in coffee, which has been grown with great and increasing success Firm government of the country, the absolute suppression of the slave-trade, and of intertribal wars, were almost certain to result from the recent extension of the British protectorate, but the problem of communication remained as a bar to the effective development of the country With really free traffic on the Zambesi and lower Shire, and a railway, or at least a steam tramway, on the new road from Chilomo to Lake Nyasa, the success of Nyasaland commercially would be assured Lieutenant Crichton-Browne gave a popular account of a recent journey to Lobengula's capital, and of an interview with that monarch At the close of this paper Mr Joseph Thomson, whose health is still in a very unsatisfactory state, made a few remarks, the first he has been able to make in public since his return invalided from Africa a year ago Dr A H Hallen described the Haussa country, in the language of which he is specially interested He hopes to be able, under the auspices of the recently founded Haussa Association, to proceed to the western Sudan, and continue his studies in the country itself Mr Ravenstein submitted the report of the Committee on African meteorology, of which Mr. Symons, F R S, was secretary The Committee has collected a considerable number of unpublished records of meteorological observations in tropical Africa, and has charged itself with exercising a friendly influence over existing stations and the equipment of new stations likely to promote a better knowledge of the climatological conditions of the continent Instructions of an eminently practical kind have been drawn up, and by the circulation of these and the grant of sets of instruments to suitable observers, it is hoped that the special difficulties of tropical observing may be overcome The committee has been re-appointed, with the addition of Dr. H R Mill as secretary

Proposed New Map of the Globe.—Mr E G Ravenstein explained Prof Penck's scheme of a new map of the world, on the scale of 1 to 1,000,000, or about sixteen miles to an inch It was proposed to draw each sheet on an independent projection, the sheets embracing 5° in each direction, except those for latitudes higher than 60°, which would have a width of 10° of longitude The map would be contoured at 100, 300, 500, and 1200 metres, hills would be printed in brown, and rivers in blue The official spelling of all names written in the Roman alphabet would be adhered to, accepted names in other alphabets would be transliterated on a system to be afterwards agreed on,

and names in unwritten languages would be rendered phonetically The land surface of the globe would be represented in 769 sheets, and on an edition of 1000 copies it is estimated that there would be a deficit of over £100,000 if the sheets were sold at 2s This sum would require to be subscribed by the Governments interested, or by private individuals The practicability of such a map is proved by the fact that Mr Ravenstein has himself produced with the aid of the Royal Geographical Society 46 five degree sheets of a map of Africa. The utility of the new map is universally conceded

Recent Travels —Mr. Walker Harris described an adventurous journey through Yemen in the early part of this year, during a rebellion of the Arabs against the Turks In spite of many difficulties, including imprisonment by the Turkish authorities, Mr Harris succeeded in reaching Sanaa from Aden, and found the country to be well watered, of magnificent fertility, and by no means badly cultivated

Mr Coutts Trotter summarized the recent advances in the exploration and organization of British New Guinea

Mr H O Forbes described a visit to the Chatham Islands, where he discovered the bones of a remarkable flightless bird, identical with an extinct species also found in New Zealand, which is separated by 450 miles of deep water The inevitable inference is that a land connection must formerly have existed between the two groups of islands The importance of a careful search for similar remains in other islands of the southern hemisphere in the light of geographical distribution and speculations as to former lands is obvious

Mr W R D Beckett, of the British Consular service in Siam, was the first Englishman to descend the Mekong river from the Eastern Laos States to Saigon, and described the various incidents of his adventurous journey

Mr C W Campbell, of the British Consular service in China, described his journey through Northern Korea, reporting favourably on the people as compared with the Chinese in their treatment of strangers

Other Papers —Prof P H Schoute brought forward a new scheme for draining the Zuyder Zee, and Mr Yule Oldham, lecturer on geography at Owens College, recalled attention to the early discoveries of Cadamosto on the west of Africa in the fifteenth century

Sub section on Chemical Oceanography —A joint meeting of Sections B and E was held under the presidency of Mr Buchanan for the consideration of a series of papers on oceanography Mr Buchanan communicated the result of some observations of the density of the water at a depth of 2000 fathoms off the coast of South America made by Captain Thomson, of the telegraph ship *Silvertown* They are held to demonstrate that the deep water there has come direct from the Antarctic Sea. Prof Pettersson gave a detailed and elaborate paper on the hydrography of the Kattegat and Baltic, illustrated by numerous special maps Observations were made simultaneously at a number of points in the Baltic and its approaches, samples of water were preserved in sealed tubes for estimation of gases, and the density was in all cases measured on shore by means of Sprengel's pyknometer The excess of precipitation over evaporation was found to cause an outflow of comparatively fresh water and a progressive decrease in the salinity from the Skagerrak inward The fresh Baltic stream flows close round the coast of Norway as it escapes into the Atlantic An under-current of salt water inward takes place, partly by reaction and partly by the rising up of the deeper layers against the ridges which divide the Baltic area into basins This action is not uniform, but occurs by successive impulses and pauses The physical boundary between the North Sea and the Baltic is not in the Belts, but along the ridge joining Rugen and Felster The great mass of Baltic water from Rugen to the Gulf of Finland is of uniform salinity, it grows salter toward the North Sea, and freshens rapidly in the Gulf of Bothnia. In this region of uniform salinity temperature appears to be the chief cause of circulatory movement By winter cooling a layer of intermediate minimum temperature is usually formed, in which flakes of ice may be produced that rise to the surface and consolidate there. Indications derived from observations fourteen years apart point to a partial or complete stagnation of the water in the deeper parts of the Baltic basin The fresh Baltic stream is felt in summer far to the north along the Atlantic coast of Norway, but in winter it is greatly reduced, and comparatively warm North Sea water (4° to 6° C.) comes into the Skagerrak. This influx is coincident with the commencement of the great herring fishery, which comes to an end when the cold Baltic outflow is re established in spring

Dr Andrussoff, of St Petersburg, summarized the results of the recent Russian investigations on the Black Sea, the most remarkable discovery being the fact that below the depth of 200 fathoms the great mass of the water is stagnant, and so highly charged with sulphuretted hydrogen that all life is impossible

Each paper was followed by animated discussion, in which Dr John Murray, Dr Buchan, Prof Hartley, Dr J Gibson, Mr Irvine, and Dr H R Mill took part

THE AMERICAN ASSOCIATION, PRESIDENT'S ADDRESS[1]

A DIVISION of science has a work of its own to do, a work that well might be done for its own sake, and still more must be done in payment of what is due to the other divisions Each section of our Association has its just task, and fidelity to this is an obligation to all the sections Those engaged in any labour of science owe a debt to the world at large, and can be called to give an account of what they are doing, and what they have to do, that the truth may be shown on all sides

If it be in my power to make the annual address of this meeting of any service at all to you who hear it—in your loyalty to the Association—I would bring before you some account of the work that is wanted in the science of chemistry Of what the chemists have done in the past the arts of industry speak more plainly than the words of any address Of what chemists may do in the future it would be quite in vain that I should venture to predict But of the nature of the work that is waiting in the chemical world at the present time I desire to say what I can, and I desire to speak in the interests of science in general The interests of science, I am well assured, cannot be held in different to the interests of the public at large

It is not a small task to find out how the matter of the universe is made The task is hard, not because of the great quantity in which matter exists, nor by reason of the multiplicity of the kinds and compounds of matter, but rather from the obscurity under which the actual composition of matter is hidden from man The physicists reach a conclusion that matter is an array of molecules, little things, not so large as a millionth of a millimetre in size, and the formation of these they leave to the work of the chemists The smallest objects dealt with in science, their most distinct activities become known only by the widest exercise of inductive reason

The realm of chemical action, the world within the molecules of matter, the abode of the chemical atoms, is indeed a new world and but little known The speculative atoms of the ancients, mere mechanical divisions, prefiguring the molecules of modern science, yet gave no sign of the chemical atoms of this century, nor any account of what happens in a chemical change A new field of knowledge was opened in 1774 by the discovery of oxygen, and entered upon in 1804 by the publications of Dalton, a region more remote and more difficult of access than was the unknown continent toward which Christopher Columbus set his sails three centuries earlier The world within molecules has been open for only a hundred years The sixteenth century was not long enough for an exploration of the continent of America, and the nineteenth has not been long enough for the undertaking of the chemists When four centuries of search shall have been made in the world of chemical formation, then science should be ready to meet a congress of nations, to rejoice with the chemist upon the issue of his task

It is well known that chemical labour has not been barren of returns The products of chemical action, numbering thousands of thousands, have been sifted and measured and weighed If you ask what happens in a common chemical change you can obtain direct answers. When coal burns in the air, how much oxygen is used up, can be stated with a degree of exactness true to the first decimal of mass, perhaps to the second, yet questionable in the third How much carbonic acid is made can be told in weight and in volume with approaching exactness How much heat this chemical action is worth, how much light, how much electro-motive force, what train load of cars it can carry, how long it can make certain wheels go round,—for these questions chemists and physicists are ready With how many metals carbonic acid will unite, how many ethers it

[1] Address by Prof A. B. Prescott, the retiring President, delivered at the Rochester meeting of the American Association for the Advancement of Science, August, 1892.

can make into carbonates, into what classes of molecules a certain larger fragment of carbonic acid can be formed, the incomplete records of these things already run through a great many volumes These carboxylic bodies are open to productive studies, stimulated by various sorts of inquiry and demands of life Such have been the gatherings of research They have been slowly drawn into order, more slowly interpreted in meaning The advance has been constant, deliberate, sometimes in doubt, always persisting and gradually gaining firmer ground So chemistry has reached *the period of definition* Its guiding theory has come to be realized

"The atomic theory" has more and more plainly appeared to be the central and vital truth of chemical science As a working hypothesis it has directed abstruse research through difficult ways to open accomplishment in vivid reality As a system of knowledge, it has more than kept pace with the rate of invention As a philosophy, it is in touch with profound truth in physics, in the mineral kingdom, and in the functions of living bodies As a language it has been a necessity of man in dealing with chemical events Something might have been done, no doubt, without it, had it been possible to keep it out of the chemical mind But with a knowledge of the primary elements of matter, as held at the beginning of this century, some theory of chemical atoms was inevitable And whatever theory might have been adapted, its use in investigation would have drawn it with a certainty into the essential features of the theory now established It states the constitution of matter in terms that stand for things as they are made The mathematician may choose the ratio of numerical notation, whether the ratio of ten or some other. But the chemist must find existing ratios of atomic and molecular mass, with such degree of exactness as he can attain Chemical notation, the index of the atomic system, is imperfect, as science is incomplete However defective, it is the resultant of a multitude of facts The atomic theory has come to be more than facile language, more than lucid classification, more than working hypothesis, it is *the definition of the known truth in the existence of matter*

The chemical atom is known, however, for what it does, rather than for what it is It is known as a centre of action, a factor of influence, an agent of power It is identified by its responses, and measured by its energies Concealed as it is, each atom has given proof of its own part in the structure of a molecule Proofs of position, not in space but in action, as related to other atoms, have been obtained by a multitude of workers with the greatest advantage The arrangement of the atoms in space, however, is another and later question, not involved in the general studies of structure But even this question has arisen upon its own chemical evidences, for certain bodies, so that the "configuration" of the molecule has become an object of active research

Known for what it does, the atom is not clearly known for what it is Chemists, at any rate, are concerned mainly with what can be made out of atoms, not with what atoms can be made of Whatever they are, and by whatever force or motion it is that they unite with each other, we define them by their effects Through their effects they are classified in the rank and file of the periodic system The physicists, however, do not stop short of the philosophical study of the atom itself As a vibratory body its movements have been under mathematical calculations, as a vortex ring its pulsations have been assumed to agree with its combining power As an operating magnet its interaction with other like magnets has been predicated as the method of valence There are, as I am directly assured, physicists of penetration and prudence now looking with confidence to studies of the magnetic relations of atoms to each other [1] Moreover, another company of workers, the chemists of geometric isomerism, assume a configuration of the atoms, in accord with that of the molecule.

The stimulating truth of the atomic constitution of the molecule, a great truth in elastic touch with all science, excites numerous hypotheses, which, however profitable they may be, are to be stoutly held at a distance from the truth itself Such are the hypotheses of molecular aggregation into crystals and other mineral forms Such are the biological theories of molecules polymerizing into cells, and of vitality as a chemical property of the molecule. Such are the questions of the nature of atoms, and the genesis of the elements as they are now known, questions on the border of metaphysics Let all these be held distinct from the primary law of the atomic constitution of simple molecules in gaseous bodies, an essential principle in an exact science The chemist should have the comfortable assurance, every day, as he plies his balance of precision, that the atom-made molecules are there, in their several ratios of quantity, however many unsettled questions may lie around about them Knowledge of molecular structure makes chemistry a science, nourishing to the reason, giving dominion over matter, for beneficence to life

Every chemical pursuit receives strength from every advance in the knowledge of the molecule And to this knowledge, none the less, every chemical pursuit contributes. The analysis of a mineral, whether done for economic ends or not, may furnish a distinct contribution toward atomic valence The further examination of steel in the cables of a suspension bridge is liable to lead to unexpected evidence upon polymeric unions Rothamsted farm, where ten years is not a long time for the holding of an experiment, yields to us a classic history of the behaviour of nitrogen, a history from which we correct our theories The analysis of butter for its substitutes has done something to set us right upon the structure of the glycerides Clinical inspection of the functions of the living body fain finds a record of molecular transformations too difficult for the laboratory The efforts of pharmaceutical manufacture stimulate new orders of chemical combination The revision of the pharmacopœa every ten years points out a humiliating number of scattered errors in the published constants on which science depends The duty of the engineer, in his scrutiny of the quality of lubricating oils, brings a more critical inquiry into the laws of molecular movement There is not time to mention the many professions and pursuits of *men who contribute toward the principles of chemistry* and hold a share therein If it be the part of pure science to find the law of action in nature, it is the part of applied science both to contribute facts and to put theory to the larger proof In the words of one who has placed industry in the greatest of its debts to philosophic research, W H Perkin, "There is no chasm between pure and applied science, they do not even stand side by side, but are linked together" So in all branches of chemistry, whether it be termed applied or not, the best workers are most strongly bound as one, in their dependence upon what is the known of the structure of the molecule

Studies of structure were never before so inviting In this direction and in that especial opportunities appear, Moreover the actual worker here and there breaks into unexpected paths of promise Certainly the sugar group is presenting to the chemist an open way from simple alcohols on through to the cell substances of the vegetable world And nothing anywhere could be more suggestive than the extremely simple unions of nitrogen lately discovered. They are likely to elucidate linkings of this element in great classes of carbon compounds, all significant in general chemistry Then certain comparative studies have new attractions As halogens have been upon trial side by side with each other, so for instance silicon must be put through its paces with carbon, and phosphorus with nitrogen Presently, also, the limits of molecular mass, in polymers and in unions with water, are to be nearer approached from the chemical side, as well as from the side of physics, in that attractive but perplexing border ground between affinity and the states of aggregation

Such is the extent and such the diversity of chemical labour at present that every man must put limits to the range of his study The members of a society or section of chemistry, coming together to hear each other's researches, are better able, for the most part, to listen for instruction than for criticism Still less prepared for hasty judgment are those who do not come together in societies at all Even men of eminent learning must omit large parts of the subject, if it be permitted to speak of chemistry as a single subject These considerations admonish us to be liberal When metallurgical chemistry cultivates scepticism as to the work upon atomic closed chains, it is a culture not the most liberal. When a devotee of organic synthesis puts a low value upon analytic work, he takes a very narrow view of chemical studies When the chemist who is in educational service disparages investigations done in industrial service, he exercises a pitiful brevity of wisdom

The pride of pure science is justified in this, that its truth is for the nurture of man. And the ambition of industrial art is honoured in this, its skill gives strength to man It is the obligation of science to bring the resources of the earth, its

[1] "The results of molecular physics point unmistakably to the atom as a magnet, in its chemical activities."—A E Dolbear, in a personal communication

vegetation and its animal life, into the full service of man, making the knowledge of creation a rich portion of his inheritance, in mind and estate, in reason and in conduct, for life present and life to come. To know creation is to be taught of God.

I have spoken of the century of beginning chemical labour, and have referred to the divisions and specialities of chemical study. What can I say of the means of uniting the earlier and later years of the past, as well as the separated pursuits of the present, in one mobile working force? Societies of science are among these means, and it becomes us to magnify their office. For them, however, all that we can do is worth more than all we can say. And there are other means, even more effective than associations. Most necessary of all the means of unification in science is the use of its literature.

It is by published communication that the worker is enabled to begin, not where the first investigation began, but where the last one left off. The enthusiast who lacks the patience to consult books, presuming to start anew all by himself in science, has need to get on faster than Antoine L. Lavoisier did when he began, an associate of the French Academy in 1768. He of immortal memory, after fifteen eventful years of momentous labour, reached only such a combustion of hydrogen as makes a very simple class experiment at present. But however early in chemical discovery, Lavoisier availed himself of contemporaries. They found oxygen, he learned oxidation: one great man was not enough, in 1774, both to reveal this element and show what part it takes in the formation of matter. The honour of Lavoisier is by no means the less that he used the results of others, it might have been the more had he given their results a more explicit mention. Men of the largest original power make the most of the results of other men. Discoverers do not neglect previous achievement, however it may appear in biography. The masters of science are under the limitations of their age. Had Joseph Priestley lived in the seventeenth century he had not discovered oxygen. Had August Kekule worked in the period of Berzelius, some other man would have set forth the closed chain of carbon combination, and Kekule, we may be sure, would have done something else to clarify chemistry. Such being the limitations of the masters, what contributions can be expected in this age from a worker who is without the literature of his subject?

In many a town some solitary thinker is toiling intensely over some self-imposed problem, devoting to it such sincerity and strength as should be of real service, while still he obtains no recognition. Working without books, unaware of memoirs on the theme he loves, he tries the task of many with the strength of one. Such as he sometimes send communications to this Association. An earnest worker, his utter isolation is quite enough to convert him into a crank. To every solitary investigator I should desire to say, get to a library of your subject, learn how to use its literature, and possess yourself of what there is on the theme of your choice, or else determine to give it up altogether. You may get on very well without college laboratories, you can survive it if unable to reach the meetings of men of learning, you can do without the counsel of an authority, but you can hardly be a contributor in science except you gain the use of its literature.

First in importance to the investigator are the original memoirs of previous investigators. The chemical determinations of the century have been imported by their authors in the periodicals. The serials of the years, the continuous living repositories of all chemistry, at once the oldest and the latest of its publications, these must be accessible to the worker who would add to this science. A library for research is voluminous, and portions of it are said to be scarce, nevertheless it ought to be largely supplied. The laboratory itself is not more important than the library of science. In the public libraries of our cities, in all colleges now being established, the original literature of science ought to be planted. It is a wholesome literature, at once a stimulant and a corrective of that impulse to discovery that is frequent among the people of this country. That a good deal of it is in foreign languages is hardly a disadvantage; there ought to be some exercise for the modern tongues that even the public high schools are teaching. That the sets of standard journals are getting out of print is a somewhat infirm objection. They have no right to be out of print in these days when they give us twenty pages of blanket newspaper at breakfast, and offer us Scott's novels in full for less than the cost of a day's entertainment. As for the limited editions of the old sets, until reproduced by new types, they may be multiplied through photographic methods. When there is a due demand for the original literature of chemistry, a demand in accord with the prospective need for its use, the supply will come, let us believe, more nearly within the means of those who require it than it now does.

What I have said of the literature of one science can be said, in the main, of the literature of the other sciences. And other things ought to be said, of what is wanted to make the literature of science more accessible to consulting readers. *A great deal of indexing is wanted.* Systematic bibliography, both of previous and of current literature, would add a third to the productive power of a large number of workers. It would promote common acquaintance with the original communications of research, and a general demand for the serial sets. Topical bibliographies are of great service. In this regard I desire to ask attention to the annual reports of the committee on Indexing Chemical Literature, in this association for nine years past, as well as to recent systematic undertakings in geology, and like movements in zoology and other sciences. Also to the Index Medicus, as a continuous bibliography of current professional literature.

Societies and institutions of science may well act as patrons to the bibliography of research, the importance of which has been recognized by the fathers of this Association. In 1855, Joseph Henry, then a past president of this body, memorialized the British Association for cooperation in bibliography, offering that aid of the Smithsonian Institution which has so often been afforded to publications of special service. The British Association appointed a committee, who reported in 1857, after which the undertaking was proposed to the Royal Society. The Royal Society made an appeal to her Majesty's Government, and obtained the necessary stipend. Such was the inception of the Royal Society Catalogue of scientific papers of this century, in eight quarto volumes, as issued in 1867 and 1877. Seriously curtailed from the generous plan of the committee who proposed it, limited to the single feature of an index of authors, it is nevertheless of great help in literary search. Before any list of papers, however, we must place a list of the serials that contain them, as registered by an active member of this Association, an instance of industry and critical judgment. I refer to the well-known catalogue of scientific and technical periodicals, of about five thousand numbers, in publication from 1665 to 1882, together with the catalogue of chemical periodicals by the same author.[1]

Allied to the much needed service in bibliography, is the service in compilation of the Constants of Nature. In the preface of his dictionary of solubilities, in 1856, Prof. Storer said "that chemical science itself might gain many advantages if all known facts regarding solubility were gathered from their widely-scattered original sources into one special comprehensive work." That the time of the philosophical study of solution was near at hand has been verified by recent extended monographs on this subject. In like manner Thomas Carnelley in England, and early and repeatedly our own Prof. Clarke in the United States,[2] bringing multitudes of scattered results into co-ordination, have augmented the powers of chemical service.

What bibliography does for research, the Handworterbuch does for education, and for technology. It makes science wieldy to the student, the teacher, and the artisan. The chief dictionaries of science, those of encyclopædic scope, ought to be provided generally in public libraries, as well as in the libraries of all high schools.[3] The science classes in preparatory schools should make an acquaintance with scientific literature in this form. If scholars be assigned exercises which compel reference reading, they will gain a beginning of that accomplishment too often neglected, even in college, how to use books.

[1] "Bolton's Catalogue of Scientific and Technical Periodicals" (1885, Smithsonian) omits the serials of the Societies, as these are the subject of Scudder's "Catalogue of Scientific Serials" (1879, Harvard Univ.). On the contrary, Bolton's "Catalogue of Chemical Periodicals" (1885, N. Y. Acad. Sci.) includes the publications of Societies as well as other serials. Chemical technology is also represented in the last-named work.

[2] The service of compilation of this character is again indicated by this extract from Clarke's introduction to the first edition of his "Constants" (1873). "While engaged upon the study of some interesting points in theoretical chemistry, the compiler of the following tables had occasion to make frequent reference to the then existing lists of specific gravities. None of these, however, were complete enough. . . ."

[3] The statistics of school libraries in the United States are very meagre, the expenditures for them being included with that for apparatus. For libraries and apparatus of all common schools, both primary and secondary, the annual expenditure is set at 937,048 dollars, which is about seven-tenths of one per cent. of the total expenditure for these schools.

The library is a necessity of the laboratory Indeed, there is much in common between what is called the laboratory method, and what might be called the library method, in college training The educational laboratory was instituted by chemistry, first taking form under Liebig at Giessen only about fifty years ago Experimental study has been adopted in one subject after another, until, now, the "laboratory method" is advocated in language and literature, in philosophy and law It is to be hoped that chemistry will not fall behind in the later applications of "the new education" in which she took so early a part

The advancement of chemical science is not confined to discovery, nor to education, nor to economic use All of those interests it should embrace To disparage one of them is injurious to the others Indeed, they ought to have equal support It would be idle to inquire into their respective advantages This much, however, is evident enough, chemical work is extensive, and there is immediate want of it

Various other branches of science are held back by the delay of chemistry Many of the material resources of the world wait upon its progress In the century just before us the demands upon the chemist are to be much greater than they have been All the interests of life are calling for better chemical information Men are wanting the truth The biologist on the one hand, and the geologist on the other, are shaming us with interrogatories that ought to be answered Philosophy lingers for the results of molecular inquiry Moreover the people are asking direct questions about the food they are to eat, or not to eat, asking more in a day than the analyst is able to answer in a month The nutritive sources of bodily power are not safe in the midst of the reckless activity of commerce, unless a chemical safeguard be kept, a guard who must the better prepare himself for his duty

Now if the people at large can but gain a more true estimation of the bearing of chemical knowledge, and of the extent of the chemical undertaking, they will more liberally supply the sinews of thorough going toil It must be more widely understood that achievements of science, such as have already multiplied the hands of industry, do not come by chances of invention, nor by surprises of genius It must be learned of these things that they come by breadth of study, by patience in experiment, and by the slow accumulations of numberless workers And it must be made to appear that the downright labour of science actually depends upon means of daily subsistence It must be brought home to men of affairs, that laboratories of seclusion with delicate apparatus, that libraries, such has bring all workers together in effect, that these really cost something in the same dollars by which the products of industrial science are measured Statistics of chemical industry are often used to give point to the claims of science For instance, it can be said that this country, not making enough chemical wood pulp, has paid over a million dollars a year for its importation That Great Britain pays twelve million dollars a year for artificial fertilizers, from without That coal tar is no longer counted a bye product having risen in its value to a par with coal gas But these instances, is striking as numerous others, still tend to divert attention from the more general service of chemistry as it should be known in all the economies of civilization

It is not for me to say what supplies are wanted for the work of chemists These wants are stated, in quite definite terms, by a sufficient number of those who can speak for themselves But if my voice could reach those who hold the supplies, I would plead a most considerate hearing of all chemical requisitions, and that a strong and generous policy may in all cases prevail in their behalf

If any event of the year is able to compel the attention of the world to the interests of research, it must be the notable close of that life of fifty years of enlarged chemical labour, announced from Berlin a few months ago When thirty years of age, August Wilhelm von Hofmann, a native of Giessen and a pupil of Liebig was called to work in London Taking hold of the organic derivatives of ammonia, and presently adopting the new discoveries of Wurtz, he began those masterly contributions that appear to have been so many distinct steps toward a chemistry of nitrogen, such as industry and agriculture and medicine have thriven upon In 1850 he opened a memoir in the philosophical transactions with these words, "the light now begins to dawn upon the chaos of collected facts" Since that time the coal tar industry has risen and matured, medicine has learned to measure the treatment of disease, and agriculture to estimate the fertility of the earth It seems impossible that so late as March of the present year, he was still sending his papers to the journals If we could say something of what he has done we could say nothing of what he has caused others to do And yet, let it be heard in these United States, without such a generous policy of expenditure for science as gave to Dr Hofmann his training in Giessen, or brought him to London in 1848, or built for him laboratories in Bonn and Berlin, without such *provision by the State*, the fruits of his service would have been lost to the world Ay, and for want of a like broad and prudent provision for research with higher education, in this country, other men of great love for science and great power of investigation every year fail of their rightful career for the service of mankind

For the prosecution of research, in the larger questions now before us, no training within the limitations of human life can be too broad or too deep No provision of revenue, so far as of real use to science, can be too liberal The truest investigation is the most prudent expenditure that can be made

In respect to the support that is wanted for work in science, I have reason for speaking with confidence If I go beyond the subject with which I began I do not go beyond the warrant of the Association This body has lately defined what its members may say, by creating a committee to receive endowments for the support of research

There are men and women who have been so far rewarded, that great means of progress are in their hands, to be vigorously held for the best advantage Strength is required to use large mean , as well as to accumulate them It is inevitable to wealth, that it shall be put to some sort of use, for without investment it dies By scattered investment wealth loses personal force The American Association, in the conservative interests of learning, proposes certain effective investments in science If it be not given to every plodding worker to be a promoter of discovery, such at all events is the privilege of wealth, under the authority of this Association If it be not the good fortune of every investigator to reach knowledge that is new, there are, every year, in every section of this body, workers of whom it is clear that they would reach some discovery of merit, if only the means of work could be granted them Whosoever supplies the means fairly deserves and will receive a share in the results It is quite with justice that the name of Elizabeth Thompson, the first of the patrons, has been associated with some twenty one modest determinations of merit recognized by this association

"To procure for the labours of scientific men increased facilities" is one of the constitutional objects of this body It is time for effectiveness towards this object The Association has established its character for sound judgment, for good working organization, and for representative public interest It has earned its responsibility as *the American trustee of undertakings in science*

"To give a stronger impulse to scientific research" is another declaration of what we ought to do To this end larger endowments are necessary And it will be strange if some clear seeing man or woman does not put ten thousand dollars, or some multiple of it, into the charge of this body for some searching experimental inquiry now waiting for the material aid The committee upon endowment is ready for consultation upon all required details

"To give more systematic direction to scientific research" is likewise stated as one of our objects To this intent the organization of sections affords opportunities not surpassed The discussions upon scientific papers give rise to a concord of competent opinions as to the direction of immediate work And arrangements providing in advance for the discussion of vital questions, as formally moved at the last meeting, will in one way or another point out to suitable persons such lines of labour as will indeed give systematic direction to research

In conclusion, I may mention another, the most happy of the duties of the American Association It is to give the hand of hospitable fellowship to the several societies who year by year gather with us upon the same ground. Comrades in labour and in refreshment, their efforts reinforce us, their faces brighten our way May they join us more and more in the companionship that sweetens the severity of art A meeting of good workers is a remembrance of pleasure, giving its zest to the aims of the year

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

1851 EXHIBITION SCIENCE SCHOLARSHIPS —Her Majesty's Commissioners for the Exhibition of 1851, assisted by a com-

mittee of gentlemen experienced in scientific education, have made the following appointments to the science scholarships for the year 1892 The scholars have been students of science for at least three years, and have been recommended for the scholarships by the authorities of their respective Universities or Colleges, as indicating high promise of capacity for advancing science, or its applications, by original research The scholarships are of the value of £150 a year, and are tenable for two years (subject to a satisfactory report at the end of the first year) in any University at home or abroad, or in some other institution to be approved of by the Commissioners The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of this country

ARTHUR FLLIS, Major General,
Secretary

18, Victoria-street, Westminster, August, 1892

University of Edinburgh —Mr Andrew John Herbertson
,, Glasgow —Mr James Blacklock Henderson
,, Aberdeen —Mr John Macdonald
Mason Science College, Birmingham —Mr Lionel Simeon Marks
University College, Bristol —Mr George Lester Thomas
Yorkshire College, Leeds —Mr Harold Hart Mann.
University College, Liverpool.—Mr James Terence Conroy.
Owens College, Manchester —Mr Thornton Charles Lamb
University College, Nottingham —Mr Edward Arnold Medley
Firth College, Sheffield —Mr William Henry Oates
University College of North Wales —Mr Edward Taylor Jones (*conditionally*)
Queen's College, Cork —Mr George Ryce
,, ,, Galway —Mr William Gannon
University of Toronto – Mr Frederick J Smale
,, Adelaide —Mr James Bernard Allen
,, New Zealand —Mr David Hamilton Jackson
,, Sydney (*postponed from* 1891) —Mr Samuel Henry Barraclough

ROYAL COLLEGE OF SCIENCE, LONDON (SESSION 1891–92) — List of Scholarships, Prizes, and Associateships, awarded July 1892 —

First Year's Scholarships	Spencer, Bernard E West, George S Gray, Charles J Verney, Harry	
Second Year's Scholarships	Allan, William Melton, George R	
"Edward Forbes" Medal and Prize of Books for Biology	West, William Vanstone, John H	2 Medals and Prize divided
"Murchison" Medal and Prize of Books for Geology	Starling, Sydney E	
"Tyndall" Prize of Books for Physics Course 1	Spencer, Bernard E	
"De la Beche" Medal for Mining	Cooke, Lewis H	
"Bessemer" Medal and Prize of Books for Metallurgy	Jeans, Harold	
"Frank Hatton" Prize of Books for Chemistry	Perry, George H	

Prizes of Books given by the Department of Science and Art

Mechanics	Longbottom, John G
Astronomical Physics	Bruce, James
Practical Chemistry	Perry, George H
Mining	Cooke, Lewis H.
Principles of Agriculture	Jones, Thomas

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, August 16 —M Duchartre in the chair.—Theory of a condenser introduced into the secondary circuit of a transformer, by M Désiré Korda.—Vaporization in boilers, by M de Swarte —On some new combinations of piperidine, by M Raoul Varet —On an application of chemical analysis for fixing the age of prehistoric human remains, by M. Adolphe Carnot This determination is based upon the progressive diminution of fluorine contained in the fossil bones of the various geological ages If the quantity contained in the most ancient remains be designated by 1, we shall have 0 64 for Tertiary remains, 0 35 for "Quaternary," and 0 05 or 0 06 for the recent ones This fact was utilized in fixing the age of a human tibia found in the sandy layers of Billancourt (Seine) in the neighbourhood of some remains of undoubted Quaternary origin The ratio of the quantity of fluorine contained in the animal fragments to that in the human tibia was found to be 0 469 or 0 578 to 0 066 This establishes the more recent origin of the tibia —On a new genus of permio carboniferous stems, the G *Retinodendron Rigolloti*, by M B Renault The specimen upon which this new genus has been founded was discovered by M Rigollot in the silicified layers of Autun It represents a stem 12 mm thick, 3 mm of which belong to the wood and 9 mm to the bark The latter is composed of several eccentric zones of gum or resin canals, and of cells with sclerified walls in regular alternation The canals are arranged in continuous circular lines, their cavities enclose a brown substance which is sometimes granular The structure of the wood indicates that the new genus belongs to the gymnosperms, its density and the small thickness of the ligneous cellular rays distinguish it from the ordinary cycads, while their composite nature makes it impossible to class them with the conifers Hence it belonged to a family of gymnosperms which is actually extinct It may be concluded that at no other epoch have the plants secreting gums, resins, tannin, &c, been more abundant, and that the carbonization of these products is the origin of the yellow or brown substances found not only in the bituminous schists, forming bands or small lenticular patches, but also in pitcoal, impregnating more or less the preserved tissues, and in cannel-coal, enclosing a large number of recognizable vegetable fragments —Pancreatic diabetes, by MM Lancereaux and A Thiroloix Further experiments show that there exists a diabetes actually consequent upon the destruction of the pancreas, this diabetes is not, however, caused by the absence of the external glandular secretion, but simply by the absence of the liquid secreted internally by the gland and absorbed by the blood vessels and the lymphatics —On a new treatment of the glanders, by MM Claudius Nourri and C Michel This is identical with that applied recently to human tuberculosis, with which it has much in common

CONTENTS.

THURSDAY, SEPTEMBER 1, 1892

EPIDEMICS, PLAGUES, AND FEVERS

Epidemics, Plagues and Fevers their Causes and Prevention By the Hon Rollo Russell (London Edward Stanford, 1892)

IN this handbook the author has aimed at collecting together the main facts concerning preventable diseases and presenting them in a convenient form for the use of those interested in the promotion of public health The work is in the main a compilation of extracts from the most varied sources, and references are given which enable the original authorities to be consulted It is difficult to speak too highly of the care and industry with which Mr Russell has fulfilled this task, and of the completeness with which the work has been brought up to date

In an introductory chapter on the nature of spreading diseases in plants and animals the analogy is traced between such processes as dry-rot and yeast fermentation, and the action of disease germs upon the animal organism, a short account is given also of various epizootic diseases

Passing to the main subject of the book, the author deals *seriatim* with the different human diseases of microparasitic origin A long chapter is devoted to cholera Accepting provisionally Koch's comma-bacillus as its cause, Mr Russell exhibits in a mass of evidence the conditions of filth and water pollution which enable the disease to maintain itself in its native home, India, and to spread thence in epidemic visitations to other parts of the world In many parts of India much has been done by sanitary measures, such as drainage and improved water supply, to reduce the incidence of cholera in a later part of the book stress is justly laid on the responsibility which rests on England in the matter of the sanitation of India The measures by which cholera may be arrested are set forth in full, the most important being personal cleanliness, a pure water supply, and the disinfection of dejecta and soiled linen No adequate account is given of the measures of notification and supervision which in this country replace strict quarantine

Another important section of the book is devoted to consumption, which it is a pleasure to find included amongst preventable diseases Nothing is more lamentable than the carelessness with which a phthisical patient is allowed to spread infection broadcast by the sputum, and though public opinion is not yet ripe for the question of seclusion of cases of consumption, much might yet be done by educating patients to disinfect the sputum and use reasonable precautions against the infection of members of their families The diffusion of tubercle by means of domestic animals and especially by milk is enforced by Mr Russell, and attention is drawn to the general sanitary measures such as drainage and ventilation which have already reduced its mortality in this country

In the chapter on diphtheria mention is made of the recent researches of Klein and others showing the connection of this disease with a certain disease in cows and in cats The author has drawn also on Dr Thorne Thorne's recent Milroy lectures, but he has hardly laid sufficient emphasis on the aggregation of children in schools as the main cause of the late increase of urban, as compared with rural diphtheria mortality, a point to which Dr Thorne draws especial attention

The section on influenza is based on the most recent observations, and even contains in a note some account of Pfeiffer's and Canon's influenza bacillus Exception must be taken to the statement that this organism is present in immense numbers in the blood In the sputum it is extremely abundant, but in the blood, as a rule, only in the scantiest numbers

Scarlet fever and small-pox have each a comparatively short chapter devoted to them That on scarlet fever contains mention of the so called "Hendon disease" in cows, to which the extensive outbreak in the north west of London in 1885 was traced, and a good practical epitome of the precautions to be observed in the sick room In the section on small-pox vaccination statistics are given, but we find no reference to the elaborate Local Government Report by Dr Barry on the late Sheffield epidemic, which contains a mine of information on the most serious outbreak of small-pox in England in recent years, and should certainly have been noticed The spread of the disease by aerial diffusion from small-pox hospitals is clearly illustrated

Typhoid fever receives long and thorough consideration Mr Russell accepts the "typhoid bacillus" of Eberth, Klebs, and Gaffky as the true virus of the disease -a conclusion which is far from settled in the minds of many, inasmuch as the true lesions of the disease have not been reproduced by it But this does not affect the questions at issue The ordinary method by which the disease spreads, viz, excremental pollution of drinking water, is abundantly illustrated by numerous examples, and the contamination of milk is likewise mentioned The thorough disinfection of typhoid dejecta is clearly a matter of the first importance, and a sound practical method of accomplishing this is much to be desired, at present it must be admitted that no adequate means has been devised

Amongst the numerous other diseases which Mr Russell has treated of, we are glad to notice that pneumonia finds a place, it is undoubted that some forms at least of inflammation of the lungs are infectious and preventable in the same manner as other specific fevers The claims of rheumatic fever, which has also been included, to a similar position, are to say the least doubtful

In the concluding chapters of the book, Mr Russell deals with more general problems, such as susceptibility, immunity, the distribution of microbes, the origins of epidemics, and so forth Gathering his evidence from various sources, he deals with these matters in a very impartial way Thus in discussing immunity, while accepting provisionally the doctrine of phagocytosis, he by no means regards it as the only means by which micro-organisms are eliminated from the body The germicidal powers of the fluids of the body receive due consideration as at least an equally important defensive agency The scheme of a National Health Service is discussed in an appendix.

Mr Russell is to be congratulated on the service which he has done to Public Health by the collection of this

mass of information on its more important topics. It is only natural that a work which is essentially a compilation, should be of a somewhat patchwork character; but it is to be regretted that in some of the sections the different paragraphs do not offer more coherent reading. It would further have been an advantage to the general public, whose education in these matters is so essential an element in the further progress of public health, if so many technical terms had not been used without explanation. Occasional looseness of expression is to be noticed. As when we read of "Bacterium termo, the microbe of impure water," or, "the Zeiss system magnifies three to four thousand times." But to those for whom the book is specially written, those interested or officially concerned in the promotion of health, it will prove a valuable work of reference.

THE PHYSIOLOGY OF THE INVERTEBRATA

The Physiology of the Invertebrata. By A. B. Griffiths, Ph.D., F.R.S. (Edin.), F.C.S. (London: L. Reeve and Co., 1892.)

STUDENTS of biology, and especially of physiology, have long wanted a book treating of the physiological problems of the invertebrate animals. It is true that what is sometimes called human physiology is in great measure the physiology of the lower animals. Physiologists, however, generally select for experiment animals which are as much as possible like themselves; it is comparatively seldom that they invade the invertebrate branches of animal life. There are vast fields there for exploration which are almost untouched from the physiological standpoint, and one can hardly doubt that great treasures in the way of fact and reasoning could be unearthed, which would throw light on the functions not only of these lower creatures themselves, but on the life problems of the higher animals also. The present book by Dr. Griffiths will therefore be welcomed as a first attempt to fill this gap. He is well known as one of the few who have carried the method of physiology down to the invertebrates, and his researches have been marked by great industry and patience.

In treating of invertebrate physiology, it is obvious that there are two courses open to a descriptive writer: one is to take the various sub-kingdoms as the main headings, and to treat of the different functions of each before proceeding to the next; the other method is to head the chapters with the functions—circulation, respiration, and the like—and to describe each of these in the various branches of the invertebrata. No doubt there is much to be said for each course. The latter, which is the one adopted in the present volume, appears, however, to have these disadvantages, that it involves a good deal of repetition, and that each chapter is split up into a number of small paragraphs, and there is thus but little continuous narrative. This is increased by the habit the author has of making extensive quotations, so that there is little uniformity of style; half a page will be given in the flowing style of Huxley, and the next half in the less fluent English of other writers. It appears to us it would have been better if Dr. Griffiths had given the results of other investigators in his own language. This, however, is a minor point. Passing to more important matters, we may proceed to enquire if the book really meets the want which has been stated to exist; and the answer to such an enquiry must depend on whether the good in it outweighs the bad, or the reverse. The features in the book which appear to be excellent, are, first, the evidence that a vast amount of pains has been expended in its compilation; and on those subjects to which the author has devoted research-work—the excretions, the blood gases and salts, and digestion—he is distinctly good, and men of science will be glad to have all Dr. Griffiths' experimental work in a handy form, instead of having to hunt it out from journals. Then the whole is exceedingly interesting, and will no doubt stimulate others to prosecute new work on the subject.

There is, however, much that must come in for adverse criticism, and the first point to which attention may be called is not so much the fault as the misfortune of the author in having to deal with a portion of biological science which is in an embryonic condition. Where little is known little can be said, and some of the chapters are little more than anatomy, with physiological excerpts from anatomical works. Again, on certain subjects such as muscular contraction and blood coagulation, the author is evidently not acquainted with the literature of his subject, and in other cases again there is internal evidence to show that Dr. Griffiths has not consulted original memoirs, but abstracts of them that have appeared elsewhere.

The main objection, however, that physiologists will feel about the work, is the conclusion to which they can hardly help coming, that Dr. Griffiths has not the advantage of being a physiologist; there is no wide grasp of the facts and hypotheses with which he has to deal, and the hand of the amateur is continually to be seen. Take as an instance the following sentences: "Urea is a product of *more or less* complete oxidation of *organic substances*, and is *formed in muscular tissues* by the *disintegration of the anatomical elements*. Uric acid on the other hand is the result of an incomplete oxidation, and is produced for the most part *in the blood*, or its equivalent when such fluid is *surcharged with peptones* which the tissues are unable to assimilate." (The italics are our own.) Again, in the chapter on the physiology of the sense organs, the difference between the tactile sense and general sensibility has not been apparently grasped; and even on subjects which the author has himself investigated, very often elementary facts have escaped him. Thus it appears that uric acid is the most constant of the nitrogenous metabolites in the invertebrata, but we are not in the majority of instances told how this insoluble substance is held in solution in an aqueous liquid. We also read that after starch has been digested with the secretion of the hepato-pancreas, it gives a precipitate of cuprous oxide with Trommer's test, and this is regarded as sufficient evidence of the formation of glucose. No reference is made to the fact that anylolytic ferments in the vertebrata produce maltose and not glucose from starch. Again, one would judge from Dr. Griffiths' words, that he regards the formation of leucine and tyrosine as the chief functions of a proteolytic ferment, or from the omission of hæmocyanin from the chapter on respiration that it was not a respiratory pig-

ment, though this would be corrected by reference to the chapter on the blood

Taking a general survey of the whole, we see that the book is far from perfect Few books are when they first appear, and much that is faulty can be corrected in subsequent editions We must, however, congratulate Dr Griffiths on being the first to break new ground by producing a work on the subject, as well as on the good points that the book exhibits, and to which allusion has already been made

W D H

THE DESIGN OF RETAINING WALLS AND RESERVOIR DAMS

A Text-Book on Retaining Walls and Masonry Dams By Prof Mansfield Merriman (New York John Wiley and Sons, 1892)

BEFORE entering upon the investigation of retaining walls and their design, the author devotes two chapters to the consideration of earthwork slopes and the lateral pressure of earth Owing to the changeable condition of earth under the influence of moisture, and the variable nature of any stratum, it is impossible to obtain strictly exact expressions for the forms of slopes of cuttings and embankments, or definitely accurate values for the lateral pressure of earth, but, nevertheless, the formulæ deduced by the author from general principles are useful in serving as a guide to correctness of design It is indicated that theoretically an earthwork slope should be curved, becoming flatter towards the base, and though a straight slope is always adopted for cuttings and embankments, the curved form left by slips is somewhat in accord with this theory The inclination of slopes must indeed depend on the nature of the soil, and must be flatter in made ground than in cuttings, whilst efficient drainage and protection of the surface of the slopes from the weather are equally important for ensuring stability

The pressure of earth is the basis of all theoretical principles relating to retaining walls, and it has formed the subject of numerous experimental investigations in England and on the Continent which might have been advantageously referred to in this book The author adopts the view that the pressure is normal to the back of the wall, but as this theory is not universally accepted, he has also obtained a formula for inclined pressure A retaining wall may fail by sliding or rotation, and the masonry is assumed to be laid dry, owing to the uncertain amount of cohesion in mortar joints In practice, however, retaining walls of any height are built with cement mortar, and sliding occurs at the base, or even sometimes on detached slippery surfaces of clay below the base, whilst rotation is due to excessive pressure on yielding foundations at the front of the wall Stability largely depends upon the nature of the foundation and the backing behind the wall A clay foundation is far less trustworthy than gravel, and sliding is most effectually prevented in slippery soils by carrying down the foundations well below the surface, whilst careless backing up with bad materials, not brought up in their layers, may push over the wall Efficient drainage, moreover, at the back of the wall, and outlets for water at intervals through the wall to prevent its accumulation behind, are almost as important considerations as the design of the wall A wall leaning over backwards is shown to be the most economical, but though this form might be adopted for building against an embankment, it would not be convenient for a wall built in a timbered trench to retain the side of a cutting The four chapters relating to earthwork and retaining walls, which comprise the main portion of the book, will be very useful for practical engineers who desire to extend their theoretical knowledge on these subjects, but students should bear in mind that an almost exclusive treatment of the theoretical aspect of these questions must be supplemented in actual design by practical experience

The theory of the strains on masonry dams, considered in the concluding chapter, is more precise, owing to the exactness of our knowledge of the laws of water pressure as compared with the uncertain and variable pressure of earth The well-known condition of stability, that the lines of resultant pressures, with the reservoir empty and full, should fall within the middle third of the cross section, is explained, as well as the uncertainty which exists as to the actual distribution of the pressures throughout the dam The lines of resultant pressures for any given section are easily obtained graphically, for the line of pressure with the reservoir empty is the locus of the centres of gravity of the sections above a series of base lines taken down the dam, and the actual pressure is the weight of these successive sections, whilst the line of pressure with the reservoir full is the modification produced in the former line by the addition of the water pressure at the successive depths The theoretical section given on page 110 resembles the section of the Furens dam in France, the highest masonry dam hitherto erected, the form of which was determined by elaborate analytical calculations The principles laid down concerning masonry dams require to be supplemented by two practical considerations, namely, that high masonry dams must be founded on solid rock to secure them against undermining and settlement, which would be fatal to their stability and that their inner face should be coated with an impervious material, to prevent the infiltration which otherwise takes place through their joints at great depths In taking the pressure due to waves on the top three or four feet of the dam below the water as equivalent to the greatest observed pressure exerted by waves on the sea coast, the author far exceeds the probable limit, for ocean waves, owing to the great extent of the exposure and the depth, are impelled with a much greater force than the waves of a comparatively small and sheltered reservoir The additional strength given to a dam by arching it towards the reservoir is very properly neglected in the calculation of its stability, for besides being difficult to estimate precisely, this increase in strength is inappreciable in a long dam, and even in the short Furens dam the arched form was merely regarded as an extra safeguard

The book is clearly and concisely written, it is illustrated by numerous diagrams in the text, and problems to be worked out are given at the end of most of the articles, each of which deals with a subject under a special heading.

OUR BOOK SHELF

Directions for Collecting and Preserving Insects. By C. V. Riley. (Washington: Government Printing Office, 1892.)

DURING the last few years there has been in America a considerable increase of the number of persons interested in entomology. This may be due mainly to the fact that farmers have very practical reasons for studying insects, but no doubt it springs in part from a growing appreciation of the scientific aspects of the subject. However the increased interest is to be explained, one of its results is a constant demand, especially from correspondents of the U.S. Museum and the Department of Agriculture, for information as to how to collect, preserve, and mount insects. In the present work Mr. Riley undertakes to meet this demand. He also brings together a number of directions on points connected with such matters as the proper packing of insects for transmission through the mails or otherwise; labelling; methods of rearing; boxes and cabinets; and text-books. The work was prepared as a part of a Bulletin of the National Museum, but is also issued separately; and we need scarcely say that it is likely to be of great service to the class for whose benefit it was originally planned. Mr. Riley knows his subject so thoroughly that he is able to explain it simply and clearly, and the value of the text is enhanced by a large number of suitable illustrations. We may note that, in a paragraph on the scope and importance of entomology, he refers to various estimates of the number of insects in the world. Linnæus knew nearly 3000 species. In 1853 Dr. John Day thought there might be 250,000 species on the globe. Dr. Sharp's estimate thirty years later was between 500,000 and 1,000,000. In 1889 the estimate formed by Sharp and Walsingham reached nearly 2,000,000. Mr. Riley thinks even this estimate too low. Considering that species have been best worked up in the more temperate portions of the globe, that in the more tropical portions a vast number of species still remain to be characterized and named, that many portions of the globe are entomologically unexplored, and that even in the best worked-up regions by far the larger portion of the Micro-Hymenoptera and Micro-Diptera remain absolutely undescribed in our collections, and have been but very partially collected, he is of opinion that to say there are 10,000,000 species of insects in the world would be "a moderate estimate."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Science and the State

IN last week's NATURE I find the statement that I was allowed to leave the public service "without the slightest recognition" by the State.

However distasteful it may be to me to have anything to say on this subject, I feel bound, in justice both to Lord Salisbury's and to Mr. Gladstone's former Governments, to point out that it is incorrect. Very substantial recognition was awarded me by both; and the late Lord Iddesleigh, in offering to recommend me for a Civil List pension, expressly put it as an honour.

The distinction which the Queen has recently been pleased to confer upon me must therefore, I am afraid, be placed in the category of "unearned increments." T. H. HUXLEY.

Barmouth, Wales, August 30, 1892.

[We did not refer to such recognition as is implied in the granting of pensions. What we meant was that the State ought to have marked its appreciation of Prof. Huxley's great services by conferring on him some national distinction of the kind he has now received.—ED.]

An International Zoological Record

ON this subject Mr. Minchin (NATURE, August 18, p. 367) writes as a Recorder, and he writes feelingly. Those who use Records can write with feeling too. The absurd waste of labour involved, even in the production of a single Record, by the present system is hardly to be excused by the consideration that the labour is voluntary. I say "voluntary" advisedly, for some three or four pounds is no pay for a month's hard work. And yet, for all this toil, the result, when, after a year or so of delay, we are presented with it, is notoriously unsatisfactory. It is indeed impossible for a single individual—often very far from acquainted with the subject he is recording—to work through all the scientific literature of the whole world for the preceding year, in search of some scattered references. Actually impossible, for the literature of one year never comes completely to hand before the end of the next, and perhaps not then; and this the Recorders seem to know, for many of them postpone their work till the autumn, though it should have already been published in the spring. The acceptance of Mr. Minchin's admirable suggestions would do away with the ridiculous decimplication of labour, but it would neither make the Record complete nor hasten its publication. The public are probably more anxious for the latter results than they are for the relief of the Recorders.

Almost absolute completeness, a higher standard of work, and greater expedition, would probably be attained by some such organization as the following:—In each country a Bibliographer, possessing an all round acquaintance with the subjects to be recorded; this bibliographer simply to record, on separate slips, titles and places of publication of papers issued in *his own* country (and therefore probably in his own language), and to mark by some symbol the groups of animals or facts alluded to in those papers. An Editor-in-chief, situated in some convenient postal and printing centre, *e.g.*, Naples, London, New York, Berlin, Paris, or Washington; this editor to govern the general plan of the Record, at present somewhat anarchic, to sort and distribute to specialists the slips which he receives from the bibliographers, and to edit the work. Lastly, for each group or division of a group, a Specialist, who, on receipt of the title slips from the editor, should prepare the lists of new species, the abstracts of the papers, and a general review of advance in the subject. It may be pointed out that, by means of carbon-paper, title slips can be easily written in duplicate or even triplicate; thus, by one writing of the bibliographer, slips can be prepared for the information of two or three specialists.

Such a scheme has the following advantages:—The literature is only gone through twice, instead of perhaps a dozen times. There is a possibility of completeness without much effort. Dates of publication can be ascertained with greater certitude. The quality of the work is improved by the employment of those specialists who will never consent to the colossal drudgery of the present system. Promptness of publication is possible. Thus, all slips for Europe and America could easily be sent to the editor within the first fortnight of the New Year, and by him transferred to specialists before the end of January. Literature from a greater distance would have to be sorted later on. Any specialist worthy of the name would already have seen most of the papers, and, with the help of abstracts from authors, could be ready with his manuscript before March, by which time the literature from the most distant parts would have come in and might be incorporated. The Record should go to press in separate divisions, so that the Birds need not be kept waiting because the Worms were not early; and the whole might well be issued in April or May.

The financial question must not be overlooked. As an International affair the sources of revenue of such a Record would be greatly increased. Not only Zoological and Royal, but also Geological Societies of all nations should be invited to contribute towards its expenses. The printer and the editor would have to be paid as now, the editor perhaps a trifle more. The postage would be a larger item, but postage is now so cheap that it really makes little difference. The bibliographers would of course have to be paid; but then the work of a bibliographer, even for the most prolific country, would be far less than the present work of the Recorder of, say, the Brachiopoda, who, I believe, gets about 30s. Some specialists would wish to be paid, but others would probably be satisfied by receiving the information from bibliographers and the abstracts and separate copies from authors. These latter, it is presumed, would gladly send single copies of their works for the use of a well-known specialist, but it is rather hard to have to distribute them to a dozen

different Records, as one is requested to at present. The sale of such a work would be greater than that of the present incomplete and tardy publications. Besides, the promoters would doubtless be prepared to sell the various sections separately—an urgent reform that has long been clamoured for in vain; this alone would materially increase the receipts.

Having thought much of this subject during the last five years, and having talked it over with many Recorders and bibliographers, I venture to take this opportunity of putting forward the crude outlines of an undeveloped scheme. There is no wish to offend those unselfish toilers who have done and are doing so much for us, or the corporate bodies that support them. But this is a question that must be approached from a cosmopolitan standpoint. Men of science all the world over should support it with purse and person. All petty considerations of nationality, even of language, should be sunk. The aim of the work should be the advancement of science; only if it is truly International, can it possibly be realized out of Utopia. F. A. BATHER

British Museum (Nat. Hist.), August 19.

PERHAPS you will kindly allow me, as the author of a certain pamphlet on "The Organization of Science," to say a few words on Mr. Minchin's letter (NATURE, August 18), which naturally had an especial interest for me. I am sorrowfully pleased to find the principles advocated in my pamphlet illustrated so well by concrete instance, and, needless to say, I heartily wish Mr. Minchin success in his endeavour to introduce order into at least one province of the scientific class, seeing that the text of my pamphlet may be exactly summed up in his remark—"A great need is the intelligent *organization* of scientific research."

One point in Mr. Minchin's letter was of especial interest to me, for he invites the Royal Society to take in hand this work of organization, instead of leaving private individuals to execute at a great sacrifice the work which this wealthy corporation systematically neglects. Now a reference to my pamphlet (pp. 11-14) will show that this was a main thesis sustained there. Whether Mr. Minchin has done me the honour to read my pamphlet and is already preaching my crusade for me, or whether the similarity between our views is a simple coincidence of opinion, I know not, but whichever be the case, it is peculiarly gratifying to me to receive practically an endorsement from one whose experience renders him so especially qualified to speak with authority. A FREE LANCE.

London, August 23.

"The Limits of Animal Intelligence."

MR. DIXON has not, I think, quite grasped the main tendency of my paper read before the International Congress of Experimental Psychology. Nor is this to be wondered at. He quotes from a brief summary of what was itself but an abstract of a portion of a work on Comparative Psychology on which I am engaged. I am in agreement with nearly all that Mr. Dixon says, except where he misunderstands my position, and except in the opinion he expresses in the last sentence. When Mr. Dixon says, "Of course it is true that my knowledge of *my own* psychology does differ in kind from my knowledge of that of animals, but it differs in exactly the same way from that of all other men," he is expressing the views which I, in common with most men who have seriously studied the question, hold. And when he says, "If in no case is 'an animal activity to be interpreted as the outcome of the exercise of a higher psychical faculty if it can be fairly interpreted as the outcome of one which stands lower in the psychological scale,' the same rule should be applied to the (scientific) interpretation of human activities," I can only say that I heartily agree with him. Since, therefore, we have so much in common, I do not propose to occupy valuable space in discussing the outstanding points of difference between us. I may perhaps be allowed, however, to take advantage of the courtesy of the Editor of NATURE, and to say a few words in elucidation of the thesis I very imperfectly set forth in my paper, a thesis based entirely on observation and induction.

In the first place the study of my own mental processes, and of the nature and sequence of my own states of consciousness, has led me to the conclusion that there is a great difference between the mere feeling or awareness of certain relationships and the clear cognizing of these or other relationships. When I am bicycling, or playing tennis, or when I am living the practical life of naïve perception, I am aware of, and shape my actions in accordance with, a feeling of the relations which the objects of the external world bear to me and to each other. The greater part of my practical skill in action and of such intelligence as I show in meeting the emergencies that occur in my active life, are the outcome of this awareness of relations. But when I begin to attempt to *explain* phenomena, and to formulate my knowledge of the world, I find I am forced to pay special attention to these relationships *as such*, and to clearly and precisely cognize them. This conclusion, I repeat, is the outcome of observation, and is not, so far as I am aware, the result of any *a priori* considerations.

Looking back upon my own past, and collating the results with those reached by other observers, I find that the mere feeling or awareness of relations is prior in development to the clear and precise cognition of them. The awareness of relations seems to be, in fact, the undifferentiated germ from which their clear cognition has been developed; it is not knowledge, properly so called, but it is the raw material from which knowledge and the products of the intellect are shaped. Hence I conclude that the order of development or evolution in man is—first, the practical awareness of relations among phenomena, and then subsequently the cognition and clear knowledge (in the full sense of the word) of these relations as such.

Now, passing to the psychology of animals, such as the higher mammalia, the hypothesis suggests itself that they are still in the stage of mere awareness, and have not reached the stage of clear cognition, which, as I showed in my paper, involves reflection and introspection. This is put forward as an hypothesis; one based on observation and the doctrine of evolution; and one to be treated in the same spirit and on the same methods as other scientific hypotheses. It must be submitted to the touchstone of verification. The question is:—Are the activities of animals explicable on the supposition that the agents are merely aware of the relations; or must we suppose that they fully cognize them? I feel sure that my own practical activities are in the main based on awareness, and this leads me to suspect that the practical activities of animals are also of like psychological implication. The matter must, however, so far as is possible, be put to the test of experiment and observation. I have conducted from time to time experiments with the object of ascertaining how far there is evidence in the dog of true cognition—of causation for example. I am inclined to believe as the result of my observations that there is nothing beyond a simple awareness of the causal nexus. But I am far from wishing to dogmatize in the matter. I am chiefly concerned that the phenomena should be carefully observed, and that experiments should be conducted on definite scientific lines.

In conclusion I must be allowed to say that the phrases "difference in kind" and "difference of degree" savour somewhat of mere academic discussion, and may perhaps be left for those who deal with the matter on *a priori* lines and not from the standpoint of evolution. I for one do not for a moment question that the mental processes of man and of animals are alike products of evolution. The power of cognizing relations, reflection and introspection, appear to me to mark a new departure in evolution. But whether as I am at present disposed to hold, the departure took place through the aid of language coincident with, or subsequent to, the human phase of evolution; or whether, as other observers and thinkers believe, it took place, or is now taking place, in the lower mammalia or in other animals, is a matter for calm, temperate, and impartial discussion founded on accurate, and, as far as possible, crucial experiment and observation. C. LLOYD MORGAN.

Rules of Nomenclature.

In your review of Mr. Massee's monograph of the Myxogastres (NATURE, p. 365) I notice the sentence, "Under the generally accepted rules of nomenclature, this leads to Massee standing as the authority for many species, transferred by him, in reality, to another genus." I take this to mean that, for example, a species of which the trivial name is, say, *abix*, and which was originally described by an author Xyz, and referred (erroneously) by him to the genus *Cdiu*, has been transferred now to another (the correct, according to present knowledge) genus *Efia*, and the name is now printed in this work not as *Efia abix*, Xyz, but as *Efia abix*, Massee. I am aware that this course is frequently adopted, but surely not "under the generally accepted rules of nomenclature." There is no copy of the British Association "Rules" within reach here, but my recollection is that they

prescribe a different course, viz, to retain as authority for a species the name of the original describer and that is the course adopted in, I think, most of the *Challenger* reports, and by very many zoologists I may state briefly as an example the first case that occurs to me—I have no systematic books here to refer to (1) About 1870 Cunningham described a new Ascidian as *Cynthia gigantea* (2) About 1880 Herdman transferred that species to the genus *Molgula* (3) In the *Challenger* report this species figures as *Molgula gigantea*, Cunningham, and I would submit that that, rather than the course indicated in the review, is "under the generally accepted rules of nomenclature" W A HERDMAN

Tarbert, Loch Fyne, August 23

An Earthquake Investigation Committee

IT may perhaps interest you and your readers to hear that by the Imperial ordinance of June 25 a committee has been established for the investigation of the earthquake phenomena, with the view of finding methods of predicting earthquakes, if possible, and of ascertaining the nature of construction, building, and otherwise, best calculated to resist the effect of the shocks President Kato, of the Imperial University, has been nominated the president, and myself the secretary Other members of the Committee are Furuichi (Director and Professor of Civil Engineering, Engineering College, and Head of the Engineering Bureau of the Department of the Interior), Tatonno (Professor of Architecture, Engineering College), Tanabe (Professor of Civil Engineering, Engineering College), Tanakadate (F R S E, and Professor of Physics, Science College), and Nagaoka (Assistant Professor of Physics, Science College), Koto (Professor of Geology, Science College), and Kochibe (of the Geological Survey), Sekiya and Omori (Seismologists), Nakamura (of the Meteorological Bureau), and a foreign member, Prof J Milne Other members will be nominated by and by The Parliament has granted 42,000 yen for this year, chiefly for the purchase of various instruments The committee will be glad to receive any communication or suggestion on the subject Address Earthquake Investigation Committee, care of the Department of Education, Japan D KIKUCHI

Imperial University, Tokyo, July 21

Prehistoric Epochs

I DO not think that the English authors who have written on prehistoric times have divided the Pleistocene in *epochs*, as Prof G de Mortillet has done in France Would it be possible to use in England subdivisions similar, or almost similar, to those used in France, and almost generally adopted, although that classification is often subject to criticism?

According to Prof G de Mortillet, Palæolithic silex have been found in England that could be respectively related (1) to the type of Chelles or *Chelléen* (Hoxne, Biddenham), (2) to the type of the Moustier or *Moustérien* (Creswell, High Lodge), (3) to the type of Solutré or *Solutréen* (Creswell), (4) and to the type of La Madeleine or *Magdalénien* (Creswell, Kent's Hole) The same author says that at Creswell (Derbyshire) Palæolithic silex belonging to the *Moustérien*, *Solutréen*, and *Magdalénien* divisions have been found *in situ*, superposed as in the French stations, and according to him his classification could be adopted for the English prehistoric stations Is that the opinion of the English authors who have most recently written on the matter, and is it possible to make a classification founded on the objects of the human prehistoric industry, parallel to the palæontological and stratigraphical classifications? EDMOND BORDAGE

Muséum d'Histoire Naturelle de Paris, August 2

At Portrush

BEING on holiday (at Portrush) in the second week of August, I discovered growing on the sand dunes there the following species, bearing beautiful pure white blossoms I found several patches of each —

Thymus Serpyllum (wild thyme), *Prunella vulgaris* (self-heal), *Gentiana campestris* (field gentian), *Erica Tetralix* (cross-leaved heath)

Also the wild strawberry, bearing abundantly white fruit Are these cases of reversion or of adaptability? Moths were very plentiful all over the dunes. JAMES RIGG

18, Wilton Drive, Glasgow, Aug 18

Origin of Idea that Snakes Sting

WILL you kindly inform me as to the origin of the idea that snakes sting? Froude, in "The English in Ireland," page 356, vol i, writes "The clergy started as if stung by a snake" Archdeacon Farrar, in "Darkness and Dawn," uses the metaphor of snakes stinging Sir T Browne ("Vulgar Errors") says "That snakes and vipers sting," &c, &c, "is not easily to be justified It is not fair to bring in Shakespeare as to a matter of natural history CYRIL FRAMPTON

July 29

ON THE RELATIVE CONTAMINATION OF THE WATER-SURFACE BY EQUAL QUANTITIES OF DIFFERENT SUBSTANCES

THE experiments of Lord Rayleigh and Prof Roentgen on the thickness of the invisible films of oil on contaminated water surfaces led me to repeat these measurements by a somewhat different method, which may perhaps be worth describing, and at the same time to compare the contaminating effect of various substances

In order to divide very small masses exactly I chose the course of Lord Rayleigh[1] of transferring the contaminating substance to the water-surface by means of a volatile solvent But instead of ether I used *benzine*, and let the drops of the solution evaporate *directly from the water* instead of vaporizing them on a metal plate and then immersing this, as Lord Rayleigh did

As a fixed condition of the water-surface Lord Rayleigh chose the tension when the movements of camphor fragments are stopped Still more suitable for my purpose, however, I found another smaller degree of contamination, which is always to be fixed with great exactness I mean *that degree at which the tension just begins to sink* As I have already explained (NATURE, vol xliii No 1115, p 437) the sinking of tension does not begin gradually from the very commencement of contamination, but *abruptly*, when the latter has arrived at a certain value, and then the falling of tension takes place very rapidly The state of constant tension I have called the normal and that of variable tension the anomalous condition

My task was therefore to examine how much of a substance is required to make a surface of a given size enter the anomalous state or to find the area of a surface made anomalous by a given mass of the substance The latter method was generally preferred, for it was more convenient to me

The observations were made with the adjustable trough and balance[2] described in NATURE, March 12, 1891, p 437, and were as follows —

Of the substance to be tried 13 mg were dissolved in 300 ccm of benzol Then the trough being filled with water and the surface made as clean as possible by sliding the partition all over the length of it several times, the solution was transferred to the surface in drops, each of which had a volume of 31 cmm or about 1/9600 of the whole solution and thus contained 0 001354 mg Four drops were introduced each time in order to equalize accidental irregularities of size When the evaporation of the benzol was finished I diminished the length of the surface till it became anomalous, and this length was noted Then immediately other four drops were introduced, again measured, and so on. After two or more observations the surface was cleaned anew, but generally the first length was observed to be a little too large on account of the imperfect purity of the surface

A sufficient number of observations having been thus made, the original contamination of four drops of the

[1] Proc. of the Royal Society, 1890 vol xlvii, No 293, p. 127

[2] For the purpose of actual measurements of surface-tension, I have constructed another instrument of larger dimensions, but to indicate only a slight variation of tension, any sensible balance with an adhering disc or wire-ring of any shape and size may be employed

benzol used was measured in the same way, by subtracting this from the contaminating effect of the solution I got the effect of the oil or other substance purposely dissolved.

Thus with three solutions of Provence oil of equal concentration I got the length of the surface rendered anomalous by the oil contained in four drops:—

Solution I., 8.3cm.; Sol. II., 7.8cm.; Sol. III., 7.7cm.

For the sake of verification the other method, viz., counting the drops required for making the whole surface of the trough anomalous, was also employed. By this course the effect of four drops was obtained as follows:—

Solution I., 8.0cm.; Sol. II., 7.9cm.; Sol. III., 7.7cm.

The close agreement of the two methods proves that the strip of plate, simply laid across the trough, is sufficient to separate normal surfaces.

Another trial with an *ethereal* solution of olive oil gave 7.1cm., if the somewhat different size of the drops be regarded; but I preferred benzine, because its original contamination was in most cases only between 1.3cm. and 2.5cm., whilst that of ether amounted to 4 to 6cm.

The mean of the lengths got by the three solutions was 7.9cm., and by this combined with the width of the trough = 5.8cm., we obtain the area of the surface made anomalous by 1mg. of Provence oil:

$$\frac{7.9 \cdot 5.8}{4 \cdot 0.001354} = 8460 \text{ qcm}$$

or a density of 0.000118mg. per qmm. at the beginning of the anomalous state.

In the following table are collected the results obtained with different substances:—

Substance	qcm. per mg.	mg. per qcm.
Provence oil	8460	0.000118
Ordinary olive oil	8565	0.000117
Oleine [1]	8137	0.000123
Rape-seed oil	7388	0.000135
Poppy oil	8994	0.000111
Tallow	9636	0.000104
Spermaceti	5568	0.000179
Stearic acid	4711	0.000212
Resin (colophony)	8105	0.000123
Turpentine oil (clear)	107	0.009346
Turpentine oil (older)	2944	0.000339

The table shows next that the mass required for lowering the tension is not the same with different substances, and on the other hand it affords an interesting comparison between fluid and solid bodies. If the cause of the lowered tension be a film of greasy fluid spread over the surface, the contaminating effect of solid bodies can only be explained by small quantities of such fluids present on the surface or in the interior of the solid. This may be so in many cases, but the effect of stearic acid and spermaceti is such as if more than half their weight consisted of oil. The strong effect of colophony, although this did not dissolve entirely in benzine, and the result that tallow acts more strongly than an equal weight of oleine, its fluid component, also appear to me very remarkable.

After this it seems to me very probable that the contaminating substances *are not spread in coherent films at all*, but rather in a state of very fine distribution between the superficial water-molecules, that must be named either *emulsion* or *solution*.

However, only certain organic substances seem to be capable of forming surface-solutions of this kind, whilst the effect of metals and salts, formerly observed by me, was due to incomplete cleanness of the bodies, as later researches have proven.

Finally I will add some remarks on the thickness of the hypothetical oil-films. The thickness calculated from my observations with olive oil is at the beginning of the anomalous state 1·3 $\mu\mu$. In order to derive from this number the thickness at any other condition of the surface, it needs only to be multiplied with the relative contamination corresponding to that condition, that is, with the ratio of the surfaces. So we get at the smallest relative contamination measurable in my apparatus = $\frac{1}{35}$ a thickness of the film = 37 . 10^{-3} $\mu\mu$.

For measuring the relative contamination in the anomalous state, a special mode of procedure was required on account of the imperfect separation of surfaces by the partition. For that purpose I put on the surface that is to be contracted a [-shaped swimming wire, a little shorter than the width of the trough, and by the situation of this mark, following exactly every movement of the surface, I measured the relative length of the latter, instead of reading it from the partition itself.

The ratio in which the surface must be contracted in order to arrive at the tension at which camphor comes to rest, was very different with various substances, for an instance with stearic acid = $\frac{1}{3}$, oleine = $\frac{15}{11}$, ordinary olive oil = 5, and with Provence oil the tension in question could not be reached at all, except when the oil was standing on the water in visible drops or films. The calculated thickness of the film at the stopping of camphor movements would be with olein = 2.13$\mu\mu$, ordinary olive oil = 6.5$\mu\mu$, and with Provence oil still greater, if this liquid were spread equally. A very precise specification of the sort of oil used therefore appears to be necessary, if observations concerning this point are to be compared.

AGNES POCKELS.

[1] A brown-looking liquid sold under this name in the drug stores.

NOTES.

THE Federated Institution of Mining Engineers will hold its annual general meeting in North Staffordshire on Wednesday, September 7, in the large hall of the First Shropshire and Staffordshire Artillery Volunteers, Shelton. Both on that and on the following day visits will be made to various works and places of interest.

THE Committee appointed to consider whether a national aquarium should be established in Sydney have presented a full and interesting report to Mr. F. B. Sutton, the New South Wales Minister for Public Instruction. They strongly recommend that "a commodious building of a substantial and not unsightly character" should be erected, to contain a large series of tanks constituting the public aquarium, with experimental tanks for researches on fish-breeding, &c., in connection with the fisheries of the colony, and laboratories for scientific investigation. It is calculated that the "initial cost" would be about £10,000, and that an annual amount of about £1200 would be needed for salaries and for purchases, repairs, and other incidental expenses.

IN response to an invitation from President G. Stanley Hall, of Clark University, a number of psychologists met from various institutions at that University, Worcester, Massachusetts, on July 8, for the purpose of forming an American Psychological Association. Prof. G. S. Fullerton, of the University of Pennsylvania, presided. After some general discussion on the form of organization the entire matter was referred to a committee. Sessions were held in the afternoon and evening, at which papers were read by Profs. Jastrow, Sanford, and Bryan, and Doctors Nichols, Krohn, and Gilman. It was decided in response to an invitation from Prof. Fullerton to hold the next meeting of the Association in Philadelphia, at the University of Pennsylvania, on Tuesday, December 27. Prof. Jastrow was appointed secretary to provide a programme for that meeting. He asked the co-operation of all members of the Association for the section of psychology at the Chicago Exhibition, and invited correspondence on the subject.

DR VON LENDENFELD, at one time assistant to Prof Lankester at University College, Gower Street, has been appointed to the chair of zoology at the University of Czernowitz, rendered vacant by the death of Prof V Graber

PROF DR CHARLES BERG has become director of the National Museum at Buenos Ayres, in the place of Prof Dr Hermann Burmeister

THE Council of the Institution of Civil Engineers has issued a list of subjects on which it invites original communications The list, it is explained, is to be taken merely as suggestive, not in any sense as exhaustive The Council points out that it has power to award to the authors of papers premiums arising out of special funds bequeathed for the purpose No award will be made unless a communication of adequate merit is received, but more than one premium will be given if there are several deserving memoirs on the same subject

THE twenty-third session of the German Anthropological Congress, which was held at Ulm early in August, was in every way most successful At the first meeting one of the most prominent speakers was Prof Ranke, who spoke of the need for a German National Museum He recognized the value of the museums at Mainz and Nurnberg, but urged that a genuinely national institution ought to be established, and that the proper place for it is Berlin At this meeting an interesting discussion on the so called Kannstadt race was opened by Dr von Holder The opinion of the meeting was that the characteristics of the famous Kannstadt skull are found in some persons of the present day, and that the skull is not one that has come down to us from prehistoric times Prof Virchow, who took part in the discussion, uttered a general warning as to the necessity for caution in attributing high antiquity to human remains On the following day a paper on the anthropological position of the Jews was read by Dr von Luschau His main points were that the Jews are a mixed race, and that in some of their physical peculiarities (such as the form of the nose) they resemble the Armenians more closely than any people of purely Semitic origin Prof Kollmann dealt with the question of the origin of the European peoples, and Prof Virchow spoke of the fact that the traveller Vaughan Stevens has found in the interior of Malacca a genuine Negrito stock, and has sent skulls and specimens of hair At the third meeting one of the best papers was by Dr Boas, on the organization of anthropological research in North America It was decided at this meeting that the next session of the Congress would be held at Hanover in 1893 Scientific excursions were made to Blaubeuren and Schussenried, where traces of lake dwellings have been discovered, and to Sigmaringen and Schaffhausen

THE causes of the St Gervais disaster are being gradually elucidated. A very interesting paper describing a visit to the small Tête-Rousse Glacier is contributed to *La Nature* (August 20) by M Vallot, director of the new Mont Blanc Observatory At the end of the glacier, on a steep face of rock, he and M Delebuque found an enormous arching cavity, filled recently (it would appear) with ice which had been shot out by some internal force They entered the cavern, and observed traces of an interior lake A passage, strewn and overhung with blocks of ice, led up to an open space, a sort of huge crater, with walls of white ice, absolutely vertical. It was about 270 feet long, and 133 feet broad and deep M Vallot and his friend returned by the way they entered, and examined this crater from above. Their opinion is that a lake had been formed at the bottom of the glacier, and the crater, gradually accumulating through obstruction of the orifice of outflow, had undermined the ice-crust over the upper cavity. This at length collapsed, exerting enormous pressure on the water, which pressure, transmitted to the lower grotto, burst the glacier, throwing out the anterior part on the steep rocky slope Thus is explained the enormous quantity of water precipitated into the valley, carrying in its passage the soil of the banks, and forming a torrent of liquid mud mixed with ice blocks and rocks M Vallot estimates that about 100,000 cubic metres of water and 90,000 of ice issued from the glacier On reaching the Baths the torrent may have been 300,000 cubic metres He supposes that the sub-glacial lake may form again, and the remedy would be to blast the rocky bottom so as to provide an escape for the water, a work which should be done speedily to be of use

THE weather has been very unsettled during the past week, several low-pressure systems having passed over our islands from the westward, accompanied by very heavy rain, especially in the southern, northern, and western parts of the country Between mid day of Saturday and Sunday 1¾ inches fell in the south, being about three-fourths of the average fall for the month of August, and another heavy downpour occurred in the north and west on Monday night, two inches being measured in the west of Scotland, and 1½ inches at Holyhead The temperature has fallen considerably since the previous week, the daily maxima rarely exceeding 70° in the southern parts of the country, while in the north and west it has been considerably lower The wind has reached the force of a gale on the coasts on more than one occasion during the week, and on Tuesday the centre of a rather deep depression lay over Ireland, while the sea was rough on nearly all coasts, the conditions being very threatening, with a prospect of further heavy rains In southwest England the amount of rainfall from the beginning of the year up the week ending August 27th, was still more than eight inches below the average, and the only district where the amount just exceeded the average was the northern part of Ireland

THE New England Meteorological Society has issued a volume of Investigations for the year 1890 (reprinted from the Annals of Harvard College Observatory, Vol xxxi pt I, 1892) containing a summary of the observations made at the Society's stations, reports were received from 172 observers during the year, also five-year tables of temperature and precipitation, by J Warren Smith, with an introduction by W M Davis, Director of the Society The title scarcely explains the real amount of work done, for at some stations there are many periods of five years, *e g*, at New Bedford (Mass) the observations extend over 15 pentades (1816–1890) It has not been possible to keep to the same years in all cases, nor has any attempt yet been made to discuss the data —The tornado at St Lawrence (Mass.), of July 26, 1890, by Helen Clayton This storm caused considerable loss of life and property The distances between the points where destruction was reported seem to indicate that the de structive winds descended at times to the earth's surface at certain points, and after a short track rose again. Prof Davis has written a preface to this paper, in which he discusses fully the characteristics of tornados

THE Annual Report on the Royal Botanic Gardens, Trinidad, for 1891, contains a table showing the monthly and yearly rainfall values for thirty years ending 1891 The average yearly fall for that period was 65 91 inches Mr. F H Hart points out that the rainfall shows a decrease at a seriously rapid rate, for, dividing the period into decades, the first decade shows a total of 7 12 inches more than the second, and the third shows another decrease of 9 56 inches on the second, or 16 68 inches on the first decade. This is a subject of the utmost importance to questions of forestry and water supply. He also points out that the rainfall is not so much affected as is generally supposed by the contiguity of Trinidad to the mainland, but more particularly to the course of the trade-

winds which blow towards the continent of South America. It is a curious fact that it always rains at Trinidad with a high barometer. On June 25 last the observer states that it was not daylight until long past the proper hour, the readings at 9h. a.m. having to be taken by candle light. The rain was heavy and continuous, and was accompanied by the *highest* barometer readings for the year.

"FIFTY Years of York Meteorology, 1841-1890," a paper contributed to the report of the Yorkshire Philosophical Society for 1891, by Mr. J. Edmund Clark, has been issued in pamphlet form.

SOME of the effects of the absence of light upon animal life were strikingly revealed, not long ago, on the reopening of an old mine near Bangor, Cal. In a dry slope connecting two shafts, one of the explorers was astonished to find a number of flies that were perfectly white, except the eyes, which were red; and directly afterwards he killed a pure white rattlesnake. The animals had lived in the dry passages, where they had been supplied with air but not with light. It is supposed that the flies were the offspring of some that had been imprisoned by the partial filling of the mine with water about thirty years ago, and that the snake, when quite young, had been washed down in a rain. A few of the flies were exposed to light in a glass case, and resumed the colours of ordinary house flies within a week.

A WHALING party is being fitted out in America for the purpose of obtaining a live whale for exhibition in the Fisheries department at the World's Fair at Chicago. If captured the whale will be confined in a tank and towed to Chicago by the way of the St. Lawrence river.

IT would appear that naphtha is poisoning the Volga, doing great injury to the fishing industry. Dr. Grimm says (*Messager des Pêcheries*) that the quantity of naphtha conveyed on the river rose from some 32 million kilogrammes in 1887 to nearly 50 millions in 1889. Most of this is carried in badly-made wooden barges, and there is a great deal of leakage into the river, about 3 per cent. on an average (it is estimated). Thus in the three years, 1887 to 1890, the Volga must have absorbed some three million kilogrammes of naphtha, without reckoning petroleum, of which there is a considerable (though less) leakage. Everywhere the fish are decreasing, and they quite disappear at places where boats stop. On the other hand, various fishes—the sturlet of Astrachan, *e.g.*—living in the infected water, get a flavour of naphtha, and are no longer eatable. The naphtha also kills the infusoria, insects, flies, mosquitoes, &c., which serve as food for the fishes. In its spring floods the river spreads naphtha over the meadows, destroying the larvæ of those organisms. The thin layer of naphtha on the water hinders the larvæ from breathing. Further, the naphtha injures the vegetation in the meadows. Naphtha is found in such quantities on the land as to suffice for domestic use to the natives, who collect it. Dr. Grimm urges the necessity of taking steps to prevent the ruin of the Volga fisheries.

AMONG the most interesting Echinoderms collected by the United States Fish Commission steamer *Albatross*, on her voyage from New York to San Francisco, was a stalked Crinoid, which is described in No. 2, vol. xvii., of the Memoirs of the Museum of Comparative Zoology at Harvard College (January 1892). The material, consisting of portions of three specimens, was dredged in 392 fathoms off Indefatigable Island, one of the Galapagos group. During the last dredging trip of the *Albatross* an additional specimen was obtained off Mariato Point, in 782 fathoms. When this last specimen was taken out of the water it was of a brilliant lemon colour, with a greenish tinge on the sides of the arms and along the food furrows of the ventral surface. A coloured sketch of it is given from a drawing made on the spot by Mr. Westergren. Its base of attachment came up with a fragment of stem nearly 14 inches long. At the first glance Prof. Agassiz was inclined to regard it as a modern representative of Apiocrinus, but a more careful examination showed so many points of difference that he had to establish the new genus Calamocrinus for its reception, and it stands as *C. Diomedæ*. It is most closely allied to a large group of Mesozoic Crinoids, and it assists in making clear many points in their morphology. This genus has the orals greatly reduced, much as in Bathycrinus. It also possesses heavy perisomic plates, passing gradually into still stouter so-called interradial plates, in Calamocrinus, in no wise to be distinguished from the true interradials of Palæozoic Crinoids. Another structural feature is the limitation of the articular facet to the middle of the radial. This is an eminently embryonic character, and there are traces of it in some of the forms of Millericrinus described by De Loriol in his Jurassic Crinoids, especially in *M. milleri*. After a very detailed and masterly description of the stem, calyx, and arms of the species, Prof. Agassiz discusses the subject of the "Apical System of the Echinoderms," and "Of some of the Homologies of the Echinoderms." Thirty-two plates, some coloured, accompany this Memoir, which is inscribed as follows: "From the time the Crinoids which form the subject of this Memoir came into my hands, I have been in constant correspondence with my late friend, Philip Herbert Carpenter, regarding the many points of interest suggested by their discovery. I can now only have the melancholy satisfaction of inscribing to his memory a Monograph which I had hoped to dedicate to him as an expression of my admiration for his researches in a field where we had long been fellow workers."

M. DE LAPOUGE calls attention, in *La Nature*, to an interesting object he has found in one of a number of ancient graves he has been excavating at Gignac (Hérault). It is a finely carved head of jade, representing a type of the yellow race. It evidently formed part of a statuette of a religious character, and the style shows that it must have come either from China or Japan. M. Sindho is of opinion that the statuette was probably made in Japan a little before the Christian era, from a Hindu or Sinhalese model of Buddha. M. de Milloué thinks the head is that of Kouan Yin, a Chinese divinity, while M. de Rosny and M. Motoyosi attribute it to Mayadêvi, the mother of the founder of Buddhism. Whatever the object may be, M. de Lapouge is inclined to believe that it hung as an amulet around the neck of a Hun or Goth, and that the graves at Gignac belong to a cemetery of a West Gothic colony.

A VALUABLE essay on the Ainos of Yezo, by Mr. Romyn Hitchcock, is included in the report of the U.S. Museum for 1890, and has just been issued separately. It is based mainly on the author's personal observations. He has much that is interesting to say on the various aspects of the life of the Ainos, and his remarks are admirably illustrated. Mr. Hitchcock notes the remarkable fact that the Ainos have been very little influenced by the civilization of the Japanese, with whom they have so long been in close contiguity. The Aino, he says, has not so much as learned to make a reputable bow and arrow. Unable to affiliate with the Japanese, the Ainos "remain distinct and apart," and for that reason, in Mr. Hitchcock's opinion, are "doomed to extinction from the face of the earth."

THE second volume of Mr. J. Walter Fewkes's "Journal of American Ethnology and Archæology," has just been issued. The most important article in the first volume was an interesting account, by Mr. Fewkes, of "a few summer ceremonials at Zuñi Pueblo." The greater part of the second volume is devoted to a description, by the same writer, of "a few summer cere-

monials at the Tusayan Pueblos." Mr. Fewkes and his assistant, Mr. J. G. Owens, were admitted as priests by the Tusayans, so that the paper contains many details which have not hitherto been accessible to students. Mr. Fewkes also presents a report on the present condition of a ruin in Arizona called Casa Grande, and Mr. Owens describes various natal ceremonies of the Hopi Indians.

THE new number of the *Internationales Archiv fur Ethnographie* (Band V., Heft 3) opens with a paper, in French, by M. G. van Vloten, on the flags used at Teheran in connection with the festival in memory of the martyrdom of the Imâm Huçein. M. Desiré Pector contributes (also in French) some observations suggested to him by the reading of a work by M. de Montessus on Pre-Columbian Salvador. Herr F. Grabowsky writes (in German) on the theogeny of the Dayaks.

THE following are the subjects of papers in the current number of the *Mineralogical Magazine*:—Minerals from the apatite-bearing veins at Noerestad, near Risor, on the south-east coast of Norway, by R. H. Solly (with a note on their occurrence, by A. L. Collins); on the pinite of Breage in Cornwall, by J. H. Collins; danalite from Cornwall, by H. A. Miers and G. T. Prior; mineralogical notes from Torreon, State of Chihuahua, Mexico, by Henry F. Collins; note on crystals of manganite from Harzgerode, by Frank Rutley; analysis of aragonite from Shetland, by J. Stuart Thomson; orpiment, by H. A. Miers. There are also reviews and abstracts; and Mr. Miers and Mr. Prior contribute a valuable index to mineralogical and petrographical papers, 1888.

WE have received from the Geological and Natural History Survey of Canada, Part 4 of "Contributions to Canadian Micro-Palæontology." The report consists of descriptions and illustrations of thirteen new and three previously known species of Radiolaria, collected by officers of the survey from the upper cretaceous rocks of North-Western Manitoba, and has been prepared for publication by Dr. D. Rust, of Hanover. Mr. Tyrrell, geologist in charge of the explorations in Manitoba, contributes a short introduction to the report.

BULLETIN No. 11 of the Imperial University College of Agriculture, Komaba, Tōkyō, has recently been published. It consists of the report of Dr. O. Kellner on the third year's "Manuring Experiments with Paddy Rice."

AMONG the contents of the June number of *Timehri*, the Journal of the Royal Agricultural and Commercial Society of New Guinea, are papers on "Twenty Years' Improvements in Demerara Sugar Production" (Part 2); "The Bats of British Guiana," "Guiana Gold," and "Our Birds of Prey." The number also contains many short notes of an interesting nature.

MR. S. GARMAN publishes a treatise on the fishes of the families Cyclopteridæ, Liparopsidæ, and Liparididæ, in the Memoirs of the Museum of Comparative Zoology at Harvard College (Vol. XIV., No. 2, April 1892). Though several of the rarer forms of Discoboli are not represented in the collections of the Harvard Museum, yet it possesses so many duplicates of several species, in addition to rare and some undescribed types of others, that it presented great facilities for a study of the group, of which Mr. Garman has well availed himself. Prof. F. W. Putnam had at one time intended to write a history of the group, and many drawings had been some years ago prepared for it by Mr. Roetter; these drawings have been utilized in the present memoir, and the work has been made more complete by the drawings of the young stages of several of the species, contributed by Prof. A. Agassiz. After a short introduction there is a history of the distribution of the species, followed by one on the history of the genera from the times of Pliny, Gesner, and others, and then a description of the recognized genera and species, of which the following is a summary: *Cyclopterus lumpus*, Linn.; *Eumicrotremus spinosus*, Mull.; *E. orbis*, Gthr.; *Cyclopteroides gyrinops*, gen. et spec. nov. (St. Paul's Island, Alaska); *Cyclopterichthys ventricosus*, Pall.; *C. amissus*, Vaill.; *Liparops*, gen. nov. established for *Cyclopterus stelleri*, Pall.; *Liparis montagui*, Don.; *L. mucosus*, Ayr.; *L. calliodon*, Pall.; *L. liparis*, Linn.; *L. antarctica*, Put.; *L. agassizii*, Put.; *L. tunicatus*, Reinh.; *L. steineri*, Fisch.; *L. pulchellus*, Ayr.; *L. pallidus*, Vaill.; *Careproctus micropus*, Gthr.; *C. major*, Fabr.; *C. gelatinosus*, Pall.; *C. reinhardi*, Kroy.; *Paraliparis rosaceus*, Gilb.; *P. bathybius*, Col.; *P. liparinus*, Goode; and *P. membranaceus*, Gthr. *Careproctus longipinnis*, spec. nov., and *Paraliparis fimbriatus*, spec. nov., are also indicated, but will be described at length in the forthcoming report of the "U. S. Fishery Commission."

SOME experiments have recently been made at the New York Agricultural Experiment Station upon the possible effect of long-continued applications of a copper sulphate spray used as a fungicide (Bulletin 41). Two soil mixtures were used, one containing 5 per cent. and the other 2 per cent. of copper sulphate. These quantities are comparatively so enormous that useful practical conclusions cannot yet be drawn, though some of the results have proved interesting. Seeds of plants representing widely differing natural orders were planted in these soils, and at the same time an equal number of the same kinds of seeds were planted for checks in similar soil to which no copper sulphate was added. Care was taken to select good seed, and to give the soil mixtures, and checks exactly similar conditions and treatment. In the soils containing sulphate of copper more seeds germinated in almost every case than in the soils containing no copper. The average length of time required for germination was greatest in the copper soils. The foliage of plants grown in the copper soils was of a deeper green and darker with the 5 per cent. soil mixture than with the 2 per cent. one, but although darker the leaves were smaller and the height of the plants and the yield of fruit very much less than in the case of plants grown under normal conditions. Peas grown in the 2 per cent. soil mixture seemed to be more vigorous for the first few weeks than the check plants grown in untreated soil; they also came to maturity earlier, but finally showed a dwarfed appearance, and the yield was less than with the check plants, being little more than one-half the yield under normal conditions. In the 5 per cent. soil mixture peas gave a yield only one-seventh of that from untreated soil. In the case of all plants grown in the soil mixtures the roots were very small and ill developed. Analysis of the tops of tomatoes grown in the 5 per cent. soil showed in the air-dried substance ·06 per cent. of copper, proving conclusively that these plants can take up sulphate of copper by their roots. Analyses were made of berries and stems from vines which had been sprayed with copper compounds, and although the amount of copper found upon the stems varied, that found on the grapes was practically constant, and amounted to 1/120th of a grain per pound of grapes, this quantity being considered quite negligeable and harmless.

THE additions to the Zoological Society's Gardens during the past week include two Rhesus Monkeys ♂ ♀ (*Macacus rhesus*) from India, presented by Mr. J. Hall-Browne and Mr. Rivers respectively; four Virginian Foxes (*Canis virginianus*) from California, presented by Mr. Edward Chauvenet Holden; two Ogilby's Rat Kangaroos (*Hypsiprymnus ogilbyi*) from Australia, presented by Mr. John W. Roche; a Ruffed Lemur (*Lemur varius*) from Madagascar, deposited by Captain Marshall, F.Z.S.; three Tigers ♂ ♀ ♀ (*Felis tigris*) from India, deposited by Messrs. William Watson and Co.; a Blue and Yellow Macaw (*Ara ararauna*) from South America, presented by Mr. R. Larchin; ten Spanish Blue Magpies (*Cyanopolius cooki*), and

two Ravens (*Corvus corax*) from Spain, deposited by Lord Lilford, F Z S , two Fringed Chameleons (*Chamæleon tænio bronchus*) and a Lobed Chameleon (*Chamæleon parvilobus*) from Natal, presented by Mr Charles W Heaton , a Black Iguana (*Metopoceros cornutus*) from West Indies, purchased , six African Scorpions (*Scorpio*, sp inc) from South Africa, presented by Mr J F Hawtayne

OUR ASTRONOMICAL COLUMN

PHOTOGRAPHIC MAGNITUDES OF NOVA AURIGÆ —*Astronomical Journal*, No 269, contains the results of Mr J M Schaeberle's work with regard to the determination of the photographic magnitudes of stars, including also that of Nova Aurigæ The method he has adopted differs from those used by former observers in that the photographic magnitude of a star for any exposure-time is expressed "as a function of the equivalent theoretical aperture which a standard star (Polaris in this case) would require to make the same impression on the plate in the same time" The particular form which the expression, as obtained from this investigation, assumes enables one, after having once adopted the photographic magnitude of the standard star, to determine the theoretical photographic magnitude of any other star without any reference at all to the visual magnitude As this method had only been applied to bright stars, the appearance of Nova Aurigæ suggested a further trial for stars of less magnitude which were visible only in large instruments On the plates, which were each night exposed, three stars in the region of the Nova, the images of which resembled somewhat that of the Nova in form, size, and density, were selected for the sake of comparison The magnitudes of these comparison stars were then determined by direct measurement of their images on the standard positive plate, this plate being a second positive from the original negative The resulting photographic magnitudes for the month of February showed that the light of this new star fluctuated very considerably, confirming the visual observations.

The following list gives the theoretical magnitudes as obtained in this way, the mean time at Mount Hamilton being also added The exposures up to March 10 were all moderately short, varying from 2 to 128 seconds

Date 1892	Mt Hamilton M T	Mag	Date 1892	Mt Hamilton M T	Mag
	h m			h m	
Feb 6	12 30	4 63	Mar 2	10 45	5 20
8	7 20	4 54	3	9 10	5 09
9	9 40	4 67	4	8 25	5 63
10	10 7	4 77	6	9 15	5 40
11	8 55	4 4	7	9 40	5 90
12	7 20	4 5	8	9 10	6 09
13	9 20	4 3	9	8 55	6 16
14	7 40	4 03	10	8 ±	7 10
15	6 15	5 22	11	8 ±	7 70
21	10 10	4 96	13	8 24	7 70
22	9 30	5 12	15	11 9	8 45
24	7 ±	4 84	16	8 35	8 60
25	8 55	4 90	20	8 56	9 25
26	9 50	5 04	21	8 50	9 40
27	8 20	4 75	22	9 17	9 55
28	8 50	4 98	24	9 2	9 80
			25	9 10	10 03

COMPARISON STARS OF THE PLANET VICTORIA —Dr Gill, in *Astronomische Nachrichten*, Nos. 3107-08, communicates an article on the definite places of the stars used for comparison with the planet Victoria in the observations for parallax made in the year 1889 The positions of these stars are now, as he says, "more accurately known than those of any other group of stars in the heavens," and he suggests that they should be advantageously used for the determination of optical distortion and scale values of photographic telescopes, and for testing the various methods for the "raccordement des plaques" The positions of the thirty seven stars are based on 3766 meridian observations of right ascension, and 3771 meridian observations of declination, together with several other observations made with the heliometers at the Cape, Yale, and Gottingen, amounting to 1867 measurements of distances, and 151 position angles In the first tables which Dr Gill here gives, are shown the definite places for the Victorian comparison stars computed for the Equinox 1889 90, and Epoch 1889 55 Owing to the comparatively large quantities that the probable errors of the proper motions amount to, Dr Gill mentions that it is desirable to obtain photographs for determining scale value distortion, &c , as soon as possible Table 2 consists of a comparison between the distances as obtained from definite co ordinates, and these as measured by Gill, Finlay, Jacoby, Chase, Schur, and Ambronn with the heliometer

INTERNATIONAL TIME —In a small pamphlet, published by Mr Edward Stanford, a scheme for a systematic regulation of time is discussed by Major the Hon E Noel The principle on which the system he proposes is based is the same as that which is at present in use on the American continent It consists in dividing the earth's surface up into time zones each covering fifteen degrees, so that they will differ from one another by one hour In considering the question of the initial time meridian, there are many points which have to be well borne in mind In the first instance there must be a first class observatory, on which every one could depend , secondly, the contra meridian, *i e* , that half of the initial meridian in the opposite hemisphere, must fall in a convenient place, by which is meant that it must not cut through a continent or any large tract of land Another important consideration is the arrangement of the time zones, which must, if possible be conveniently related to the longitude boundaries as are shown in our maps Taking these points into account, Major Noel retains Greenwich as the initial for longitude, but selects Rome as our initial for time On this basis he discusses this scheme with reference to each individual country The only great country which this arrangement would not suit is France for she, as is well known, keeps Paris time , a suggestion put forward here is that France should form a special zone, making her time exactly, instead of approximately, forty minutes after Rome The folding diagram which accompanies this pamphlet shows a map of the world graduated on this system From this one sees that the meridian of Rome traverses the centre of the Scandinavian Peninsula, coincides with Copenhagen, passes close to Leipzig, and between Berlin and Munich, while it cuts Italy from north to south The western boundary of this zone, which is exactly on the fifth meridian west of Greenwich, passes between Italy and Spain, outside the western frontier of Germany, and skirts the west coast of Norway, while the eastern boundary also traverses convenient points for such a division of time In considering the scheme as a whole, there is much to be said in its favour , but as such a question as this deals with so many nations, its development and final adoption cannot take place in a trice, but can only be brought to a head after many years' deliberation and debate

COMET SWIFT (MARCH 6, 1892) —The ephemeris of Comet Swift is given in *Edinburgh Circular*, No 29, and has been computed from elliptic elements supplied by Herr Berberich This comet in large telescopes is quite a conspicuous object, while in smaller ones it is still visible The following ephemeris we take from the above mentioned source —

Ephemeris for Berlin Midnight

1892	R A	Decl	Log Δ	Log r	Br
	h m s	° '			
Aug 31	0 42 35	+52 42 6			
Sept 1	41 24	38 3			
,, 2	40 10	33 6	0 2693	0 3922	0 081
,, 3	38 55	28 5			
,, 4	37 39	22 9			
,, 5	36 22	16 9			
,, 6	35 4	10 5	0 2720	0 4004	0 077
,, 7	0 33 46	52 3 7			

Taking the comet's position for September 2, we find that it will lie very nearly $3\frac{1}{2}°$ south of α Cassiopeiæ, being in the prolongation of a line joining the stars λ and ζ of the same constellation

GEOGRAPHICAL NOTES

THE Berlin Geographical Society are preparing for publication one of the most valuable mementoes of the Columbus celebration, in the form of a magnificent atlas, containing amongst other early maps a series of hitherto unpublished delineations of the Atlantic of very early date These maps have been discovered in manuscript in Italian libraries, where they were copied by a young German geographer of great artistic power. They will be published with all the brilliant colouring of the original illuminated MSS

IN the recent risings of the Arabs against European traders and officials on the Lomami in the Congo Free State, there is too much reason to fear that the veteran M Hodister, Director of the Katanga Company in Africa, has lost his life. This is a disaster of a much more serious kind than the mere collapse of a trading company, for M Hodister in the course of his long service in Central Africa had acquired a remarkable knowledge of the Arabs, and great tact and success in dealing with them In his personal character he commanded the respect of all with whom he came in contact, courage he shared with many fellow-explorers, but his calmness in danger and serious earnestness in work are not too common amongst the Congo State officials or the leaders of caravans through the territory. M Hodister was one of the first Belgian officers appointed on the establishment of the Congo Free State, and as an official, and later as the head of the Katanga syndicate in Africa, he has spent the best years of his life in opening up the Congo Basin

THE Sixth International Geographical Congress having been fixed to meet at London in June, 1895, an organizing committee, of which Major Leonard Darwin is President, and Mr J. Scott Keltie Secretary, has been appointed by the Council of the Royal Geographical Society Circulars have been sent out calling attention to the fact that the meeting is to take place, and inviting suggestions A provisional programme of the proceedings will be drawn up in the course of next year

AN exhaustive bibliography of Socotra has just been published as a pamphlet of forty pages by M James Jackson, the librarian of the Paris Geographical Society Including references to maps, there are 176 entries relating to this island, many of these papers had almost passed into oblivion, and their recovery and systematic presentation is of much value

SOME PROBLEMS IN THE OLD ASTRONOMY[1]

IF a comparison were instituted between the position of the modern astronomer and that of his prototype on the plains of Chaldea, it would not be altogether to the disadvantage of the ancient student of the heavens He stood at the gateway of the unexplored Uranian mysteries, unfettered by the dogmatic theories of a line of predecessors From his own imagination he constructed hypotheses and theories, with no feeling of uncertainty about the priority of invention, and with little anxiety concerning the agreement of theory and observation The modern questions that distract the astronomical world had no place among the thoughts that disturbed the tranquillity of his soul He had not reached that critical epoch when he must choose between the "old" and the "new" astronomy, and he was free from the harassing perplexity that besets the luckless astronomer of this age who seeks to learn the mysteries of the moon's motion, or strives to formulate the cause and the law of the variation in the terrestrial latitude The iniquitous behaviour of the astronomical clock and level, combined with the possible, but unknown, influences of temperature, were not then in league to vex his waking hours and fill his dreams with illusory solutions that ever floated just beyond his grasp He was not obliged to search the ancient records in musty volumes and strain the limits of conjecture in the interpretation of careless observations and imperfect memoranda, in short, he was a happy man, free to work in any direction, and not liable to be called upon from time to time to amuse or to instruct his fellows, or even to weary them, with prosy discourse on his own work or a stale *résumé* of astronomical progress

Unfortunately for us, we live in an age when astronomy is no longer a simple subject, stimulating the imagination by the nightly display of stellar and planetary glories, and involving in its study only the elements of geometrical analysis Within the last fifty years the science has been separated into many divisions, and within a few years several of these branches have assumed new phases As a result of this continued division, the range of study and investigation has spread beyond the efficient grasp of any individual, and specialists are rising up in all directions

It has been the custom for the presiding officer of this section to present, on the first day of the annual session, an address setting forth either the progress in general astronomy or in some branch of the science, or the history or development of some department of mathematics, each confining himself to his own special branch of scientific work

It has seemed to me that a formal statement, to this section, of the general progress of astronomy within the last year or the last decade, would be to lay before you a mass of data with which you are already familiar This view of the case has led me to attempt the presentation of the importance of one branch of astronomical work in which for several years I have taken a deep personal interest, and which, owing to the present tendency towards specialization, is likely to suffer from serious neglect

It is not many years since we first heard of the distinction between the "old" and the "new" astronomy, but in the comparatively short interval since those terms were first used the scope of physics has so expanded in all directions and so adapted itself to its new surroundings that we find it, in one department at least, casting aside its former title and masquerading under the name of astronomy That this departure has quickened the zeal of many students, stimulated the development of numerous and valuable modes of research, and resulted in grand and important discoveries, is one of the most gratifying scientific facts of this epoch The direction of this new movement has followed rigorously the line of least resistance Except in rare instances, that line of work which promises the quickest returns in the proper form for publication is most attractive to the young student of physics and astronomy, and the comparatively inexpensive apparatus required for the simpler astro physical work is apt to lead him in that direction The new and important changes that have been wrought within a few years in the methods of teaching and in the laboratory work in physics, together with the apparent ease with which an account of a few hours' labour with the spectroscope or camera may be spread attractively over several printed pages, have doubtless had their influence in leading the candidates for honours into the new fields of astro-physical research

The advance in the development of methods of research and the improvements in apparatus are so rapid, and the field is so broad and increasing, that constant vigilance is necessary to keep even in touch with the progress of the "new" astronomy One of the most striking examples of the achievements in this new line of work has resulted from a skilful combination of the spectroscope and the camera in the determination of stellar motion in the line of sight with a remarkable linear exactness

The limits of this address would scarcely suffice to simply name the problems now under discussion by the more modern methods, without essaying even a cursory review of their importance or their bearing on current scientific investigation, and yet, from the true astronomical point of view, all of these questions are at least secondary to the fundamental problems of finding the true position of the solar system in the stellar universe and determining the relative positions and motions of those stars that, within the range of telescopic vision, compose that universe

To this latter phase of our science I ask your attention for a few minutes These problems still lie at the foundation of the "old" astronomy and cannot be relegated to the limbo of useless rubbish or to the museum of curious relics, not even to make room for the new-born astro-physics On this foundation must rest every astronomical superstructure that hopes to stand the tests of time and of observation, and the precision of the future science depends rigorously upon the accuracy with which this groundwork is laid.

This work was begun in the sixteenth century, but, in spite of all the improvements in apparatus and in methods of analysis and research, a really satisfactory result has not yet been reached There is no more fascinating phase of the evolution of human thought and skill in the adaptation of means to ends than is found in the development of the mathematical and instru-

[1] Address delivered before Section A of the American Association for the Advancement of Science by Vice President J R Eastman

mental means for the determination of the positions and motions of the bodies included in the solar system. Accuracy in astronomical methods and results did not exist, even approximately, until after the revival of practical astronomy in Europe about the beginning of the sixteenth century, and, before the end of that period, the crude instruments of the early astronomers reached their highest perfection in the hands of the skilful genius of Uraniborg.

The invention of the telescope, the application of the pendulum to clocks, the invention of the micrometer, the combination of the telescope with the divided arc of a circle, the invention of the transit circle by Roemer, with many improvements in minor apparatus, distinctly stamp the seventeenth century as a remarkable period of preparation for the achievements of the next century.

From the standpoint of the modern mechanician the instruments at the Greenwich Observatory in Bradley's time were very imperfect in design and construction, and yet on the observations obtained by his skill and perseverance depends the whole structure of modern fundamental astronomy. The use of the quadrant reached its highest excellence under Bradley's management.

The next advance, the real work with divided circles, began at Greenwich in 1811, under the direction of Pond. Since that epoch, theory and observation have held a nearly even course in the friendly race toward that elusive goal perfection, and the end is not yet. A careful, but independent, determination of the relative right ascensions of the principal stars, supplemented by a rigorous adjustment of such positions with regard to the equinoctial points, and a similar determination of the relative zenith or polar distance of the same bodies, finally referred and adjusted to the equator or the pole, seem in this brief statement to be, at least, simple problems. If, however, we examine the conditions in detail the simplicity may not appear so evident, and this characteristic may prove to be one reason why this important branch of astronomical research is now so generally neglected.

In the first place, it must be understood that such an investigation cannot be completed in a few months. At least *two* and preferably *three* years' work in observing are necessary to secure good results. Skilled observers, and not more than two with the same instrument, are absolutely necessary. Such work cannot be confided to students or beginners in the art of observing, or to observers who have acquired the habit of anticipating the transit of a star. The telescope and the circles, the objective and the micrometer, the clock and the level must be of the best quality, for imperfections in any of these essentials render the best results impossible. A thoroughly good astronomical clock is the rarest instrument in the astronomer's collection. It is not sufficient that a clock should have a uniform daily rate, the rate should be uniform for any number of minor periods during the twenty-four hours. The absolute personal error in observing transits should be determined at least twice a week, and when it is not well established it should be found every day. The level error should be found every two hours, and the greatest care should be exercised in handling this important instrument. The division marks should not be etched on the level tube unless the values of the divisions are frequently examined, for, sooner or later, such tubes become deformed on account of the broken surface, and are then worthless.

In the determination of zenith distances the effect of refraction plays such an important part that no work can rightly claim to be fundamental until the local refraction has been carefully investigated, and special corrections to the standard tables, if necessary, have been deduced for each observing station. The ordinary mode of observing temperature is quite inadequate to the importance of the phenomena. These observations should be made as near as possible in the mass of air through which the objective of the telescope is moved, and also in the opening in the roof and the sides of the observing room where the outside air comes in contact with that in the building. The thermometers should all be mounted, so that they may be whirled in that portion of the air where the temperature is desired, and they should be tested at least once a year to determine the change in the position of the zero of the scale. But a complete list of the things to be done, and of the errors to be avoided, are too voluminous for this occasion, and are not necessary to show the complex character of the problem; the suggestions already made must suffice.

For many years an immense number of observations of the larger or the so-called standard stars have been made at the principal observatories, for different purposes and with varying degrees of accuracy, but it is not certain that the work of the last thirty years, with all the advantages of improved apparatus, has resulted in more exact determinations of even the relative right ascension of such stars. There can be no doubt that the chronographic registration of star transits has given more accurate results for the smaller stars, but I think it is equally true that, in the case of first and second magnitude stars at least, no improvement has been made in accuracy.

With double threads it is possible to observe the zenith distances of such stars with a fair degree of precision, because the operation is one of comparative deliberation, and the centre of the mass of light can be placed midway between the threads with little difficulty. But the attempt to note, with a chronograph key, the instant when a swiftly moving and irregular mass of light, like α Canis Majoris or α Lyræ, is bisected by a transit-thread, is an operation that rises but little above the level of ordinary guesswork. Transits of first and second magnitude stars cannot be observed with an objective of more than four inches aperture with the desired accuracy, unless the apparent magnitude is reduced, by means of screens, to that of a fourth or fifth magnitude star. It is necessary in this connection to avoid confounding the methods employed in the observations of the bodies of the solar system with those for obtaining fundamental places of the stars. The observations of the Sun, Moon, Mercury, and Venus with a transit circle are, from the unavoidable conditions, necessarily uncertain to a degree even beyond the probable error involved in the observations of the large stars. In spite of these unfavourable conditions, however, the continued observations of these bodies at the principal observatories for many years have produced the most valuable results, even when the work on the standard stars, on which their results depend, has no claim whatever to a fundamental character.

In geographic exploration the first endeavour is to secure approximate positions of salient points from a rapid reconnoissance. This is followed by more careful work, fixing the observing stations with that degree of precision which ensures good results. Finally, the highest qualities of skill and science are combined to exhaust all available means to reach the greatest attainable accuracy. In the exploration of the heavens, the first two of these steps have already been taken, and most of the stars of the larger magnitudes have been so well observed, that the accuracy of their positions is not only far higher than is required by the greatest skill of the navigator, but it is equal to all the demands of ordinary practical work. It is the next step which challenges the skill of the mechanician, the observer, and the computor, and astronomers cannot rest at ease until all known resources have been exhausted in the attempt to reach the best results. It is not a very difficult matter to fix the position of stars within a range, in the individual observations, of three or four seconds of arc, but that degree of accuracy is not sufficient for the more exact problems of astronomy, and it falls far short of what is required in the important discussions of solar and stellar motions.

Bradley's observations furnish the data for Bessel's "Fundamenta Astronomiæ," and many astronomers have since attempted by reductions to obtain improved positions for Bradley's stars. The value of these observations in the development of modern astronomy can hardly be exaggerated. Their importance in the determination of stellar proper motions increases with the lapse of time, and yet the accuracy of the original observations was far inferior to that obtained in ordinary routine work with modern methods and improved instruments.

Fundamental catalogues of stars have notably increased since the "Fundamenta Astronomiæ," but the demand has not yet been satisfied. The catalogues of declinations or north polar distances are more numerous than those of right ascension, evidently because, for many reasons, independent declinations are more readily determined.

There is probably no collection of the right ascension of the large stars that has attained, or justly deserved, a higher reputation than the Pulkowa Catalogue. The observations on which this catalogue is founded were made by Schweizer, Fuss, Lindhagen, and Wagner, at the Pulkowa observatory between 1842 and 1853. The observations were reduced by the several observers, thoroughly discussed by Wagner, and published in 1869. Only one observer was employed at any period. As these results have received high praise for their accuracy, and for their freedom from systematic errors, it may be of some interest to consider

briefly, and in a general way, the character of the data on which the results depend

The objective of the transit instrument with which these observations were made, had a focal length of 8 feet and 6 inches and a diameter of 5·85 inches. It was so constructed that the ocular and the objective could be interchanged It was also reversible, and a part of the observations were made with the clamp east and the remainder with the clamp west This construction permitted the observations to be made under four different sets of conditions, and for that reason the observed right ascensions of each star were arranged, for facility of discussion, in four separate groups

An examination of the results in each group discloses some interesting facts that are worth considering somewhat in detail The whole number of stars in the catalogue that are reckoned as standard stars, and are south of 70° north declination, is 365 Of this number 70 per cent have a range, in the individual results, in at least one of the four groups, of two-tenths, or more, of a second of time This range is between 0 20 and 0 29 for 142 stars, between 0 30 and 0 39 for 92 stars, between 0 40 and 0 49 for 15 stars; and 0 50 or more for six stars The mean range for the 255 stars is 0 297 In general, the accordance between the individual results is quite good, but the discordance just mentioned sometimes occurs more than once in the collected observations of the same star, and these doubtful data have been used in deducing the standard places given in the catalogue It is not necessary to look for minor discrepancies, for enough of appreciable magnitude have been cited already to warrant the conclusion that better observing can and ought to be done with modern instruments, and that the needs of astronomical science to day demand a more comprehensive, and a more accurate, standard catalogue of right ascensions

These remarks must not be interpreted as unfavourable criticism of the Pulkowa Catalogue, by far the best work of its period, but they are made simply to call attention to the fact that the present state of stellar astronomy and the direction which the investigations of the immediate future are likely to take, plainly require the most accurate fundamental catalogue of the standard stars that modern instruments and appliances, modern methods and the most skilful observers can produce All of these conditions are essential, and they must be carefully co ordinated to obtain the desired results

It must be plain to every astronomer that the needed fundamental catalogue must be deduced from new observations The reduction and the discussion of old observations of doubtful quality is a waste of time and energy Under existing circumstances the greatest weight must be given to the observations Neither amount of labour nor skill in computation can derive results of the desired accuracy from careless, incomplete, or incorrect observations An attempt on the part of the computer to apply any system of theoretical weights, either simple or complex, to such observations is almost certain to lead, at least, to self-deception, and the safe as well as reasonable rule in such case would be to use the weight zero

One example may serve to illustrate the effect of dealing continuously with old observations In standard star positions the four principal national ephemerides are not only not in accord with each other, but they generally do not exhibit results even from the few best modern observations The many discrepancies of varying magnitude in these volumes present with marked emphasis the undesirable results arising from the custom of "threshing old straw"

The data on which these several ephemerides are founded are the common property of all astronomers, and no one can claim the exclusive use of any published observations, and yet national pride or national obstinacy, which is sometimes mistaken for the nobler sentiment, or some computer's pet scheme or system of combination, has led to the adoption of a variety of assumptions in the interpretation and treatment of the original data until our standard ephemerides are so complex in their structure that the exact details of their preparation are practically unknown outside their respective computing offices The accuracy of the star positions is unchecked by any recent fundamental observations, and they lack that trustworthy character that should inhere in a system intended to serve as a basis for even good differential work.

If this character were wholly satisfactory, we should soon see the representatives of astronomy, geodesy, and geology gathering about the zenith telescope, confident of reaching some definite conclusion in regard to the variation of terrestrial latitudes by the systematic use of this simple instrument But the accurate star positions do not exist, and under the present conditions the most feasible plan for utilising this instrument is to so arrange the observing stations as to eliminate the effect of errors in the star places

If it be admitted that sidereal astronomy is worthy of further and more accurate study, that the needs of astronomical research at the present time and in the immediate future demand more exact positions of the standard stars, it may be desirable to consider briefly the status of those agencies to which we must look for the successful prosecution of such an investigation

It is not an easy task to determine the exact number of active observatories in the world Some published lists contain the names of all observatories, from the most expensive and fully equipped Government establishments to the temporary shelter that protects a small equatorial telescope, and perhaps a chronometer, which is kept by the owner for the amusement and possibly for the instruction of himself and his friends A fair enumeration, however, would probably give a list of about 250 observatories sufficiently equipped to do some kinds of astronomical work Of this number more than 20 per cent are found in North America In the equipment of these 250 observatories are to be found about sixty transit circles with objectives ranging from nine to about three inches The quality of about one fourth of these instruments is such that good results may be expected from their proper employment To the latter class of instruments we are limited when we seek for the highest class of work now under consideration If we take account of the modern subsidiary apparatus, and of the electric methods of recording transit observations and illuminating the different parts of the instrument, it does not seem extravagant to conclude that, if one third of the best transit circles were devoted for the next four years to observations for the formation of a fundamental star catalogue of right ascensions and north-polar distances, the aggregate result would be not only the best positions ever published, but it would be of the greatest value in the discussion of current, as well as future, astronomical problems Unfortunately, however, we do not find any such number of instruments employed in fundamental work At the present time there is no general fundamental work in progress in any portion of the world, and within the last thirty years there have been no results of that character to take the place of the Pulkowa determinations This statement does not refer to observations of one ordinate only, or to those cases where several observers, both trained and untrained, are accustomed to observe in turn with the same instrument and their several results are indiscriminately mingled in such a way that critical discussion is out of the question Several observers may work together in the determination of declinations with a fair degree of success, because, to a large extent, each observer's work in a period of twelve or twenty four hours is independent of that of his fellow's, but even this work is better when done by one skilled observer alone Fundamental right ascensions, however, cannot be determined with the requisite accuracy, and the necessary freedom from systematic errors, if more than one or, at most, two observers work with the same instrument If only accidental errors of observation, or such as are due to atmospheric disturbances, uncomfortable positions, or the unsteady nerves of the observer, were introduced by increasing the number of observers, then increasing the number of observations would tend to diminish the error of the result But the personal errors of observers, and their various habits of manipulation, are of the same nature as systematic errors, and cannot be eliminated by increasing the list of observers or the number of observations

Of the many valuable star catalogues in existence, I know of none in which the right ascensions depend upon the observations of more than one astronomer, where it is possible to know, or to eliminate, either the constant or the variable errors due to the personal equation of the observers

In the current astronomical work of this country in which we, as members of this section, are especially interested, observations and discussions, planned solely, and properly carried out, for the determination of absolute star places, are quite unknown The necessary instrumental outfit, with the exception in some cases of a clock of the requisite quality, exists in several observatories, and I have no doubt that trained observers of the highest character can be found to meet all demands

With the exception of a few Government establishments, and of those built to promote a higher grade of instruction, the ob-

servatories throughout the world have been founded generally for some special purpose. Their existence depended upon some endowment or bequest originating in the real or fancied interest which the wealthy benefactor took in some popular branch of the science, and this founder, with a real enthusiasm for the stimulation of research, and a noble generosity that deserved recognition in a broader field, often unwittingly limited the scope of his foundation and restrained the usefulness of his gift. Utility or novelty, separately or in combination, were frequently the groundwork on which were based the successful claims for pecuniary assistance in founding and maintaining astronomical observatories. The working observatories founded fifty years or more ago, with scarcely an exception, were supported entirely in the belief that the results of the observations would be, directly or indirectly, beneficial to navigation and to commerce. At that time this belief rested upon a reasonable basis. This plea for the construction and support of observatories is sometimes heard even at this period in the evolution of science, in spite of the fact that, if every fixed observatory in the world were destroyed to-day, no interest of navigation or commerce would suffer for the next fifty years. The function of astronomy in promoting the development of navigation and in fostering the extension of commerce has been completed.

In the periodical struggle with wealthy patrons to secure the yearly stipend, and with corporations and legislative bodies to obtain the annual appropriations for the support of observatories, may be found perhaps an apparent, if not a sufficient, motive for selecting the class of work that is pursued in most of the American observatories at this time. The apparent conclusion of those who have sought financial support for astronomical observatories seems to have been that such aid could not be secured except for some special work or research, and that the particular branch of investigation selected must be one that promised either immediate and novel results, or such as would enable capital to win, either in material benefits or in popular reputation, some returns for the risks incurred in speculative advances. Persistence in these theories and in the consequent lines of action, has doubtless resulted in the evolution of a certain type of astronomer, and also of a corresponding type of astronomical patron, whether the latter be an individual, a corporation, or the legislative agents of millions of intelligent people. Such a result would be the obvious outcome of the forces in action.

The motives that actuate the early settlers in new countries, that guide them in the struggle with the untamed forces of nature, arise mainly from the material interests of the pioneer. As the subjugation of the land progresses and the comforts and luxuries of life are substituted for the bare necessities of existence, the higher, intellectual side of humanity asserts itself and demands, not only a hearing in the councils, but also its share in the advantages won in the campaign for material prosperity.

The progress in the development of the various stages of civilization has its parallel in the evolution of the science of modern astronomy. For many centuries the timid navigator skirted the familiar shores of his native land, or, occasionally lured by the hope of unusual gains, he rashly tempted fate by adventurous cruises along distant shores that bore no name in the traditions of his forefathers. But, however lofty his ambition, he never allowed the known or unknown peaks and headlands to sink below his horizon. To him the open ocean was a symbol of infinite space that he dared not explore until astronomy furnished the key to its uttermost recesses, and the art of navigation rose to the dignity of a science.

Greenwich Observatory was founded in 1675 to promote the interests of navigation. The royal warrant appointing the first astronomer royal also declares that his duty is "forthwith to apply himself with the most exact care and diligence to the rectifying the tables of the motions of the heavens and the places of the fixed stars, so as to find out the so much desired longitude of places for the perfecting the art of navigation." Right faithfully have the successive astronomers royal carried out the spirit of the royal mandate. For many years the success was far from uniform, nor was the progress always satisfactory, but, through adversity as well as prosperity, the original design of the foundation was always kept in view, and the results have been commensurate with the effort. If the work of all the other observatories of the world were neglected or destroyed, the data in the annual volumes of the Greenwich Observatory would be sufficient, not only to build anew the science of navigation, but to reconstruct the entire planetary and lunar theories. Surely there can be no more flattering commentary on the value of a well-planned system of observatory work closely followed, through two centuries, with true Anglo-Saxon pertinacity.

The history of Greenwich Observatory is in many respects that of nearly all the observatories, of that early epoch, that have survived to the present time, but most of the urgent needs that led to their foundation have ceased to exist, and new problems have arisen to take their place. The immediate material and commercial advantages, sought for in obedience to the demands of the original foundations, have been fully gained, and the scientific results obtained from the same researches remain a permanent benefaction to the whole world.

To this extent the science of astronomy is deprived of some, perhaps the most efficient, of the influences that commended it to public approval and support during the last two centuries; and the science has now reached a period in its development where we may with propriety consider two pertinent questions. First, what has astronomy gained for itself in the effort to present, in its results, commercial advantages or popular reputation to its patrons, in return for financial support? Second, what shall be its future attitude when seeking aid in the foundation and endowment of new observatories or in the maintenance of those already in existence?

It may be assumed without fear of contradiction that after the revival of astronomical studies in Europe the rapid development of practical and applied astronomy and the consequent establishment of a large number of observatories was due to the stimulus derived from newly awakened interests of navigation and commerce. Around these centres of scientific activity the astronomers of the world gathered to discuss not only the problems of practical astronomy, but the more abstruse, theoretical questions which lay at the foundation of the higher branches of the science. The work of each observatory not only furnished the means for determining the accuracy of the numerous theories then extant, but it produced original data on which new theories were constructed, to be in their turn subjected to the rigid test of observation. In the extreme interest evolved in such discussions by those who eagerly sought the key to Nature's methods in the simple form of general laws, the minor problems of practical astronomy were soon solved or passed over to clear the way for the more profound questions that involved the motions in the solar system and the structure of the stellar universe. So, indirectly at first, with a zeal superior to all obstacles, and an ambition that looked beyond the simple and practical idea underlying the original foundation, astronomers have steadily but persistently sought for Nature's general laws in the labyrinth of complex phenomena, have devoted years of intense labour to the most refined tests of methods and theories, and finally, have won for their exacting but fascinating study the foremost place among the sciences. Success in all these labours has justified the wisdom of those royal and wealthy patrons who generously gave their support when a favourable issue was by no means certain.

In its practical results astronomy has returned to mankind a thousand-fold the cost of founding and maintaining its observatories, and at the same time it has developed a science whose field of action includes not only the figure, motions, and positions of our own insignificant planet, but it reaches the uttermost limits of the universe.

If the second question be regarded as involving only a simple problem in ethics it could be readily answered by following the homely, but sometimes pertinent, injunction to "speak the truth." But in view of the complexity of interests now existing this question has a wider signification and deserves some consideration. As already stated, utility or commercial advantage can no longer be given as a reason for carrying on astronomical investigations. Novelty, combined with a desire for architectural display and an absurd ambition to secure the largest telescope and the greatest variety of astronomical instruments, has, even at the present time, a place, and sometimes a prominent one, among the reasons assigned for establishing new observatories. In view of these facts, it is surely the duty of astronomers to see to it that, for their own reputation and for the present and the ultimate welfare of their science, the true purpose of astronomical study and research, and the grounds for the existence and the support of observatories should be frankly given and courageously maintained. It is possible that pecuniary

profit may sometimes indirectly arise from some branches of astronomical work or investigation, but the only sound and honest reason that can be given for such work is, that it stimulates the highest form of intellectual activity, widens the already broad field of investigation, and increases the sum of human knowledge Whoever pleads the cause of astronomy on a lower plane discounts the intelligence of himself or of his audience Why should the astronomer stoop to select a less noble theme, or consider it from a lower point of view? He who leads an intelligent and thoughtful life must feel himself in daily touch with those phenomena that are involved in the most important astronomical problems of the present and the immediate future The figure and motions of the earth which he treads, the constitution and translation of the sun that invigorates his life and lights his days, the movements and structure of the moon and planets that beautify his nights, the proper motions and distances of the countless stars that nightly set before his eyes the highest types of rigorous law and of boundless space that the mind can grasp, all of these, and more, tend to convince him that the constantly growing demand for broader and more exact knowledge is ample warrant for the time and expense involved in the most profound astronomical investigation In this direction lies the justification of astronomical research, on this basis the astronomer is sure of the stimulating support of every cultivated mind as long as the questions "why" and "how" are constantly reiterated and still are unanswered On this ground, and on this alone, rest the valid reasons for the expenditure of corporate, municipal, or national funds for the establishment of expensive observatories and the prosecution of astronomical investigations, and in the closing years of this century the conscientious astronomer can in no way more thoroughly vindicate the highest claims of his science than by holding the standard of work well above the popular fancies of the hour, and by devoting his time and energy to that class of fundamental work that shall not only satisfy the rigorous demands of the present time, but shall make the last decade of the nineteenth century an important epoch in the real progress of astronomy

GEOLOGY AT THE BRITISH ASSOCIATION

NEARLY fifty papers were contributed to Section C during the meeting of the British Association, and although no new facts or theories of startling interest were brought forward, the record of the year's geological work was decidedly above the average Owing to Professor Lapworth's regrettable illness his address could not be delivered until Monday, and the chair at the meetings had usually to be taken by one of the vice-presidents

Glacial and local papers occupied the first two days, the most remarkable being the pair by Messrs Peach and Horne on the Radiolarian Chert of Arenig age, once probably a deep sea ooze, which covers 3000 square miles in the southern uplands, and passes like the Moffat shales into sediment when traced towards the north When the chert is traced to within half a mile of the Loch Doon granite the quartz has become quite granulitic, the radiolaria being still recognizable in the matrix although there is a faint development of mica, close to the granite the rock is completely recrystallized, and consists entirely of large quartz particles full of liquid cavities and rounded inclusions of biotite Dr Hicks claimed as pre Cambrian some tender gneisses, schists, quartzites, and limestones, of the central Highlands, of which he gave microscopic descriptions, and Prof Blake argued that the discovery of *Olenellus* of the type of *O Thompsoni*, in beds above the Torridon sandstone, did not necessarily parallel these beds with those containing *Olenellus* beneath the Paradoxides zone of America. Amongst the other papers dealing with Palæozoic rocks may be noted Prof Blake's discovery of a felsite like that of Llyn Padarn, apparently intrusive into the Llanberis slates, seen in a new section in the Penrhyn quarries, Prof Sollas's discovery of bodies like radiolaria in the slates of Howth, and the limestone of Culdaff, and Prof Bonney's comparison of the pebbles of the English Bunter with those in the old red conglomerates in Scotland

Several important glacial papers were read. Dr Crosskey reported on the recording of new erratics chiefly in the north of England. Mr. Lomas traced Boulders of the Ailsa Craig, Riebeckite Rock, on Moel Tryfaen, in Anglesey and the Vale of Clwyd, at Liverpool and Birkenhead Mr Bell considered that the evidence from the shell-beds of Clava and Chapelhall was less consistent with the theory of submergence than with that of transportation by land ice Messrs Peach and Horne adduced evidence to show that in Sutherland and Ross shire, at the time of greatest glaciation, the ice shed was to the east of the present watershed, and the lofty mountains of Assynt and Loch Maree were glaciated by ice travelling westward Mr Clement Reid gave a list of twenty-eight species of Arctic plants from a series of silted-up tarns at Corstorphine and Hailes, near Edinburgh Prof Axel Blyth exhibited and described a beautiful set of plant remains preserved in calcareous tufas from Gudbrandsdal, in central Norway The investigation of the Elbolton cave will probably be completed this year, and it has so far failed to reveal any trace of occupation by Palæolithic man Messrs Peach and Horne have studied one out of a group of caves in the Assynt limestone of Sutherlandshire, and found charcoal with split and calcined bones of reindeer, fox, and grouse in the upper layers, and a finely preserved canine tooth of brown bear at a depth of about five feet from the surface Mr Coates gave a description of the cuttings, chiefly in boulder-clay, in the Crieff and Comrie railway And Mr Kendall attributed the glacial period to variability in the heat of the sun

Foremost amongst the palæontological papers stands that of Mr E T Newton, in which was given an account of several remarkable skulls obtained from the Elgin sandstone and probably belonging to two or three species related to the African dicynodonts, together with these occurred the skull of a reptile allied to Pareiasaurus of the Karoo beds, but with no less than thirty horns varying from a quarter of an inch to three inches in length Mr M Laurie described two new species of *Eurypterus*, two of *Stylonurus*, and one of a new genus, *Drepanopterus*, of Eurypterids from the Silurian rocks of the Pentland Hills The work of the type committee still continues, and lists have been received from several museums and private collectors Reports were also presented on Cretaceous Polyzoa and Palæozoic Phyllopoda, and a paper by Mr Bullen Newton recorded the discovery of *Chonetes Pratti* in the carboniferous rocks of Western Australia

The petrological papers included a note on the Malvern crystalline rocks, by Mr Irving, one on the felsites, andesites, and diabases of Builth, by Mr Woods, and a short note on the Limerick Traps, by Mr Watts Mr Ussher endeavoured to prove that there must have been a rigid mass occupying the position of the Devon and Cornwall granites at the time when the stratified rocks were folded, in order to account for the deviations in their strike Mr Goodchild argued that the junction of the granite of the Ross of Mull was best explained by the absorption of sedimentary rocks in the granite Mr. Harker explained the presence of porphyritic quartz in basic igneous rocks by supposing that it had formed in the upper layers of a magma basin, and sunk to its present position by gravity Mr Teall gave a sketch of the succession of rocks in an area of gneisses, which accorded with the succession from basic to acid types in plutonic masses, and Mr Somervail endeavoured to explain the chief rocks in the Lizard area by segregation from a single magma

Finally must be mentioned Professor Hull's paper on the Physical Geology of Arabia Petræa, a very interesting paper by Miss Ogilvie, on the landslips in the South Tyrol, in which she showed how much the mapping of that region was complicated by the constant repetition of portions of the strata by landslips, a new classification of the New Red Sandstone of Northern England, by Mr Goodchild, and papers on the Green sand and Fuller's Earth of Bedfordshire, by Mr Cameron

Dr Johnstone Lavis's report on Vesuvius chronicled the phases of eruption in the past year, and was illustrated by a beautiful series of photographs, chiefly of fumarolles and spiracles in the streams of lava. Mr De Rance's report on underground water was continued Mr Davison's earthquake report dealt chiefly with new forms of seismic apparatus, and the photographic committee recorded that the collection of geological photographs now numbered 700, amongst which half the English counties and Scotland were, however, poorly represented An excellent exhibition of the photographs was held in a room provided for the purpose, where also the Geological Survey of Scotland showed a fine series of views illustrating the scenery and structures of the ancient gneisses and schists of the Highlands.

MECHANICS AT THE BRITISH ASSOCIATION

SECTION G had a good meeting at Edinburgh this year, there being a great improvement on last year's gathering at Cardiff On the members assembling on Thursday morning the fourth inst in the old University Buildings the first business was naturally the Presidential address Prof W C Unwin, F R S, who this year occupied the chair, is eminently fitted to preside over the Mechanical Science Section His knowledge of the scientific side of mechanics is well known, and his past experience in the region of practical mechanics puts him thoroughly in touch with the many engineers who frequent the section His address, which we have already printed, was listened to by a large audience, the theatre being quite full The vote of thanks to the President for his address was moved by Lord Kelvin and seconded by Mr Deacon, of Liverpool

The first paper on the list was a contribution from Mr James Dredge and Mr Robert S McCormick on the American Exhibition, which is to be held next year in Chicago The paper gave a good general description of the coming show from the engineer's point of view, but the subject is one that offers better scope for the members of Section F It is manifestly impossible to give anything like a good engineering description within the limits of a short paper, whilst the advantages and disadvantages of exhibiting might well have supplied a theme for discussion in the Economic Section In fact, the discussion which followed the reading of the paper turned wholly on this branch of the subject The next three papers were of a sanitary nature Prof George Forbes and Mr G Watson, of Leeds, both dealt in the disposal of town refuse, the former bringing in the electrical lighting of Edinburgh as a part of his scheme Mr Forbes points out that in the electric lighting of towns the demand for power is but for a few hours daily With no system of accumulators, or power storage, this necessitates a large plant compared to that which would suffice if the demand could be made continuous The author, therefore, proposes to use Arthur's Seat as an accumulator, by forming a reservoir on its summit, and into this reservoir water would be pumped continuously The head of water thus obtained would be used for working turbines, which would be of sufficient power for the maximum demand There would thus be a gain through keeping the steam engines constantly at work, smaller engines could be used, and there would not be the loss incidental to raising steam or keeping the boiler fires banked The great feature of the scheme, however, is to use the dust bin refuse of the city as fuel for raising steam The author would erect destructors, and the waste heat from these would be passed through the boiler flues Prof Forbes quoted figures in support of his contention that the scheme is practicable, and he instanced what has been done at Southampton, and elsewhere, in the matter of using domestic refuse for steam generating purposes We are not able to criticise the details put forward, but we may venture to say that, if the scheme can be worked out practically, engineers will have put before them an example of the use of waste material which many have not hitherto considered capable of being so successfully applied The author stated that the refuse of a city, if properly burnt, would generally supply sufficient heat to raise the steam necessary for the electric lighting required. That is a very satisfactory adjustment of supply and demand, and if Prof Forbes can show municipal engineers how to put it in practice he will have rendered a most important service for which every one should be devoutly grateful After disposing of the particular scheme for the refuse destruction and electric lighting of Edinburgh, the author gave some interesting particulars of that which has already been done in this country in the matter of burning town refuse.

The next paper was contributed by Mr G Watson, of Leeds, and was an excellent treatise on the refuse-destructor question. The various types of apparatus which have already been put in use were illustrated by wall-diagrams, and the chief points in their construction were explained. Mr Watson is of opinion, and he supported his opinion by results of actual experience, not only that dust-bin refuse can be burned in a properly constructed destructor without nuisance, but that the waste heat can be used for raising steam; or, if required, that dust-bin refuse and sewage sludge, containing 90 per cent of moisture, may be satisfactorily burnt together, the Horsfall destructor being, apparently, particularly suitable for the purpose. The whole subject is one of great and growing importance. It is to be regretted that both these papers were not printed and distributed previously, so that a thorough criticism of the various points raised might have been made during the discussion

A paper by Mr R F Grantham, on the absorption and filteration of sewage was next read The author gave accounts of many examples that have been carried out in different parts of the world, and of experiments made in this connection Mr Grantham is of opinion that the Maplin and Foulness Sands at the mouth of the Thames might be used to advantage for treatment of the sewage of London

The next paper was of a different character It was by Mr G F Deacon, and contained a description of the work the author had carried out in shield tunneling in loose ground whilst constructing the Vyrnwy Aqueduct tunnel under the Mersey The work, as is generally known, was one of remarkable difficulty, and the manner in which the various obstacles to its completion were overcome affords a valuable lesson for engineers

Mr D A Stevenson next read a paper in which he advocated the construction of a ship canal between the Forth and the Clyde The scheme included a tunnel high enough to pass the masts of big vessels, and locks sufficiently large to take in ocean going steamers The estimated cost is £8,000,000 After a short discussion of this paper the section adjourned

On the next day, Friday, the 5th inst, the first business was the reading of a paper by Mr D Cunningham, in which he described a mechanical system for the distribution of parcels The device was illustrated by means of a working model, without the aid of which, or drawings of the mechanism, it would be difficult to make the principle understood.

Mr Alexander Siemens next described two electric locomotives which his firm had recently supplied to the City and South London Railway These, as it is proper they should, have been more successful in their working than the engines originally placed on the line The armatures of the motors are wound on the axles, so that no gearing is required According to diagrams displayed, the efficiency varied between about 90 and 94 per cent Each locomotive, fully equipped, weighs $13\frac{1}{2}$ tons, and the weight of the train of carriages is about 21 tons, without passengers The weight, we believe, is considerably greater than in the original locomotives used on the line, and this is undoubtedly an advantage Mr J H Greathead, Professors Silvanus Thompson, and G Forbes took part in the discussion, in replying to which the author attributed the success of the motors to large armatures and large field magnets Prof Silvanus Thompson stated that Messrs Mather and Platt, of Manchester, are now building an electric locomotive which is to be more powerful than anything that has gone before

Hydraulics next occupied the attention of the section, Messrs F Purdon and H E Walters describing an interesting tide-motor which they have devised and constructed The machine takes the form of a floating barge or flat, which is moored athwart the tide-way There are two drums placed some distance apart, and on these drums a chain is made to travel by floats attached to it, which floats project downwards into the water, and are carried along on the forward stroke by the action of the tide, whilst the return stroke is made in the air As the flat is moored athwart the stream—in order to utilize the greatest possible area of the current—and as the chain travels fore and aft, guides are used to conduct the water in the proper direction to actuate the floats or paddles The guides also concentrate the stream These are roughly the fundamental features of the design, further details of which we are unable to give through limits of space The machine, however, is very interesting, and is perhaps one of the most promising and best worked-out motors of its kind There appears now to be better prospect for inventions of this nature than heretofore, on account of the facilities offered for transport of power by means of electricity. It is always a tempting problem to try to use some of the vast store of energy running to waste in the tides, although the question is one beset with practical difficulties that have been sufficient hitherto to make tide-motors very scarce.

A paper by Mr Pearsall, in which he described a new arrangement of hydraulic ram, which he had made, was next read, Prof Blyth described a new form of windmill on the principle of the Robinson cup anemometer; and Mr G R Redgrove having read a contribution on Levavasseur's flexible metallic tubing, the second day's proceedings were brought to a close

The next sitting was held on the following Monday, the section not meeting on Saturday The arrangement was de-

cidedly a pleasant innovation, the Saturday morning's meeting being by no means popular Whether there be few or many papers, it seems impossible to get through a sitting in a short time, as there are always one or two speakers, at any rate, who will spin the discussions out, so that those who are obliged to stay to the end have no time to get lunch before starting on the excursions Section G made a trip to Glasgow on the Saturday, and were rewarded by perhaps the finest exhibition of marine machinery ever collected in a single installation This comprised the propelling engines of one of the pair of enormous vessels the Fairfield Company are building for the Cunard line The engines were erected in the shop, and one was enabled to get a fair prospective of their grand proportions, such as will be impossible when they are confined to their natural position on shipboard

On the section again assembling on the Monday following the first business was the reading of the report of the committee appointed to consider "The Development of Graphic Methods in Mechanical Science" This report had been prepared by Prof Hele-Shaw, of Liverpool, who must have spent a vast amount of pains in compiling the very bulky document, which was read in abstract The bibliography should be especially valuable This is the second report that has been presented by the committee, and, we believe, the subject is to be further investigated The use of graphic methods is far less common with engineers than it might be with advantage, and the matter is one which the Mechanical Section of the British Association is especially fitted to deal

Mr Preece next read two papers, in the first of which he took the municipal authorities to task for causing stack pipes to be disconnected from the drains, and thus depriving these natural lightning conductors of their lead to earth If Mr Preece's prognostications are fulfilled there will be a great increase in casualties from lightning when the new legislation comes widely into effect, unless some other means be taken to make connection between stack pipes and earth Mr Preece did not read his second paper, but contented himself with saying a few words to signify its scope Its title was "The use of secondary batteries in telegraphy" For the past seven years secondary batteries have been used at the Post Office to supply current to two large groups of circuits, one group consisting of 110 single needles, and the other of 100 Morse inkers and sounders

Mr Gisbert Kapp next read a practical and interesting paper on "Power Transmission by Alternating Current," describing an installation which has been carried out at Cassel In that town the water supply is a municipal undertaking, the source being at a distance of four miles or so from the town In the summer a large quantity of water is used, and for this reason a certain amount of pumping has to be done The pumps are worked by turbines. In the winter the existing natural gravitation supply is sufficient, and the turbine pumps are, therefore, not required It is, of course, in winter that the chief demand for light occurs and then the turbines, in place of being idle, are used for driving dynamos Mr Kapp explained by means of diagrams the manner in which a storage system is carried out so that the turbines may be kept constantly at work The power is transmitted by a single phase alternating current from the generating station to two sub-stations at Cassel At one of the sub-stations there is a battery which is charged during the hours of light load, to be in turn drawn upon during the time of heavy load Each of the two sub stations contains a transformer so that the distribution is by continuous current, whilst between the generating station and the sub stations the current is alternating, the pressure being 2000 volts The installation was the work of Mr Oskar von Millar, Mr Kapp designing the alternators The author gave a good many details of the arrangement of which the above is an outline In the discussion which followed an interesting point was raised as to the effect of putting the alternators out of step The author said that in the present instance he had no hesitation in putting the load on suddenly and no effect followed, but if the load were suddenly taken off, the machine would start howling in a frightful manner until it again got in synchrony This was alarming at first, but not otherwise hurtful

Mr E H. Woods next read a paper in which he gave particulars of a new design of electric locomotive The driving wheels are placed horizontally, the necessary grip being, we understood, obtained by springs, which press the pairs of wheels against a central rail There is an ingenious device for points and crossings which was illustrated by a model The motor is to be kept running continuously, the grip of the wheels being released when the train is stopped, the power then be absorbed by frictional brakes The relative value of this device naturally depends on the length of the stoppage Mr Kapp and Prof Forbes both spoke on the question of continuous running motors, neither appearing to look with favour on the device

Monday is generally devoted wholly to electrical engineering, but on this occasion the papers on the subject were not sufficiently numerous to fill up the sitting The rest of the day was, therefore, filled up with papers of a miscellaneous nature The first of these was a contribution by Lieut W B Basset, R N, who described a very ingenious coin-counting machine which has been recently placed in the Royal Mint It would be impossible to describe this apparatus without the aid of drawings, but it may be stated that 3,000 coins can be counted in a minute, or one ton in three quarters of an hour The coins are made to move along a channel of such a size that only one can pass at a time They are forced along by means of two driving wheels, actuated by an electric motor At the lower end of the channel is a wheel with notches in its rim, the notches being of a shape that the coins just fit into them The wheel is made to turn by the coins as they are forced forward, the action being comparable to that of a rack and pinion, the rack being formed by the procession of coins pushed forward by the driving wheels The counting wheel must necessarily pass a coin for each notch or tooth it advances, and as a given number of teeth always go to a revolution, an accurate record is obtained The machine in the Mint is arranged to count pence, half-pence, piastres, half-piastres, and Hong Kong cents It counts on an average over two million coins a month without error

Mr Killingworth Hedges next read a paper on "Anti-Friction Material for Bearings used without Lubrication" This referred chiefly to a bearing composed of finely powdered carbon mixed with steatite, which the author had found valuable He referred to the advantages of non lubricated bearings, such as saving in labour, cost of oil, and cleanliness In the discussion which followed, Professor Unwin well summed up the question by saying that though there might be a higher co-efficient of friction with a non lubricated bearing, manufacturers could generally well afford a small additional expenditure of power in order to be free from the defects of oiled bearings

A paper by Mr B H Thwaite on high pressure boilers, which does not call for notice here, was the last read on this day

The last day on which Section G sat was Tuesday, the 9th inst, when the proceedings were opened by a paper by Mr D A Stevenson, entitled "Petroleum Engines for Fog Signalling," being read The paper, which was read by Mr C A Stevenson in his brother's absence, stated that the maximum number of hours of duration of fog in Scotland was 395 per annum For sounding the siren various motors are available, which may be actuated by the waves or tides, manual labour, clockwork, steam, hot air, gas, or oil The author states that the oil engine is the best for the purpose He states, however, that all fog signals which appeal to the ear must be of an unreliable nature, and he would prefer some method, such as had been proposed by Mr C A Stevenson, in which an electric conductor is laid down off a coast, so as to act on an instrument attached to each vessel It would have added to the value of the paper had sufficient detail of this device been given to afford the meeting an idea of its general principle As the description stands we quite fail to see how a useful result could be brought about An interesting discussion followed the reading of this paper, in which the chief feature was the speech of Mr A R. Sennett, who pointed out that water is a better medium than air for conveying sound, and reminded the meeting that sound was very liable to be deflected by "acoustic clouds" Tyndall found that the presence of such clouds reduced by one third the distance at which a given sound could be otherwise heard. Mr David Cunningham, the harbour engineer at Dundee, gave a remarkable example of the influence of acoustic clouds He had gone out in a steam yacht when the siren was in operation. At a distance from it of half a mile the sound was not to be heard, but when they had steamed four miles the siren was again audible It had been sounding the whole time To return to Mr Sennett's remarks, that speaker said he proposed taking advantage of the sound-carrying power of water in the following way He would have the siren, which indicated a danger, submerged in place of being in the air. It would be arranged to give off a certain note. In each ship there would

be a chamber to which the sea would have access, and in this would be a diaphragm which would be tuned to the same note as that emitted by the siren. By the well known law the diaphragm would not resound unless the note to which it might be attuned were in harmony with that given off by the siren, and therefore false alarms would not be given by the sounds produced by paddle wheels or in other ways. An officer would be placed in a padded cabin, so as to isolate him from the noises of the ship, and by means of an ordinary speaking tube he would be able to hear the vibrations of the diaphragm, which, as stated, would only take place when they synchronised with the sound waves produced by the siren. Mr. Sennett's proposal is ingenious, and may contain the germ of a principle of great value. We understood him to say that he had made some experiments in this direction, and that these had been encouraging. It is obvious, however, that investigations of this nature must be somewhat costly, and can lead to but little prospect of pecuniary reward. We would suggest that the matter is one that might well be taken up by the Board of Trade or the Trinity House. Perhaps some of those big ship-owners who do their own insurance might be induced to give assistance in this direction. It is quite possible, and indeed probable, that we have been entirely on the wrong tack in sending sound-signals through the air. The experience of Prof. Hughes, quoted by Mr. Sennett, when he found the sound of two stones being knocked together under water could be heard for a distance of half a mile, and heard so distinctly that the Professor did not wish to repeat the experiment, bears on this point. An ordinary bell has been struck under water, and the sound conveyed a distance of nine miles.

Mr. C. A. Stevenson next read a paper of his own "On the Progress of the Dioptric Lens as used in Lighthouse Illumination." This paper was largely historical, going back to the early days of the century, when Alan Stevenson introduced the Fresnel apparatus in Great Britain, and bringing the record up to the year 1886, when the author proposed the spherical lens, an example of which was introduced in one of the Fair Isle lighthouses. This introduction of the spherical refractor has made practicable the construction of more powerful apparatus, with less total space occupied. It has also rendered practicable a quadrilateral arrangement with hyper-radiant lenses. This arrangement has been installed at Fair Isle, the lenses being cut so as to give two flashes from each side of the quadrilateral. An experimental example for Ireland is 2 m. focal distance, and the spherical refractor is 7′ 6″ in diameter, and will give one flash from each side of the quadrilateral.

Mr. A. R. Sennett next read a paper which was both interesting and of practical importance. Its theme was the much ill treated smoke-prevention question, and we may at once say it was refreshing to find this important but ever-abused problem approached in an intelligent manner. Mr. Sennett has evolved a very simple device which, it might perhaps be rash to say, has exorcised the smoke fiend in regard to boiler furnaces; but if we are to accept his statements—and we see no reason why we should not—there is no longer excuse for steam users allowing smoke to emerge from boiler chimneys. We all know it is not difficult to prevent smoke if fuel economy be left out of the question, but Mr. Sennett tells us he not only prevents smoke, but saves coal. The latter part of the claim is vouched for by Professor Alexander Kennedy, who is perhaps our best authority on this subject; and, with regard to the smoke prevention, Section G was able to judge for itself, as the author had a fair-sized return-tube boiler at work in a yard close to the meeting-room. The paper was of considerable length, but was listened to with interest throughout. By means of wall diagrams, devices of various classes, previously introduced, were illustrated and described. These played much the same part as the awful example at a teetotal lecture, only serving to emphasize the virtues of the author's own invention. Some of them, it must be confessed, were sufficiently absurd; one especially, in which the products of combustion were cleansed from soot by a sand filter, afforded the meeting a good deal of amusement. We imagine the impression of the average engineer to be that the drier and hotter the air fed to a furnace the quicker and more perfect would be the combustion. This Mr. Sennett shows to be not exactly the fact, or, at any rate, that the presence of steam with the air promotes combustion. He says that hydrogen, steam, or aqueous vapour, in the furnace is necessary. He combats the view, "too readily assumed," that the presence of an excess of oxygen contained in dry air will of necessity effect complete combustion. The advantage of supplying air above the grate bars, as well as below, is, of course, well understood, and it is with the volume of air introduced above that the author chiefly deals. His device consists chiefly of an air injector, the steam for inducing the air current being super heated in a coil placed in the chimney. The apparatus is termed a transformer, because it transforms the kinetic energy of a small current of steam at high pressure into that of a large current of air at low pressure: a description which conveys the whole scheme of the invention, although the working out of the details requires some attention. With the transformer Mr. Sennett has carried out some experiments. He worked it firstly by steam, and secondly by compressed air, and he found that the volume of air required for combustion was very much less in the former case than in the latter. In explanation, or rather in illustration, of this fact the author quotes several interesting facts. Mr. H. Brereton Baker investigated the phenomena which accompany the burning of carbon and phosphorus in oxygen. "Finely powdered charcoal was carefully dried and sealed up in a hard glass tube containing oxygen saturated with water. The tubes were placed in a flame, and the carbon burnt with bright scintillating flashes. When the oxygen was dry no combustion took place in the tube, though the latter was heated to bright red;" a result which came clearly as a surprise to many of the members of non chemical Section G. Mr. Baker has said that the results obtained clearly show that the burning of carbon is much retarded by drying the oxygen. With regard to the presence of moisture and the behaviour of carbonic oxide gas in oxygen the effect is even more remarkable. The author quotes Prof. H. B. Dixon, who says: "That if the mixture of the two gases be very carefully dried it is no longer explosive, and a platinum wire may be heated to redness in it without causing explosion; oxidation of the carbon monoxide to dioxide then taking place gradually, and only in the immediate neighbourhood (at the surface) of the glowing wire. A burning jet of carbonic oxide may even be extinguished by plunging it into a jar containing dried oxygen." We will quote one more interesting fact in connection with this subject. Sir Lowthian Bell has noticed that the gases at the throat of blast furnaces, which are of a temperature of about 250 to 300 Cent., are not inflammable in atmospheric air. Any small quantity which escapes does so without undergoing combustion. But the moment a tuyere commences to leak the gas takes fire; just as a small quantity of hydrogen in the eudiometric researches produced explosion in a mixture not previously influenced by the electric spark. The author does not attempt to decide whether the acceleration or retardation of the union of oxygen with the evolved hydro-carbon gases is due to the presence of aqueous vapour or of the hydrogen. Section G may fairly look to Sections A or B for enlightenment upon that point.

We have given so much space to what we think the most interesting part of Mr. Sennett's paper that we may, perhaps, be doing him the injustice of suggesting that other points do not receive attention. This, however, is not the case, for he does not lose sight of the leading canons of furnace practice, such as proper admixture of the gases, adequate space for combustion, keeping the gases from contact with the heating surface (from this point of view the cooling surface) of the boiler, and other matters, of a similar nature. The result of the whole arrangement is that smoke is undoubtedly prevented from issuing from the funnel. In the boiler referred to a very dirty coal was burned, the result being a particularly pungent smoke, which was sometimes carried down among the spectators by an eddying wind. When the transformer was put in operation this smoke entirely disappeared. Upon the apparatus being put out of action the sable cloud was again to be seen rolling forth from the chimney top. These operations were repeated several times, the fire being constantly supplied with green fuel, so as to keep it in its smokiest condition.

Following Mr. Sennett's paper a contribution on the same subject was read by Colonel E. Duller. The author of this paper deals with the domestic fire, to which, of course, the greater part of the smoke of civilization is to be attributed, but he does not aim at the prevention of smoke, but simply to its arrestation before its gets into the air. In order to effect this object he proposes to wash the chimney gases with a spray, and thus precipitate all soot. He also claims to arrest the greater part of the sulphurous acid, which is of even greater importance. Every dweller in towns and cities will wish Colonel Duller well

in his enterprise, but there are some very big difficulties in his way The biggest perhaps is that before the plan can become general legislation must be brought to bear Unhappily dwellers in towns and cities are so little disinterested that the average householder would prefer to see his next door neighbour erect a costly apparatus (the first cost for a seventeen chimney house is said to be about £50) rather than go to the expense himself The large quantity of water required for a general smoke-washing would be a serious problem, not only of cost but of supply at any price, although it is quite possible this difficulty could be, as it should be, met The cleaning out of the apparatus would be also a serious matter, for the tarry deposit due to smoke washing is of a particularly tenaceous nature

The sewage problem next occupied the attention of the meeting, Mr Crawford Barlow reading a paper on "The London Sewage Question" Mr J Cooper also read a paper on "The Sanitation of Edinburgh" The last paper read at this meeting in this section was contributed by Mr H C Carver It related to fire extinction on board ship The author has devised an apparatus by means of which he can turn the effluent gases from the boiler furnaces into the hold of a ship where fire is raging, the gases having been previously washed and cooled The apparatus has been tried practically, and has been found to answer remarkably well The ordinary practice is to turn boiler steam into a ship's hold, but the spent gases from the furnace are naturally more effective, as steam condenses, and air is thus drawn in Nevertheless, steam is better than nothing

After the usual votes of thanks the business of the section was brought to a close

ANTHROPOLOGY AT THE BRITISH ASSOCIATION

AFTER the President's address, on Thursday, August 4, Mr E W Brabrook read a paper on the Organization of Local Anthropological Research The writer, as the representative of a joint committee of delegates from the Society of Antiquaries, the Folklore Society, and the Anthropological Institute, communicated a plan for an ethnographical survey of the United Kingdom, by which observations should be made simultaneously in selected localities on the ancient remains, the local customs, and the physical characters of the people The matter is one that will not brook undue delay, as the evidence is fast slipping out of our grasp

The Rev Frederick Smith read a paper on the Discovery of the Common Occurrence of Palæolithic Weapons in Scotland The author has made patient and long continued search in modern and ancient gravel beds of existing rivers, in "Kame" deposits, and finally in certain phases of boulder clay, and he finds abundant evidence in the shape of glaciated, broken, and crushed specimens of the weapons of palæolithic man He has collected at least 350 specimens, which he believes to be definite evidence of the long continued sojourn of palæolithic man north of the Border

A paper on Cyclopean Architecture in the South Pacific Islands was read, also the Reports of the Anthropometric Laboratory Committee, and of the Anthropological Notes and Queries Committee

In the afternoon the following papers were read —Dr L Manouvrier, On a Fronto Limbic Formation of the Human Cerebrum, Prof G Hartwell Jones, The Indo-Europeans' Conception of a Future Life and its Bearing upon their Religions

On Friday, Mr J Graham Kerr exhibited a collection of weapons, articles of clothing, and a fire drill, used by the Toba Indians of the "Gran Chaco" He accompanied the exhibition with a few explanatory remarks The specimens had been obtained from a tribe of the Tobas on the banks of the Rio Pilcomayo. Amongst weapons the chief were bows and arrows, the former being noteworthy from their reinforcement by a back string The arrows were of cane, with long wooden points made of cascarandá. An arrow with an iron head was also shown, the head being formed of fencing wire beaten out.

Mr. J. Montgomerie Bell exhibited a collection of flints from the North Downs of Kent, which he called "pre palæolithic" The peculiarities of these flints is that they are not shaped into particular forms by the will and skill of the workman, as palæolithic flints are, but they are simply stones taken from the ground and used almost in the state in which they are picked up, only the edges are altered, they are chipped flints rather than shaped flints, used tools, not made tools Mr Bell explained the reasons which had convinced him of their authenticity, namely, that the chipping is regular and purpose-like, such as Nature is not likely to have hit upon, it is sometimes within a hollow curve, where natural agencies could not act, the edges of many unbulbed flints have far more regular marks of wear, which is the true indication of use by man, than many bulbed flakes possess, whose edges have undoubtedly been used, and lastly, there is a sequence in the types which leads into the types of the river valley period

Mr J. Theodore Bent read a paper on the Present Inhabitants of Mashonaland and their Origin The inhabitants of this country are an oppressed and impoverished race of Kaffirs, who dwell amongst the rocks and crannies of the mountains Their recognized name—Makalanga—means "the children of the sun," and there were traces of a higher civilization amongst them Their origin is obscure, but references to them by early Arabian writers prove beyond doubt that a similar people inhabited the country one thousand years ago Each tribe has its totem Their religion has a monotheistic tendency, but they sacrifice to ancestors, and sacrifice goats to ward off calamities Their manners are courteous and refined, and their skill in music is considerable

Prof A C Haddon contributed a paper on the Value of Art in Ethnology In order to study such an intricate subject as Decorative Art from the point of view of the Biologist it is necessary first to confine one's attention to savage art where the problems are presented in a simpler form In taking a definite area into consideration, such as British New Guinea, one finds that there are several distinct and well defined artistic provinces The Torres Strait district was characterized by the prevalence of straight and angled lines to the exclusion of curved lines and the representation of animal forms, the latter being associated with totemism In the Gulf District the human face and form is the basis of almost all their art In the Port Moresby District decoration is in the form of panels and mainly straight and angled lines, whereas in the South Cape and Archipelago District there is a wonderful richness of design in which curved lines are abundant

It is well known that in this latter district there has been a great mixture of race It would appear that homogeneous peoples have a uniform style in their art, but that race mixture tends to varied artistic treatment

Dr J S Phene read a paper on the Similarity of Certain Ancient Necropoleis in the Pyrenees and in North Britain. At Luchon, a spot where the traditions of the Pyrenees were most concentrated, remarkable customs had till recently been practised The locality abounded with interments of a peculiar kind, more or less surrounding a central mound, serpentine in form, the head of which had been cut away and a small church erected in the cavity The walls of this antique little church are covered with votive tablets of early Christian and pagan Roman times Almost all the features shown had been discovered by the author in Somersetshire, Bedfordshire, Argyleshire, and Peebleshire.

The following papers were read —A Contribution to the Ethnography of Jersey, by Dr Andrew Dunlop Notes on the Past and Present Condition of the Natives of the Friendly Islands, or Tonga, by Mr R B. Leefe Damma Island and its Natives, by Dr F Bassett Smith The Reports of the Mashonaland Committee, and of the Canadian Committee were also read.

In the afternoon a discussion on Anthropometric Identification was opened by Dr Manouvrier, who described the system of measurements introduced by M A. Bertillon into the French Criminal Department, and showed the manner in which they were made He said that by its means the identification of criminals was made absolutely certain Dr Benedikt of Vienna also bore testimony to the efficiency of M Bertillon's system and strongly advocated its introduction into Great Britain Dr. Garson referred to Mr Galton's method of identification by means of finger marks.

As a result of this discussion the Council have been requested to draw the attention of her Majesty's Government to the subject

A discussion on the subject of Criminal Anthropology was opened on Saturday by Dr T. S Clouston, who reviewed the work done in this and other countries, and pointed out the failure

of the workers to agree on any anatomical, physiological, or psychological data for establishing a criminal type

If inquiry established physical, hereditary, and psychological bases of criminality, the State would have to treat the criminal from a point of view entirely different from the punitive method The essential likeness of the epileptic and the criminal brain is one of the most striking of Dr Benedikt's observations What were to the doctor symptoms of disease were to the policeman and the magistrate proofs of criminality In the rich family the physician looked after the case, in the poor family the policeman and the gaoler Yet both cases were equally phases of brain development due to hereditary weakness

Dr Benedikt emphasized the importance of studying criminals of different types They must study the classes from which the criminals came, and must not confuse the poor and miserable with the criminal classes

On Monday Sir William Turner exhibited the coiffure of a Kanaka labourer who had been employed on a sugar plantation in Queensland The mode of dressing the hair in locks, each of which was tied round with a narrow ribbon formed of vegetable fibre, was described 834 such locks were present in the coiffure, and it was estimated that about 120 hairs were in each lock, making in all about 100,000 hairs in the coiffure

Prof Struthers read a paper on the Articular Processes of the Vertebræ in the Gorilla compared with those in Man, and on Costo-vertebral variation in the Gorilla

Mr J P Mansel Weale made a communication on the probable derivation of characteristic sounds in certain languages from the noises made by animals

Dr Louis Robinson read a paper on the prehensile power of infants Long continued experiments had proved that the muscles of the hands and arms of a newly born infant are far stronger in proportion to weight than those of most healthy adults In many cases a newly born child would hang and support its weight with ease for a minute, and some for thirty seconds longer Several infants less than a week old hung for over a minute and a half, a few others a fortnight old for nearly two minutes, and one child of about three weeks old for two minutes thirty five seconds If the child were in a good temper to begin with it would hang quite placidly until its fingers began to slip, when it at once evinced distress, and screamed lustily as if from a fear of the consequences of falling An examination of the foot of an infant showed that it was much more hand like than that of the adult The heel was much narrower than in after life, and the fore part of the sole, instead of presenting a rounded smooth surface, was flat or even concave, with creases like those of the palm of the hand The author was not aware that any explanation could be given of these lines, so characteristic of a prehensile organ, on the foot of the human infant, other than that they were vestiges of an arboreal state of existence He believed that it was due to the habit of the young clinging to the body of a parent who would require to use all her limbs for climbing

Dr Hepburn read a paper on the Integumentary Grooves on the Palm of the Hand and Sole of the Foot of Man and the Anthropoid Apes

In a communication on the Contemporaneity of the Maori and the Moa, Mr H O Forbes gave an account of the exploration of a cave in the neighbourhood of Christchurch, which had been closed by the landslip of a great part of the mountain at whose base it lay From the remains of the last feast partaken of by the dwellers in this cave, it was clear that Moa eggs had been eaten by them, and therefore that the bird that laid those eggs was contemporaneous with the eaters The ornamentation of the implements, &c , found in the cave proved that the cave-dwellers were true Maoris

In the afternoon Dr Garson opened a discussion on Human Osteometry, in the course of which Sir William Turner explained and demonstrated his method of taking the capacity of crania by the use of shot poured into the cavity of the skull through a funnel, the spout of which was 2 cent long and 2 cent in diameter. It was claimed for this method that it gave the actual capacity and did not over measure it as is the case with the plan adopted by Broca.

On Tuesday Dr J G Garson exhibited some composite photographs of United States' soldiers

Dr Francis Warner contributed some Observations as to the Physical Deviations from the Normal as seen among 50,000 Children The most important defects were found to be those of the cranium as indicated by the proportion among them delicate, dull, and with nerve disorder or weakness, many of these cases are doubtless due to rickets Small heads were especially common among girls, the only defect to which they seem specially liable The greatest amount of defectiveness did not occur in the poorest districts, for in the wealthier parts of London 12½ per cent showed deficiency, while in the poorer districts only 7 per cent showed defects

The following papers were read by Prof A Macalister — On Skulls from Mobanga, Upper Congo, On some Facial Characters of the Ancient Egyptians It was remarkable how little variety was to be found in the heads of these ancients The hairs of the eyebrows were small, and that on the head was not woolly but wavy The nose was well formed, usually prominent, rather high bridged and narrow The nostrils were narrow, and very rarely was there much of a moustache The chin was narrow and tapered There were no traces of holes in the lobes of the ears Prof Macalister also read a paper On the Brain of an Australian

Dr Garson read a communication On some very Ancient Skeletons from Medum, Egypt These skeletons were some where about 6000 years old, and their most interesting feature was that in the upper and lower limbs they had markedly negro characters In the pelvis they had intermediate characters between the Egyptian and the Negro, while in the head they had well-marked Egyptian characters

The following papers were also read —C Phillips, On a Skull from Port Talbot, Glamorganshire, Dr R Munro, On Trepanning the Human Skull in Prehistoric Times, E H Man, On the Use of Narcotics by the Nicobar Islanders, and certain Deformations connected therewith

The reports of The Indian Committee, of The Prehistoric Remains of Glamorganshire Committee, of The Elbolton Cave Committee, and of The Prehistoric Inhabitants Committee were submitted

In the afternoon Mr G W Bloxam exhibited The Philograph —a Simple Apparatus for the Preparation of Lecture Diagrams, &c , and Dr Louis Robinson showed a series of photographs illustrating his paper on the prehensile power of infants

CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES

FIRST CONFERENCE, AUGUST 4, 1892

THE Corresponding Societies' Committee was represented by Prof R Meldola (chairman), Sir Douglas Galton, Mr G J Symons, Mr W Whitaker, Mr E B Poulton, Mr Cuthbert Peek, Dr Garson, and Mr T V Holmes (secretary)

The Chairman, after welcoming the delegates to the seventh conference which had been held under the new rules of the Association, said during the seven years of their existence they had, he ventured to think, done some good work for the Association and for themselves They occupied now in relation to the Association very much the same position as one of its sectional committees, and for that they were very largely indebted to Sir Douglas Galton, who had very keenly watched their proceedings, and had taken a great interest in them The report of the committee was then submitted, and the different subjects which had engaged attention during the year were dealt with under the heading of the Association Sections to which they belonged.

In Section A the Chairman introduced the subject of Temperature Variations in Lakes, Rivers, and Estuaries, but no delegate specially interested therein being present, the Conference proceeded to that of Meteorological Photography Mr. Clayden and Mr Symons spoke of the desirability of photographs illustrating the damage done by whirlwinds and floods, and Mr W Watts (Rochdale) said that the Society he represented was taking up the subject Mr Symons mentioned the Helm Wind of Crossfell and the peculiar cloud accompanying it, photographs of which would be useful Mr Watts stated that a difficulty in photographing the effects of floods arose from the state of the weather during their occurrence, and Mr Cushing (Croydon) exhibited photographs of a recent thunderstorm The Chairman then remarked that Mr. Kenward (Birmingham), who was unable to be present, had sent a letter stating that for some years in Birmingham meteorological observations had been made in the building called "The Monument" Mr. Symons and Dr Stacey Wilson discussed the mode of operations pursued at Birmingham.

After some remarks by Prof Merivale, the Chairman, and Mr Symons, the Conference passed on to Section B

In Section B the Chairman introduced the subject of the conditions of the atmosphere in manufacturing towns, and Mr Mark Stirrup (Manchester) and Mr Watts (Rochdale) said that observations and experiments were being made thereon in their respective districts

Mr De Rance (Section C) stated that the 18th Report of the Committee on Underground Waters had been read that morning; that the Committee thought it should be reappointed, and that a volume containing abstracts of the previous Reports should be published The Committee on Coast Erosion hoped to conclude its labours next year The Committee on Erratic Blocks continued to do good work The Local Societies could do much to assist this Committee by noting the position of boulders, and by preserving them from destruction Prof Lebour (Section C) postponed his remarks on Earth Tremors

Mr Watts (Rochdale) spoke upon the denudation of high-lying drainage areas, and some observations he had made on the amount of material brought down by flood waters, and the degree of protection given by heather, grass, and peat Dr H R Mill said that something had recently been done in Germany to ascertain the amount of sediment in river water He thought it very desirable that a series of observations should be made to determine the relative values of woodlands and heather in protecting land, and was inclined to suggest the formation of a Committee for that purpose Mr Watts said he would be glad to give information as to the methods followed in Rochdale

Geological Photography —Mr Arthur S Reid (East Kent) said that Mr Jeffs had asked him to speak on the work of this Committee The number of photographs amounted to about 700 He exhibited a specimen volume of photographs, and explained the way in which they were mounted and bound He thought it important that some uniform plan of photographing geological subjects should be adopted, and that the plates used should be orthochromatic or isochromatic Mr W Gray then spoke of the photographic work done by the Belfast Naturalists' Field Club, and Dr Stacey Wilson of that of the Birmingham Philosophical Society, Mr. J Barclay Murdoch mentioned the course proposed by the Geological Society of Glasgow, and the Chairman recommended the use of orthochromatic plates

The Chairman invited remarks on the destruction of native plants and of wild birds' eggs The Rev E P Knubley (Yorks Nat Union) alluded to the Report presented to Section D on the disappearance of native plants and its causes Mr Watts said that two or three members of the Rochdale Society proposed to work at this subject Mr Mark Stirrup had a short paper by Mr Leo H Grindon on the disappearance of wild plants in the neighbourhood of Manchester The Chairman thought it might be read at the second conference Mr Cuthbert Peek remarked on the great difficulty of obtaining a conviction in cases in which ferns and other wild plants had been taken from private grounds

Destruction of Wild Birds' Eggs —The Rev E P Knubley said terrible damage had been done by the destruction of birds' eggs It was a serious matter, but it was very difficult to know what to do in regard to it For instance, take the case of the great skua, which nested in the Shetland Islands, in 1890 it is said that not a single chick was reared on the whole of the Foula colony Every egg was taken, and in 1891 all the eggs of the first laying were taken by the inhabitants and sold to dealers Other rare birds which nested in the Shetland Islands were also persecuted He had it on good authority that last year not more than two or three nests of the red-throated diver got off their young, and the black throated divers were not more fortunate One shilling apiece was given by dealers for the eggs of the red-throated diver and 10*s* a brace for those of the black-throated diver The whimbrels, which also nested on the same islands, had been reduced to about twenty pairs, and were likely to disappear The red necked phalarope was very much in the same circumstances The dealers gave a commission to a local man, who was to get about 3*d* a dozen for every egg collected of all sorts and kinds The local men in turn got the herd boys to sweep the country of every egg they could lay hands on, big and little, and for these they got about 1*d*. a dozen. That was one way in which parts of Scotland had been regularly swept, and that in spite of such protection as the owners could afford They had men who followed about strangers all day, but the natives took the eggs at night Then, again, one might mention that one heard that in Edinburgh there was a gentleman who made it his boast that he had over 100 eggs of the golden eagle What was to be done with a case of that kind? In some parts of England things were not any better The nesting stations of the lesser tern which existed on the Fifeshire coast, the Lincolnshire coast, and at Spurn, in Yorkshire, would shortly disappear altogether The oyster catcher and the Arctic tern had practically ceased to nest on the Lincolnshire and Yorkshire coasts, and the ringed plover was much scarcer than formerly The redshanks and greenshanks had in many parts also been persecuted to the death. The nests of the bearded reedling, whose breeding station in the British Islands was the Norfolk Broads, had been to his own knowledge systematically poached for sale for a number of years The only hope seemed to him to be in the creation of a public feeling against the extermination of these birds It would be difficult to advocate anything like legislation The most practical plan he had seen was this—that the Imperial Legislature should grant powers to the County Councils to protect known nesting places in their districts for certain months of the year, say from April 1st to June 30th Such a plan would be simple, and might be effective, but for one thing they should endeavour to do all in their power to help the owners and occupiers of land to protect the birds and their eggs during the breeding season They might also see if they could not enlist the aid of the gamekeepers, who, with the farmers and proprietors, were beginning to find out that all birds were not their enemies Collectors and dealers should also be discouraged Just as he came there that day he had been told that 200 eggs of the stormy petrel had been taken from one island on the west coast of Ireland and given to one dealer

Mr E B Poulton, Oxford, said that if they discouraged the purchase of eggs, the trade of the dealer would soon cease

Mr G J Symons said it was an old saying that there would be no thieves if there were no receivers, and possibly there would be no dealers if there were no collectors They should discourage as much as they could this spoliation of the nests of rare birds

Mr Mills, Chesterfield, thought it would do good if some small recognition were given to gamekeepers to assist in protecting the nests of the birds

The Chairman asked if it would not strengthen the hands of Mr Knubley if the meeting was to pass some resolution on the subject

Sir Douglas Galton hoped any resolution of the kind would make an appeal to egg-collectors

A Delegate suggested that it might do some good if the name of the Edinburgh gentleman with the 100 eggs of the golden eagle were published

Mr Whitaker suggested that the gentleman with the eggs should have the feathers of the birds also presented to him with the addition of a little tar (Laughter)

Mr Knubley said he would submit a resolution at the next conference

In Section E the Chairman remarked that last year there had been a discussion on the cost and antiquity of ordnance maps Sir Douglas Galton said that a Departmental Committee was inquiring into the matter Mr Sowerbutts spoke of the badness of the teaching of geography in schools, giving examples from examination papers

Flameless Explosives —Prof Merivale (in Section G) said he had nothing to report The Durham strike had interfered with their arrangements, the proposed laboratories having been utilized as stables

Under Section H Dr Garson reported that there had been no applications to the Committee last year for aid in connection with anthropological exploration He contended, however, that local bodies, when they meant to make such explorations, should give them notice Valuable hints could be given them as to how they should proceed Notice was also taken by Dr Garson of certain anthropometric inquiries which were being conducted as to the effects on the health and physique of the public school system

The Secretary, at the request of the Chairman, read an extract from a letter of Mr Kenward, of Birmingham, giving particulars of an anthropometric laboratory established at Birmingham, like that of Mr Francis Galton at South Kensington Mr Watts and Dr. Garson added a few remarks. The Chairman proposed

that a claim should be made for the usual grant towards carrying on the work of the Corresponding Societies Committee, and the Conference adjourned

SECOND CONFERENCE.—August 9

The Corresponding Societies Committee was represented by Prof R Meldola (Chairman), and Messrs Symons, Whitaker, Cuthbert Peek, Garson, Poulton, Rev Canon Tristram, Sir Rawson Rawson, and T V Holmes (Secretary)

The Chairman made a proposal that in future some subject in which the delegates were generally interested should be brought as a short paper before the conference, such as the management of local museums, and the relations of County Councils to technical instruction, and the working of the Technical Education Acts This was considered an excellent suggestion Mr Symons mentioned that he had arranged with Mr Griffiths that delegates on the first day of the meeting of the British Association should be supplied with copies of the reports on subjects in which they were interested This would give them longer time than they had at present to make themselves acquainted with the work which was being done Mr Robert Brown thought it would be a good thing if the printed report of the proceedings of the conference of delegates could be sent to the delegates earlier than at present After some additional remarks from Mr Cushing and the Chairman, the meeting proceeded to sectional work In connection with the meteorological work in Section A, Mr Symons spoke of the value of making observations on the temperature of underground waters, especially when new wells were being formed, and Mr Whitaker remarked on the equally important point of the fluctuations of water in wells

In Sections B and C there was nothing to bring before the Committee When the work of Section D was reached an interesting discussion took place on the disappearance of native plants Mr Mark Stirrup began the discussion by reading a short note from an eminent Manchester botanist on the state of the district in that respect round Manchester Mr Sowerbutts, Manchester, said he believed the gentleman from whom the notes had been read was largely responsible for the eradication of rare plants round Manchester, inasmuch as he published a very charming book indicating where they were to be found (Laughter) Mr Coates, Perthshire, said their Naturalists' Field Club, in publishing accounts of excursions or notices in papers of rare flora, only indicated generally where these were to be found And Mr W Gray said that the Belfast Nat Field Club acted in a similar way

The Rev Canon Tristram, Durham, next addressed the delegates on the question of making their field clubs more useful He strongly advocated that these clubs should combine natural history, archæology, and geology, and that their function should be, not to destroy, but to preserve all that was rare and curious in a district Lately their field excursions in many places had been too much of a picnic party On the subject of local museums, the Canon argued that, as a rule, these should only contain objects of local interest, and he suggested that an approach should be made to the County Councils in order to get assistance for forming and keeping such museums in order In regard to spoliation of districts of rare plants and ferns, the Canon advocated the formation of a public opinion on this question On the question of the preservation from destruction of the eggs of rare birds, the Rev E P Knubley, Leeds, moved the following resolution, which was seconded by Mr E Poulton, Oxford, and agreed to —

"The conference of delegates, having heard of the threatened extermination of certain birds, as British breeding species, through the destruction of their eggs, deprecates the encouragement given to dealers by collectors through their demands for British taken eggs, and trusts that the corresponding societies will do all that lies in their power to interest and influence naturalists, landowners, and others in the preservation of such birds and their eggs."

On this subject Canon Tristram also spoke, and put in a strong plea for the preservation of birds of prey—pointing to the case of the mice plague in Dumfries and Lanark shires as a result of destroying the balance of nature by wholesale killing of birds of prey The resolution brought forward by Mr Knubley was cordially adopted by the meeting

In Section E Mr Sowerbutts said that he should like to be able to communicate during the year with other delegates who were interested in geographical education

In Section H Mr F W Brabrook brought under the notice of the delegates the Ethnological Survey of the British Isles, which it was proposed to undertake by a committee of the Association on the suggestion of the Society of Antiquaries, the Folk Lore Society, and the Anthropological Institute Schedules would be sent down to societies, and he asked the co-operation of the delegates Mr Brabrook agreed with Canon Tristram in thinking that archæology should be one of the subjects of study of a field club Mr Whitaker said that in his district the Hants Field Club always did its best to protect antiquities, and Mr Gray said that at Belfast the Field Club not only tried to preserve ancient remains, but also photographed them Some of these photographs he exhibited Canon Tristram mentioned the difficulties Field Clubs sometimes had with clergymen who were over zealous in church restoration, and Mr Tate (Belfast) alluded to the exertions of his society on that point, while the Chairman thought the clergy were not always as black as they were painted in this matter Mr Brabrook made some remarks on the best mode of making an archæological survey, pointing out the best sources of information, as regards the way of carrying it out

Finally, Mr Sowerbutts thought better terms might be obtained from the railway companies for delegates and others travelling to meetings of the British Association The Chairman and Mr Symons promised to represent the matter to the Council of the Association, and the conference adjourned

SCIENTIFIC SERIALS

THE *American Meteorological Journal* for July contains the following articles —On the appearance and progressive motion of cyclones in the Indian region, by W L Dallas The object of the inquiry is to see whether the cyclones of the Indian Ocean originate from the unequal distribution of temperature over and above the earth's surface The author favours the assumption that cyclones are a production of the upper atmosphere, and thinks that the evidence, although far from conclusive, goes to show that (1) cyclonic storms descend from and retreat to the superior layers of the atmosphere, (2) the whirl may travel along in the upper atmosphere, giving only faint indications of its presence at the earth's surface, (3) the movements of cyclones agree generally with what may be supposed to be the movements of a superior layer of the atmosphere —S A Hill, a memoir, by Edna Taylor Hill —The eye of the storm (conclusion), by S M Ballou The cause of the clearness of the eye is attributed by the author to the deficiency of the air at the outer edge of the calm, owing to the deflective force of the earth's rotation and the upward and outward movements of the air before reaching the centre, the deficiency being supplied by a gradual settling of the air over the whole area, thus dissolving the cloud stratum and showing the blue sky The author admits that the discussion of the subject shows the need of more observations concerning the phenomenon —Recent efforts towards the improvement of daily weather forecasts, by H Helm Clayton The author states in a clear and interesting form the various rules which have hitherto been established, and draws attention to a law of averages discovered by Francis Galton, which might with advantage be used in weather forecasting, for, although only applied by Mr Galton to heredity, it is probably universal For example, if a storm during a given twelve hours has moved with a velocity below the average, the probability is that it will move with a velocity one-third nearer the average during the next twelve hours —The other articles are—on the sea breeze, by W C. Appleton, and temperature sequences, by H A. Hazen, being an inquiry as to whether, if the temperature has been high or low for a certain period, we may anticipate the contrary condition shortly The inquiry does not seem to have led to any result which could be turned to practical use.

Bulletin of the New York Mathematical Society, vol i., No 10 (New York, the Society, 1892) —The opening article is a review (pp. 217 223) of "An Elementary Treatise on the Differential Calculus by Joseph Edwards" (2nd edition, Macmillan, 1892), by Miss C A Scott Whilst the reviewer praises the "lucid and incisive style," the well chosen words and the well-balanced sentences, she does not fail to make a slashing attack upon details, and to point out "certain specially vicious features" There is considerable force in Dr Scott's

criticisms, and it is probable that a careful consideration of them will enable Mr Edwards still further to improve his, in many respects, excellent treatise The remaining short contributions are a note on resultants, by Prof Haskell, and collineation as a mode of motion, by Dr Bôcher (originally delivered as a lecture before N Y M Society (pp 225 231) The usual notes, new publications, and index close the first volume of this new mathematical venture

IN the *Botanical Gazette* for June, Mr A F Foerste has an interesting paper, illustrated, on the Identification of trees in winter —Mr Charles Robertson continues his notes on the mode of pollination of American plants —Mr A P Morgan describes two new genera of fungi belonging to the Hyphomycetes, *Cylindrocladium* and *Synthetospora*

IN the *Journal of Botany* for July, M G Massee describes and figures a new marine lichen from the coast of Scotland, *Verrucaria lætevirens*, and continues his description of new species of fungi from the West Indies —Mr W H Beeby argues in favour of the occurrence of natural hybrids among plants In the number for August, Rev E S Marshall supports the claim of *Cochlearia grœnlandica*, and the editor that of *Sagina Boydii*, to be considered as British plants; both are figured In the continuation of his Notes on *Potamogetons*, Mr Arthur Bennett describes two new species, *P Delavayi* from China, and *P tricarinatus* from Australia

THE articles in the *Nuovo Giornale Botanico Italiano* for July are all geographical Among them Dr A N Berlese and Signor V Peglione give a monograph of the Micromycetes of Tuscany, 293 in number The list includes several new species, and one new genus, *Phaeopeltosphaeria*, belonging to the Sphæriaceæ —Signor S Sommier commences a very interesting description of the physical features of the lower valley of the Obi in Siberia, with some account of its botany

IN Nos 5 and 6 of the *Bullettino della Soc Bot Italiana*, most of the articles are also of local interest Signor A Jatta describes a new genus of lichens, *Sciphulastrum*, from Tierra del Fuego —Signor E Baroni gives a full description of the anatomy of the fruit and seeds of *Eugenia myrtillifolia* — Signor L Re contributes an account of the spherites found in *Agave mexicana* and other Amaryllidaceæ

SOCIETIES AND ACADEMIES,

PARIS

Academy of Sciences, August 22 —M Duchartre in the chair —Heat of combustion of some chlorine compounds, by MM Berthelot and Matignon The method of the calorimetric shell was employed for determining the heat of combustion of certain acid bodies Monochloracetic acid, $C_2H_3ClO_2$, gave + 174 2 calories at constant volume, and + 173 9 at constant pressure, as the result of two combustions with camphor in presence of arsenious acid The values obtained for trichloracetic acid, $C_2HCl_3O_2$, were + 106 3 at constant volume, and 105 4 at constant pressure Trimethylene chloride, $C_3H_6Cl_2$, burnt in the presence of an equal quantity of camphor, gave a mean of 3 900 calories per gramme of the substance —On glyoxylic or dioxyacetic acid, by the same —M Pasteur, in presenting to the Academy a work by Dr Daremberg on Cholera, its Causes, and Means of Guarding against it, called attention to the following points "Dr Daremberg, in one of the principal chapters of his book, protests with great force against the pollution of the water-courses by drain waters, and equally against the pollution of the soil by the distribution of these waters on the land under cultivation He thinks that the germs of cholera, in the form of the bacillus which produces it, can remain living and virulent in the soil for several years, and eventually lead to the spread of the disease Thus the cholera in the environs of Paris would have originated in cholera germs preserved since the last epidemic in 1884."—Thermo-chemical study of certain organic bodies with mixed functions, by M. Léo Vignon —Quantitative determination of peptone, by precipitation in the state of peptonate of mercury, by M. L. A Hallopeau. This method is claimed to be superior to the polarimetric, the calorimetric, and the absolute alcohol methods as being a complete precipitation admitting of more trustworthy measurements than the first, and less difficult than the second A solution of peptone, which must be neutral or very slightly acid, is precipitated by a large excess of mercuric nitrate The precipitate of mercuric peptonate, white, flocculent, and bulky, falls almost immediately to the bottom of the vessel It is allowed to settle, and then poured on to a filter of known weight, washing with cold water until no precipitate is produced by sulphuretted hydrogen The increase in the weight of the filter, dried at 106° to 108°, represents the weight of the peptonate of mercury, multiplying this by 0 666 gives the amount of peptone present The mercuric nitrate is readily obtained from the "pure" commercial nitrate Since this contains an excess of free nitric acid, which partially redissolves the peptonate of mercury, the acid must be removed by heating the nitrate with ten times its weight of water for fifteen or twenty minutes, filtering and heating to near boiling in a porcelain capsule Then stir and add a few drops of carbonate of soda until the precipitate of oxide of mercury is no longer redissolved —Etiology of an enzootic disease of the sheep, called Carceag in Roumania, by M V Babes In the very fertile and often submerged islands of the Danube, where the shepherds from Roumania and Transylvania congregate, and where there are always hundreds of thousands of sheep, a disease occurs among them, especially in May and June, to which often a fifth of the herd will succumb, especially if it should have been brought thither from a distant pasture It is an acute malady of a febrile nature combined with hæmorrhage and œdema, and always with hæmorrhagic and sometimes necrotic inflammation of the rectum In the red corpuscles of the blood are found round, immovable cocci, often undergoing subdivision They are very similar to those observed in the corresponding cow disease known in America as the Texas fever —On a new chemical function of the comma-bacillus of Asiatic cholera, by M J Ferran The growth of this microbe is always rapid and luxurious in the ordinary culture solutions, if they contain milk-sugar, it is incomparably more so, but the growth ceases entirely as soon as the solution becomes acid by the development of lactic acid, and the vitality of the microbe is extinguished It seems reasonable to employ lactic acid in lemonade against cholera, and to aid its action by the anexosmotic power which morphin offers us, this substance would perhaps hinder the absorption of the toxic substances, and would prolong the action of the lactic acid by opposing its rapid elimination

CONTENTS

THURSDAY, SEPTEMBER 8, 1892

THE HIGHER THEORY OF STATISTICS

Die Grundzuge der Theorie der Statistik Von Harald Westergaard, Professor an der Universitat zu Kopenhagen (Jena Verlag von Gustav Fischer)

THIS is an important contribution to the Calculus of Probabilities and the higher theory of Statistics The foundation of experience on which the whole edifice of probabilities is based has been strengthened and extended by the new material which Prof Westergaard has deposited Here, for instance, is one of his experiments — From a bag containing black and white balls in equal numbers, he drew (or caused to be drawn) a ball 10,000 times, the ball being replaced in the bag and the bag shaken up after each extraction He records not only the total numbers of each colour, but also the number of white balls in each of 100 batches, each numbering 100 balls, also in 50 batches each of 200 balls, and so on The diminution of the relative deviation from the average as the size of the batch is increased comes out clearly On an equally large scale Prof Westergaard has observed the proportion of prizes to blanks in batches of tickets drawn at a lottery, and the frequency with which different numbers, drawn under conditions such that one number was as likely as another, were observed to occur actually He has similarly tabulated the frequency with which the different digits 1, 2, 3, &c, terminate certain officially recorded amounts, the "kontis" of a savings bank, of which documents he has examined 10,000 These experiences afford new confirmation to the first principles of the calculus namely, the fundamental fact of statistical regularity which the definition of probability involves, and the postulate that certain events are independent of each other in such wise that, if the probability of each be , the probability of the double event is a quarter

Ascending from these simple experiences, Prof Westergaard reaches by a new and easy route the formula for the measure, or *modulus*, of the extent to which the observed number—*e g* of white balls in a batch of 100 or 1000—is likely to differ from the most probable number, in the instance just given $100p$ or $1000p$, if p is the probability of drawing a white ball The sought expression, it is presumed, must be a *symmetric* function of the probability of the event (drawing a white ball), which we have called p, and the complementary probability (drawing a non-white ball), viz, $1 - p$ This hint enables us to decipher from the records of experience that the modulus is proportioned to $\sqrt{p(1-p)}$ The influence of the *size* of the batch upon the extent of the deviation is similarly elicited from observation. Thus with a minimum of mathematical equipment, by easy steps and through an unpretentious *a posteriori* gate, we are led into the very stronghold of Probabilities—if not to the law of error itself, at any rate to one of its most important properties

Prof Westergaard has not only popularized the law of error, he has also proved it He has added considerably to its evidence, by observing in an immense number of instances the exact correspondence between fact and theory. We must content ourselves with citing one set of instances Ten thousand balls having been drawn at random, as above mentioned, and the composition of each batch of a 100 being examined, it was found that for twenty five out of a hundred such groups the number of white balls lay between 49 and 51 (inclusive)—limits distant ± 1 from 50, the most probable number For forty out of the hundred groups the number of white balls lay between the limits 50 ± 2 And so on The observations are exhibited and compared with theory in the annexed table —

Number of batches in which the number of white balls is between certain limits		Limits
Observed	Calculated	
25	24	± 1
40	38	± 2
50	52	± 3
70	73	± 5
85	87	± 7
95	96	±10

The multiplication of correspondences like this, the concatenation of evidence in favour of the law of error which the author has put together in his fifth chapter, is very cogent

Another sort of verification to which the law of error is submitted is to compare it with the explicit binomial to which the exponential law is an approximation This approximation is closer than may be supposed For example, if a hundred balls be taken at random, each ball being as likely to be black as white, the probability of obtaining exactly 50 balls, as evaluated by the binomial theorem, is 080, as approximately determined by the exponential law of error is also 080 The probability of obtaining either 49, 50, or 51 is, according to the exact calculation, 236, according to the approximative formula, also 236 And so on

Among other contributions to the calculus which Prof Westergaard has either adduced from authors rarely read, or himself deduced, may be noticed his elegant treatment of the case where the probabilities of two alternative events (say, drawing white or black balls) are not equal (p 70) Suppose that the probability, say p, of one event is very small, then the formula for the deviation of the number of white balls actually drawn from the number most likely to be drawn, viz np, admits of simplification The "mean error" ($=$*modulus* $\div \sqrt{2}$) is in general $(\sqrt{np(1-p)}$, in the particular case it becomes approximately $\sqrt{np}$ A further simplification may be explained by an example. Suppose that we know the number of deaths, say 900, per unit of time in a certain population Then, without knowing the number of the population, or without taking the trouble of referring to it and calculating the death-rate, we may determine approximately the fluctuation to which the number of deaths is liable. For the measure of that fluctuation the "mean error," is approximately $\sqrt{np}$, n being the number of population, a large number, and p the death-rate, a small fraction Now np is 900, and accordingly 30 is the mean error, that is, assuming that the urn in which the lots of Fate are shaken—"omnium Versatur urna

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serius ocius Sors exitura" —is constituted as simply as the urn in which we have supposed black and white balls to be shaken up This is a question in Applied Probabilities to which we are just coming

Prof Westergaard's applications of the calculus to statistics are even more striking than his developments of the pure theory of probabilities The law of error may be applied to concrete phenomena in two cases where the fluctuation of averages follows the analogy of the simpler games of chance—as we just now assumed with regard to deaths—and where this condition is not fulfilled Prof Westergaard's contributions belong chiefly to the first class He has considerably added to the instances discovered by Prof Lexis, in which a set of ratios—such as the proportion between the mortality of male and female infants in different years—are grouped according to the same law of dispersion as the percentages of white balls in a set of batches drawn at random from an urn containing black and white balls mixed up in a certain proportion The uses of this discovery are twofold—negative and positive In the first place, we may be deterred from a search after causes which is hopeless In the typical instance of the urn and balls it would be vain to trace the reason why any particular ball, or set of balls, extracted should be white (or black) We cannot hope to analyse the "fleeting mass of causes"—as Mill calls Chance—upon which the event depends We may have been able to break up our batches of balls into two classes, say rough and smooth, such that the rough balls are extracted from an urn containing mostly white, while the smooth balls are more frequently black But when this process of "depouillement" has been carried as far as possible, when we have reached the ideal type of a single urn and constant proportions, then the investigation of causes halts Then it is only crazy gamblers who hope to discover a principle underlying the "runs' of black and white balls We have reached the bounds of the territory of science, beyond there is only the sea of chance Prof Westergaard has not only indicated this limit, but also pushed many of his investigations up to it

These considerations do not preclude us from applying the theory of error to detect delicate distinctions such as the difference between a loaded and a perfect die, which make themselves felt in the averages of great numbers of observations In fact, it is by the mathematical method that we can best determine whether a difference between two averages is significant of a real constant difference, or only apparent and accidental Prof Lexis, and Dr Duesing after him had applied this method to the investigation of the conditions under which the excess of male over female births is greater or smaller than usual Prof Westergaard shows that the method is applicable to many other subjects, among which the mortality at different age-periods promises to be most useful. We could wish, indeed, for more copious evidence in favour of the premise that the mortality of a population at a certain age-period (say of clergymen or innkeepers between the ages 35-44 See *Grundzuge*, p 82, with context, and *cf* p 52) fluctuates according to the analogy of games of chance

Here the question arises: must the phenomenon under consideration be known to vary after the manner of balls extracted from an urn, in order that the mathematical method may be applicable? Certainly the apparatus of the law of error—probable and improbable deviation—may be employed to ascertain whether the difference between the average heights of two groups of two men is significant or accidental, though in this case the modulus (or mean error) does not follow the analogy of the simpler games of chance Might we not similarly compare the *general* mortality of two sections of population, although the dispersion of such death-rates about their average is much greater than it should be on the hypothesis of pure sortition. The advantage, indeed, which we have above distinguished as negative, would no longer exist in this case But might not the positive advantage still be enjoyed in some degree? Prof Westergaard, so far as we have observed, is silent on this topic

We have left ourselves too little space for noticing Prof Westergaard's other contributions to applied Probabilities His treatment of Insurance, together with the adjacent theory of Life-Tables, involving the arts of Interpolation, may dispute with Cournot's classical chapters the honour of forming the best introduction to the subject for the general reader—the reader prepared by a general mathematical, as distinguished from a special actuarial training Nor must we pass over the chapter in which the author surveys "economic" (exclusive of Vital) statistics He has here occasion to employ largely the important principle of inference from samples For instance, in order to discover the amount of wood in a country, we should first select one or more sample surfaces (*Probe-flachen*), and a sufficient number of sample trees thereat, and then measure the quantity of wood on those trees "From the figures so found conclusions can be drawn as to the whole sample surface, and from those to the total quantity of wood in the country" So in order to determine the quantity of milk, we must proceed by way of *Probe-kuhe* The method of samples is no doubt a potent instrument when wielded by a trained hand like Prof Westergaard's We may perhaps extend to economics generally what he suggests with reference to its statistical side that a given effort and expense may be better laid out in obtaining a detailed knowledge of a few parts with a general view of the whole, rather than a more uniformly distributed information

The last part of the work is devoted to a history of statistics, not a chronicle, but such a history as a great tactician would write of past wars The criticism of Quetelet's methods is particularly instructive In connection with Quetelet we may note—without assenting to—one of the Professor's objections to the principle of the "Mean Man" It is in effect the same objection as Cournot raised that the average of one limb derived from measuring several specimens might not fit the average similarly found as the type of another limb The model man constructed by putting together these averages of parts might prove to be a monster

In conclusion we venture to express the hope that this important treatise may be translated into English, in order that the insular student may not have to encounter the difficulties of German and Probabilities at once We might advise the translator to follow the excellent English custom of prefixing descriptive headings to all the

tables. As they stand, a close attention to the context is sometimes required in order to be quite certain of the principle in which figures referred to as "calculated" have been obtained. We refer chiefly to the fourth chapter. There occur also, in the second chapter, some terms vital to the meaning, which may require to be interpreted for the benefit of the English reader, e.g. *Zahlenlotto, Klassenlotterie, Kontis* relating to the *Sparbank* "Bikuben" in Kopenhagen.

F. Y. E.

THEORETICAL PHYSICS IN ITALY

Trattato di Fisico-Chimica secondo la Teoria Dinamica. Opera Postuma di Enrico dal Pozzo di Mombello. (Milano, 1892.)

THIS is an elementary treatise from the hand of the late Prof. Mombello, of the Free University of Perugia. In the general nature of its contents it might be compared to Prof. Ostwald's *Allgemeine Chemie*. It is, however, much smaller, and is indeed less of a systematic treatise than a condensed statement of the many principles and laws on which physics and chemistry are built. The English terms physics and chemistry have, under the influence of our examination systems, become so stereotyped in meaning that neither term could fitly describe the character of this *Trattato di Fisico-Chimica*. The time-honoured division of subjects would ill fit into its plan. Dynamics, properties of matter, heat, light, sound, electricity, and magnetism are certainly all treated in their more theoretical aspects; but there are also introduced the laws of chemical combination and the atomic theory, which give the book a character possessed by none of our English treatises on physics. A brief sketch of its character may not then be wholly valueless.

The treatise is divided into five parts, under the headings *Dinamica, Azione Molecolare, Elettrologia, Luce e Colore, Filosofia Scientifica.*

The first part contains much that we understand as Dynamics; but it contains a good deal more. In chapter I. (*Moto ed Energia*) physics is described as the science of motion. The universal law of nature is the law of causality, after a brief discussion of which we are introduced to four general principles—namely, the law of the conservation of mass, the law of the equality of action and reaction, the rectilinear action of force, and the composition of motions. Then follow two *General Physical Laws*, the conservation of energy and the transformation of energy (*la correlazione ed equivalenza dei moti*). Thereafter are introduced somewhat less general formulæ, which are distinguished as *Definite Physical Laws* and *Definite Chemical Laws*. Of the former, two examples are given—namely, "Pascal's Law" concerning the transmission of pressure in a liquid, and "Dalton's Law" that there is no physical action between the particles of gases, which are not chemically combinable. Then of the definite chemical laws four are particularised, being distinguished by the names of Lavoisier, Proust, Avogadro, and Cannizzaro, the last being a modified statement of Dulong and Petit's law of the specific heats of the elements. The rest of the chapter is devoted to a discussion of inertia, of Newton's laws of motion with special reference to the second interpretation of the third law, of kinetic (*attuale*) and potential energies of action at a distance, and of the conception of stress (*conflitto*) between particles. Chapter II. (*Composizione dei Moti*) is purely kinematical. In chapter III. (*Velocità moleculare*) the physical molecule is led upon the stage. Cohesion, viscosity, rigidity, porosity, volatility, critical points, crystalline form, and gravitation—in a word, the essentially molecular and *dynamic* qualities of bodies—are touched upon; and the whole finishes with an elementary treatment of the kinetic theory of gases, including an account of Crookes's experiments on radiant matter. It is satisfactory to notice that Prof. Mombello, like Prof. Ostwald, has the boldness to speak simply of Boyle's Law untainted by the Marriotte blend. This, of course, is merely historic justice. On the other hand, surely Herapath deserves mention as one of those who aided in the development of the kinetic theory of gases.

This early introduction of the kinetic theory has no doubt its merits; but a more logical course would have been to give in the first place some notion of the real meaning of temperature. This is touched upon in the immediately succeeding chapter, *Teoria termo-dinamica*, which forms Chapter I. of Part II. The treatment here is certainly peculiar. Two theorems (*enunciati*), we are told, are to be taken for the study of heat. The first embraces Carnot's doctrine of the logical necessity for a complete cycle, and his great principle of the reversibility test. Lord Kelvin's definition of temperature is brought in as a kind of corollary and dismissed in a few sentences. We hear no more of Carnot. "The second *enunciato* is concerned with the fact that in the universe an immense indefinite quantity of heat is being generated constantly during the formation of the stars." Then follows a brief sketch of some of the conclusions of spectroscopy, leading up to a broad discussion, in terms of the molecular theory, of the meaning of temperature, and of radiant energy in its four-fold aspect—thermal, luminous, chemical, and phosphorescent. After this thermodynamics, in the usual significance of the term, is presented under the guise of two propositions ascribed to Hirn. These propositions are, to all practical intents and purposes, simply the two laws of thermodynamics. But we search in vain for any reference to Joule; while Rankine and Clausius are merely mentioned as having proposed a demonstration of Hirn's second principle! Now Hirn deserves all credit for his experimental corroboration of the truth that only a fraction of the heat which leaves the boiler is transformed into useful work; but to magnify his labours in the way indicated is surely an inversion of history. Moreover there is no hint as to the relation between Carnot's reversible engine and the second principle; and the absolute zero of temperature is defined only in terms of the gaseous laws. Of entropy and the dissipation of energy we find no trace.

The succeeding chapters of Part II. are devoted to such subjects as the atomic theory (chemical) and the various aspects of capillarity, diffusion, osmose, &c. A brief account is also given of electro-chemistry, although electrical phenomena in general are not discussed till later. The seven chapters of Part III., in which electricity and magnetism are treated, form a highly condensed and instructive compendium of fact and theory, the two not always, perhaps, very clearly distinguished.

Chapter V is concerned with "The Induction Balance of Hughes", and here, for the first and last time, we encounter the name of Joule, who appears as the discoverer of the elongation of iron in a magnetic field This is, of course, thoroughly accurate, but why, we naturally ask, is there no mention of Joule's Law of the heating accompanying conduction of electricity? The whole question of resistance is, indeed, barely touched It is difficult to imagine by what process of reasoning such an important subject is omitted in a book which positively bristles with laws and principles named after their discoverers

This method of cataloguing physical laws -for it is little else at times—has its advantages, especially from an examinee's point of view It is doubtful, however, if it can be carried out consistently Prof Mombello certainly has not done so, although in the majority of cases he seems to be historically sound One objection to the method is that, as it is impossible to group physical principles, like geometrical propositions, in a logical series, and as physical principles belong to different axiomatic, experimental, or hypothetical grades, there is a strong tendency, in a compendium of the kind we are reviewing, to present these principles in a false perspective There is no doubt, however, that Prof Mombello has placed in the hands of the countrymen of Galilei an instructive and suggestive treatise bearing on the varied phenomena of molecular physics There is editorial carelessness in the spelling of foreign names, and serious faults of omission of the character discussed above But the teaching is in general sound, and Part V fitly closes with an account of Maxwell's electromagnetic theory of light, and a discussion of the character of the ether.

C G K.

THE MICROSCOPE IN THE CLASS-ROOM AND LABORATORY.

The Microscope and Histology for the use of Laboratory Students in the Anatomical Department of the Cornell University By Simson Henry Gage Third edition Part I (Ithaca, New York, 1891)

THIS is a practical handbook by a thoroughly practical histologist It is an expansion of an earlier and more concise treatise, written not for the amateur and the dilettanti, but for the laboratory student.

The recognition of the need of such a handbook is in itself an evidence of the practical character of its author, and of his knowledge of the wants of the serious student To follow intelligently the best and most suggestive histological teaching requires more than a passing or perfunctory knowledge of the use of the microscope; and this can only be really acquired by those who have at least an elementary knowledge of the principles upon which this now really complex instrument is constructed It has become an instrument of precision, and precise methods must be adopted in its use This does not mean that it is more difficult to use than it was in the early years of the last quarter of a century; but it only implies that the principles upon which it is to be successfully employed should be thoroughly understood and practised

Thus the apochromatic system of lens construction is an immeasurable gain, an improvement so great that its amount cannot be exaggerated, and these lenses are, if anything, rather easier to use than those of the older achromatic construction, but if the principles of their construction, and consequently the principles involved in the employment of them, be not understood and carefully practised, they yield results entirely unsatisfactory

Again and this is a point not referred to by Prof Gage —those who may be provided with a good battery of achromatic lenses, and do not desire to face the cost of changing these for a series of apochromatics, may come wonderfully near the best results of the finest apochromatic objectives by the use of real monochromatic light To obtain this with complete certainty, using any monochrome of the spectrum we may desire, with good lamplight, is now not only possible, but easily within the reach of all, and in such a manner as to lend itself to employment with the condenser and any magnifying power it may be needful to apply, and by this means not only is a good achromatic lens, as it were, elevated optically into an "apochromatic," but its numerical aperture is increased —the great desideratum, all else being equal, of good optical performance

These are indications enough to emphasize the importance to the medical student generally, and to the histological student in particular, of a book that will briefly and accurately give him a knowledge of the principles involved in the construction and employment of the microscope, upon his intelligent use of which so much depends, but to which, as a rule, so little time is devoted, and therefore so little knowledge is possessed

We do not for a moment suppose that a treatise like this, however well conceived and carried out, can give efficient, to say nothing of exhaustive, knowledge of optical theory, principles, and the laws and conditions of construction so as to enable a student to become in this sense a master of microscopic manipulation and interpretation, but it will go far to enable him to go through his work as a student with an intelligence and insight otherwise unapproached, and what is still more important, it will give him the opportunity of acquiring ability to see in the preparations he is instructed to make, or which he is required to study, or which he makes of his own initiative, that which he is *not* directed to look for, and which may open up for him and his science new and important paths But this cannot be done if the student is not, in a strictly scientific sense, using his instrument, and is therefore approximately certain of the propriety of the interpretation of what he has been able to make out in his preparation.

Prof Gage has adopted a system of illustrations (which we think might have been of a more refined artistic character, with much advantage) which are concisely and in the main accurately explained, and are intended to cover the entire subject, definitions, descriptions, and textual illustrations are added, which, taken together give a completeness to the treatise, that thoroughly fit it for its intended purpose In many points it is as a matter of necessity, from its very nature, inefficient, It can only indicate, and not exhaustively explain, many most important points But to the intelligent student alive to his subject, these are but spurs to

further reading, and the larger treatises, giving full explanations of the matter in hand, will not be long unread In short this treatise lays the foundation for a thorough microscopical training, entirely adapted to the wants of medical students

It is printed only on one side of the page throughout, so that the blank page is open for notes, and by using the opportunities presented with wisdom, the book may acquire, in the hands of an industrious student, a doubled value

We may note that there are some points that even with the restricted object of the book we think might have received fuller, or even more accurate treatment A fuller treatment might certainly have been given to the subject of "oblique light," which is very lightly touched, but which is none the less, to the partially instructed, whether medical student or ordinary amateur, one of the most prolific and frequent sources of erroneous judgment and entire misinterpretation, and we believe that no treatise on microscopic work, whatever its object, can be thoroughly efficient without giving it grave and careful consideration

On the other hand it would have given greater value from the point of accuracy if the details given for the "Centring and arrangement of the Illuminator," by which is meant the sub-stage condenser, had been of a somewhat later period On the use—the right use—of the condenser much of the best English work of the past quarter of a century has been spent Happily German microscopists and opticians have during the past seven or eight years begun to perceive the value, nay, indispensable importance, of this apparatus, and the firm of Zeiss have, through Abbe, made successively chromatic, and subsequently achromatic condensers of increasing value We trust they may be induced to follow English opticians and make apochromatic condensers, especially one adapted in numerical aperture to their latest optical triumph in lenses, viz, that possessing a N A of 1 60, the full value of which as an apochromatic objective can never be seen without it It is a pleasure to note that Prof Gage tells us that "for *all* powers, but especially for high powers," the condenser is of "great advantage" We believe it for the highest results, even with "low" powers, to be indispensable But it will never be by the employment of "a pin-hole diaphragm put over the end of the condenser" so that this aperture shall appear in the middle of the field, that the best possibilities of the condenser will be reached The student is plainly told that the "optic axis of the condenser and of the microscope should coincide," but the best way of securing this coincidence is certainly not stated

The blemishes of the book are nevertheless few, it has a decided purpose, and there is a large sphere for its action We believe that another edition will not long hence be called for in which its author will not find it difficult to emend and expand it in certain parts, and possibly still further to enlarge it, and we will add that we think it may not only prove of value to the students in the Anatomical Department of the Cornell University, but also to others on both sides the Atlantic.

W. H DALLINGER.

OUR BOOK SHELF

An Elementary Text-book of Magnetism and Electricity By R. Wallace Stewart Univ Corr Coll Tutorial Series (London W B Clive and Co, 1892)

IN this work Mr Wallace Stewart presents us with another of his excellent text-books on elementary science Just as his treatment of the subject was concise and clear in his book on heat and light,* so here he has followed the same lines, and has placed before the student, especially one who is preparing for the matriculation examination of the London University, a course in magnetism and electricity which will give him a thorough knowledge of the subject and a sound basis on which to make further study The illustrations and diagrams will be found to form a valuable addition to the text, while the numerous examples at the end of each chapter, if thoroughly worked out, should give a student a good insight into the art of solving problems

Key to Arithmetic for Beginners By J and E J Brooksmith (London, Macmillan and Co, 1892)

THIS key will be welcomed by all those who are employing Mr Brooksmith's excellent arithmetic It has been prepared especially for the use of teachers, who will find it a valuable aid in their work, but no doubt it will be largely demanded by those who are studying this subject for themselves, for much may be learnt by a judicious use of such a book The examples, so far as we have been able to see, have been very carefully and concisely worked out, and many difficulties that usually arise have here received careful attention

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

International, Geological, and other Records.

MY friend Mr Minchin's letter has opened a question that I have been ruminating for a very long time We occasionally hear of the organization of science, but the very ABC is at present neglected, or carried out in a spasmodic and disjointed manner Let us take for example geology We have several attempts at a catalogue and review of its yearly literature, of which I give the following examples. First comes the "Geological Record," a publication very well in its way, but making its appearance at irregular intervals, and often much behind time We have in Prof Blake's Annual the attempt of a single individual to cope with a mass of literature that it is impossible for him to read, and treating of questions that no single person is or can be qualified to deal justly with The very obvious result of this is careless reviewing, and general dissatisfaction of most authors whose papers are submitted to the abstracting process I hope Prof Blake will not take these words as a disparaging appreciation of his attempt, which I think does him much credit as a single handed worker, but it will not satisfy the geologists in general. Next we have the "Annuaire Géologique Universel," for which great credit is due to Drs Carey and Agincourt Here we have the geological literature of each country treated separately, followed by a subject literature. Each article is compiled by a specialist in his own branch, and one who is able to form a just opinion of the work and appreciate the salient points of it. Altogether the organization of the "Annuaire" is on the right lines, but I understand it is not a financial success, and I have very grave doubts if it will continue, because the supporters of one publication cannot be the supporters of several The motto "L'union fait la force" is as true in this case as in any other. Then again there is not that official character about it that there would be with international co-operation, supported by governments, scientific societies, &c. As two years' collaborator for the subjects of seismology and

vulcanology I can give some of my experiences In the first place it means a very big slice of time to read (for without this the thing had better be left alone) and review the annual literature of such subjects, for this there is no recompense whatever, but as I shall show actual money out of pocket It is impossible for the reviewer, unless residing in such towns as London, Paris, or Berlin, to see all the literature of his subject He, therefore, has to send out circulars, the expenses and postage of which, without counting labour of addressing I found to come to about 2*l* annually A considerable proportion of these circulars are not even answered by those who have published papers on the subject during the year, and I am sorry to say that in one or two cases I have had a reply insinuating that I had been "*cadging*" for a copy of the author's paper or book After the review is published come protests from authors (not many in my case, fortunately,) whom, out of common courtesy, time and money must be spent in answering Finally, with every care such a work is far from complete I would, therefore, hazard the following propositions —A preliminary committee to be formed as soon as possible to study the question of international records of scientific literature That such committee should determine the language of such records, the methods of organization of each separate subject committee, the means and resources of such, and invite the co operation of other nations

To my mind each record committee—say, for example, that of geology—should invite the specialists who are willing to collaborate to do so, should examine their manuscripts before going to print, keep a list of all known workers in that particular branch, and find as many subscribers to the work as possible The central committee should nominate the subject committees, treat with governments, societies, and universities for support, and keep a loose card catalogue of all scientific investigators in the world, to whom should be posted annually a circular requesting the dispatch of their publications, if possible with a short abstract by themselves, to the reviewer of their special subject, the names and addresses of whom should be appended to the circular In this way reduplication of reviewers circulars would not take place, and if a botanist wrote a paper on an earthquake, for example, he would be reached by the application from the vulcanologist as well as by the botanist Finally, should profits accrue in the future, I would suggest that they be equally divided annually amongst the reviewers I really hope that the subject will be taken by the horns before we reach—and we are near—a great scientific literary deadlock

Harrogate, August 30 H J JOHNSTON LAVIS

A Suggestion for the Indexing of Zoological Literature

IT is obvious that the numerous records of all sorts which comprise the zoological literature of each year are only of use so far as we have access to and knowledge of them, and that their existence is actually a very serious encumbrance to those workers who are unable to make use of them

It is self-evident that sooner or later, if zoology is to be preserved from chaos, every fact of any importance will have to be indexed for reference Otherwise, nearly the whole lives of zoologists will come to be spent in libraries, until the thing gets so intolerable that some one suggests that we burn all the books, and start afresh from nature

Of course, a great deal of indexing has been done, and is being done The "Index Gen et Spec Anim" is well on the way, and the "Zoological Record" and other works of a like nature appear annually But these are mainly records of names of species and genera described as new, and the "Zoological Record," admirable and invaluable as it is, is not always complete, nor in some sections (notably the last on mollusca) entirely accurate Much indexing is continually being done in monographs, such as the Brit Mus Catalogues, and the value of this work can hardly be over-estimated, but here again it mostly relates to *species* as such. Then there is the Royal Society's "Catalogue of Scientific Papers," which is good so far as it goes, and the still more perfect Engelmann and Taschenberg Putting aside, for the present, the question of indexing past records, would it not be a great advantage if we could begin now, and index everything as it appears? Possibly this could be done on the following plan —

Let a society be formed, called, say, the Zoological Index Society, consisting of all writers on zoological subjects who will join.

The members of the society to be provided with uniform record slips at cost price, on which they will undertake to record *everything* in their writings that they believe to be important or new These records might be under various heads, *e g*, the "semi-melanoid variety" of the leopard, described to the Zoological Society on November 20, 1883, might be indexed under *Felis pardus*, under *Melanism*, and under *Cape Colony*

These slips to be sent to the secretary of the society, who would arrange them in alphabetical order, in cabinets provided for the purpose The slips, under each special heading (*e g*, Species, Higher Groups, Variation, Distribution, &c) would form continuous series The slips of each year might be kept separate for six months, and then merged in the general index

The members would be required to pay a subscription sufficient to cover the expenses of the above, but it would probably be possible to obtain assistance from some of the scientific societies, and the most suitable place for the index to be kept is doubtless the Natural History Museum If this were accomplished, it would still be desirable to raise further funds, in order to increase the utility of the index in the following ways —

(1) By obtaining an assistant secretary, whose duty it would be to copy out records from the index for workers residing in the country or abroad, at a certain small charge The applicant might ask, *e g*, for *Limax*, or Jamaica, or Albinism, and would pay according to the number of records

(2) By publications Possibly some arrangement might be made with the Zoological Record Committee, and special publications containing the records relating to matters then of interest might appear as often as possible

Volunteer work in indexing earlier works would be acceptable Thus, some admirer of Darwin might be willing to index the works of that author But in such cases a careful list should be kept of the books indexed and every index should be complete Presumably no one will dispute the utility of an index as proposed, but some may doubt the possibility of getting sufficient co-operation If the idea of such an idex became familiar to writers, it can hardly be doubted that each would desire to place his writings on record along with the rest If a man's writings are not worth this trouble, they are surely not worth printing, unless, of course, they are of such a nature (*e g*, educational works) as not to require indexing in this manner T D A COCKERELL

Institute of Jamaica, Kingston, Jamaica, August 15

Rain with a High Barometer

IN NATURE of September 1 in your note on the Annual Report on the Royal Botanic Gardens, Trinidad, you emphasize the fact that at Trinidad it always rains with a high barometer

This is a not uncommon phenomenon in other parts of the world Last year I made a series of meteorological observations in Mashonaland, and more especially while stopping during June and July at Zimbabwe, and I there found that a high barometer was invariably accompanied by rain, and the higher the barometer the more certain and heavy was the rain. The atmosphere was driest when the barometer was lowest, and then the difference of the readings of the dry and wet bulb thermometers sometimes exceeded 20° F

This state of climate in Mashonaland is I think mainly due to the configuration of the country, which is such that moisture can only be carried there by southerly and south easterly winds, and they—as winds blowing towards the equator generally do—increase the atmospheric pressure

It will be interesting to know if some such explanation will not account for the condition of things in Trinidad, and if any of your readers can tell of a similar state of climate elsewhere.

ROBERT M W SWAN

15, Walmer Crescent, Glasgow, September 3.

The Perseids

WITH reference to the note, August 18th, that no news of the Perseids had then come to hand, I fancy the shower must have been fairly bright this year One of our scholars, C. E Elcock, while crossing from Belfast on the 9th, saw some bright meteors in ten minutes between 9 and 9.30, one lasting some time Afterwards only occasional ones occurred

J EDMUND CLARK.

Bootham, York, August 29

Variable Star T Cassiopeiæ.

FROM long-continued observations of the above star, irregularities in the ascending light curve may be expected about October or November next I shall be happy to supply a diagram of the field to any one interested in the question

CUTHBERT E PEEK

Rousdon Observatory, Lyme, September 5

THE OPPOSITION OF MARS.

THE *Times* of Saturday contains a most important telegram, giving the results of Prof Pickering's observations in Peru during the present opposition of Mars, which is one of the most favourable which has occurred during the last half of the present century The work done at Arequipa in one respect contradicts, and in others goes far beyond, the results recently announced from the Lick Observatory There can be no doubt that a considerable advance has been made by this year's results; many prior observations which have been considered doubtful have been confirmed, and an additional interest lent to the observation of the planet

The time, therefore, seems opportune for considering several questions connected with Mars, and it will be convenient to begin with the conditions of this year's observations, especially since the least astronomical among us has certainly noted with surprise the bright red star which now nightly rises low down in the south-east Nor will he or she be less inclined to regard it when it is recognized as the planet about which during the last month so much has been written of human rather than of astronomical interest. If everything that one sees in print be true, the inhabitants of Mars are signalling to us, and it only remains for us to choose our manner of reply Of course from signals the imagination of the ready writer has passed at once to words, and having got so far, each planet is about to become acquainted with the history and present conditionings of the other by means of a language understanded of our neighbours as well as ourselves

But first as to the cause of its excessive brilliancy during the last month or so, for this doubtless has had something to do with the present general interest taken in the planet. Mars was as bright in 1877, but on that occasion nothing like the present amount of interest was taken in its movements and possible structure For this there are two obvious causes—one the increasing interest taken by people in science generally, the other, popular glosses on several recent discoveries made regarding Mars itself

The popular idea that the changes which have been recently observed on the planet are changes due to the work of its inhabitants—an idea based upon a mistranslation of a word—has, of course, generated the other one—namely, that vast operations have been undertaken for signalling purposes, and from this idea the step to Mr Galton's or Mr Haweis's method of signalling back is a small one. Small though it be, however, the public interest has thereby been greatly enhanced

One of the most serious suggestions in modern times regarding signalling to bodies outside the earth we owe to a German astronomer, who some while ago enriched the world with the idea that the inhabitants of the Moon might possibly be communicated with by establishing on the vast plains of Siberia geometrical figures, such as circles, &c., built up of fire-signals, to which signal, if seen, the Lunarians would reply by reproducing them

Then the popular mind was content to bridge the chasm of 240,000 miles which separates us from the moon But *now* Mars is the objective—Mars, which at its nearest approach is 35,000,000 of miles removed!

But Mars when in opposition may be very much further away than that; so far, indeed, that it is then observed to be 1-5th of its maximum brightness, and naturally with very reduced angular diameter The two preceding oppositions at which its brightness has been at all comparable to its present one, took place in 1860 and 1877, so that we find the most favourable oppositions about sixteen years apart The reason of this will easily be gathered from Fig 1, which shows with sufficient accuracy the very elliptic orbit of Mars in relation to that of the earth The lines joining the two orbits are those connecting the two planets during some oppositions from 1830 onwards to 1871 The outer planet, Mars, is represented nearly at the *perihelion* part of its orbit, that is the point at which it is nearest the sun (and therefore the earth, if we treat the earth's orbit as a circle), and the reason that the 1830 and 1862 observing conditions were so much better than those of 1869 and 1871 is at once clear The opposition of 1877 and the present are not shown on the diagram, but they occurred at a time when Mars was not far from its perihelion

The diagram also allows us to see that at the perihelion point of Mars' orbit the planet is very nearly at the

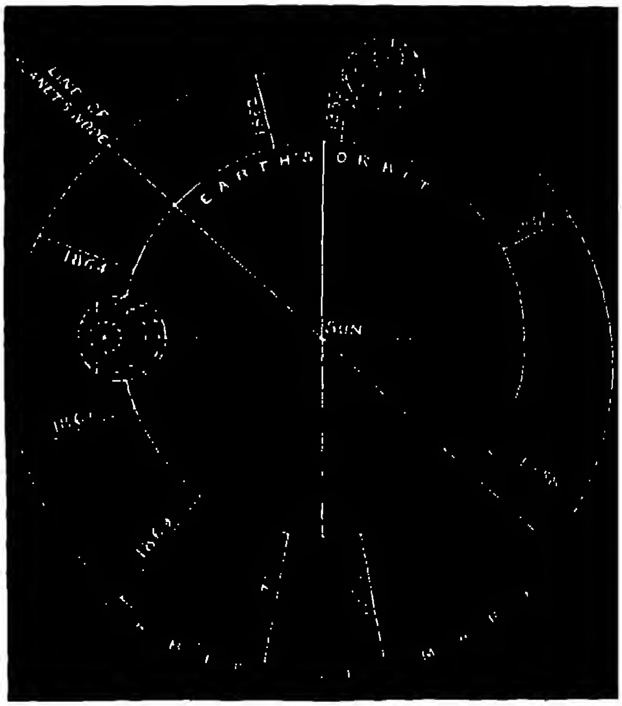

FIG 1 —The orbits of the Earth and Mars.

time of the southern solstice, the N. pole being inclined away from the sun Also that this must occur about four months before the southern solstice of the earth, the direction of the axis of which is also shown

So that at an opposition which occurs in August, as the present one does, we observe what happens in the summer solstice of the northern, and winter solstice of the southern, hemisphere of the planet. In fact, generally we have —

Time of opposition.	N hemisphere.	S hemisphere.
August	Winter	Summer
November	Spring	Autumn
February	Summer	Winter
May	Autumn	Spring

The perihelion point of a planet's orbit is astronomically expressed by its heliocentric longitude, and the apparent size of its disc (on which its apparent

brightness depends) by its semi-diameter in seconds of arc. Presuming that the longitude of the perihelion of Mars may be taken as about 334° the following table will show how the great brilliancy of the planet in 1877 and the present year was caused; other less favourable oppositions are given for purposes of comparison:—

Date of opposition	Semi-diameter ″	Heliocentric longitude of planet
1862, October 5	10·8	12
1869, February 13	8·2	145
1873, April 27	9·7	217
1877, September 5	**14·7**	**343**
1881, December 26	9·2	95
1884, January 31	8·3	132
1888, April 10	9·2	201
1892, August 13	**14·7**	**312**

So much, then, for the distance conditions. At its nearest approach the planet is 35,000,000 miles removed—let us say 150 times more distant than the moon.

We next come to the conditions of visibility. Mars is nearest to us (the degree of nearness depending upon its position in its orbit) when "in opposition," as we have said—that is, when it is in the south at midnight, and opposite the sun, the sun then being, of course, due north below the horizon. It will then appear to us "full," as the moon is said to be full when she occupies an analogous position. At this moment, then, the earth is invisible to the inhabitants of Mars unless she happens to transit the sun's disc.

The earth appears to Mars precisely as Venus does to us, and if inhabitants there be on Mars, and they study astronomy, a transit of earth to them will be what a transit of Venus is to us.

Further, as we see Venus as a half-moon, and when nearer to us as a fine large crescent, so the Martians, as the earth approaches them, will see her as a half-moon and then as a crescent, getting finer as the apparent diameter of the completed circle gets greater.

Mars, to see us best, must occupy a point near its perihelion. These things may be gathered from Fig. 2, in which an opposition at Mars' perihelion is shown, the orbits, but not the size of the bodies concerned, being to scale. Before the conjunction of the three bodies (in the line Mars, earth, sun) is approached, Mars will first have the earth as a half-moon at a; this will gradually melt into a crescent till the moment of conjunction. Afterwards the crescent will broaden, and its diameter will be reduced till the point a' is reached, when the earth will appear as a half-moon again.

It is clear, therefore, that the earth will be a morning and evening star to Mars at the time of their nearest approach. The earth's crescent must not be too fine, or no observation will be possible on a dark background of sky. In other words, although we can observe Mars best when he is nearest, the privilege of seeing the earth when nearest to Mars is denied to his inhabitants.

We are now, then, in a position to discuss, so far as the mere conditions of visibility are concerned, the two suggestions as to earth-signalling to which I have already referred.

Mr. Galton's proposal depends upon the observation that a "reflected beam of sunlight sent through a hole in a plate in front of the mirror was just distinctly visible as a faint glint at a distance of ten miles when the hole was a square of one-tenth of an inch in the side." He then adds: "The amount of fog and haze that a beam of light would traverse between us and Mars when the planet was high above our horizon could not exceed that along a terrestrial base of ten miles; consequently the same proportion between the size of mirror and the distance would still hold true. It follows that the flash from many mirrors simultaneously, whose aggregate width was fifteen yards, and whose aggregate length (to allow for slope) was, say, twenty-five yards, would be visible in Mars if seen through a telescope such as that at the Lick Observatory. With funds and good will, there seems no insuperable difficulty in flashing from a very much larger surface than the above, and sending signals that the inhabitants of Mars, if they have eyes, wits, and fairly good telescopes, would speculate on and wish to answer. One, two, three, might be slowly flashed over and over again from us to them, and possibly in some years, to allow time for speculation in Mars to bear practical fruit, one, two, three, might come back in response. Dr. Whewell, if I recollect right, wrote a paper on the possibility of coming to an understanding with lunar inhabitants, if there were any. He would begin from the mathematical side. The practical difficulty is by no means insuperable of enabling many independent observers (who need not be near together) to direct their flashes aright. If mirrors could be mounted without much cost as heliostats (and perhaps they can be) it would be easy enough to do this. My own method is not practicable, at least without considerable addition and

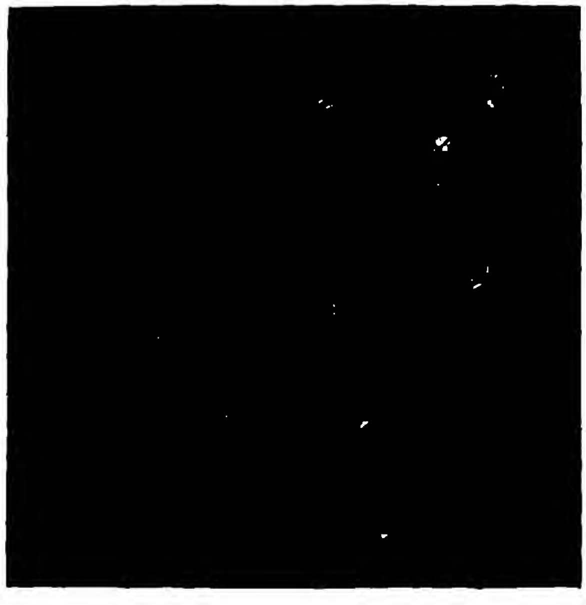

Fig. 2.—The Conditions of Visibility of the Earth from Mars.

modifications, as it requires the object to be visible towards which the flash is directed, but Mars is not visible to the naked eye at day."[1]

Mr. Galton then uses sunlight and works in the day; Mr. Haweis, on the other hand, suggests electricity and night-time:—

"I infer from the astronomers that a signal on our earth about six miles in size of the nature of a bright light could be seen by the inhabitants of Mars, who by all accounts seem to be making the most systematic and herculean efforts to communicate with us by flashing triangular signals of presumably electric light. Why cannot we answer those signals by something which would resemble the lighthouse intermittent signal? Here is the method. London every night presents an area of at least twelve miles square brilliantly illuminated. That illuminating power might be enormously increased with only a few additional centres of powerful electric light. But without *any additional expense*, a little co-operation on the part of the gas companies would suffice to alternate darkness and light at intervals of five

[1] *Times*, August 6, 1892.

minutes over the whole of London between certain hours when traffic is more or less suspended. If only tried for an hour each night some results might be obtained. We have actually the mechanism for interplanetary communication every night—why not use it?"[1]

Mr. Galton is careful to point out that his method of signalling requires sunlight, and that the signals are to be flashed to Mars in the Earth's daytime; the moment of opposition therefore is at once out of the question. Even with the Earth at either *a* or *a* in our Fig. 2, the Sun and Mars would be 90° apart, and in any case the signals would be visible to the Martians (if visible at all) on the part of the earth lit up by the Sun. This does not seem a favourable condition, or at all events the most favourable one.

Mr. Haweis' plan secures a much stronger contrast. If it or something like it could be carried out, we can imagine the inhabitants of Mars studying the delicate earth crescent (with telescopes as powerful or more powerful than our own *bien entendu*), whether as a morning or evening star, and then seeing rhythmic flashes, reproducing the star included in the crescent of the Ottoman flag well within the horns of the crescent. Here we certainly get light on dark instead of light on light.

But there are other conditions of visibility besides those we have so far discussed. Supposing the whole electric energy of London turned on Mars would the volume of light be sufficient to produce a valid signal?

It is worth while, quite independently of the popular expectations of the present moment, to inquire into the actual conditions of the problem, telescopes on Mars as powerful as our own being always assumed.

If we are armed with a powerful telescope, under the best seeing conditions, first among which is its location at a considerable elevation, we may perhaps reckon upon using a power of 1000, that is, the object is magnified a thousand diameters; in other words, it is brought a thousand times nearer. In the case of the moon, under these conditions any part of her we might choose to study could be examined, as if from London we were viewing it over Yorkshire with the naked eye.

The late Mr. Lassell, I believe, claimed as the highest achievement possible with his 4-foot telescope in the pure air of Malta, that if the lunarians were shaking a carpet as large as Lincoln's Inn Fields he could see whether it was round or square. This then would be the *ne plus ultra* in the case of a body 240,000 miles away.

Now, if we take the nearest distance to Mars as 35,000,000 miles, as I have stated,

			Miles	
1,000,000 magnifying power would give us the power of studying Mars as if it were			35	away from us
100,000	ditto	ditto	350	
10,000	ditto	ditto	3500	
1000	ditto	ditto	35,000	

We can put this differently. To the naked eye at the distance of Mars 1" = 160 miles. Were Mars 1000 times nearer 1" would become 16 mile. Now this at first seems very hopeful, for the exterior satellite of Mars has been seen in various telescopes.

We have already learned that the power employed last month at the Lick Observatory has not been so much as 1000, but such that the planet has been brought within a distance of 50,000 miles. Under these conditions a line on Mars a quarter of a mile long will subtend an angle of 1", or two lines a quarter of a mile apart should be separated and appear as doubles.

The second satellite to which reference has been made is only some 10 miles in diameter. We are justified by the visibility of the satellite, then, in saying that if a space 10 miles in diameter could be lighted up, as brilliantly as by sunlight, on the dark hemisphere of the Earth when Mars is above the horizon and at perihelion, it could be seen from Mars by telescopes equal to our own.

London, of course, is more than 10 miles in diameter, and we can imagine all the navies of the world with their search lights to flash simultaneously towards the planet, or to light up the clouds in a space as large as London, but there then will remain the question of the intensity of the light. What do electricians say is possible in this direction?

Whatever the answer to this question may be, it seems that signalling on Mr. Haweis' lines, light on dark, is a more hopeful proceeding than that suggested by Mr. Galton, and that on this system our conditions for reading signals are far better than those on Mars, as our dark hemisphere is much more exposed to our sister planet than is hers to us.

It is time now that we turn to those recent observations of our neighbour which have given rise to the ideas we have been discussing—ideas based upon the supposition that there is evidence which goes to show that the Martians are signalling to us by digging "canals" 1000 miles long and 200 miles wide, and then doubling them, and in addition lighting numerous signal fires or flashing electric lights!

Here we approach a region of astronomical inquiry which requires no enhancement of its interest by the intrusion of popular delusions or imaginings, which, moreover, for the next few months as details come to hand, will have all eyes directed to it.

It is not necessary to go further back than the year 1830 to appreciate the importance of the later inquiries. In 1830 Beer and Mädler made an admirable series of drawings of the planet which enabled them to affirm the existence of fixed markings, and having fixed markings, not a long series of observations was necessary to determine the period of the planet's rotation on its axis.

In 1862 I (and many others) had no difficulty in recognising the features on the planet which Beer and Mädler had observed with smaller optical power thirty years before. The instrument employed was a 6-inch Cooke achromatic, which I still hold to be one of the finest telescopes ever made. It enabled me to add details to those before noted, and the observations left no doubt on my mind that Mars had an atmosphere like our own; that its temperature did not vary many degrees from our own; that there were land surfaces and water surfaces; clouds and very obvious cloud drift; polar snows which melted with marvellous rapidity as the perihelion sun made its full strength felt. Further, that the changes in the appearances observed, especially in the lighter or darker shading, depended upon clouds and the smoothness or roughness of the water surfaces.

This latter conclusion I arrived at from the fact that the darkest markings, assuming them to be water surfaces, were more or less land locked, and that changes in some of these surfaces were always most obvious close to the land. It was clear also that the rapid melting of the polar snow must be accompanied by tremendous inundations.

I append, as an example of the kind of work done on the planet with the small refractors generally available thirty years ago, some extracts from a memoir I communicated to the Astronomical Society at that time.[1] The large refractors employed added so far as I know very little.

"Although the complete fixity of the main features of the planet has been thus placed beyond all doubt, daily—nay, *hourly*—changes in the detail and in the tones of the different parts of the planet, both light and dark, occur. These changes are, I doubt not, caused by the transit of clouds over the different

[1] *Pall Mall Gazette*, August 18.

[1] Mem. R.A.S. 1863, p. 179.

features The effect of a cloudless and perfectly pure sky, both here and on Mars, appears to be that the dark portions of the planet become darkest and most distinctly visible, the coast-lines (if I may so call them) being at such times so hard and sharp, that (as has been mentioned by Mr Lassell) it is quite impossible to represent the outlines faithfully, and this effect, be it observed, is completely distinct from the way in which the features grow upon one. MM Beer and Madler remark 'Generally some time elapsed before the undefined mass of spots seen upon first looking into the telescope resolved itself into recognizable parts' This observation will commend itself to all who have observed such a delicate object

"The effect of clouds, on the contrary, will be, I think, to make the *dark portions less dark* in proportion to the density of the clouds, and the *light portions lighter* in the same proportion *It can never make a light portion dark* If this be so, when we see a dark spot well defined, we can be sure that no clouds are above it, and that we actually see the planet itself, we cannot be sure, however (unless we are acquainted with the locality from previous observation), that dark spots do not underlie any of the lighter portions Some instances of cloud-transit were suspected by Father Secchi in 1858 Several unmistakable instances occurred during my observations

"But besides the cloud-masses, which, as we have seen, obliterate the dark portions either partly or wholly, giving rise to different contours and tones, and rendering the actual features of the planet undistinguishable, the dense atmosphere of Mars, with its fogs and mists, appears to go for very much I mention this more especially to point out that—although its effect was evident in the southern hemisphere in mid summer, upon the spots as they came on, and left the disc, as remarked by previous observers—it was much more evident in the northern hemisphere in mid winter, blotting out, as before remarked, *even on the central meridian*, all features north of + 30° latitude This would appear to furnish another proof of extreme seasons on Mars, in addition to that supplied by the rapid melting and great extent of the polar snows, and to point out the desirability of taking advantage of all oppositions which happen, as did those last year and in 1830, in the full summer-time of the southern hemisphere, when the atmospheric conditions of the planet may be considered the best possible With regard to this last point, it may be remarked that the southern hemisphere is the one which we shall ever be able to study best, in consequence of the great distance of the planet from us at those oppositions which occur when the northern one is turned to us

"With regard to the green and red tints so often noticed on Mars, my observations have led me to hold the same opinions as to their nature as those arrived at by Father Secchi in his study of the planet in 1858 Nor do I think that it can any longer be doubted that—as he considered probable—the green and red portions do actually represent seas and continents, and are not the effect of contrast

"The dark portions were noticed to be decidedly green in my instrument, both by myself and others who observed Mars from time to time with me, the colour being especially marked in Beer and Madler's spot *p n* (Drawings Nos 7 and 8) In spite of the over correction of my object-glass, which should have 'reinforced' the red tinge, it was never sufficiently decided, I think, to suggest a contrast, and, indeed, the green was sometimes unmistakable when the red was not noticed, and when therefore there was no contrast to mislead the eye

"Another point of agreement between the two series of drawings is not a little remarkable the spots which were observed to be of a most decidedly dark tint in 1830 were darkest last year, and supposing the dark portions to be water, the darkest spots are those which are nearly, if not quite, land-locked. Passing on from the consideration of the general features of the planet, the snow zone next demands our attention. . . Last year the solstice occurred on August 30, on the 23rd of which month the snow-zone was estimated to be $\frac{1}{5}$ of the apparent diameter, by the 25th of the next month, September, this was reduced to about $\frac{1}{10}$, and again to $\frac{1}{17}$ by October 11, when it was at times scarcely discernible, after which it began apparently to increase again

"To the great eccentricity of the orbit of Mars, and the fact that the summer of the southern hemisphere occurs when the planet is near perihelion, is doubtless to be ascribed this very rapid melting of the southern snow-zone, an observation confirmed by the much slighter variation in the dimensions of the opposite one. It appears to follow from my drawings, and I think also from those of Messrs. Beer and Mädler, although they make no mention of the fact, that even at its minimum the centre of the snow-zone was not absolutely coincident with the planet's pole, being situated in somewhere about 20° of areocentric longitude (using Beer and Madler's start point), and in a latitude probably only a very few degrees from it . The snow-zone was at times so bright that, like the crescent of the young moon, it appeared to project beyond the planet's limb This effect of irradiation was frequently visible, on one occasion the snow-spot was observed to shine like a nebulous star when the planet itself was obscured by clouds, a phenomenon noticed by Messrs Beer and Madler, recorded in their valuable

FIG 3. Mars September 25, 1861 showing the darker shading of a land-locked water surface and its projection into the open water beyond

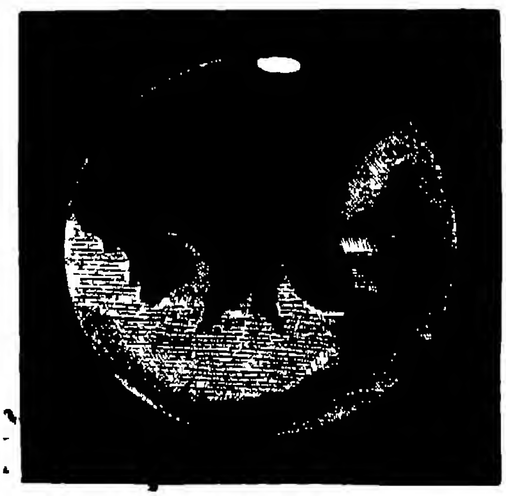

FIG 4 Mars September 25, 1862, showing bright appearance of snow cap, and the details of one of the chief coast lines

work, *Fragments sur les Corps Célestes* The brightness, however, seemed to vary very considerably, and at times, especially when the snow zone was near its minimum, it was by no means the prominent object it generally is upon the planet's disc"

We owe it to the illustrious Italian astronomer Schiaparelli that a world of wonders undreamt of thirty years ago now forms the chief subject of inquiry. His work was begun at the opposition of 1877, which, as we have seen, was as favourable as the present one, and continued during that of 1879-80 He showed that those

parts of the planet which had been regarded by myself and others as the land surfaces, instead of being wanting in detail, as they had been seen, were really riddled by streaks, many of them very long and very straight, but in every case running towards a water surface, and in many cases connecting two water surfaces These streaks he called *canali*, which in Italian, as *canalis* in Latin, means either a channel, a canal, or a pipe Unfortunately, however, whenever it has been translated into English the word *canal* has been used, which of course with us suggests human labour We have already seen what this has led to

As a result of this minute inquiry rendered possible by his fine instrument (8¾ in Merz) and perfect observing weather, a complete map of the planet with these channels was made [1] But this was but the beginning of marvels During the opposition of 1881-82 the work was continued, and now Schiaparelli, besides endorsing all the discoveries of 1880-81, found that in at least twenty cases the channels were doubled and consisted of two streaks 200 or 400 miles apart, instead of one I append a copy of the sketch map he gave in his preliminary communication to the Academy of the Lincei [2]

He distinctly stated that the doubling of these channels seemed to be connected with the time of the planet's year, and to occur simultaneously over the superficies of the planet which is supposed to represent land. When the opposition took place in August, that is in the full winter of the northern hemisphere, no trace of the doubling was visible which is precisely what we should expect if the doubling depended in any way upon inundations caused by the melting of the northern snows, the north pole being turned away from the sun The vernal equinox took place on December 18, 1881, and the opposition took place in the same month The doubling of 17 of these channels was observed between January 19 and February 19—that is, in the late spring of the northern hemisphere, which again is precisely what we should expect if they were connected with inundations.

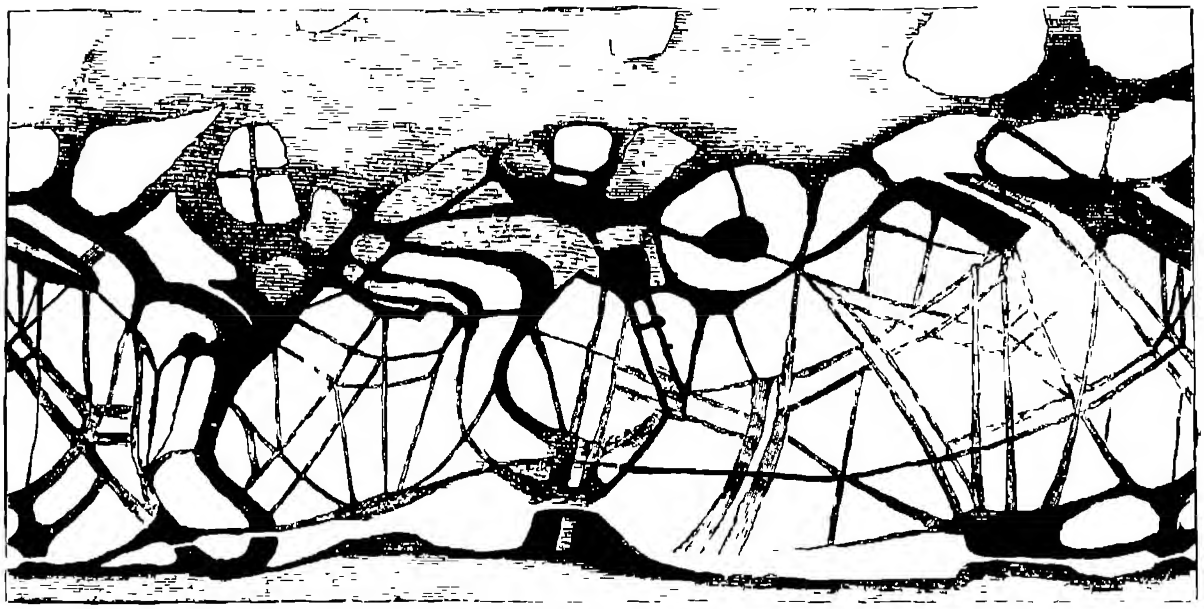

FIG 5 Doubling of the channels, observed by Schiaparelli in 1882

Not only was this wonderful change noted, but here and there bright spots (previously noted by Green in 1877, and recalling Dawes' "snow island," seen in 1865), were recorded

In the doubling of these water channels then, and in these snow tipped hills, we have the origin of the "canal digging" and "fire signals" of which we have lately heard so much

It will thus be seen that the widespread notions of the signals from Mars rest only on a mistranslation and upon the popular imagination running riot among the startling revelations of modern observers, among whom in this special line of work Schiaparelli must be acknowledged as *facile princeps*

The observations which engendered invention in one class of minds engendered doubts in others, but the work of Perrotin and Thollon at Nice in 1886 with the 15-inch refractor has completely endorsed the main points advanced by Schiaparelli with regard to the existence of the channels or straits Two or three references to their published papers will show clearly what their view of the relation of them to the variously-tinted parts of the planet really is -

"The triangular continent, somewhat larger than France (the Lybia of Schiaparelli's map), which at that time stretched along both sides of the equator, and which was bounded south and west by a sea, north and east by channels, has disappeared The place where it stood, as indicated by the reddish-white tint of land, now shows the black, or rather deep-blue, colour of the seas of Mars. The Lake Mœris, situated on one of the channels, has also vanished, and a new channel, about 20° long and 1 or 1°5 broad, is now visible, running parallel with the equator to the north of the vanished continent This channel forms a direct continuation of a previously existing double channel, which it now connects with the sea Another change is the unexpected appearance about the north pole of another passage, which seems to connect two neighbouring seas through the polar ice" [1]

A short time afterwards M Perrotin stated that this same district of Libya, had undergone a further change, the "sea" which had so recently covered it having retreated

[1] Osservazioni astronomiche e fisiche sull' asse di rotazione e sulla topografia del planeta Marte R. Accad dei Lincei, 1880 81

[2] Memorie della Soc. Spettroscopisti Italiani, vol ix Dis. 6, p 25

[1] Abstract in NATURE May 21, 1888

again for the most part, so that the appearance of the district was intermediate between that which it recently presented and that under which it was seen in 1886 Of the channels M Perrotin has noticed four, three of which are double, which, starting from the "seas" of the southern hemisphere near the equator, and following a nearly meridional course, extend right up to the north polar ice cap, being traceable across the "seas" which immediately surround the latter

Although Schiaparelli, as it will have been seen, connects the changes in the channels with the seasons of Mars, and although Perrotin and Thollon show their relation to the seas in their vicinity, other explanations of the phenomena have been suggested Among these we must first refer to the view of Fizeau,[1] that we were in presence of the results of glaciation on a tremendous scale, the parallel ridges being likened to crevasses or rectilinear fissures! It was imagined by him that relatively longer seasons and a lower temperature were capable of producing crevasses some thousands of miles long and hundreds broad

But this was not the only physiographic explanation offered Mayeul Lamey, a Benedictine monk, ascribed the channels to volcanic action, to him they were the remains of enormous crater walls, and he states that they are best seen when Mars reaches its most gibbous form and the angle of the incident light is greatest

"Le plus souvent les astronomes se bornent a observer Mars vers l'époque de son opposition, c'est-à-dire de sa plus grande proximité de la terre, c'est, pensent-ils, le meilleur moyen de voir bien et de près les 'mers' de Mars Si ces taches étaient des mers la raisonnement serait excellent, mais il n'en est pas ainsi M. Schiaparelli a déjà fait la remarque que les canaux découverts par lui ont été observés non au voisinage de l'opposition mais un mois, deux mois après Et pourtant la planète est alors bien eloignée déjà de nous Pour moi, je constate également le même fait, je découvre tous les soirs un nombre de cirques de plus en plus considérable La raison en est bien simple, du moment que les taches sont des ombres, ou du moins des parties réfléchissant moins lu lumière A l'époque de l'opposition, en effet, les rayons solaires tombent à peu près perpendiculairement sur la surface de la planète, Mars ne possède alors pas de phase, tandis qu'un mois avant ou après, la phase est très accentuée et les ombres deviennent possibles avec les élévations du sol."[2]

Another attempted explanation was that the channels were doubled in consequence of some play of diffraction But enough has been said on this head, let us rather turn to the first fruits of last month's work

At the Lick Observatory the channels were seen, and one of them was considered by three observers to be doubled

From Peru we learn that Prof Pickering saw many of the channels observed by Schiaparelli, but all were found to be single The telegram adds, "not double, as stated by him", but here is an error. We are near the southern solstice, as in 1877, and they were *not* seen double at that epoch But even this is comparatively uninteresting after the revelations as to the effects of the melting snows.

Prof. Pickering discovered two mountain ranges in Mars to the north of the green patch near the planet's south pole. Between these mountain ranges the melted snow has collected before flowing northward. In the equatorial mountain regions snow fell, covering two of the summits, on August 5 On August 7 the snow had melted "I have seen eleven lakes," the professor writes, "varying in size. These lakes branched out in dark lines connecting them with two large dark areas like seas, but not blue There has been much local disturbance in the clouds round the planet since the snow melted, as is evident from the dense clouds which were concentrated within one area These clouds were not white, but yellowish in colour, and partly transparent They now seem to be breaking up, but are still hanging densely on the south side of the mountain range The northern green spot has been photographed"

Surely we have here the connection between the work of 1862 and 1877 The channels are true water channels, at one time at low channel we may have an unimportant stream like the low Nile, at another an ancient river-bed as it were, is filled to the utmost limit by the inundation One requires to have seen an Indian river, or better still, the Nile valley to realize what an inundation may mean, and especially under the conditions which have now been established to exist on Mars But we may go further A comparison of Schiaparelli's sketch of 1882 with his map of 1879, helps us considerably, and shows that we must take the effect of clouds over warm water into consideration Two among the most undoubted and continuous water-surfaces which I observed in 1862, which he has named Mare Cimmerium and Sabæus Sinus, were doubled also in 1882, and in my mind there is no doubt whatever that this doubling, at all events, is due to cloud banks lying, or rather travelling longitudinally, along the centre of the water-surface, precisely as the most magnificent cumuli which I have seen on this planet, follow the Equatorial current, entering the Carribean Sea by Tobago Obviously, by their lightness of shade, the channels are shallow, and they are only noticed in or near the tropics, so that the water must be highly heated before it empties itself into any of the southern seas

Certainly it must be acknowledged that while the revelations show a remarkable similarity to our own atmosphere, so far as chemical structure and temperature are concerned, for the *onus probandi* lies with those who deny that we are dealing with the various forms of water, it would appear that the extremes of heat and cold are more generally operative in Mars than with us The problem thus presented to us should prove interesting to the geologist Was there any period in the earth's past history, or can there be in the future, which more resembles the present Martian conditions? Had we these enormous inundations, chiefly caused by polar snows melting? If not, were we sheltered from them by our more circular orbit and shorter year? Is Mars red because it is muddy? If so, what mud could give it the tinge we know?

J NORMAN LOCKYER

NOTES

FOR some days much anxiety was felt as to the condition of Sir Richard Owen We are glad to say that his health has greatly improved, and that he is now able to take more nourishment

THE four hundredth anniversary of the discovery of America is being celebrated this week with great splendour at Genoa The King and Queen of Italy are taking part in the celebration, and the maritime Powers are represented by a fine assemblage of warships

A BOTANICAL CONGRESS, which is attended by some of the most eminent botanists of Berlin, Paris, Jena, and St. Petersburg, was opened at the University of Genoa on September 5

AN interesting ceremony took place at the University of Genoa on Tuesday, when the Hanbury Institute was formally handed over to that body. The correspondent of the *Times* a Genoa says that Mr Thomas Hanbury, an English gentleman whose house at La Martola, near Ventimiglia, is well known to visitors to the Riviera, had already won the gratitude of Italian

[1] *Comptes Rendus*, June, 1888.
[2] "Note sur la Découverte du Système Géologique Éruptif de la planète Mars." Par Fr. Mayeul Lamey, O S.B Autun (Dejussieu, 1884.)

by his generous deeds in that neighbourhood, and a year or two ago he offered £4000 to found an institution in Genoa for the encouragement of the study of botany Senator Secondi, president of the University, gave expression to a sincere feeling of gratitude towards Mr Hanbury, and accepted the gift of the institute in the name of the University A large number of distinguished botanists, who are attending the congress now being held there, were present at the ceremony

THE meeting of the German Mathematicians' Union in Nürnberg, and the Mathematical Exhibition, are postponed on account of the cholera

THE German Chemical Society have resolved to found an Institute in remembrance of the late Prof von Hofmann Large funds will naturally be required, and all pupils and those who honour Hofmann's life and work are earnestly requested, in a recently issued circular, to send contributions Even those who had no personal knowledge of the illustrious *savant*, but have been inspired to work by his example, will no doubt be willing to take part in the scheme The proposed Institute will not merely serve chemical purposes, but will be a place of general scientific research

THE International Congress of Physiologists has held its second triennial session at Liege with Prof Holmgren (Upsala) as President, in the Physiological Institute under Prof Léon Fredericq The Congress terminated on Thursday, September 1, after a banquet at which the Burgomaster of the city was present More than one hundred physiologists attended the Congress

THE thirteenth Congress of the Sanitary Institute will be held at Portsmouth from September 12 to 17 Sir Charles Cameron will preside. The Congress will be divided into three sections—one dealing with sanitary science and preventive medicine, another with engineering and architecture, and a third with chemistry, meteorology, and geology Conferences will be held by naval and military hygienists, by medical officers of health, by municipal and county engineers and surveyors, by sanitary inspectors, and by ladies on domestic hygiene A health exhibition, including sanitary apparatus and appliances, in connection with the Congress, will be held in the Drill Hall from September 12 to October 8

A PHOTOGRAPH of the late Admiral Mouchez—one of the best photographs of him we have seen—appears in the July number of the *Bulletin Astronomique*, which journal owes its existence to his indefatigable exertions. There is also a brief account of his life written by M Tisserand

THE sixth session of the Vacation Courses, known as the Edinburgh Summer Meeting, has just come to a close after a very successful month's work The importance of this meeting increases year by year with the steadily increasing number of students, and with the more complete organization of the plan of study. This has again been arranged so as to assist in the training of school teachers and University Extension lecturers for the new duties which are beginning to devolve upon them in connection with the requirements of County Councils for technical education Hence the principle of "Regional Study" has again been kept prominently in view, Edinburgh and its districts being taken as a typical area, and affording a starting point and vivid concrete illustrations for the courses on sociology and anthropology (Profs. Geddes and Haddon) on the one hand, and on the other for those on biology (with special courses of zoology and botany) and physiology by Mr J Arthur Thomson, Prof Haycraft, and others. The course on literature by Prof. Moulton, which was very largely attended, followed to a large extent the same general lines as the more purely scientific courses The work in the historical seminary and the studio was continued, and a series of technical education lectures was given in the evenings by Principal Dyer, Profs Mavor, Geddes, and Prince, Mr C Williams, and others Many nationalities were represented among both students and teachers. Besides many British Association and other visitors, Profs. Haeckel (Jena), Delage (Paris), attended the meeting Special lectures were delivered by Profs Devine and Rolf (Philadelphia), Profs Manouvrier and Demoulins (Paris), Principal Dyer, Profs Mavor, Prince, Lloyd Morgan, Sollas, Messrs R Aitken, W Renton, R Irvine, and others A series of interpretative recitals by Prof Moulton, and four concerts illustrating the history of music were also given

FIFTY scholarships, named the Townshend Scholarships, from funds bequeathed by the late Rev Chauncey Hare Townshend, for working class boys or girls between 14 and 21, to be held for one year, have just been established in connection with the Westminster Technical Institute, 40 being free and 10 competitive The subjects taught in the Institute, which was founded by the Baroness Burdett Coutts, are rudimentary, commercial, and technical, and include drawing, technical, mechanical, and artistic, geometry, practical, plane, and solid, working in wood, lead, metal plate, &c, cookery, dressmaking, shorthand, foreign languages, &c

A REMARKABLE grotto, which is exciting the interest of French geologists and mining engineers, was recently revealed by an explosion during the progress of the ordinary work in a quarry at Taverny The Paris correspondent of the *Times* says there is a subterranean gallery, with walls polished as if by water, and that it is some 1500 feet in length, and ends in a great chamber about 40 feet in diameter and 6 feet in height Scientific men have hazarded various conjectures as to the source of the watercourse by which this cavity seems to have been formed

MR HERMANN KRONE gives, in No 7 of Wiedemann's "Annalen," an account of some further experiments connected with the photography of spectra in their natural colours by Lippmann's method He finds that the correct rendering of the various colours depends upon a high degree of accuracy in the proportions of the finely divided silver haloid and the colour sensitiser, as also upon the temperature of drying, the exposure, and the development If the essential conditions are not fulfilled, it may happen that yellow appears in the place of red, or that green exhibits a direct transition into violet, the blue being unrepresented The result also depends upon the amount of water contained in the film, as influencing its thickness, and in the case of the solar spectrum upon the altitude of the sun With a very long exposure the infra red appears as a dark purple, and the ultra-violet as a yellowish-pink lavender colour Mr Krone has also succeeded in producing coloured photographs without Lippmann's mercury mirror He simply covers the film with black velvet, exposing, as Lippmann did, through the glass In this case, the reflection from the inner surfaces of the glass takes the place of that from the mercury. The exposure has to be considerably prolonged, and the colours towards the red end are less pure; but the blue, violet, and ultra-violet are quite as brilliant and well defined as in the mercury process.

DURING the past week the weather has assumed a decidedly autumnal character, the maximum temperatures being below 65° in many parts of the United Kingdom, and below 55° in some of the northern parts For the first few days depressions from the Atlantic caused unsettled and showery weather, with strong winds or gales. On Sunday, however, an area of high pressure spread over England, and under its influence the sky

rapidly cleared, and the wind became northerly, while at Greenwich Observatory a temperature of 4° below freezing point was registered on the grass, but the more northern and western parts of the Kingdom were still disturbed by depressions from the westward These have subsequently spread over the greater part of the country, and winds have again become south-westerly generally The facts shown by the *Weekly Weather Report* for the period ending the 3rd instant, are interesting —The rainfall exceeded the mean in all districts, the greatest excess being in the west of Scotland and the north-west of England, and the fall was more than twice as much as the normal amount over the Kingdom generally Temperature was below the mean in all districts, except the south of England and the Channel Islands, while in Scotland the lowest shade minima were between 32° and 35°

PROF MOHOROVIČIĆ, of Agram, writes to the *Meteorologische Zeitschrift* for August a preliminary notice of a most destructive wind rush, which occurred at Novska, in Slavonia, on May 31 last, and which he has been requested by the government to investigate on the spot He reports that as the train left Novska station soon after 4 p m on that day, a sudden darkness came on, all the carriages of the train were thrown off the line with a great crash, and three of them were carried by the force of the wind to a distance of about 100 feet, the violence of the wind being aided by the bursting of two water-spouts over the railway The tornado then traversed a primeval forest which lies to the north east of Novska, tearing up over 150,000 large trees, and stretching them on the ground round the centre of the disturbance with the regularity of arrows around a barometric minimum of a weather chart, in a lane of about 1½ to 2 miles in diameter Among the curious instances is one of a girl, seventeen years old, being carried unhurt for a distance of over 300 feet Were it not for the trustworthy source whence this information is obtained we should consider it to be greatly exaggerated, but Prof Mohorovičić states he crossed the forest three times and carefully noted the position of the fallen trees, and he will no doubt give an official report of the occurrence later on, accompanied by meteorological data from various stations

IN vol xiv of *Aus dem Archiv der Deutschen Seewarte* there is a discussion by E Herrmann on the storms of the German coast in the years 1878–1887, based upon an examination of the observations taken at forty seven stations, and containing monthly and yearly charts showing the prevalence of the winds from the various points of the compass The results show a great preponderance of storms in the Baltic as compared with the North Sea, in ten years 191 storms are recorded in the Baltic and 101 in the North Sea The decrease of storms in the North Sea in summer is also much more marked than in the Baltic The maximum of westerly storms occurs in December, and that of the easterly storms in March and April In the summer months most storms occur in August The change of direction of the storms from south-west to north west occurs most frequently in February, March, October, and November, and from north-west to south west in January, February, and October

IN a recent valuable memoir to the Berlin Academy on Thermodynamics of the Atmosphere (fourth of a series), Prof. von Bezold considers the cases of supersaturation with vapour, and of "overcooling" (regarding the latter it may be stated that clouds have been observed at a temperature below freezing, but having no ice-particles,—purely water clouds) A sudden cessation of these states, he shows, must result in rapid rise of air-pressure, which is generally of short duration, unless conditions are present which prevent its descent again As such variations of pressure are characteristic of thunderstorms, the author goes on to investigate the *rôle* of supersaturation and overcoolings in these phenomena, and he shows how various movements and changes in form of thunderclouds, and the origin of hail and other phenomena, may be explained by them He is of opinion that much thunderstorm rain has, high up, the form of hail or sleet, and the large drops are simply melted hail or sleet particles, these forms playing a more important part in thunderstorms than is commonly supposed

A REUTER'S telegram from Catania, dated September 2, announced that the eruption of Etna had broken out afresh, and that the chestnut woods on the mountain slopes were being devastated by the lava, which was pouring down the mountain in one dense mass, instead of flowing in two separate streams, as it did before

THE Norfolk and Norwich Naturalists Society has issued its Transactions for 1891 92 We are glad to see that this Society, which has now entered upon its 24th year, continues to prosper, the roll of members numbering 250, and the balance-sheet being very satisfactory The catalogue of the library, which is printed in the current number of the Transactions, occupies 43 pages Dr Wheeler, in his presidential address, discourses on the changes which have taken place in recent times in the distribution of some species of insects, more especially of the typical insect fauna of the old fen land of Huntingdonshire and Cambridgeshire and of the Norfolk Broads Dr Plowright contributes a paper on "Neolithic Man in West Norfolk," with illustrations, by Mr Worthington Smith, of a number of flint implements found on Massingham Heath, near Lynn, and a description of the site of an ancient British village in the same locality This is followed by a paper on the St Helen's Swan Pit, in Norwich, where, towards the end of August, from 80 to 100 cygnets may yearly be found gathered together for the purpose of being fatted for the table Mr Southwell, the writer of the paper, also gives some interesting particulars of the breeding of the Mute Swans, which abound on the Norfolk waters Mr Clement Reid follows with a paper "On the Natural History of Isolated Ponds," as illustrating the dispersal of the fauna and flora of a district in recent times, and Mr O V Aplin contributes a paper "On the Distribution in Great Britain and Ireland of the Red-backed Shrike" This is followed by the eleventh annual report on the Herring Fishery of Yarmouth and Lowestoft, by which it appears that the enormous number of 290,650,800 of these fish were landed at those ports in 1891 There are other minor papers "On the Meteorological Features of 1891," by Mr Preston, and shorter notes on the "Marine Fishes of Yarmouth," the "Botanical Occurrences of the Past Year," and other matters of interest

ACCORDING to a report compiled by the French Statistical Bureau, the vineyards of Europe cover 22,973,902 acres Italy comes first with 8,575,000 acres, followed by France with 4,592,500, Spain with 4,012,500, Austria and Hungary with 1,637,500, and Germany with 300,000 acres The annual average production of the European vineyards is put at 2,652,300,000 gallons, Italy producing (in round figures) 697,000,000 gallons, France and Spain 608,000,000 each, Austria-Hungary 208,000,000, and Germany 51,000,000 gallons Spain exports most wine (200,000,000 gallons), but it is chiefly common wine, and it is estimated at only £12,000,000, while the value of the 56,000,000 gallons exported from France is put at nearly as much Italy comes third with exports of 45,000,000 gallons, estimated at £2,800,000, while Austria and Hungary exported only 16,500,000 gallons worth £1,720,000.

THE American journal *Electricity* notes that Prof Elisha Gray, Chairman of the World's Congress Committee on an Electrical Congress, has returned to America from Europe. He

visited England, France, Germany, Austria, Roumania, Turkey, Italy, Greece, and found everywhere that a lively interest was taken in the Columbian Exhibition In an interview in the daily press he says, "Many eminent electricians of different countries are expected to attend the congress, including a large number from Great Britain. The work of the World's Congress auxiliary has been done so quietly that the general public is not aware of its extent and efficiency There seems now to be no question that the World's Congress of 1893 will be very much more largely attended and will be conducted on a more imposing scale than those of any previous occasion in the world's history."

A MODEL of ocean currents is to be shown at the Chicago Exhibition. The surface of the earth is represented on "a huge scientific tank" by an area of about 30 feet square, the ocean and seas being shown by actual water Small streams of water are ejected through pipes under the model so that the whole body of water moves exactly as the ocean currents move The direction of the currents is shown distinctly by a white powder on the surface of the water Near the model will be placed a large map giving details as to the force, volume, and direction of the various ocean currents

A USEFUL catalogue of Michigan plants, prepared for the thirteenth annual report of the Secretary of the Michigan Board of Agriculture, has been issued separately It has been drawn up by W J Beal and C F Wheeler It is based on a "Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Michigan, Indigenous, Naturalized, and Adventive," by C F Wheeler and E F Smith The compilers hope that the publication of their list will stimulate local observers and collectors to do what they can to add to what is known about the plants of Michigan, especially in the matter of geographical distribution.

DR R W SHUFELDT contributes to the Proceedings of the U S National Museum (vol xv, pp. 29-31) a short but interesting paper on "A Maid of Wolpai"—a girl of about fifteen years of age, belonging to the pueblo of Wolpai in north-western Arizona A portrait of her accompanies the paper The writer's object is not so much to talk about this particular girl, as to describe the life of a Wolpai woman at the various stages of her career. His conclusion is that, upon the whole, it is by no means an unhappy life. "From her babyhood to maturity," he says, "it is filled in with many pleasurable chapters, and no doubt a great deal of this is due to their contented dispositions, their love of home, and their untiring industry."

IN another paper contributed to the same volume (pp 279-282) Dr Shufeldt discusses the evolution of house building among the Navajo Indians. From November, 1884, to the early spring of 1889 Dr. Shufeldt lived at Fort Wingate, a military station in north-western New Mexico, and during the early part of this period there was always to be found a floating population of Navajos living on the outskirts of the fort He had thus many opportunities of studying their various arts and industries. He shows that contact with the civilization of the white man has led these Indians to improve their plans of house building, and has had "the effect of bringing about an evolution of the same."

A VERY original mode of treatment of some nervous complaints has been recently developed by Dr Charcot, at the Salpêtrière, in Paris (*La Nature*) He was led to it by observing that patients afflicted with *paralysis agitans*, or shaking palsy, often seemed greatly relieved after long journeys by rail or carriage. The greater the train speed and oscillation, the rougher the road and the shaking, the more they liked it and were benefited. Dr Charcot, taking up the idea, had a chair made, to which a rapid movement from side to side was imparted by electrical agency, like what one sees in processes of sifting by machinery. To a healthy person the experience is execrable, he very soon seeks relief. Not so the patient, however, he enjoys the shaking, and after a quarter of an hour of it, is another man He stretches his limbs, loses fatigue, and enjoys a good night's sleep afterwards. There are various other nervous diseases to which the method applies Certain physicians, indeed, have before used such things as tuning-forks and vibrating rods in treatment of neuralgia, &c A student of Dr. Charcot, Dr. Gilles de la Tourette, has had a vibrating helmet constructed for nervous headaches It is applied to the head by means of a number of steel strips Above is a small electric motor making 600 turns a minute, and at each turn a uniform vibration is imparted to the metallic strips, and so to the head The sensation is not unpleasant, it induces lassitude and sleepiness

ON Friday last Prof R L. Gardner, of Virginia, addressed the Balloon Society of Great Britain on his researches relating to what he calls the speech of monkeys He defined speech as that form of materialized thought which was restricted to such sounds as were designed to convey a definite idea from mind to mind It was, therefore, only one mode of expressing thought, and to come within the limits of speech the sounds must be voluntary, have fixed values, and be intended to suggest to another mind a certain idea or group of ideas more or less complete Not only did these marks characterize the sounds of monkeys as speech, but, in addition, the sounds were always addressed to certain individuals, with the evident purpose of being understood Monkeys usually looked at the individual addressed and did not utter these sounds when alone or as a mere pastime They understood and acted in accordance with the sounds when imitated by the phonograph or other mechanical means, and this indicated that they were guided by sounds alone, and not by signs, gestures, or a physical influence. He had also discovered that some monkeys could count three and had favourite colours, but he did not think they had names for them He had for hours together watched monkeys convey to each other by sound the apprehension of danger and other emotions His task, which was not easy, was to perpetuate or imitate these sounds In some cases he was successful, but to no great extent. At last he turned to the phonograph—an instrument which was practically unknown in this country, save as a clumsy toy But a properly manipulated phonograph could repeat sounds, previously recorded, with mathematical precision He had the good fortune to find that the sounds so carefully preserved in one zoological garden provoked interest, and were apparently quite intelligible to monkeys in other gardens in distant countries His observations had hitherto been conducted with monkeys in captivity, but he was now on his way to the deep forests of Western Africa, once visited by Paul du Chaillu, in order to study the language and habits of the great apes He was carrying with him an outfit of the most complete and unique character that had ever been brought into use for such purposes He meant to live in a cage and to provide himself with an electrical apparatus His cage was convertible, and weighed 320lb, and he could make four cages of it and bring home a gorilla in one of them.

AT the last prize contest instituted by the City of Paris for the best electric meter the prize of 5000 francs was awarded to Prof Elihu Thomson. Desiring that this sum should serve for the development of the theoretical knowledge of electricity, Prof. Thomson requested M. Ernst Thurnauer, General Manager for Europe of the Thomson-Houston International Electric Company, to offer a prize for the best work on a theoretical

question in electricity, and to organize a committee who should propose the subjects, examine the productions, and decide the prize The following gentlemen have consented to act as members of the Committee —J Carpentier, President of the Société Internationale des Electriciens, Hippolyte Fontaine, E Hospitalier, Professor in the School of Physics and Chemistry of the City of Paris, E Mascart, Member of the Institute, A Potier, Member of the Institute (Examiner), B Abdank-Abakanowicz, Consulting Engineer (Secretary of the Committee) The Committee has decided that the prize should be given for an investigation on one of the following subjects —(1) The heat developed by successive charges and discharges of condensers under different conditions of frequency, nature of dielectric, and quantity of charge (2) It has been shown theoretically that when the two surfaces of a condenser are connected by a conducting body, the condenser becomes the source of alternating currents as soon as the resistance of the conducting body decreases below a certain limit The formula that permits calculating the period of this oscillation has not yet been completely verified This period of oscillation should be investigated experimentally under conditions such that the exact measure of resistance, capacity, and coefficients of self induction may be possible, in order to arrive at a complete and precise verification of this formula. (3) When a condenser made with an imperfect insulating material has been charged and then left to itself, the charge is gradually dissipated The time necessary for the charge to be reduced to a given fraction of its initial value depends only on the nature of the insulating material It is proposed to investigate whether, as certain recent theories would seem to indicate, analogous phenomena do not present themselves in metallic conductors, and whether these can be shown experimentally. (4) It is proposed to arrange and systematize our present knowledge of the graphical solutions of electrical problems, and deduce from them some general methods as in graphical statics The theses presented may be written in any one of the following languages —English, French, German, Italian, Spanish, or Latin. They may be in manuscript or printed Each thesis presented must be signed by a pseudonym and accompanied by a sealed envelope bearing the same pseudonym on the outside, and with the name and address of the author inside. The papers must be sent before September 15, 1893, to B Abdank-Abakanowicz, Consulting Engineer, the Secretary of the Committee, at 7 Rue du Louvre, Paris, who will furnish any further information required

THE additions to the Zoological Society's Gardens during the past week include a Black-handed Spider Monkey (*Ateles geoffroyi*) from Nicaragua, presented by Mr F Vyner; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr Gerald E Bridge, a Black-shouldered Kite (*Elanus cœruleus*) captured at sea, presented by Mr J. Watson, a Falcated Teal (*Querquedula falcata* ♂) from China, presented by Mr A. C Moule, an American Black Snake (*Coluber guttata*) from North America, deposited, two Mule Deer (*Cariacus macrotis* ♀ ♀) born in the Gardens

OUR ASTRONOMICAL COLUMN

THE STAFF AT THE LICK OBSERVATORY —We are sorry to notice the very considerable changes that are now taking place in the staff at the Lick Observatory It seems only quite recently that Prof Keeler tendered his resignation to take over the directorship of the Allegheny Observatory, but now we hear that Mr Burnham has resigned, and that Prof. Henry Crew has done the same, the former having accepted a position of clerk in one of the courts of Chicago, and the latter having been elected to a Professorship of Physics in the North-Western University at Evanstown, Ill With the loss of these men the observatory will be crippled for some time, for, although very good men will be found to take their places, a thorough acquaintance with the instruments can be obtained only by constant and frequent practice. Of the remainder of the staff Mr Barnard and Mr. Schaeberle will be the only representatives of the older members What the cause of these changes is we do not know, but there seem to be signs of a little friction somewhere, for what is the probability that three men should sever their connection with such an observatory in the space of a year—assuming, of course, normal conditions?

THE OBSERVATIONS OF KLINKERFUES REDUCED —The second part of the *Astronomische Mittheilungen of the Royal Observatory* in Gottingen contains a complete reduction of Klinkerfues' observations which he made in the years 1858 to 1863 The work has been undertaken by the Director of the Gottingen Observatory, Prof Wilhelm Schur, and has been printed at the expense of the Konig Gesellschaft der Wissenschaften zu Gottingen In the introduction Prof Schur gives a complete account of the instruments used and the methods by which the observations were made The zone included in this work is that which lies between + 15° and - 15° declination The interest that is attached especially to these observations is caused by the fact that Klinkerfues did not wish to adopt the usual method for determining the declinations directly from the readings of the vertical circles, but he used that generally known as Gauss' method, in which a mirror and scale played an important part The epoch to which all the places are referred is that of 1860, and a table is also added by which the yearly precession in right ascension and declination can be easily determined

PHOTOGRAPHS OF SOLAR PHENOMENA —To the August number of *Astronomy and Astro Physics* are contributed some striking pictures that represent some of the latest advances made by the application of the photographic plate to the telescope These photographs were taken by Prof G E Hale, of the Kenwood Astro-Physical Observatory, with the new spectroheliograph, a description of which instrument will be found in the May number of the same Journal The first photograph displays the spots and faculæ on the solar surface on May 21 last · a single glance at it will show us that we shall have to change very considerably our present ideas as to their extent, for instead of equalling the spots in area they exceed them so much as to place them relatively in entire insignificance Another point that is at first noticed from the same photograph is the paucity of the faculæ at the limb with respect to the more central part of the disc, but this is, as we are told, only a fault in the process of reproduction, for in the original negatives the faculæ "are equally well shown on all parts of the solar surface" Another photograph of interest is that of the chromosphere and prominences taken on the same day, this was obtained by cutting off the light issuing from the solar disc by means of a metallic diaphragm, it resembles very strikingly a short-exposed photograph of the eclipsed sun, as the prominences on it as distinctly visible, while the presence of streamers and rifts is lacking Since these photographs were taken, Prof Hale has been able, by making two exposures on the same plate, to produce pictures each of which displays all the solar phenomena For the first exposure he employed the metallic diaphragm, allowing the slits which move across it to travel with the velocity required for the prominences, for the second exposure the diaphragm was removed, and the rate of movement of the slits was this time very much increased

A METEORITE —In the *American Journal of Science* for August, Mr H L Preston gives an account of the finding of a meteorite in Kenton County, eight miles south of Independence. In the year 1889 during the cleaning out of a spring, something very hard was struck which from the sound was thought to be metal. It was entangled among the roots of an ash tree three or four feet down in the ground, and was not removed from the spot until August 1890, when it was placed in a shed, and more recently bought for the Ward collection of meteorites. The measurements along its greatest diameters were 21 × 14 × 8 inches, and it weighed 359½ pounds. Its surface was covered with numerous but mostly shallow pittings, but was entirely free from crust An analysis showed that it contained iron to the amount of 91 59 per cent, nickel 7 65, cobalt 0 84, carbon 0·12, with traces of copper and sulphur.

MOUNTING OF OBJECTIVES.—A novel but very useful way of mounting objectives is that adopted by Prof Hale, who has

added another object glass to his equatorial. What he has done has been to employ a twin cell in which the glasses have been placed; the whole is then hung on an axis fixed rigidly to the side of the telescope tube so that by a simple rotation each glass, whether for photographic or for visual purposes, can be brought to the centre of the front of the tube. In order to make use of that objective which is not temporarily required for the main instrument, a tail-piece near the eye-end is also mounted, thus completing another telescope, only without a tube. One great disadvantage of this arrangement would be the difficulty of centring the lenses after each change, but this is not so as we are informed, no difficulty at all being experienced. In *Astronomy and Astro Physics* for August, there is shown a picture of Mars emerging from occultation on July 11, taken without the tube. In the original photograph, which is about $\frac{1}{16}$ inch in diameter, the polar caps on the planet are clearly shown together with some of the other markings on the surface.

JUPITER.—During the next two months the planet Jupiter will be in a very good position for observation. This year he is as much as 5° to 8° north of the equator, being situated now in the constellation of Pisces, just north of the two stars μ and ν. The next opposition occurs on the 12th October.

NOVA AURIGÆ.—In a communication to the *Daily Graphic*, the Rev. A. Freeman gives the results of some observations of the revived new star in Auriga, made by him on Sunday, August 28. Adopting Mr. Stone's values for the magnitudes of the neighbouring stars, the nova would appear to have then been a trifle brighter than mag. 10 3, but decidedly fainter than 9 7. By comparison with the zone star $+30°$ 924 the nova was rated at mag. 10 1. As Mr. Espin estimated it to be 9 2 on August 21, it is probable that the star is again waning.

From the Astrophysical Laboratory at South Kensington we have received the following:—There was no opportunity of observing the nova here until 1 30 a.m. on Thursday, September 1, and it was then too dim to be readily seen with the 10-inch refractor. A photograph of the region was taken with the $3\frac{1}{2}$-inch portrait lens, the exposure being thirty minutes, but this failed to show the nova, although clearly showing stars of the 10th magnitude.

COMET SWIFT, MARCH 6, 1892.—The following is a continuation of the ephemeris for Comet Swift, which we take from *The Edinburgh Circular*, No. 29:—

1892	R.A. h. m. s.	Decl. ° ′	log Δ	log r	Br.
Sept. 8	0 32 27	+51 56 5			
9	31 8	51 48 8			
10	29 49	51 40 7	0 2751	0 4085	0 073
11	28 30	51 32 1			
12	27 10	51 23 2			
13	25 50	51 13·9			
14	24 30	51 4 1	0 2788	0 4164	0 069
15	23 11	50 54 0			

Brightness at time of discovery is the unit of Br.

The Edinburgh Circular, No. 30, announces the discovery of a comet by Mr. Brooks, at Geneva, U.S., at midnight on the 29th ult. The comet was then in R.A. 6h. 20min. and declination 31° 48′ north, its daily motion being +1min. 44sec. and 2′ south. The same comet has also been observed at Kiel on the 31st inst. at 12h. 32 2min., its place then was found to be R.A. 6h. 5min. 59·1sec. North declination 31° 42′ 27″. Whether this comet is a new one or not cannot of course be said yet for certain, but it is neither Brooks' 1886 IV nor Tempel 1867 II if we can depend on the two search ephemerises we have at hand, for their declinations in both instances should be at this time over 30° south.

GEOGRAPHICAL NOTES.

MONTENEGRO, though one of the smallest, is certainly one of the least known countries in Europe. Dr. K. Hassert, who has already made important journeys in the less known parts of the Balkan peninsula, is this summer travelling through Montenegro, and describes the scenery as in many places of very great beauty. The frontier river Cijevna flows through a steep-sided gorge, the height of the precipices bordering which he estimates as over 3000 feet, while in its appearance it rivals the cañons of the Colorado. The traveller in this part of the country runs considerable risks from the predatory Albanian tribes.

THE *Times* publishes a telegram from Captain MacDonald of the Mombasa-Victoria Nyanza Survey, announcing that the Survey had found a good route for a railway to Sio Bay on the Nyanza, and had returned to Kikuyu on August 8. The Survey work has been carried on rapidly, and, which is more important, without any fighting.

RAILWAYS in tropical Africa may ultimately derive more revenue from native passengers than might be anticipated. The railway from St. Paul de Loando is being pushed forward to Ambaca, and now nearly reaches Casengo, where there are flourishing coffee plantations under Portuguese management. Until this point is reached the revenue from goods cannot be large, but the natives having speedily got over their distrust of the innovation, now travel freely by rail in large numbers.

PROF. POUCHET has this summer succeeded in visiting Jan Mayen Island and Spitzbergen in the French gun-boat *La Manche*. Jan Mayen, on which a landing had not been made for ten years, was visited on July 27, and the vessel proceeded to Spitzbergen, where a fortnight was spent. The west coast was followed up to 78° N., and some excursions made on foot into the interior. Glacier phenomena were studied, and collections of native fauna and of fossils made. The sea was found to be entirely free from ice.

NEWS has recently been received in Copenhagen of the safety and success of the East Greenland Expedition, which left Denmark in June 1891 under Lieutenant Ryder. The expedition passed the winter on the Greenland coast in Scoresby's Land at a point in 70° 27′ N. Important scientific results have been obtained, but the expedition is not yet over, Lieutenant Ryder intending, after a short visit to Iceland, to make an attempt to trace out the hitherto unvisited coast-line between 70° N. and the Arctic circle.

THE first chart on which the American continent appears is being reproduced in facsimile for the approaching Columbus Exhibition in Madrid. The following details are given in a Reuter telegram from Madrid. The work, which is now approaching completion, is being done by Señor Canovas Vallejo, a nephew of the Spanish Premier, and by Prof. Traynor. The original chart, which was traced in the year 1500 by the famous navigator and cartographer Juan de la Cosa, who acted as pilot to Columbus in more than one of his voyages across the Atlantic, has been since carefully preserved in the Naval Museum in Madrid. The chart presents some most interesting features, displaying, as it does, the extent of the knowledge of the best informed geographers of the day. On it are depicted the West Indies and a small portion of South America, namely, the north eastern section lying between the River Amazon and Panama. To this land the general name of Tierra Firme is given, to mark the contrast between the continent and the Antilles. Here and there are traces of modern names, such as Venezuela, Maracaibo, and Brazil. The chart even comprises some particulars of the discoveries made in Northern America by Sebastian Cabot in 1497, and such titles as these:—"Sea discovered by the English," "English Cape," "Lizard," and "St. George." La Cosa has also clearly depicted Cuba as an island, whereas Columbus died in the belief that it was a continent, and it was not until eight years later that the correctness of La Cosa's chart was in this respect finally established.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ROCHESTER MEETING.

THE forty-first annual meeting of the American Association for the Advancement of Science was held at Rochester, New York, August 17–23, Prof. Joseph Le Conte, of California, the well-known geologist, presiding.

Rochester is one of the most beautiful of American cities, being laid out quite on the *rus in urbe* principle, so that each residence is generally surrounded by grounds, instead of being built in a solid block. It is pre-eminently a city of freeholders, as appears by the fact that a recent census showed more land-owners than voters in the city. It is moreover situated in the beautiful and picturesque region of western New York, within a very short distance from numerous glacial lakes, as well as the

Falls of Niagara The fertile valley of the Genesee was long ago renowned for its wheat as it now is for its fruit and flowers, and Rochester, formerly called the flour city, is now known as the city of flowers The river flows through the city, falling in pretty cascades to a wild glen, and furnishing the water power which is utilized in flouring mills and other manufactures Lake Ontario is a few miles distant, but yet it is so far away, and the navigation of the Genesee is so restricted, that Rochester is considered an inland city, and it is the largest inland city in the United States, having a population of 144,000

The meeting of the Association coincided in time with the railroad strikes at Buffalo, some seventy miles distant, where several regiments of militia were stationed at that time to protect the railroads from mob violence The sense of insecurity doubtless deterred a few members from attending, though the attendance was above the average

For the last few years, specialists have shown a growing tendency to organize special societies outside of, though affiliated to, the general Association This year the larger meeting was preceded by meetings of the American Microscopical Society, the Geological Society of America, the Society for the Promotion of Agricultural Science, the Association of Economic Entomologists, and this year was organized the American Association of State Weather Services The latter is composed of weather observers from the several States of the Union Every State now has a weather-observing station, and an observer co operating with the general government

The first day of the meeting was taken up with opening general exercises, organizing the sections, and addresses by the retiring president, Prof Albert B Prescott, of Ann Arbor, and the presidents of the several sections, namely, mathematics and astronomy, J R Eastman, physics, B F Thomas, chemistry, Alfred Springer, mechanical science and engineering, J B Johnson, geology and geography, H S Williams, biology, S H Gage, anthropology, W H Holmes, economic science and statistics, Lester F Ward

The remaining days of the meeting were given to reading of papers in the various sections, after a brief business meeting in general session The general business included a division of the biological section into Section F, zoology, and Section G, botany, the former Section G, microscopy, having been abolished years ago The biological section has long been overcrowded

The preservation of forests has been and is one of the most important economic matters of our age Reckless and wasteful methods have prevailed to such an extent that many fine forests have been ruined, and others are rapidly going to ruin The large areas still owned by government are subject to the double peril of robbery and fire Mr Fernow, chief of the Bureau of Forestry, in a paper before the economic section, stated that the annual loss to the government by thieves is 10,000,000 to 15,000,000 dols, while that by fire is probably twice as much more To protect the twenty thousand square miles of government forest land, a paltry force of twenty to twenty four watchmen is employed, and even these are not clothed with sufficient authority They are barely able to reclaim some 100,000 dols worth of timber annually from depredators, which only suffices to repay the expense of maintaining the service Proper protection would require an annual outlay of 2,000,000 dols. to 3,000,000 dols, and would preserve 20,000,000 to 50,000,000 dollars' worth of property in each year The section recommended a resolution favouring suitable legislation, such as is embodied in the bill introduced by Senator Paddock, and the resolution was unanimously adopted in general session.

Much interest was manifested in the approaching World's Columbian Exposition at Chicago Prof F W Putnam, permanent secretary of the Association, is also chief of the department of ethnology, &c, at the Exposition In a paper before the anthropological section he detailed plans adopted for taking anthropometrical measurements of native American tribes, also of children in public schools, both white and others, as well as children in the Indian schools An exhibit of special interest will be a collection of representatives of all the native American tribes, including a family from each tribe, engaged in native industries This will require the gathering of at least five hundred aborigines, and probably more than that number, and it will be the last opportunity when such an exhibit can be made, since the extension of railroads and other appliances of civilization is rapidly subverting aboriginal methods and conditions; the tribes are becoming disintegrated and amalgamated, and machine made articles are supplanting those by hand

Committees were appointed from each section to co-operate with other organizations having similar aims, in holding joint meetings during the Exposition By resolution in general session the Secretaries of the several sections were appointed a committee to co-operate with the World's Congress Auxiliary in securing space for each section for the entire time of the Exposition in which to register as headquarters for that section, and similar organizations, both foreign and domestic.

Thursday evening was occupied with a reception by the Women's Reception Committee of the Local Committee at the Powers Art Gallery This is by some considered to be the finest art collection in America, including pictures by Diaz, Corot, Millet, Verboeckhoven, Gérome, Munkacsy, Doré, Bonheur, Vibert, Bougereau, Zimmerman, Cooman, Leloir, Hagborg, Schreyer, Henner, Le Rolles, Knaus, Jackobides, Defregger, Daubigney, Rousseau, and other foreign artists, besides works of the best American artists, and copies of Rubens, Titiens, Raphael, Correggio, and others

Besides the annual address of the retiring President, Prof Prescott, only one other address was made in general session This was by Dr Joseph Jastrow on Friday evening on "Hypnotism and its Antecedents" In the first part of his lecture he gave a historical sketch of the development of hypnotism, and described various procedures in which it is involved The careers of Messmer and other early hypnotists were sketched, up to the time when it obtained scientific recognition about fifteen years ago through the efforts of Charcot and Richet The second part of the lecture described the chief phenomena of modern hypnotism as revealed and recognized during the last score of years The lecturer illustrated the illusions of sense in various ways, and described in detail the methods of inducing the state In some instances, it was stated, the subject may not lose control, but simply finds it impossible to resist the demands of the operator For instance, upon being told that he cannot open his eyes, he finds it impossible to do so, though perfectly conscious, a cane placed in his hands he is unable to drop, and fingers set in motion he is powerless to stop Many interesting phenomena were cited One of the most curious of these is what is termed the post hypno suggestion While the subject is asleep it is suggested that he shall perform some act at a certain time after awakening These acts are performed by the patient, sometimes even when the time set to elapse has been a year But perhaps the most surprising of all the phenomena cited was the control of the patient over involuntary powers Upon being told that a postage stamp placed on the arm is a plaster which will raise a blister, the effect is actually accomplished Sometimes the mere tracing of a line upon the skin has produced the same effect In some cases rigidity of the muscles is induced, so that the arm may be kept extended or the body may be rigidly supported, with the head on one chair and the feet on another, for a long time Important legal questions may be raised as to the responsibility of hypnotized patients. Crimes may be committed at the instigation of the operator It has long been known that petty crimes could be so caused It is found also that the gravest crimes are equally controlled, as shown by repeated instances where the patient was given a dagger and told to stab a person lying on a certain cot in the hospital, which the patient did, though the person stabbed was only a straw figure, but so covered as not to be recognized as such. The control over the nervous system renders hypnotism a valuable remedial agent in paralysis, aphasia, tetanus, and many other diseases controlled by or specially related to the nervous system.

Another lecture, which was practically tantamount to a public address before the Association, was that of G K Gilbert, President of the Geological Society of America, before the Rochester Academy of Sciences, on "Coon Butte and Theories of its Origin" This extinct crater, located in Eastern Arizona, is unique in showing no signs of lava or scoriæ, and also in the fact that meteoric iron is found abundantly near it, numerous specimens, one of them over 600 pounds in weight, having been picked up here This suggested to Prof. Gilbert the hypothesis that the crater may have been caused by the impact of a larger meteor, sufficient to make such a hole three-quarters of a mile in diameter, just as a cannon ball fired into a target would do, especially as the general appearance of this crater is remarkably similar to that of some results caused by projectiles. To test the correctness of this theory, he caused a careful magnetic and geodetic survey to be made to determine whether any large mass of iron was buried beneath the crater, and also whether

the rim exceeded the crater in bulk sufficiently to indicate a mass of matter in the rim larger than would be caused by the displacement of the material removed from the crater. Both these surveys, however, gave negative results. The magnetic survey indicated that if any considerable mass of iron exists there it is buried at least fifty miles deep, and a comparison of the quantity of matter in the rim shows no more than would fill up the space of the crater. He was compelled, therefore, to abandon the meteoric theory, notwithstanding that the chances of the fortuitous concurrence of such a crater accompanied by such a meteoric downfall is only one in five thousand. The origin of the butte must therefore be an explosion of steam.

The president elect of the Association, Prof. William Harkness, of Washington, was born at Ecclefechan, Scotland, in 1837, where his father, Rev. James Harkness, resided till 1839, when the family removed to America. The father was for a while pastor of a church at Rochester, where the son was educated, after having spent part of his college life at Lafayette College, in Pennsylvania. He graduated at the University of Rochester in 1858, and received from the same university the degree of doctor of laws in 1874. It was, therefore, peculiarly appropriate that he should be elected to the presidency at the Rochester meeting.

Prof. Harkness studied medicine, and practised as an army surgeon in 1864, but, with the exception of a short time in the army, he has been employed by the Government as an astronomer for about thirty years. During the total eclipse of 1869, he discovered the 1474 line of the spectrum of solar protuberances. He became prominent in observations of the transits of Venus.

It is difficult to select the most important and valuable papers from the whole number of 182 read before the several sections, but a few abstracts will be subjoined which appear to merit notice.

George E. Hale, of Chicago, read a paper before the astronomical section on "The Spectroheliograph of the Kenwood Astro physical Observatory, Chicago, and results obtained in the study of the Sun." He described the ingenious apparatus which he had invented and perfected for photographing the faculæ and protuberances of the sun. This apparatus gives by far the most perfect pictures ever taken, and is the first which has successfully photographed the bright spots, showing faculæ which the eye cannot detect. Means were devised for taking on the same plate at one exposure both the faculæ and the protuberances, and Prof. Hale exhibited the first complete picture of the sun ever taken. Comparison with the best plates made at the Lick Observatory showed the great superiority of the work at Chicago. An observation of unusual interest was made on July 15, 1892. A photograph of the sun showed a large spot. A few minutes later another photograph was taken, which, when developed, showed that the bright band had appeared since the last exposure. Twenty seven minutes thereafter another photograph showed that almost the entire spot was covered with brilliant faculæ, which by the end of an hour had entirely disappeared, leaving the spot as at the first exposure. This indicates an eruption proceeding with indescribable and inconceivable velocity. This disturbance seems to be connected with magnetic disturbances and the brilliant aurora noted the next day. The section, with much enthusiasm, passed a vote of thanks to Prof. Hale for his researches.

Edwin B. Frost read a paper on "Thermal Absorption in the Solar Atmosphere." Among the interesting phenomena observed were some cases where the umbra of sun spots radiated more heat than the neighbouring photosphere, indicating either that the dark spot is at a higher elevation than the surrounding photosphere, and consequently loses less heat by absorption of the sun's atmosphere, or that it is attended by an invisible facula.

Prof. R. S. Woodward described the iced bar base apparatus lately devised by him for the Coast and Geodetic Survey. This is a line measure, micrometer microscope apparatus. The measuring bar is of steel, five metres long, and its temperature is kept constant by a packing of melting ice. The use of thermometers is thus avoided entirely. From results submitted by the author it appears that the total probable error of one measure with this apparatus of a distance a kilometre or more in length will not exceed one part in four to five millions.

One of the most important uses to which Prof. Woodward has applied the iced bar apparatus is that of showing that long steel tapes, when properly handled, will give from one measure the length of a line, a kilometre, or more long with a probable error not exceeding one part in a half million. Considering that this can be done at the rate of two kilometres per hour with a 100 metre tape, it would seem that such tapes must soon take high rank amongst apparatus for measuring bases.

Prof. W. A. Rogers read two papers before Section D, the first of which was a description of a standard yard and metre upon polished steel. The standard, which was exhibited, had upon one edge a metre subdivided by 20 millimetres and 40 inches subdivided to tenths of inches. Both are standard or 62 Fahr. It appears from an investigation of these standards that 772 of the separate millimetres have errors not exceeding one mikron, and that of the 400 tenth of inch spaces 280 have errors not exceeding one-twenty five thousandth of an inch.

Prof. Rogers read a second paper on an investigation of a 21 foot screw. This screw was made by the Pratt and Whitney Company for R. Hoe and Co., of New York. It appeared from this investigation that the pitch of this screw was very regular in its character, but that the linear error amounted to nearly one hundredth of an inch in 21 feet. A part of this is undoubtedly due to flexure, but a part is due to changes of pitch in the screw itself.

In the section of anthropology Permanent Secretary F. W. Putnam gave an interesting talk on "Copper Implements and Ornaments in the Ohio Mounds." He emphatically denied the statements that these copper instruments were fashioned by white men and given to the Indians in trade. "It must be," said he, "that these implements were made by the native Americans. In all cases where implements and ornaments are found in these mounds there are found also on the altars nuggets of copper. So it is with the silver implements and those made of meteoric iron. Now, is it likely that the trader would furnish the Indian with nuggets of the natural material? There is conclusive proof that the original settlers of the Ohio Valley worked the metal into these implements and ornaments. Again, many of these mounds have trees growing on them that are between 400 and 500 years old. This carries them back beyond the time of trading." Prof. Putnam explained that holes could be cut in the sheet copper which had been hammered out by the Indian by simply placing the sheet of copper on the trunk of a tree and pounding into it one end of an oak limb squared. He was unable to describe the probable mode adopted by the Indians in cutting edges shaped like the teeth of a saw, but thought it was done by the use of an instrument made of meteoric iron.

In the section of biology, C. V. Riley read a paper on "Fertilization of the Fig and Caprification." In the production of the best Smyrna figs certain minute insects perform an essential function in fructifying the fig. The process is called "caprification," and has been performed by the aid of fig growers ever since the time of Aristotle. The cultivator is accustomed at a certain season to place the fruit of the "caprifig," which contains these insects, on the fig tree which contains the edible fig. The caprifig does indeed produce a fig, but it is small and insipid. The tree which produces the edible fig does not yield fruit of fine flavour unless it is thus fertilized by the aid of these insects, the scientific name of which is Blastophaga psenes. The absence of these explains the insipidity of figs raised in California. There are, indeed, a dozen species of Blastophagæ found in America, but it is improbable that any one of them is adapted to the fertilization of the Smyrna fig, which growers there are trying to cultivate. The caprifig, however, is already well established, and the desideratum seems to be to introduce the insects. This, Prof. Riley thinks, can be done by gathering the fruit containing them in Smyrna and rapidly transporting it to California, which, he urges, should be undertaken by the Government. An attempt was made last summer by J. Shinn, of Niles, Alameda County, California. The fruit containing insects was gathered at Smyrna in the last days of June and received at Niles on July 23, within twenty-five days, but it is not known whether the experiment was successful.

In the section of physics, several valuable papers were contributed by G. W. Hough, A. E. Dolben, W. L. Stevens, E. L. Nichols, B. W. Snow, and others. One of the most interesting papers giving results of original research was by Edwin S. Ferry on "Persistence of Vision."

Prof. Frank P. Whitman, in a brief paper on the "Magnetic Disturbances caused by Electric Railways," gave the following results of recent observations:—"No magnetic instruments dependent on the earth's field can be used for reasonably accurate work at less than 1500 feet from an electric railway, and the

distance must be made greater still if the building in which the instrument is placed is fitted with a system of iron pipes Minor galvanometers must use iron shields and artificial fields, while earth indicators and other similar methods of finding the constant of a ballistic galvanometer must be abandoned Experiments are under way for providing the thinnest shield of soft iron which will serve as complete protection to magnetic instruments under such conditions as just mentioned."

The preliminary meetings of affiliated societies drew off much material which would otherwise have been presented to the chemical and zoological sections

Prof. Robert T Hill read to the geological section a paper on "The Volcanic Craters of the United States," in which he said —"At the present moment, when many of the great volcanoes of the world are in activity, Vesuvius and Etna in Europe, others in the Australian region, and Colima in Mexico, I thought it a good idea to review the many beautiful volcanic craters found in our own land The great cinder cones of New Mexico, Arizona, California, and Oregon are among the most interesting The most eastern crater in the United States is Mount Capulin, a vast mountain in New Mexico This is composed of volcanic cinder, which looks very much like that which comes from a locomotive It rises 2750 feet above the plain on which it stands It is twelve miles in circumference at its base Were it situated in the eastern part of the United States it would be considered one of the greatest objects of natural interest, but in the West, where the phenomena are so abundant, it is hardly noticed and it has not found a place on the maps. In Arizona and New Mexico over 300 old volcanic necks or 'pipes' are found, and there are 20,000 square miles of lava which has flowed from them The recent earthquakes in California were shown to have been produced by the terrific volcanic disturbances in Western Mexico"

Prof Hill thinks it probable that the extinct volcanoes in the United States may again become active The volcanic region has only been known about fifty years, and experts say that appearances indicate eruptions within two hundred years past

The next meeting of the Association will be held at Madison, Wisconsin, on the third Thursday of August, 1893, unless the date shall be changed by the council

Cordial invitations from the city government of San Francisco, the California Academy of Science, the University of California, and the new and munificently-endowed Leland Stanford, Jun, University, indicate that a meeting at San Francisco will be arranged for 1895

THE INTERNATIONAL CONGRESS OF ORIENTALISTS

THE meetings of the International Congress of Orientalists are being held this week in London, and the proceedings, which are of great interest, have been attracting a good deal of popular attention The Congress is being attended not only by a large number of British scholars, but by many representatives of other countries, among whom are the following —Austria-Hungary Prof G Buhler, the Rev. Joseph Dahlmann, Dr I Goldziher, Dr J Karabacek, Prof L. Reinisch, Belgium. Dr Abbeloos, Egypt Dr Vollers, France Prof J Darmesteter, Germany Prof K Abel, Prof R E. Brunnow, Prof Geiger, Prof Hommel, Prof Hubschmann, Dr G Huth, Prof Kautzsch, Prof Kielhorn, Prof Leumann, Holland Prof J P N Land, Italy Prof Ascoli, Dr Carlo Formichi, Count Angelo de Gubernatis, Dr Pavolini, Sweden and Norway Dr Karl Piehl, United States of America. Prof. Charles Lanman, Mr W H Ward

At the opening meeting on Monday, Prof. Max Muller delivered his presidential address. After some preliminary observations, in the course of which he expressed the obligations of the Congress to the Duke of York for having consented to act as honorary president, Prof Muller spoke of the splendid service which has been rendered by Oriental scholarship in proving that in prehistoric times language formed a bond of union between the ancestors of many of the Eastern and Western nations, and that in historic times also, language, which seemed to separate the great nations of antiquity, never separated the most important among them so completely as to make all intellectual commerce and exchange between them impossible. These two discoveries seemed to him to form the highest glory of Oriental scholarship during the present century It was often supposed that students of Oriental languages and of the science of language dealt with words only Even now, when scholars spoke of languages and families of languages, they often forgot that languages meant speakers of languages, and that families of speech presupposed real families, or classes, or powerful confederacies which have struggled for their existence and held their ground against all enemies "Languages," said Prof Muller, "as we read in the book of Daniel, are the same as nations that dwell on all the earth If therefore Greeks and Romans, Celts, Germans, Slavs, Persians, and Indians, speaking different languages, and each forming a separate nationality, constitute, as long as we know them, a real historical fact, there is another fact equally real and historical, though we may refer it to a prehistoric period, namely, that there was a time when the ancestors of all these nations and languages formed one compact body, speaking one and the same language, a language so real, so truly historical, that without it there would never have been a real Greek, a real Latin language, never a Greek Republic, never a Roman Empire, there would have been no Sanskrit, no Vedas, no Avesta, no Plato, no Greek New Testament We know with the same certainty that other nations and languages also, which in historical times stand before us so isolated as Phenician, Hebrew, Babylonian, and Arabic, presuppose a prehistoric, that is, an antecedent powerful Semitic confederacy, held together by the bonds of a common language, possibly by the same laws and by a belief in the same gods Unless the ancestors of these nations and languages had once lived and worked together, there would have been no common arsenal from which the leading nations of Semitic history could have taken their armour and their swords, the armour and swords which they wielded in their intellectual struggles, and many of which we are still wielding ourselves in our wars of liberation from error, and our conquests of truth"

With regard to the question as to the exact part of the world where these consolidations took place, no definite or positive statement could be made Nothing, however, had shaken his belief—he did not call it more—that the oldest home of the Aryas was in the East All theories in favour of other localities, of which so much had been said lately, whether in favour of Scandinavia, Russia, or Germany, rested on evidence far more precarious than that which was collected by the founders of comparative philology There was also a difference of opinion as to the original home of the Semites, but all Semitic scholars agreed that it was "somewhere in Asia" With regard to time the difficulties were still greater, but Prof Muller expressed the opinion that if we must follow the example of geology and fix chronological limits for the growth of the Proto Aryan language, previous to the consolidation of the six national languages, 10,000 B C would by no means be too distant as the probable limit of what he would call our historical knowledge of the existence of Aryan speakers somewhere in Asia There must also have been a long period previous to the formation of the great Semitic languages, because thus only can the fact be accounted for that on many points so modern a language as Arabic is more primitive than Hebrew, while in other grammatical formations Hebrew is more primitive than Arabic. Whether it was possible that these two linguistic consolidations, the Aryan and Semitic, came originally from a common source was a question which scholars did not like to ask, because they knew it did not admit of a scholarlike answer Another question also which carried us back still further into unknown antiquity, whether it was possible to account for the origin of languages or rather of human speech in general, was one which scholars eschewed, because it was one to be handled by philosophers rather than by students of language The deeper we delved the farther the solution of this problem seemed to recede from our grasp, and we might here too learn the old lesson that our mind was not made to grasp beginnings And yet, though accepting this limitation of their labours as the common fate of all human knowledge, Oriental scholars had not altogether laboured in vain No history of the world could in future be written without its introductory chapter on the great consolidations of the ancient Aryan and Semitic speakers. It might be said that this great discovery of a whole act in the drama of the world, the very existence of which was unknown to our forefathers, was due to the study of the Science of Language rather than to Oriental scholarship. But where would the Science of Language have been without the students of Sanskrit and Zend, of Hebrew and Arabic? "At a

Congress of Orientalists we have a right to claim what is due to them, and I doubt whether anybody here present would deny that it is due in the first place to Oriental scholars, such as Sir W. Jones, Colebrooke, Schlegel, Bopp, Burnouf, Grimm, and Kuhn, if we now have a whole period added to the history of the world, if we now can prove that long before we know anything of Homeric Greece, of Vedic India, of Persia, Greece, Italy, and all the rest of Europe, there was a real historical community formed by the speakers of Aryan tongues, that they were closely held together by the bonds of a common speech and common thoughts. It is equally due to the industry and genius of Oriental scholars such as de Sacy, Gesenius, Ewald, and my friend the late Prof. Wright, if it can no longer be doubted that the ancestors of the speakers of Babylonian and Assyrian, Syriac, Hebrew, Phenician, and Arabic formed once one consolidated brotherhood of Semitic speech, and that, however different they are when they appear for the first time in their national individuality on the stage of history, they could once understand their common words and common thoughts, like members of one and the same family. Surely this is an achievement in which Oriental scholarship has a right to take pride, when it is challenged to produce its title to the gratitude of the world at large."

Turning to another field, Prof. Muller showed that Oriental scholars had inspired the oldest period in the history of the world with a new life. Instead of learning by heart the unmeaning names of kings and the dates of their battles, whether in Egypt or Babylon, in Syria or Palestine, we had been enabled, chiefly through the marvellous discoveries of Oriental scholars, to watch their most secret thoughts, to comprehend their motives, to listen to their prayers, to read even their private and confidential letters. The ancient history of the world might be said to have assumed, under the hands of Oriental scholars, the character of a magnificent dramatic trilogy. The first drama told us of the fates of the Aryan and Semitic races, as compact confederacies before their separation into various languages and historical nationalities. The second drama was formed by the wars and conquests of the great Eastern Empires in Egypt, Babylon, and Syria, but it showed us that besides these wars and conquests, there was a constant progress of Eastern culture towards the West, towards the shores and islands of the Mediterranean, and lastly towards Greece. The third drama represented the triumphant progress of Alexander, the Greek far more than the Macedonian, from Europe through Persia, Palestine, Phenicia, Egypt, Babylon, Hyrcania, and Bactria to India, in fact through all the great empires of the ancient East. Here we saw the first attempt at re-establishing the union between East and the West.

Prof. Muller concluded his address with an eloquent and impressive plea for the encouragement of Oriental studies in England. "When," he said, "I accepted the honourable post of president of this congress, it was chiefly because I hoped that this congress would help to kindle more enthusiasm for Oriental scholarship in England. But that enthusiasm must not be allowed to pass away with our meeting. It should assume a solid and lasting form in the shape of a permanent and powerful association for the advancement of Oriental learning, having its proper home in the Imperial Institute. If the members of this congress and their friends will help to carry out this plan, then our congress might hereafter mark an important epoch in the history of this the greatest Eastern Empire, and I should feel that, in spite of all my shortcomings, I had proved not quite unworthy of the confidence which my friends and fellow-labourers have reposed in me."

A vote of thanks to Prof. Muller for his interesting address was moved by Prof. von Buhler, seconded by Count de Gubernatis, and carried with enthusiasm.

On Tuesday the work of the sections was proceeded with. Special interest was given to the proceedings on Wednesday by the reading of an address written by Mr. Gladstone, for the section dealing with Archaic Greece and the East.

THE ERUPTION AT SANGIR

ON Friday last the *Times* printed some interesting extracts from a letter (dated Labuan, July 11, 1892) by Mr. George Ormsby, a magistrate in the British North Borneo Company's Service, containing an account of the recent eruption in Sangir, and of a visit paid to the spot immediately afterwards. Mr. Ormsby left Sandakan on June 4 in the s.s. *Normanby*, and arrived at Menado on the morning of the 7th. After a visit to Govontalo the vessel returned to Menado on the 10th, and here Mr. Ormsby heard that there had been an eruption on some of the islands to the north, and that the s.s. *Hecuba*, which had arrived at Menado just after the *Normanby* had started for Govontalo, had been chartered by the Dutch Government, and had gone out to find the scene of the eruption and to render assistance. On the 12th the *Hecuba* was sighted coming into Menado, and Mr. Ormsby and the skipper of the *Normanby* went on board as soon as she dropped anchor. "The captain," says Mr. Ormsby, "told us that he first went to an island called Siow, as the volcano there was known to be active. He found the island covered with ashes, but was told that the eruption had taken place at Sangir, an island about 30 miles further north. He went on there, and found it buried in ashes; they were digging the houses out at Tarona, the port. The cocoanut trees were all destroyed, and the loss of life was unknown. The volcano was slightly in eruption when he arrived. He went along the coast, stopping at the villages, and sending rice ashore, as the people were without food. He said some of the people were frightfully burned and maimed."

When the Dutch official who was on board the *Hecuba* reported the state of affairs to the Resident, the *Normanby* was chartered to take rice to the island and land it at Tarona. She left Menado at midnight, and arrived at Tarona next afternoon. "As we steamed up the coast of Sangir we could see the cocoanuts, with all the leaves broken and hanging downwards and covered with ashes, although the southern end of the island is sheltered from the volcano by hills. The harbour of Tarona is a narrow inlet, about half way up the western side of the island, with steep hills on each side. The village is on the north side of the harbour, and is sheltered from the volcano by the hills behind it; behind the hills a large plain stretches to the foot of the volcano."

The eruption took place on the 7th at 7 p.m., and there was a slight eruption on the 9th, followed by heavy rain. The only damage done in Tarona was by the weight of ashes; many of the lightly built native houses were crushed. "The afternoon we arrived," Mr. Ormsby says, "I went ashore, and followed the road from Tarona along the harbour. On rounding the end of the hills the road turned and ran along the northern slope of the hill; down below the road there was a deep ravine, with a small stream at the bottom, which was warm and smelt strongly of sulphur. The ravine was 40 ft. or 50 ft. deep, and had evidently been partly cut out by a stream of mud, which had rushed down it from the foot of the mountain and torn away the road in places. Looking across the ravine towards the crater the whole plain was burnt up, and near the foot of the mountain there was a jet of steam and thick black smoke. On the slope of the crater there was no sign of lava or mud. The three mud rivers I saw started from the foot of the mountain. I followed the road for some distance. About two miles from the sea it crossed a small triangular plain, and then zigzagged up the central range of hills. Where it crossed the plain it was entirely washed away by mud and ashes, which had been hardened by the rain after the eruption. The bridge across the stream was also destroyed, only the butts of the piles remaining. I got up to the top of the hills and a bit down the other side. I had a fine view of the volcano from the top; it was smoking, but there were no fireworks while we were on the island. I noticed a column of steam rising from the plain, close to the foot of the volcano, and determined to try and reach it next morning."

The column of steam was visited next day by Mr. Ormsby and the chief engineer, but they reached it with difficulty. On the way they had to jump a "stream which was steaming, and must have been very hot." He says:—"We went up to where the steam was blowing up through the mud. The mud was quite firm, but so hot that we had to shift from one foot to the other. The steam was puffing up through a lot of holes, but not very strongly where we were. I poked up a lot of stones out of one of the holes with my stick; they were so hot you could not hold them. I let two of them cool a bit, and then rolled them up in my handkerchief and put them in my pocket. One of them was covered with sulphur crystals, but, unfortunately, I lost it as we were returning. The whole place smelt strongly of sulphur, and we soon decided we had had enough of it, as it was about 9 a.m., and between the sun above and the earth below we were both streaming with perspiration. We got back to the ship pretty well fagged, and I stayed on board

till we left at 3 p m We went direct from Tarona to Sandakan, and as we steamed past the north end of the island I counted 18 jets of steam and smoke on the plain where in the morning there had only been two The volcano itself was wrapped in smoke, and there were heavy clouds of smoke hanging over the plain . . The Dutch controleur told us that they had already recovered 300 bodies, but that it was impossible to estimate the total loss He said the other side of the island was worse, lava as well as mud having overflowed there, and that whole villages were buried No lives were lost in Tarona itself, but forty men from there went into the jungle just before the eruption, and only one got back alive. We got to Sandakan at midnight on the 16th, and stopped a day there The eruption was distinctly heard at Sandakan, though it is nearly 500 miles from Sangir"

THE WEST INDIAN FAUNA IN SOUTH FLORIDA

DR C H MERRIAM has lately published a paper on "The Geographical Distribution of Life in North America" (Proc Biol Soc Wash, April, 1892), which should attract attention on account of the important problems discussed, and the interesting and somewhat novel views advanced On pp 49–55 there is a review of the faunal relations of Southern Florida, in which Dr A R Wallace is severely criticized for having stated that Florida is, from a biological point of view, essentially North American, and totally distinct in character from Cuba and the Bahamas, from which it is separated by only a narrow strait The phrase specially attacked is out of "Island Life," as follows "Between frigid Canada and subtropical Florida there are less marked differences in the animal productions than between Florida and Cuba"[1]

I well remember that some time ago, when I knew next to nothing of the West Indian fauna, this particular phrase seemed to me very erroneous An American zoologist cannot fail to be struck with the presence of a colony of West Indian forms in Southern Florida, so distinct from the species and genera of the United States Following Dr Merriam's enumeration, we see nine genera of tropical birds, hundreds of tropical insects, a dozen or more land shells, many plants, and so forth It would seem impossible to doubt that Southern Florida should be referred to the West Indian faunal division in the face of such evidence

But if we examine the matter from the point of view of a West Indian, who is searching for a fauna in Florida, which is identical, or nearly so, with that of the islands, things look very different indeed Dr Wallace's reference was to Florida as a whole, the term "subtropical" being used as descriptive of the State, not of the southern coast only, as used by Dr Merriam In the map given by Dr Merriam, about nine-tenths of Florida are coloured orange, to indicate that they belong to the Lower Sonoran Region of the author Now this, with the Upper Sonoran, which stretches into Canada, north of Lake Erie, forms the Sonoran, one of Dr Merriam's primary divisions, the distinction of which from the Tropical region he has so well demonstrated Furthermore, a large part of Canada is coloured blue on the map, to show that it belongs to the Transition Region between the Sonoran and the Boreal Hence it appears, from Dr Merriam's own map, and the statements throughout his paper, that by far the greater part of Florida is more allied faunally to portions of Canada than it is to the West Indies, so far exactly confirming the truth of Dr Wallace's statement

This will no doubt be readily admitted by Dr Merriam, who bases his criticisms on the ground that Dr Wallace had overlooked the existence of a West Indian fauna along the extreme south coast of Florida. We may, therefore, consider the evidence whereby this limited portion of the State is placed in the Tropical division. For convenience, we may allude to this tract as Tropical Florida, using the term tropical to indicate the climate rather than the fauna.

In order to get at the necessary facts, I have compared the birds of the regions under consideration, using Cory's "Birds of the West Indies" as a guide to the ornithology of the several islands.

Dr Merriam says that "no less than nine" genera of Tropical American birds inhabit Tropical Florida, and cites nineteen species or subspecies of Antillean birds living in the same area, but not further north

I find on examining and comparing the West Indian statistics,[1] that no less than 51 genera of West Indian land birds *fail* to reach Florida or any other part of North America. These genera are as follows —

Mimocichla, Cichlherminia, *Margarops*, Ramphocinclus Cinclocerthia, Leucopera, Catharopera, *Microligea*, *Teretistris* *Glossiptila*, *Laletes*, *Dulus*, Calliste, *Spindalis*, *Nesospingus*, *Phœnicophilus*, *Calyptophilus*, Saltator, *Loxigilla*, *Melopyrrha*, *Loximitris*, *Sicalis*, *Nesopsar*, *Elainia*, *Lawrencia*, *Blacicus*, *Nyctibus*, *Siphonorhis*, *Hemiprocne*, Glaucis, *Lampornis*, Eulampis, *Aithurus*, Thalurania, *Mellisuga*, *Doricha*, *Bellona*, *Sporadinus*, *Priotelus*, *Temnotrogon*, *Saurothera*, *Hyetornis*, *Todus*, *Picumnus*, *Nesoceleus*, *Ara*, *Chrysotis*, *Gymnasio*, *Ruporms*, *Regerhinus*, *Xiphidiopicus*

Those printed in ordinary type appear to occur in the West Indies only in the Lesser Antilles

The number of West Indian species not reaching Florida is of course overwhelmingly great, but here the comparison would be unfair, owing to the large number of representative species, on different islands. In order to obtain a just estimate I have therefore made a list of the land birds inhabiting Cuba which do not occur in Tropical Florida, and the result shows one family (*Todidæ*), 18 genera, and 52 species There are also a few sub species

The list is as follows —

Icterus hypomelas	Myiarchus sagræ B.
Agelaius humeralis	* Blacicus caribæus
,, assimilis	Tyrannus magnirostris
Sturnella hippocrepis	Antrostomus cubanensis
Quiscalus gundlachii	Cypselus phœnicolius.
,, atroviolaceus	* Hemiprocne zonaris.
Corvus nasicus.	Calypte helenæ
,, minutus	* Sporadinus riccordi B.
Pitangus caudifasciatus	* Priotelus temnurus
* Saurothera merlini.	Petrochelidon fulva.
* Todus multicolor	Viveo gundlachi
* Xiphidiopicus percussus	* Spindalis pretrei
Centrurus superciliaris	* Melopyrrha nigra
Colaptes chrysocaulosus	* Pyrrhomitris cucullata
* Nesoceleus fernandinæ	Euetheia olivacea.
* Mimocichla rubripes	* Ara tricolor
,, schistacea.	Conurus euops.
Myiadestes Elizabeth	* Chrysotis leucocephala B
Mimus gundlachi B	Asio stygius
Polioptila lembeyi	* Gymnasio lawrencii.
Dendroica petechia (race gundlachi) B	Glaucidium siju.
,, pityophila	Accipiter gundlachi
* Teretistris fernandinæ	,, fringilloides
,, fornsi	* Regerhinus wilsonii.
* Cœreba cyanea	Columba corensis
	,, inornata.

Geotrygon caniceps

The two species of *Columba* are not definitely given as Cuban in Cory's work but I believe they occur there Species marked with an asterisk are of genera not reaching Florida, species marked "B" also occur in the Bahamas.

The Bahama Islands also have many birds that are not in Tropical Florida, including some genera, as *Doricha* (two species)

It is thus apparent that, so far as the birds are concerned, the arm of sea between Cuba or the Bahamas and the mainland has been very efficient in preventing the mingling of two faunas, although a limited number of species have crossed it.

To give many other instances would unduly prolong this letter, but one may cite the land shells as a much more striking case. The land mollusca of Cuba and Florida are almost entirely distinct, the small number (about a dozen[2]) of West Indian forms which have reached Florida is really surprising, considering the favourable currents and the proximity of the two areas. Cuba contains numerous generic and subgeneric types, and hundreds of species, which have never reached Florida.[3]

On the other hand, even on the Florida Keys we get such

[1] This statement is qualified by a footnote in the new edition of "Island Life," where the existence of some West Indian forms is referred to.

[1] These might be modified in slight details by searching the most recent literature, but Cory's work (1889) is very complete up to the time it was published

[2] Dr Merriam cites 20 on Dr Dall's authority, but several of these are not land shells but belong to brackish or fresh water

[3] Thus, Cuba has considerably over 200 species of operculate land-shells which have not reached Florida.

North American types as the subgenera *Polygyra* and *Mesodon* of *Helix* (*H. jejuna*, No Name Key; *H. pustula*, Cedar Keys; *H. carpenteriana*, Key Biscayne; *H. cereolus*, Indian Key, Key West, Egmont Key; *H. septemvolva*, Key West; *H. oppilata*, Cedar Keys (but this is also a Yucatan species); *H. uvulifera*, plentiful on several Keys; *H. auriculata*, Cedar Keys).

How far the birds of Tropical Florida agree with those of the Sonoran region I do not know, having no list at hand from which to glean the facts; but inasmuch as they must greatly exceed nineteen, the number of Antillean forms quoted by Dr. Merriam, it is apparent that the character of the air-fauna cannot be so totally different from that of more northern regions as to justify the proposal to merge it in a different primary faunal division. Dr. Merriam gives a list of the birds which are supposed to be restricted to Southern Florida, comprising two species and seven sub-species; this list emphatically confirms the view that the region in question is really North American (Sonoran), for of the two species, one belongs to a genus which does not occur in the West Indies, and the other to a North American genus which has no endemic West Indian species. The seven sub species are *all* of North American species, and three of them belong to genera (*Meleagris*, *Cyanocitta*, *Sitta*) which do not exist in the West Indies.

To sum up, the facts seem to be as follows:—The whole of Florida really belongs to the eastern division of the Nearctic region (or to the Sonoran region of Dr. Merriam), but along the southern coast, on land of comparatively recent origin, a number of West Indian forms have appeared, owing to the assistance of currents conveying floating trees, &c., and to the proximity of Cuba and the Bahamas, which has permitted many birds and insects to fly across. These immigrants have formed a distinct colony, but not to any great extent, so far as can be learned, at the expense of the native fauna. The recent appearance of this colony is shown by the fact that (except somewhat doubtfully in the case of a few mollusca) there is at present no tendency to form new endemic species. Mr. Schwarr, who was so impressed with the great number of West Indian insects he found in this region, specially mentions that there were *no endemic forms*.

The northward spread of this colony has doubtless been largely prevented by climate, as stated by Dr. Merriam; but doubtless also quite as largely owing to the *competition of the Sonoran fauna*, for, as Dr. Merriam has himself put it in another connection, "the sustaining capacity of a region is limited; hence such a thing as overcrowding, in the sense of greatly increasing the number of organisms a region can support, is an impossibility."

If climate had been the only barrier then Tropical Florida should have a fauna like that of Cuba; but so far from doing so, it is still essentially Nearctic, notwithstanding the existence of a very important and interesting West Indian colony. At best it is a transition region.

Under the guidance of Dr. Merriam, researches into the geographical distribution of North American birds and mammals are being energetically carried on; and if I am not mistaken in the above stated opinions, no doubt information will in due course accumulate that will cause him to withdraw from the position here criticized, and to admit that Dr. Wallace was, in the main, perfectly correct.

T. D. A. COCKERELL.

Institute of Jamaica, Kingston, Jamaica,
July 31.

"A NEW SECT OF HERO-WORSHIPPERS."

UNDER this title, the *Japan Mail* describes a curious Society, established in Japan, in honour of Isaac Newton, and which is not a new scientific association so much as a new cult. The day of all the year to the members is Christmas Day, being that on which in 1642 the immortal Newton was born. The constitution is of the simplest. The professors, graduates, and students of the mathematical, astronomical, and physical classes of the Tokio University are *ex officio* members; once a member always a member; and there are no others. The Society was launched as one for undergraduates by Messrs. Fujisawa, Tanaka, and Tanakadate, the first brilliant triumvirate of mathematical graduates which the Tokio University gave to the world. In its early days it met in the students' dormitory. But as the undergraduates developed into graduates and assistants, the professors themselves were drawn into the fold, and a more suitable assembly hall was found in the University Observatory. Now, however, that building is devoted to seismological pursuits. At Christmas, 1890, or Newtonmas, 248, for the first time, the members of the *Newtonkai*, or Newton Association, met in the Physical Laboratory of the Imperial University, to hear each other talk, to distribute appropriate gifts, and to lengthen out the small hours with laughter and good cheer. The Society has no President; a portrait of the august Sir Isaac presides over the scene. It keeps no written records, no minutes; but its traditions are simple, and easily handed down from year to year. The entertainment provided is the work of the second year students, assisted by those of the first year. Each professor is expected to make a little speech, which is sometimes historical, sometimes whimsical, as the individual spirit may prompt; but it must not be suggestive of the background of a blackboard. The meeting in fact is essentially social; and in the preparation of the magic lantern slides, the committee of management lay themselves out for frolic and jest. The picture may represent a comical incident familiar to most of the members, or it may be a pictorial conundrum to guess. It was a fine humour, for instance, which gave a caricature of one student notorious for his indefatigable asking of questions. This youth was shown labouring under a shoulder beam, from which hung two buckets filled to overflowing with points of interrogation; while in the background was seated one of the professors, perfectly aghast as this mathematical labourer approached with his load. After the magic lantern exhibition comes the lottery for presents. This is a great feature, productive of much merriment. Each person draws a paper, which may be blank, but usually has a name on it. This name may be one of the illustrious living, or the still more illustrious dead. Corresponding to each name is an article, which, with all solemnity, is presented to the holder of the paper. The connection between the article and the name is more or less symbolic, or it may rest on a far-fetched pun, to which the Japanese language readily lends itself. Usually the jokes are very technical; but occasionally they appeal to a circle more wide than mathematical. Thus the drawer of "Newton" got an apple, and the drawer of "Franklin" a kite. "Herschell" (Sir John) was represented by a sprig of *Nanten* ("southern heavens," which he surveyed); "Archimedes," by a naked doll supposed to be returning from the bath; while the holder of "Kant Laplace," got a puff of tobacco smoke blown in his face, symbolic of the nebular hypothesis. Some time ago it was pointed out by a European member of the *Kai* that in holding the "Newtonmas" on Christmas Day the members were guilty of a chronological crime hardly to be excused in men trained in the accurate school of Newton. For although he was registered as being born on Christmas Day, 1642, it was Christmas Day, old style. In all strictness he was born on January 5, 1643. But the great convenience of having the *fête* at the beginning rather than towards the end of the winter vacation, and the avoidance of clashing with Japanese New Year festivities, were sufficient to outweigh all other considerations whatsoever. Besides, did not Newton himself hold his birthday on Christmas Day? Why, then, should his admirers hold it on any other? After all, concludes the Yokohama journal, the peculiar interest of the "Newtonmas" lies in its existence. Only to the hero worshipping Japanese has it occurred thus to pay honour to the memory of the greatest mathematical sage of all time. Very few English-speaking naturalists, to use the word in its widest and legitimate sense, are even aware that Christmas Day in 1642 beheld the birth of Newton. It is possible that nearly fifty years ago a bicentenary *fête* was held in Cambridge; and it is very probable that about fifty years hence Newton's tercentenary will be celebrated in England—perhaps over all the civilized world. But an annual celebration by a Newton Club outside Japan is a thing not to be dreamed of, unless Japan influences the hero-worshipping instinct of the Western people as profoundly as she has influenced their æsthetic taste.

SCIENTIFIC SERIALS.

Royal Society of Victoria, Vol. 3 (N.S.), *Proceedings*, Part I. contains Notes on West Australian oology, by A. J. Campbell (Pls. 1 and 2); On some Victorian fishes, with descriptions of *Cristiceps wilsoni*, *C. phillipi*, *Syngnathus phillipi*, and *Trip-*

terygium macleayanum (Pl 3) by A H. Lucas, Anthropology in Australia, by A W Howitt, On the nomenclature of chick-embryos (Pls 4–7) Instead of indicating the stages in the development of the chick by the number of hours or days, which is unsatisfactory, as different eggs incubated for the same length of time will frequently be found to contain embryos which have reached quite different stages of development, the stages are marked based upon the external form, and each is designated by a letter of the alphabet On some Victorian Land Planarians, by Prof W B Spencer (Pls 11 and 12), enumerates ten species of Geoplana and describes *G dendyi*, sp n, and *G frosti*, sp n, all the species are figured in two admirably executed coloured plates On the movements of the heart of *Hoplocephalus superbus* in and out of the body, by Dr McAlpine, On a Nematode from the stomach of *Hoplocephalus superbus*, and on a fluke parasitic in the respiratory and alimentary systems of the same Neither parasites are named but the Nematode (Ascaris) is figured on pl 8 On the presence of amœboid corpuscles in the liquid discharged from the nephridial apertures and oral papillæ of Peripatus, by A Dendy, On the shell money of New Britain, by R H Rickard, On the Dukduk Association of New Britain, Notes on the miocene strata of Jemmy's Point and on the older tertiary at Bairnsdale, by J Dennant Some new or little known Polzyoa, by P H MacGillivray (Pls 9 and 10), Notes on the marine rocks underlying Warrnambool, by G S Griffiths

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, August 29 —M Duchartre in the chair —Observations of the new planet M Wolf, made at the observatory of Paris (west equatorial), by M G Bigourdan From observations of comparison stars, the R A of the planet in question on August 27, at 12h 20m, 33s p m Paris mean time, was 22h 41m 24 95s, its apparent declination – 10° 25′ 51″ 8, and its magnitude 12 5 —Measures of the diameter of Mars, by M Camille Flammarion To settle the divergence between the values of the diameters of Mars as predicted by the *Nautical Almanac*, the *Connaissance des Temps*, and Marth's "Ephémérides," measurements were taken with the 24cm equatorial of the Juvisy observatory, resulting in values ranging from 24″ 50 to 24″ 91 These confirm Marth's calculations, while the other two ephemerides are about 5″ in excess, based as they are upon Leverrier's tables instead of Hartwig's —On the solar phenomena observed at the Royal Observatory of the Roman College during the second quarter of 1892, by M P Tacchini —On the bacterian origin of the bilious fever of hot countries, by M Domingos Freire A microscopic comparison of the germs of the yellow fever with those of the somewhat similar bilious fever of tropical countries shows that the former is due to a micrococcus, which is round, highly refractive, and easily coloured by fuchsine, methyl blue, &c, whereas the bilious fever is originated by a bacillus which the writer has succeeded in cultivating It is about nine microns long and three broad It is motionless, and accompanied by numerous moving spores Each bacillus undergoes rapid segmentation into two parts, which give rise to terminal spores It has been found possible to produce the disease in a pig by inoculation —On the comparative assimilation of plants of the same species, developed in the sun and in the shade respectively, by M. L Géneau de Lamarlière A series of quantitative results, showing that under similar external conditions the decomposition of carbonic acid varies in intensity, for leaves of the same species, according to the conditions of development of these leaves, and that the leaves of a species developed in the sun, all other conditions being equal, decompose the carbonic acid of the air more energetically than those developed in the shade —On the present eruption of Etna, by M Wallerant The eruption of 1892, without having the importance of that of 1865, is, from several points of view, superior to that of 1886, the flows of lava are more extended and the craters more numerous. On July 8 the volcano gave its usual warnings Thick columns of black smoke emerged from the principal crater, and earthshocks were felt as far as Catania. On the following day the eruption began in earnest. Two openings appeared a short distance apart, one of which only gave off steam, while the other gave rise to a flow of lava which passed westwards of Monte Nero, and which has been called the western stream It was not till after the flow had ceased that four volcanic cones arose successively from north to south at a distance of about 60 m to the east of this cleft Another flow of lava passed to the east of Monte Nero, and was called the eastern stream For about a month the eruption followed its normal course, the lava continued to flow and the cones increased in height But on August 9 important modifications took place The ejections diminished and the explosions ceased It was thought that the disturbance was dying out, but on the 11th such an eruption of steam took place that Etna disappeared entirely in an absolutely opaque cloud. At the same time it was found that the lava, leaving the first tracks, had taken a new path across the vineyards In the morning of the 12th the opening of a new crater in the line of the preceding ones was found in the act of building up a cone The previous evening the observers had passed over the same spot and had found small vents giving off vapours, but nothing to indicate the formation of a crater in so short a time The formation of this crater was accompanied by a complete cessation of the ejections from the second volcanic cone, which had been very violent The eruption thus seemed to have entered a new stage of development

CONTENTS.

THURSDAY, SEPTEMBER 15, 1892

NEW CONTRIBUTIONS TO THE BIOLOGY OF PLANTS

Beitrage zur Biologie der Pflanzen Herausgegeben von Dr Ferdinand Cohn Band 5 Heft 3 1892

TO the new number of Prof Cohn's publication Dr Max Scholtz contributes an interesting paper on the nutation of the flower stalk in poppies and of the terminal shoots in Virginian creeper In both cases the nutation is dependent on the action of gravity, but has nothing to do with the weight of the bud In the case of poppies the downward curvature of the stalk takes place with sufficient force to lift a weight equal to twice that of the flower-bud If, however, the flower-bud be removed there is no longer any nutation, the stalk straightens itself Vochting had already shown that this is the case even if the amputated bud is tied on again with thread Dr Max Scholtz further states that if a weight three times as heavy as the bud is substituted for it, the stalk still straightens itself, and lifts up the weight The state of the case then is this the upper part of the flower-stalk, during a certain stage of growth, is in a high degree positively geotropic if it remains in connection with a developing flower-bud, but not otherwise The author has further succeeded in determining the exact part of the flower-bud which governs the geotropism of the stalk If the pistil is excised, nutation ceases, the stalk becoming negatively geotropic, but if all the other whorls of the flower are removed and the pistil left, then nutation goes on as usual But beyond this, if the ovules are extirpated, but the wall of the ovary left standing, the nutation is stopped Hence we arrive at the striking conclusion that the presence of developing ovules in the young ovary determines the reaction of the flower-stalk towards gravity A certain analogy is obvious with the irritability of root-tips, investigated by Darwin Dr Max Scholtz's observations afford a good example of the extreme complexity of those phenomena of growth which a few years ago were thought susceptible of a simple mechanical explanation The author thinks that the nutation is of advantage, inasmuch as the reversed position of the flower-bud allows a better access of light to the developing ovary As is well known, the flower-stalk ceases to nod when the flower opens, in other words, as soon as the development of the ovules is completed the flower-stalk becomes as strongly negatively geotropic as it had been positively geotropic before

Dr Max Scholtz has made similar observations on the nodding ends of the main shoots of *Ampelopsis quinquefolia*. Here also the positive geotropism of the younger internodes only exists so long as the terminal bud is present and uninjured. Both here and in the poppies the same part of the stem which for a time shows nutation afterwards erects itself, reversing its reaction towards gravity, and also becoming for the first time positively heliotropic This change in the mode of response to constant external influences is dictated by the embryonic organs at the growing point

A paper by Dr. Paul Siedler on the radial sap-current in roots, consists essentially of an anatomical description of the cortex in a number of roots, and does not appear to add much to our previous knowledge The author believes that in many cases the hypodermal layers act as a water reservoir, this is not improbable, but no experimental evidence is adduced, and the argument from structure alone is scarcely convincing

Dr F Rosen writes on differences in staining between various parts of the nucleus, and between the sexual nuclei His work is generally confirmatory of that of the zoologist Auerbach He finds, on examining the vegetative nuclei of Scilla and Hyacinth that two kinds of nucleoli can be detected in the nucleus, the one has an affinity for red, the other for blue stains The "erythrophilous" bodies are the true nucleoli, the "cyanophilous" granules form part of the chromatin framework These are simply colour reactions, and are independent of the chemical composition of the stains employed

The author's results are much more remarkable in the case of the sexual nuclei He worked at Liliaceæ, and found that the generative nucleus of the pollen-grain takes up blue stains specially, while its vegetative nucleus is conspicuously erythrophilous In the female organs, on the other hand, not only the nucleus of the ovum, but all the nuclei in the embryo-sac are erythrophilous, while those of the rest of the ovule give blue reactions on double staining He believes, therefore, that he has detected a qualitative difference between the male and female nuclear substance His statements apply to the chromatin framework of the respective nuclei

These observations are curious, but their significance is very doubtful The existence of a distinct male and female substance, distinguishable by reagents, is highly improbable in the light of our present knowledge of the phenomena of fertilization It is noticeable that the author has not investigated the reaction of the sexual nuclei at the time of their fusion Probably the differences which he has observed, like those recorded by some previous investigators, depend rather on the phase of development of the nuclei than on their sexual character

Prof G Hieronymus is the author of two "Contributions to the Morphology and Biology of the Algæ" The former of these is on a curious freshwater Alga, Glaucocystis, hitherto placed among the blue-green forms. The author shows that it possesses a perfectly typical nucleus and chromatophores, and must therefore be removed from the Cyanophyceæ, and find a place among the higher Algæ, probably in the neighbourhood of the Bangiaceæ The same applies to several other genera, which, on account of their colour, have hitherto been classed among the Cyanophyceæ

The author's second paper is on the organization of the cells of Cyanophyceæ (Phycochromaceæ of Prof Hieronymus) The existence both of chromatophores and nuclei in these plants has long been a subject of controversy.

As regards the former question, the author finds that the chlorophyll is contained in distinct granules, ranged in fibrillæ, which normally form a single or double layer in the peripheral protoplasm The blue pigment, however, is dissolved in the cell-sap He compares the green granules to the "grana" of Arthur Meyer, which, in typical chloroplastids, are the immediate seat of the

 X

colouring-matter The colourless central portion of each "granum" may perhaps consist of a product of assimilation, such as paramylon The fibrillæ formed by the grana are inconstant in number. They may sometimes become interspersed among the elements of the central body (nucleus ?) of the cell The author comes to the conclusion that, while the constituent elements of chromatophores are present in these plants, they have not become associated to form definite plastids

Passing on to the supposed nucleus of Cyanophyceæ, Prof Hieronymus confirms the observations of previous writers as to the presence in the middle of each cell of a comparatively large body of distinctly fibrillar structure The tangled fibril is almost certainly a single one, and is moniliform, the granulations being the staining portions Their substance has been called by Borzi cyanophycin The author regards them as representing the chromatin bodies of a typical nuclear fibril, though not chemically identical with them There is no nuclear membrane, and in the older cells the fibril frequently uncoils, so that its outer windings may even reach the periphery of the cell The author therefore proposes to term the central body an "open nucleus" as opposed to the "closed nucleus" of higher organisms The body differs then from a typical nucleus (1) in its chemical reactions, (2) in the absence of a limiting membrane, and (3) in the absence (so far as observed) of karyokinetic phases

The cyanophycin, under certain conditions, is said to accumulate to an enormous extent, almost filling the cell, and sometimes assuming very definite crystalline forms The author is disposed to regard it as a reserve substance, possibly the product of the direct assimilation of atmospheric nitrogen His observations may be taken as establishing the existence in the Cyanophyceæ of a body agreeing in many respects with the nucleus of the higher plants, but much less sharply limited off from the other cell-contents

D H S

THE GEOGRAPHY OF LABRADOR

The Labrador Coast a Journal of Two Summer Cruises in that Region With Notes on its Early Discovery, on the Eskimo, on its Physical Geography, Geology, and Natural History By Adolphus Spring Packard, M D, Ph.D With Maps and Illustrations New York N D C Hodges (London Kegan Paul, Trench, Trubner and Co, 1891)

A LARGE part of this excellent work has already appeared in various journals published in the United States These contributions are not known, we fear, so widely as they deserve to be—in this country at least—and therefore Dr Packard has been well advised to gather the scattered fragments into a homogeneous whole, making, in the truest and widest sense, a geographical study of the greatest value and interest Chapters vii to xvii, with the exception of Chapter xiii, are entirely new, and contain the latest results of studies which the author has made peculiarly his own, with the result that his claim that the contents of this volume represent the state of our present knowledge of the coast and interior is perfectly well founded. The outstanding feature of the work is its wide scope, appealing as it does to the geographer, the geologist, the naturalist (to use the word in its more limited sense), the botanist, the ethnologist, and the historian Each of these will find the subject in which he is interested treated with considerable skill, and, so far as opportunity for original research allowed, with minuteness and perspicuity One fault we have to find with the style, and that is an occasional looseness in the use of nomenclature This distracts the reader's attention, and, until he has gone back and re-read many passages, leads him to question several statements which, when their meaning is fully grasped, are seen to be correct but badly expressed Should a second edition of the work be called for, revision in this respect would result in a very marked improvement

To the question as to who first sighted the inhospitable shores of Labrador, Dr Packard has devoted considerable space, carefully examining the various claims that have been put forward He comes to the conclusion that the honour belongs to the Norseman Biarne, or Bjarne, who, without doubt, made a landfall somewhere in North America in 990 We are strongly inclined to agree with the result arrived at on this point The author's experiences of navigation in the region under discussion, gave him opportunities of observing and demonstrating the rate of sailing made by modern ships, and on this basis he builds up arguments which tell with considerable force against the theories advanced by Dr Kohl and others regarding the early Scandinavian seaman, who may now be considered the almost undoubted discoverer of one of the wildest and most forbidding coasts in the world

The derivation of the name is of interest Coming from the Spanish and Portuguese word for a labourer, it was applied to this part of America after the visit of Cortereal in 1500, as the survivors of the voyage, on their return, held out the hope that the natives might easily be brought into a state of slavery and shipped to the Portuguese colonies to work in the fields and be, in fact, labourers for their self-appointed masters

We have many interesting particulars regarding the ice and snow of this region The floating blocks and bergs were carefully observed, and the conclusion, now almost universally held by geologists, confirmed that ice carried by winds and waves against the shores has had little direct influence on the configuration of the coast line After Dr Packard's careful investigation of this question, the statement, so frequently met with, that the sea lochs of the west coast of Scotland were formed by the action of glacial gouges, may for ever disappear from our school-books The only instance of such glacial effect was observed at Little Mecatina Island in the Gulf of St. Lawrence, where there is no true Arctic floe-ice An instance of the impotency of what was at one time regarded as a great eroding agency, is noted in the fact that the ship in which the author spent a considerable time amid ice-packs, presented no abrasion on her sides, the paint being as whole and unbroken when she came out of as when she entered the frozen sea. No boulders, gravels, or mud were observed on any of the icebergs examined, but as they were all of considerable age, as was indicated by the marks of frequent overturning, they had, in all probability, dropped their burdens before reaching the southern area where they were inspected

The portions of the volume dealing with the fauna and flora, both of land and sea, are well done, and ought to prove of the utmost utility and service to naturalists Dr Packard has done the work of an explorer in a most masterly manner, not only setting before us the geographical skeleton of Labrador, but doing much, so far as his opportunities went —and no man's have gone farther—to clothe the bones with an array of many of the necessary facts for the building up of a complete account of the territory To those who come after him may be left the task of filling in many details, the greater part of the work has already been accomplished, and the record is before us in these pages

There is an excellent index, but the maps and illustrations are far from clear, and require much more distinctness than has been given them A word of the highest praise must be accorded to the bibliography, which must have given the author a vast amount of trouble before it assumed its present admirable shape

THE SANITARY INSTITUTE AND ITS TRANSACTIONS IN REVIEW

The Transactions of the Sanitary Institute, 1891 Vol XII (London, 1892)

THE Transactions of the Sanitary Institute cannot fail to interest a considerable section of the community now that the general principles of sanitation have become so generally appreciated, and fresh sanitary matter is so eagerly devoured—and generally assimilated—by the enlightened section of the public

It may not be generally known that the Institute only dates its birth from the year 1876, and this fact will be the more difficult to grasp when one notes in the well-bound volume of which we write, the present scope of its transactions

The headquarters of the Institute are in Margaret Street, W, in a building known as the Parkes' Museum, so-called to commemorate the celebrated Hygienist of that name. The whole purpose of this museum is to serve as a means of practical demonstration for the diffusion of knowledge in sanitary science, and at the present day it undoubtedly forms the best collection in Great Britain of all the various apparatus and material which can be claimed to have any connection with the public health The value of such an institution does not need insistence upon here ; but the remarks of the chairman, Sir Douglas Galton, in his recent address, may be aptly reproduced "The evils," he says, "of our congested population meet us at every turn If our progenitors had been properly educated in sanitary matters, our towns would not have been allowed to contain unhealthy localities, houses would not have been permitted to be built on damp unhealthy sites, buildings would not have been constructed so as to impede the circulation of air and incidence of light Our town populations would not have been allowed to grow up herded together like the beasts of the field, without moral training or self restraint, and our country population would not have been allowed to destroy the healthy conditions which surround them, by vitiating the pure air, and by contaminating the springs of pure water The Sanitary Institute is thus the direct outgrowth of the public need for sanitary education!"

An excellent descriptive catalogue of the contents of the museum has recently been compiled, and those only among the 11,500 persons who have visited the building during the year ending March, 1892, who were acquainted with the museum so recently as eighteen months ago, can appreciate at its true worth the value of this addition, and can adequately testify to the improvement in the arrangement and grouping of the various sanitary appliances which has also been effected This catalogue is bound up with the last volume of "Transactions," which, in addition, includes a lengthy list of Fellows, Members, and Associates of the Institute, a list of the contributions to the very valuable library during 1891, a very full report of valuable and able papers of hygienic interest, which have been read by Dr Louis Parkes, Mr Grantham, Prof Wynter Blyth, and Sir Douglas Galton The volume also contains a copy of the Annual Report of the Council, and a glimpse of this gives one a capital insight into the scope and work of the Institute

In the lecture room, in addition to papers such as those referred to above, a systematic course of lectures for sanitary officers is given throughout the year by a staff of exceptionally capable lecturers, including as it does such gentlemen as Sir Douglas Galton, Prof Corfield, Dr Louis Parkes, Mr Shirley Murphy, Prof Wynter Blyth, Prof H Robinson, &c That the worth of these lectures is appreciated is sufficiently exemplified by the fact that 161 students attended them during the year, nor are they lacking attractions similar to that which insured the constant attendance of young Mr Parker at the village choir-meetings, for they are regularly patronized by one or two female devotees of the Goddess Hygeia There are, however, lectures provided entirely for ladies by Dr A T Schofield, who treated the following subjects in his last course —

"The Domestic Treatment of Disease"
"Microbes"
"Physical Culture"
"The Care of Old Age"

These have been well attended, and the Duchess of Albany recently presented the prizes gained by those who emerged successfully from a competitive class examination upon these subjects The Institute holds examinations twice yearly for inspectors of nuisances and local surveyors At these examinations 361 candidates presented themselves during the year, and 246 received "certificates of competency" Both lectures and examinations are now being provided in several large provincial towns, at a great saving of expense and trouble to aspirants for the "certificate of competency," and with the apparent effect of considerably stimulating local interest in sanitary matters Finally, the annual Health Congress held under the auspices of the Institute is always an instructive and interesting feature in its proceedings, and is largely attended and much appreciated.

OUR BOOK SHELF

Cooley's Cyclopædia of Practical Receipts By W North, M A Camb, F C S. Seventh Edition, revised and greatly enlarged (London J and A Churchill, 1892)

THIS work is intended as a general book of reference for manufacturers, tradesmen, amateurs, and heads of families,

and contains information upon all sorts of subjects, from a list of abbreviations usually employed in writing, to a description of the rare metal zirconium. Between these two articles we find notices of the methods of brewing, and the proper way of laying bricks and ventilating houses, the nature and treatment of broken wind in horses, the composition of digestive, aperient, and tonic pills, the practice of photography, the nature of infective diseases in man and beast, the destruction of caterpillars in plants, the best kind of clothes to wear, and the method of taking grease spots out of clothing. From these samples of the contents it will be seen that the book is really a most extraordinary work of reference and one which is not likely to lie idle on the shelves, but to be more or less in constant use. The work of revision has evidently been carefully done, and must have been one of no small labour, as it has been brought well up to date and many articles must be entirely new. The great practical utility of the work is shown by the large circulation it has enjoyed for many years, and the editor has done his best to maintain the well-deserved reputation of the book.

Traité Encyclopédique de Photographie. First Supplement A. Par Charles Fabre. (Gauthier-Villars et Fils, 1892.)

MANY of our readers are already thoroughly acquainted with this excellent treatise which we owe to M. Fabre. In the present volume we have the first of the series of supplements which will be issued in order to keep the book well up to date. The range of progress here shown is that accomplished during the years 1889-92. The same arrangement as to numbering the paragraphs is still presented, so that it will be quite easy for those having the original volumes to refer to any section in this supplement.

The matter which is chiefly treated of here refers to the various properties and kinds of lenses and to their combinations: thus some of the most important headings that have been considerably developed may be stated as follows:—Methods of measuring focal distances, Martin's objectives, simple objectives, calculation of objectives, rapid euryscopes, Zeiss' objectives, &c. Many other new discoveries, such as Lippmann's photography in colours, have also received attention.

With these supplements this encyclopedia will be found to be greatly enhanced in value, for at the present day photography is undergoing many and rapid changes the recording of which in this form is no light task.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Mustakh Exploration

MR. CONWAY's march from our newly acquired district of Hunza into Baltistan (reported in the *Times*), up the Hisper glacier on one side and down the Biafo on the other to Askolay, is a splendid feat to have accomplished, a memorable achievement, and his account of it will be something to look forward to on his return to England. The total length of these two glaciers is certainly something between sixty and seventy miles measured upon the map, and over this distance the glacial forces in action are on the grandest scale. The view obtained of the Hisper glacier from the two points we ascended on either side of the Nushik La is hardly to be described, from thence the end of the Hisper glacier is not defined, and could only be indicated from the run of the spurs on the north side of the valley, and what information the guides could give. This made the total length sixty four miles. By traversing this length of the two glaciers Mr. Conway has been able to get into ground never before visited, viz., that great ice field on the main range of the Mustakh, the full extent of which is quite unknown, and from which the Nobundi Sobundi branch of the Panmah glaciers also descends. Most interesting will it be to read the account of this glacial area from the pen of a man who knows the Alps so well, and has ascended so many of its peaks. He has gone direct and fresh from the one to the other—what an exquisite treat—and he has now seen glacial action on the vastest scale it is presented at the present time in a mountain chain out of Polar latitudes. My experience was the reverse of this, for I had not the opportunity of seeing an Alpine glacier until twenty years after I had been surveying those on the Yarkund and Hunza frontiers, and in the interval the vividness of their aspects and minor details had much faded. It is to be hoped that Mr. Conway has with him, and used, a plane table, properly projected on the four miles to the inch scale, with all the peaks fixed by the Trigonometrical Survey of India, correctly plotted on it, and will thus be enabled to add to and correct much of the previous reconnaissance work. There is no doubt, had Capt. Younghusband, who was another late explorer in this part of the world, worked with a plane table along his line of route towards Hunza, the results of his exploration would have been of tenfold value, and far more extended. The Indian Government should make it a rule that all officers permitted or selected to explore the unsurveyed territory beyond our Indian frontier, should, as a preliminary training, do a season's work plane tabling with a Himalayan survey party. It would also be an admirable training for officers selected for the Quartermaster General's and Intelligence Departments.

H. H. GODWIN-AUSTEN

Nebular Spectrum of Nova Aurigæ

NOVA AURIGÆ faded away so steadily in March and April as to give little promise of soon again attaining any considerable brightness. All the more startling, therefore, was Mr. Espin's announcement of Mr. Corder's discovery that it had reappeared and that he himself on August 21 had seen it as a star of the 9.2 magnitude with a monochromatic spectrum, presumably about 500 mmm. in wave length.

Fortunately the 15 inch refractor of this Observatory is still in working order, and still more fortunately my old colleague in the observation of Nova Cygni, Mr. J. G. Lohse, is staying here. On August 25 and 26 we were able to examine the Nova with a compound prism in the Grubb stellar spectroscope. The spectrum thus seen evidently contained two bright lines, the positions of which we determined as follows:—

Chief Line. Brightness 5 to 10.

Date	Wave length	Measures	Observer
Aug. 25	500.4	4	R. C.
26	500.4	3	,,
25	500.5	3	J. G. L.
26	499.9	5	,,

Second Line. Brightness 1.

Date	Wave-length	Measures	Observer
Aug. 25	495.3	2	R. C.
26	494.6	3	,,
25	495.9	3	J. G. L.
26	495.4	5	,,

From these we may derive the mean values of 500.3 and 495.3, which prove, as we think beyond doubt, that Nova Aurigæ is now mainly shining as a luminous gas nebula.

Once or twice on the 25th August, at the best moments, I had noticed feeble traces of a condensed luminosity in the spectroscope, far away on the side of less refrangibility. Our time, however, was fully occupied in observing the two brighter lines and the zinc lead spectrum, with which we compared them, until daylight prevented further observation. On the 26th, haze and bad definition concealed everything but the chief lines, but on the very clear night of the 28th, continuing the observations alone, I examined the star with a power of 229 on the wire micrometer, and wishing to see if the spectrum had materially altered I viewed the star through an excellent direct-vision prism. In this way I at once saw a faint continuous spectrum in the green, together with a distinct line in the yellow. With the spectroscope the line was also readily perceived, but not having prepared the battery for the illuminations and comparisons, no reliable direct measures could be made. By introducing

the D line into the instrument, however, I found the stellar line to be distant from it towards the violet by a quantity equal to the interval between the nebular lines This gives a wave-length of 580 1, which agrees closely with a bright line in Nova Cygni, in the Wolf-Rayet stars, and in γ Argus (compare *Copernicus*, ii p 112, and iii pp 205 and 206) The continuous spectrum seemed to begin somewhat suddenly at 569 4, and faded away about 540

On each night of observation the star was about 9 6 magnitude RALPH COPELAND

Dunecht, September 6

Daytime Seeing at the Lick Observatory

To some of the readers of NATURE it may be a matter of considerable surprise, as it certainly was to the writer, to find the marked superiority which a small telescope sometimes offers over a large one for the observation of solar prominences

On numerous occasions during the last year, while adjusting the large star spectroscope of this observatory to the 36 inch refractor, I have improved the opportunity to examine the limb of the sun with a Rowland grating At no time, however, has it been possible to get any definition in prominence With the 6-inch equatorial, on the contrary, one gets very fair definition, even in the middle of the day, while in the early morning, from six to eight o'clock, the seeing is, as a rule, superb Thinking these differences might possibly vanish if the larger glass were used earlier in the morning, I have recently made a systematic comparison of the three equatorials, viz the 6-inch, the 12-inch, and the 36 inch For this purpose a small grating spectroscope (kindly loaned by the Chabot Observatory) was used with an adapter which fitted all three telescopes, so that the whole comparison could be made in a few minutes The third and fourth orders of a 14438-line grating were employed

The result of a half-dozen mornings' observations was that no detail whatever could be made out with the 36-inch, however much care one might use in the adjustment of his instrument One could form a rough estimate of the height and general outline of the prominence, but nothing more

On the 12-inch the general features were considerably more distinct, but the fine delicate tracings of the various parts of the prominence could be seen only with the 6 inch The capping down of the 36 inch and the 12 inch failed utterly, as might have been expected, to improve the definition on any occasion

The large image of the sun given by the 36 inch (six inches in diameter), combined with the poor seeing during the daytime, makes the instrument act, *for sunspot observation*, very much like an integrating spectroscope The lines affected by absorption, in spots of any considerable size, can be picked out readily, but one finds it quite impossible to compare the absorption of the nucleus with that of the penumbra These three telescopes each give images of nearly the same brightness, and one does not find much, if any, difference in the amount of dispersed light in the field.

During the dry season, the sides of the cañons surrounding this observatory become intensely hot, and highly heated currents of air are continually rising from them So that, probably, the conditions which make the order of efficiency of these telescopes in the daytime just the reverse of what it is at night, are purely local HENRY CREW

Lick Observatory, August 19

Ridgway on the Humming-birds

MR ROBERT RIDGWAY, curator of the bird department of the U S National Museum, has just published (in separate form), in the report of that institution for 1890, his monograph of the Trochili Coming from such an authority and essaying to deal with such an interesting group, this work will undoubtedly command the attention of ornithologists, and be studied with the care it no doubt merits It makes its appearance in octavo form, of some 130 pages, being illustrated by 46 full-page plates, and has besides a number of cuts in the text The plates give us many species of humming-birds and their nests, they being all of the "electro-process" variety, and chiefly copied from Gould's princely work upon the Trochili. As is usually the case, most of the figures given have suffered by the method of reproduction employed, and not being coloured, they offer us, at the best, with but a poor idea of the "living gems" they are supposed to portray. With more or less thoroughness Mr Ridgway has touched upon the early history and the literature of his subject, upon the geographical distribution of the various species, upon their number, which he makes out to be about 500, upon their natural history in general (treated in various brief sections), and there are descriptions of their external characters and a short note upon a few of their internal ones It is with the statements made in the latter that I chiefly propose to deal in the present connection, and, aware as I am of our author's knowledge of the literature of what we may call the natural history and classification of the humming-birds, as contra distinguished from their morphology and affinities, I must confess my surprise at his ignorance of the latter part of his subject Mr Ridgway remarks (p 290) that "the humming-birds possess nothing absolutely peculiar, although certain features, shared by other groups of birds, notably the swifts (*Micropodidæ*), are developed to an extreme degree, as, for example, the very high keel to the sternum and consequent excessive development of the pectoral muscles, the short armwing (humerus) and extremely long handwing (manus), and minute feet with relatively large, strongly curved, and sharp claws The humming birds and swifts further agree in numerous anatomical characters, and there can be no doubt that they are more closely related to each other than are either to any other group of birds In fact, except in the shape of the bill and structure of the bones of the face, the humming birds and swifts present no definite differences of osteological structure" As the present writer has probably published double the number of accurate figures illustrating the *entire anatomy* of a great many species of humming-birds as compared with any other worker, and, further, has published correct accounts of the same to the extent exceeding that of any three living avian morphologists, and those figures and descriptions having been very extensively accepted as correct, perhaps our author will consider me competent to criticize the statement which I have just quoted from his work Notwithstanding the extensive and painstaking labour I have given to such matters, I reckon it but as little when compared with the opinions given us by Huxley and Kitchen Parker in the same premises.

As long ago as 1867 (P Z S, p 456), Huxley expressed the view that "in their cranial characters the swifts are far more closely allied with the swallows than with any of the Desmognathous birds, the swift presenting but a very slight modification of the true Passerine type exhibited by the swallow," and Parker has said in *The Zoologist* for March, 1889 (p 2), "I agree with my friend, Dr Shufeldt, that the 'swallow and the swift are near akin' My opinion is not the simple judgment it was forty years ago I have observed a good many things since then in the structure of birds of all sorts" Both of these high opinions I can confirm, and in support of them, and as contradicting every statement almost that my good friend and ornithologist, Mr Ridgway, has made in his work touching the structure of swifts and humming-birds, I would invite his attention to many comparative figures and accounts published by me in the Proceedings of the Zoological Society of London at various times, and also to an extensive paper of mine which appeared in the Journal of the Linnean Society of London, in 1888 or 1889, having been read at the Society by W K. Parker, F R S, who accepted, in the main, what I had stated in it Therein I anatomically compare the *entire* structure of *every* species of United States swallow with the corresponding structures in a great many swifts and a great many humming birds, and I would invite Mr Ridgway's attention to the synoptical comparisons given on pages 376-378, especially as off setting his statement, as quoted, that "in fact, except in the shape of the bill and structure of the bones of the face, the humming-birds and swifts present no definite differences of osteological structure" And, unless as a true systemist and believer in *colours and measurements* rather than in structural characters as determining the real affinities of vertebrate forms, I would finally invite his consideration of my comparative figures and description of the humerus of a swallow, a swift, and a humming-bird given in the Proc. Zool Soc, Lond, for 1887 (pp 501-503), and then ask his candid opinion upon the question whether the humerus of a swift is morphologically more like that of a humming bird than it is like that of a swallow, and the humerus is one of the bones that has been so frequently dragged into the discussion to prove cypselo-trochiline affinities

Washington, D C., July 24. R W SHUFELDT

"The Limits of Animal Intelligence"

IT is with much pleasure that I have read Prof Lloyd Morgan's letter, wherein he tells us that "the power of cognizing relations, reflection, and introspection" appears to him to mark a "new departure" in the ascending scale of psychical activities His term, "feeling of awareness of certain relationships," is new to me, however, and seems to demand a further distinction I am generally aware, in a vague way, of what I may be doing—that is to say I have a certain consciousness of it But every now and then I find that I have done, without consciousness, things which I could not have done without the exercise of my sensitive faculty, or without the guidance of bodily movement, by that faculty

I most cordially concur in the Professor's desire that the investigations to which he refers should be accompanied by "calm, temperate, and impartial discussion" founded on observation and experiment I, as well as Prof Lloyd Morgan, have long carried on such observations and experiments, and it is on them that are founded what I have written on "Our lower and higher mental powers" in chapters xiv and xv of my book[1] "On Truth" To them I may perhaps be permitted to direct the Professor's attention, since he is engaged with a work on Comparative Psychology I have as little wish to dogmatize as has Prof Lloyd Morgan, and am perfectly ready and willing to recognize the true rationality of any animal whenever I obtain evidence thereof My assertion of the exclusive rationality of man has been represented as due to other causes than what I deem to be the weight of scientific evidence Such is an utter mistake To admit that animals possess intellect would neither be repugnant to my feelings nor conflict with any other of my convictions As yet I hold all animals to be irrational, simply because I have met with, in them, nothing inexplicable by what the Professor calls "simple awareness" and what I call related feelings All prejudice should indeed be eliminated from scientific inquiry, but such can hardly be the case with any one who starts from an *a priori* "standpoint of evolution" in the sense that he holds discontinuities in nature—real "new departures"—to be impossible

The Professor says, "In conclusion I must be allowed to say that the phrases 'differences in kind' and 'differences in degree' savour somewhat of mere Academic discussion" Nevertheless there really are differences of kind, and such differences are themselves different in kind from mere differences of degree He would, of course, allow that the difference between the Binomial Theorem and the Bouquet of Chateâu d'Yquem is one "of kind," as also that between solving the *Pons asinorum* and riding *Equus asinus* I am convinced there are also psychical differences of kind, and I have become so convinced (in spite of having started with a contrary opinion) through experiments and observations

ST GEORGE MIVART

Hurstcote, September 6

The Theory of the Telephone

IN a paper in this month's *Phil Mag* I ventured to publish an explanation of the fact that in the telephone it is necessary for the diaphragm to be situated in a permanent magnetic field

Since then my attention has been called to a paper (*The Electrician*, Feb 11, 1887, p. 302) by Mr Oliver Heaviside, in which he has given a very complete theory of the question at issue

I hasten to express my regret that I had not met with this paper in time FRED T TROUTON

Physical Laboratory, Trinity College, Dublin.

Crater-like Depressions in Glaciers

IN the note on the St. Gervais Catastrophe (NATURE of September 1) I read that a crater like depression had been found in the Tête Rousse Glacier As such depressions are quite exceptional occurrences in European glaciers, it may be of interest to note that I found several holes of a similar kind in the great Tasman Glacier in New Zealand One of these reached —like the Tête Rousse one—apparently to the bottom, the others, which were from 150 feet to 300 feet deep, did not The walls of these "craters" were not vertical but above only 45°, the incline increasing below. Till now I have considered these funnel-shaped depressions as immensely widened "Glaciermills," but after the observation on the Tête Rousse it seems to me not improbable that these holes on the Tasman were also originally caused by subglacial collapse

R VON LENDENFELD

[1] Referred to on p. 266 of NATURE for July 21, 1892

CHOLERA PREVENTION AND VACCINATION

THE epidemic of cholera with which this country is threatened seems likely to test very completely the means for the prevention of its spread which have been devised as the result of the extended experience of some of the ablest hygienists The working out of the history of an epidemic disorder must necessarily be extended over a prolonged period of time, for it is dependent on the researches not only of the clinical observer, but of the pathologist and the bacteriologist and of those who devote themselves to the difficult study of the march of epidemics The development of such researches is closely allied to the advance of science generally, and although there is at any one period a large admixture of "fashion" in the opinions held by experts, yet in time this fades, and the truth is established It cannot be too clearly stated that the best measures for the prevention of an epidemic disorder can only be devised when we possess an accurate knowledge of the infective agent of the disease (bacillus or not, as the case may be), of its life-history, of its varying degrees of virulence, and the mode of entrance into the body, of the conditions under which it multiplies, and of the changes which it produces in the human body

In the case of cholera our knowledge is not yet complete Clinical observers many years ago showed that the infective agent was present in the peculiar evacuations passed by the cholera patient, and it was further found that these evacuations were the means of contaminating the water supply of a locality, and so causing the spread of the disease in the community These two facts have been established beyond doubt The exact nature of the living infective agent is not, however, so well ascertained It was in 1884 that Koch described the *Vibrio Choleræ Asiaticæ* as constantly present in the evacuations of cholera patients, but he was unable to prove that it was the cause of the disease, owing to the insusceptibility of animals to cholera It was shown that the vibrio was present also in the intestinal walls, but it was never found in the organs of the body The work of subsequent observers has brought forward fresh facts of importance It is now known that the cholera vibrio (the comma bacillus) is allied to several other forms which are pathogenic, and that there are several varieties (perhaps twelve) which have been described by Dr Cunningham The cholera vibrio is also known to vary greatly in virulence, it is so susceptible to its surroundings that a slight change will diminish its activity and certain conditions will increase its virulence One method of increasing its activity is by passing it through a series of animals (guinea-pigs), after a certain time the vibrio becomes extremely active and will kill animals very quickly, it is said in even eight hours With these virulent cultures symptoms have been produced in animals closely resembling those of Asiatic cholera, in the exudation of liquid into the intestines, in the cramps, in the suppression of urine, and in the collapse so well known in the disease in man There are therefore certain grounds for considering Koch's vibrio as the cause of Asiatic cholera But the question is not settled it is not as clear that the vibrio is the cause of Asiatic cholera as that the bacillus anthracis is the cause of anthrax The probabilities are greatly in favour of this presumption, but the slight doubt existing must be borne in mind when the question of vaccination for cholera is to be considered practically The doubt that rests on the vibrio as the cause of cholera may be stated shortly in the fact of the existence of allied forms of bacteria which produce similar symptoms, such as the vibrio Metschni-

kovi We know, too, that in man cholera is produced by what is drunk, and yet animals fed with the vibrio do not get any of the symptoms which have been mentioned, unless they are "prepared" by a course of treatment, either by neutralizing the acidity of the contents of the stomach, and subsequently giving a dose of opium to quiet the intestines, or by giving a dose of alcohol with the vibrio This vibrio cannot get through the acid stomach alive The answer to the question as to how it gets through the human stomach rests partly in the fact that in the early part of digestion, or in between meals, the stomach is not very acid, and so there may not be a sufficient degree of acidity to kill the vibrio Such remarks would, however, equally apply to the guinea-pig stomach, and the question as to why in animals the swallowed vibrio does not produce choleraic symptoms unless the animal is "prepared" is still unanswered, although such animal may be killed by an injection of the virulent preparation of the vibrio into its veins This difficult point can only be settled by investigations along new lines, probably chiefly chemical

One point suggested by the investigations of the cholera vibrio which we surmised previously to 1884, is that the infective agent in the disease not only primarily attacks the intestines, but grows there, producing the symptoms of the disease by its chemical products, without itself entering the blood stream This has an important bearing on the question of vaccination for cholera The experimental investigation of vaccination against infective disorders is a product of modern bacteriological research It is too long a question to deal with in a short article, it is sufficient to say that it is based on the fact that a mild form of the disease may be produced in an animal, which will then be protected from the virulent disease As in Pasteur's historical experiments, the attenuated or weakened anthrax bacilli were found, when injected into a sheep, to prevent the animal dying when it received a dose of virulent bacilli, which would undoubtedly kill it in ordinary circumstances This vaccination, when put into practice, was found to diminish the amount of natural anthrax in sheep in France Similar results have been obtained with the vibrio of Asiatic cholera by some of Koch's assistants, and latterly by M Haffkine, in the Institut Pasteur in Paris Haffkine attenuated the virulent vibrio by means of a current of air and other means, and obtained a culture which did not kill animals, but protected them against a subsequent injection of the virulent vibrio itself The vaccine was also injected into human beings (who lent themselves for experiment), and was found to produce a local inflammation associated with some degree of fever, all the symptoms passing away in a short period It is probable that the majority of "vaccines" would produce these symptoms It is, however, a great step to apply vaccination experiments in animals to human beings when the etiology of the particular disease is not completely worked out, and there is, perhaps, too great a tendency in modern research to extend "vaccination" experiments in infective diseases before a correct knowledge of the mode of action of the infective agent has been obtained. It has been pointed out that doubt rests on the vibrio choleræ Asiaticæ as the true cause of Asiatic cholera It may be; but to impartial observers it has not been proved to be Vaccination for cholera on a large scale would therefore at present be a mistake, as it might possibly lead to carelessness in the carrying out of better tried preventive measures, which depend not only upon the State but also on the private individual As a promising field of research, it might be applied to man, since the vaccination itself appears to do no harm But it requires a long time to decide so difficult a question, and in the meantime the community is face to face with cholera It is therefore more practical to consider preventive measures than vaccination

Preventive measures against cholera are of two kinds, those taken by the State to prevent the importation of the disease from cholera-stricken districts, and those which ought to be practised by individuals when cholera is prevalent in the community Both sets of measures depend upon two well-ascertained facts, viz that each cholera patient acts as a focus of the disease, and that the disease is spread by the evacuations contaminating the water supply. The State can prevent the importation of cholera by quarantine, but this method has been abandoned in England for many good and obvious reasons and another substituted for it which is considered as likely to be more effectual, but which can only be applied with an efficiently working sanitary organization In this country we get cholera by ships bringing cholera-stricken people, who are landed At all the ports, in times of cholera, the ships are boarded by the medical officer, and if any cases of the disease are present they are taken to isolation hospitals, whilst those who are well are allowed to land after leaving their names and destinations The medical officer of their district is communicated with, and keeps them under surveillance for some days The cholera ship is moored to a special buoy and disinfected If no cases of cholera are present on the ship, the passengers and crew are allowed to land, the taking of the names and addresses being left to the discretion of the medical officer who inspects them It is possible that no better method than this could have been devised, which, with the least inconvenience to the individual, would at the same time keep under surveillance all the imported cases of cholera, and thus check the spread of the disease It is evident that such a method is quite impracticable without efficient sanitary officers, it would, for example, be useless in a country like Turkey, where the system of quarantine and sanitary cordons exists as in most other European countries And in our country the application of this method of isolation and surveillance is surrounded by practical difficulties and dangers which may become serious, and which are in any case worthy of discussion It is quite possible that the medical officer of the port will have too much to do At present the cholera epidemic at the Continental ports, even in Hamburg, appears to be diminishing, and it may disappear when the cold weather comes, to reappear with unabated virulence next spring As this is probable, no decrease of vigilance of medical inspection is permissible during the winter months, and it is to be hoped that the sense of security felt by the community at the diminution of cholera on the appearance of cold weather will not extend to the medical officers in whose keeping the general health of the nation lies If, next spring, cholera becomes disseminated along the Channel on our opposite shore, the medical officers of our ports may be exercised to their utmost in providing accommodation for patients on cholera-stricken ships, and some, apparently well, may proceed to their homes and develop the disease before the medical officer of their district has been advised of their advent This is, no doubt, a danger which might come even from a ship which has been passed by the port medical officer with a clean bill of health

The personal measures to be taken when cholera is in our midst are important, but need only be mentioned Since cholera spreads by the evacuations, these must be disinfected with hydrochloric acid, carbolic acid, or corrosive sublimate as soon as they are passed, and all linen soiled by a cholera patient must be rigidly disinfected Since the water supply may become contaminated, all water used for drinking, washing utensils, &c, must be boiled, and all articles of food, such as milk, likely to be contaminated with unboiled water, should also be subjected to the heat of boiling water When these and similar measures for personal protection are rigidly observed, it is not too much to say that cholera will not spread

THE PLANET VENUS

M. E. L. TROUVELOT has published a most important and extensive paper on some observations of the planets Venus and Mercury, which for many years past have been occupying his attention. The physical features of the other planets have been treated on previous occasions in like manner, and have extended our knowledge very considerably, so that the reader of this work will be sure to find something really new in the great number of observations that are here recorded. Up to the month of April, 1882, the observations were made at Cambridge, United States, but since then Meudon has been the seat of operations, the air at the latter place did not prove so pure as that in the States, and the horizon not being so open, the number of observations of course was somewhat reduced.

In the work which we have before us the author divides this subject up into nine sections, and we cannot do better than treat of each of them in turn, commencing with the visibility of Venus to the naked eye in full daylight. The best way is, he says, to use the telescope as a pointer, directing it to her by means of the circles, by then looking along the telescope tube he has been able to see her at every point of her orbit, when her angular distance from the sun towards inferior conjunction was not less than 10°, and also towards superior conjunction when she was not less than 5°. Her visibility depended to some extent on the phase she represented, for it is known that the eye can distinguish more easily a disc small and distant than a comparatively larger and nearer crescent. At Cambridge it seems to have been more or less the rule, while at Meudon it was the exception, to see Venus in the daytime, the atmospheric conditions at the latter place being comparatively very bad.

With regard to the general aspect of Venus nothing very striking has been noticed, the part of the limb turned towards the sun, as recorded by other observers, always appeared more brilliant than the more central portions extending towards the terminator. Sometimes the limb was not so bright as usual, being observed to be "dull and without brilliancy," one very noticeable time occurring on April 15, 1878.

Under favourable conditions, whitish and greyish spots can be seen on the surface of Venus, which, at any time, are very difficult to observe. These different-tinted spots give, according to M. Trouvelot, indications of being at different levels. The whitish spots, situated near the terminator, produce on it slight deformations, and seem to so alter it as to suggest that these spots are at a higher level than the other parts. The greyish spots, on the other hand, when situated in about the same positions, also deform the terminator to a small extent, but in an opposite way to those just mentioned, suggesting that these spots lie at a lower level than the parts near them. These two kinds of spots have another peculiarity which has been particularly noticed, and that is their size, the white ones seem to assume a round or slightly oval form, and are nearly always small, but the grey spots are generally of an elongated shape, and are of very large proportions, forming sometimes straight bands. The interval between the appearance and disappearance of these spots is not long, in their formation they are analogous, as M. Trouvelot says, "avec ces taches diffuses des couches nuageuses continues de notre atmosphère précèdent les pluies, et qu'un simple jeu de lumière fait naître ou disparaître." Their contours are always very vague, the whites being a little less brilliant, and the greys a little less dark.

One of the largest spots that has been diligently observed was that which appeared on the 3rd September, 1876. Its size, as will be seen from the figure, was, comparatively speaking, enormous, occupying nearly a third of the illuminated visible surface. At its north and south extremities it was separated from the terminator by a large white band, the north one being considerably larger than the southern one. Up to the 10th of the same month this spot was still visible, but after that date no trace of it at all could be found. Curiously enough, on February 13th, 1891, another large grey spot (Fig. 2), bordered with white, made its appearance, and was very similar to the one we have just mentioned, both with regard to its position and form—indeed, the resemblance was so striking that the spots were considered the same.

FIG. 1.—Showing the large spot on September 3, 1876.

Why it should have disappeared so soon in 1876, and become visible again in 1891, is a mystery which is hard to fathom.

Perhaps one of the most interesting features visible on the surface of Venus are the two snow caps (Figs. 3 and 4) at the extremities of her poles. These spots, as M. Trouvelot says, surpass in brilliancy and importance all that he has ever observed. In 1877, on November 13th, a white spot was seen at the north limit of Venus; its brilliancy attracted considerable attention, resembling

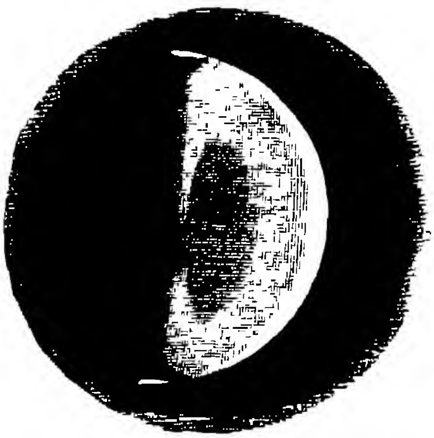

FIG. 2.—Large spot visible on February 18, 1891.

very much those situated on Mars. On the following day, another spot, also very striking and of the same character, diametrically opposed, was observed. The question then arose as to the cause of these spots, and we may here quote an entry that was written in the observer's book on the 17th of the same month:—"Est-ce que Vénus aurait des taches blanches semblables aux taches polaires de Mars?" The seeing of these spots was by no means a difficult task, and it seemed certain that if

they were snow caps as suggested, perhaps they had been previously observed. This was the case. On June 9 and 17, July 20, August 1 and 27, 1876, and February 5, 1877, observations of these spots had been recorded in the notebook, but owing to their not having attracted very great attention at the time, they were regarded as ordinary spots. That they are analogous to the white spots on Mars is now undoubted: they have the form of a uniform white segment of a circle, which, when seen edgeways, appear as simple lines; they are always exactly 180

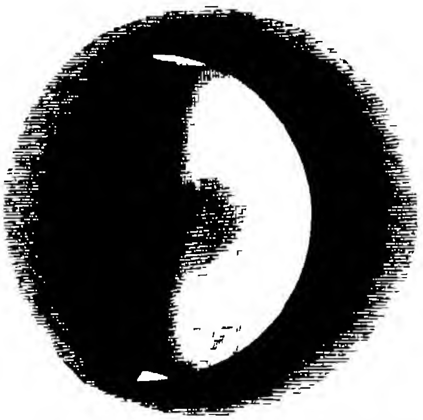

FIG. 3.—The snow caps, February [illegible], 1891, 10h 45m.

apart; sometimes only one is seen because the other is not lighted up by the sun; they are always approximately near the terminator, and seem to oscillate backwards and forwards, balanced, so to speak, around the axis of the planet; and, lastly, they are of a permanent nature, their disappearances being due not to their annihilation, but simply to the fact that they cannot be seen when receiving no light upon them. One main feature in which they differ from the spots on Mars is that they neither increase

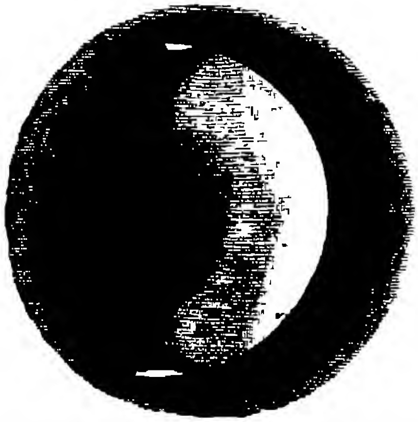

FIG. 4.—The snow caps, February 25, 1891, 10h 15m.

nor decrease with the seasons, at any rate to a sufficient extent to be sensibly noticed.

When Venus is in a favourable position for observation many details on these spots have been recorded. M. Trouvelot mentions here some bright spots (Figs. 5 and 6), which seem to be very numerous, and resemble the bright specks which are seen on the terminator of the moon, "sinon qu'elles sont plus brillantes, surtout sur leur bord interne, et qu'au lieu de petits cratères, elles sont entièrement couvertes et hérissées de pics et d'aiguilles, qui, parfois, réfléchissent la lumière avec une si grande intensité, que ce bord apparaît tout constellé d'étoiles alignées comme les grains d'un collier de pierres précieuses, sans quelques irrégularités dans cet alignement." The whole appearance seems to suggest that the spots are at a higher level than the contiguous parts of the planet situated at the edge. This idea is also further borne out when the phase of the planet is a small crescent, for then much more of the polar cap is found to be visible than should be the case if the form of the phase

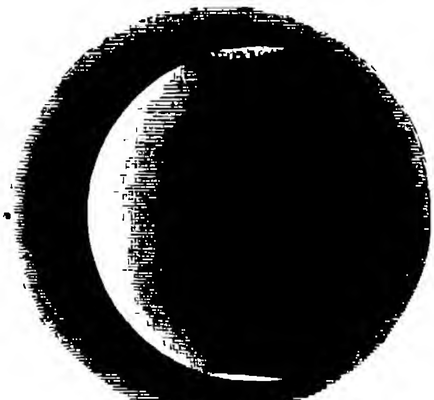

FIG. 5.—Details on the snow caps, January 19, 1878.

was an exact crescent. In many cases a penumbra has distinctly been seen, and in one of them it was so strong and distinct on that part of the terminator lying between the two polar caps, that it lasted for a month, the spots remaining clear and brilliant throughout their entire length. Ever since the year 1700, observers of Venus have remarked these two spots that occupy the polar regions. La Hire and Derham, observing the inequalities of the surface at the extremities of the crescent, believed

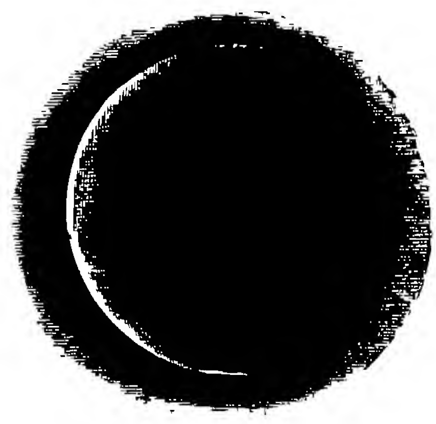

FIG. 6.—The snow caps, February 5, 1878.

that they could be produced by mountains higher than those on the moon. Bianchini at Rome, Schroeter, Gruithuisen, and several others, all have reported the existence of such markings, but they were never led to conclude that they were snow caps analogous to those on Mars.

To obtain a general idea of the ruggedness and smoothness of the planet's surface, the terminator has helped to considerably distinguish the high and low elevations and depressions respectively. The surface of Venus from

such observations as these has been found to be considerably studded not only with small, but with great differences of configuration, the terminator varying greatly in many phases of the planet. M. Trouvelot's results

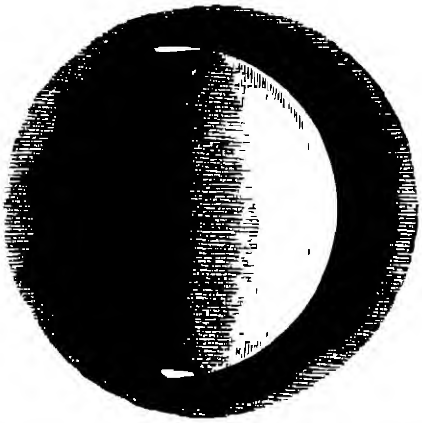

FIG. 7.—Showing irregularity of Terminator, November 23, 1877.

show that these deformations become most apparent when Venus is at her greatest eastern and western elongations. Sometimes one half of the terminator is seen concave, while at the same time the other is convex

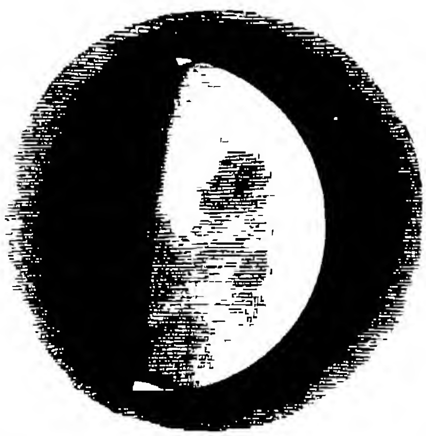

FIG. 8.—Showing indentations at the horns, February 28, 1891.

(Fig. 7), small indentations at the horns (Fig. 8) also seem to be of common occurrence, and occasionally the curve of the terminator is perfect, no trace of any irregularity being noticed. Not only then does the terminator

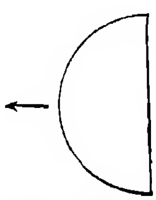

FIG. 9.—February 5, 2h.

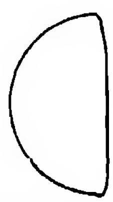

FIG. 10.—February 5, 5h. 43m.

change in form, but changes are found to occur very rapidly in intervals of only a few hours. To take one case out of many, we may quote the instance recorded in 1881 on February 5 at 2 p.m. (Figs. 9 and 10). At this time the terminator appeared as a straight line showing Venus then in apparent quadrature, but at 5h. 43m. this line was quite gibbous, and its curve regular. A very important point about the repetitions of the same deformations is that they do not occur at exactly the same time each day, but appear to change the hour of observation, "the periodicity of these phenomena, if periodicity there is, not being exactly twenty-four hours."

From a long series of observations, the most striking irregularities were found at the extremities of the ter-

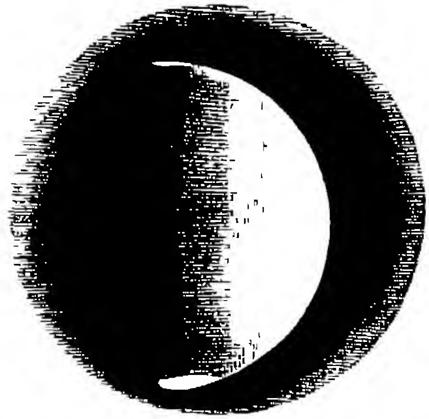

FIG. 11.—Showing the shape of the horns, September 27, 1876.

minator close to the edge of the pole caps, where deep niches were often recorded. These indentations were noticed to be generally of different sizes and shapes, sometimes the north one being larger than the southern one, and *vice versâ*. They also underwent very rapid changes even in the space of a few hours, a case occurring on September 27, 1876 (Fig. 11). "At one time the extremity of one of the horns would be more or less truncated, when the other would be sharp, and some hours later the

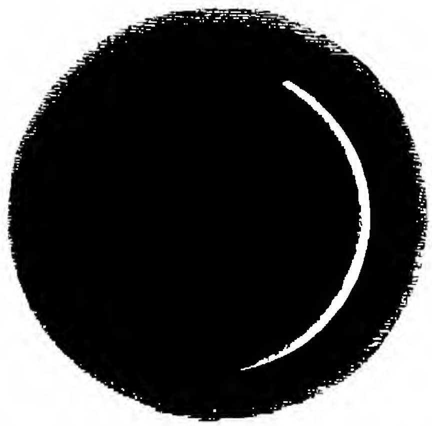

FIG. 12.—An abnormal extent of the crescent, May 13, 1881.

reverse would be the case, that which was sharp being truncated, and that which was truncated being sharp." M. Trouvelot concludes that his observations bring out a very important fact—"qu'il a une relation très étroite entre les déformations les plus importants subies par le terminateur et par les cornes, et les taches polaires de la planète."

When Venus approaches inferior conjunction with the sun, its crescent gradually diminishes until the illuminated surface is turned exactly away from us. Just before this position is reached, the crescent has been found to present

many curious features The most prominent of them is that this fine crescent is sometimes observed to extend to a greater angular extent than 180 (Fig 12), 260° of the limb of the planet having once been recorded Sometimes, by adopting special precautions, the whole circumference has been observed, the obscured disc being completely surrounded by a pale and thin luminous ring This, as M Trouvelot says, is of very rare occurrence, for it has happened that although the greatest precautions have been taken, no trace of the planet could be found

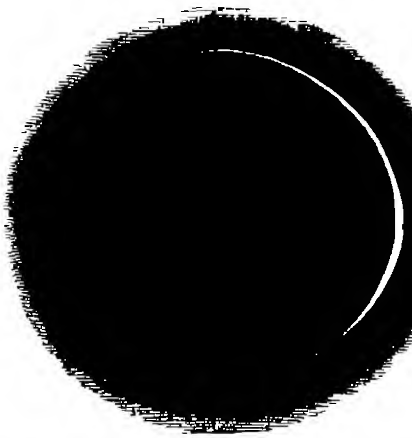

FIG 13—Showing the bulging out of the crescent as seen on February 24, 1878

When the crescent is extremely fine, great irregularities have been noticed to mar the continuity of its curve, they differ also not only at different but at the same conjunctions according as the planet is to the east or west of the sun

Another fact that has been observed relates to the bulging out of the planet (Figs 13 and 14) at some parts of its visible limb This was especially noticed in the month of February, 1878, while the crescent was being

FIG 14—The crescent as seen on February 26, 1878.

looked at, the south-south east portion seemed to suddenly appear thicker than the remaining part In fact, the observer in the first instance thought it might have been due to some optical defect in the instrument, but subsequent observation showed that this was not the case, a real change of form having taken place. Two days later this deformation was still more noticeable, the thickness of the visible section being about double what it would have been had it been in its normal condition.

Perhaps one of the most important points referred to in this work is the determination of the period of rotation by means of the spots This question of rotation is one that has baffled many observers, for the difficulty that has presented itself lies not only in the proper motions of the spots themselves, but in the identification of the same spots after brief periods of time Glancing over some of the periods already obtained, we find that Schroeter deduced from his observations a rotation of about 24h, basing his value on the movement of a small isolated spot situated in one of the horns Fritsch's value of 23h 22m, and P. de Vico's 23h 21m 21s, are both also of about the same length From observations by D Cassini and F Bianchini, we have a very wide deviation, the periods of rotation being reckoned in days, the former arriving at a value of 23 days, and the latter at a somewhat larger one of 24 days 8 hours Coming now to Schiaparelli's value of 225 days, we have here altogether a new departure, the planet rotating on its axis in the same time as it revolves round the sun

With such values as these it will be at once seen that there is something radically wrong with the spots or their positions on the planet's surface, in some cases, of course, there might have been instances of mistaken identity, but with such an observer as Schiaparelli, who very definitely settles upon a 225 daily period obtained from direct observation, it is hard to conceive that any such sources of error would not have been remarked

The observations which we have now before us bear out Schroeter's view of a short rotation, Prof Trouvelot telling us that they were made during the years 1876-78 under exceptionally good conditions One very interesting point which is of great importance is the fact that these observations were made at the same period, "souvent dans la même journée, sous un ciel également propice et précisément sur la même point de la planète"

The value nearest to 24 hours that Prof Trouvelot obtained was 23h 49m 28s, and in giving this period he remarks that it is founded on the supposition that the spot had no proper motion In referring to the period deduced by Schiaparelli he says, "La cause probable de l'erreur de M Schiaparelli semble résulter de ce fait que les taches *h* et *k*, qui ont servi de base à ses conclusions, faisaient partie de la tache polaire méridionale qui, étant située centralement sur l'axe de rotation de la planète, semble rester stationnaire, comme cela se voit sur la tache polaire de Mars, quand elle se trouve réduite à de faibles dimensions" Taking into account many of the general features visible on the planet's surface, such as the rapid deformations of the horns and of the terminator, all these point to short periods of rotation, which, as Prof Trouvelot points out, is "inconciliable avec la période de rotation, si lente et si inattendue, déduite par l'éminent astronome de Milan"

In concluding our remarks we cannot help mentioning the very complete way in which Prof Trouvelot has taken into account the prior work in this interesting field of inquiry W. J L

NOTES

THE Iron and Steel Institute will meet at Liverpool from Tuesday, September 20, to Friday, the 23rd Sir Frederick Abel will preside The following papers will probably be read and discussed —(Tuesday) on the condensation of ammonia from blast furnaces, by Sir L Bell, F R S, on alloys of chrome and iron, by R A Hadfield; on the Liverpool overhead railway, by J H. Greathead; (Wednesday) on the engineering laboratories in Liverpool, by Prof H S Hele Shaw, on the Siemens-Martin process at Witkowitz, Austria, by P Kupelwieser, on failures in the necks of chilled rolls, by C A Winder. (Thursday) on a new process for the elimination of

sulphur, by E Saniter, on the elimination of sulphur from iron, by J E Stead On Tuesday evening the members and their friends will dine together, and on Wednesday evening there will be a conversazione in the Walker Art Galleries, offered by the Mayor of Liverpool and Mrs James De Bels Adam A part of each of the first three days will be devoted to the inspection of various works, and on Friday there will be excursions, one party going to Chester, another to Stoke-on-Trent If a sufficient number of names are given in, there will also be an excursion to the new Water Supply of Liverpool at Lake Vyrnwy

THE Sanitary Institute, whose Transactions for 1891 are reviewed elsewhere, is holding its thirteenth annual Congress this week at Portsmouth About 400 members are attending the meetings The proceedings began on Monday, when Sir Charles Cameron, the president, delivered an address on "The Victorian Era, the Age of Sanitation" He presented a very interesting sketch of the good results which have sprung from the improved sanitary methods of modern times The frightful mortality of London and other cities in the last century he described as an evil due to insanitary conditions By the earlier part of the nineteenth century the grosser defects had been remedied, and the death rate had been greatly reduced For about half a century no further improvement took place, but with the passing of the Public Health Acts of 1872 and 1875 an era of active sanitation ensued, with the result that the death-rate fell sensibly in nearly all the towns Sir Charles urged that the success of past sanitary work ought to encourage us to redouble our exertions to reduce the urban death rate to at least that of the most healthy of our towns

THE International Congress of Orientalists finished its scientific labours on Friday last, and every one connected with it agreed that the meetings had been most successful On Saturday a good many members visited Oxford, while others went to Cambridge Both parties were cordially received by representatives of the Universities A meeting held on Monday for the despatch of business brought the proceedings to a close. At this meeting a number of reports and resolutions were read by the secretary, Prof Rhys Davids The first resolution proceeded from the Semitic section, and recommended that the Government should be urged to subsidize the study of modern Arabic The Assyrian and Babylonian sub-section, and also the Egyptian section, passed a resolution in favour of holding at least one combined meeting of the Assyrian and Egyptian sections The anthropological section expressed its sense of the political as well as the scientific importance of the anthropometric investigations now being conducted in Bengal The same section also expressed its view of the desirability of forming a collection of Oriental folk lore on a scientific basis In the Semitic section a committee had been formed, consisting of men of science from different countries, for the purpose of preparing an Arabic Mahomedan encyclopædia At the head of this committee was Prof Robertson Smith The Australasian section desired to express its sense of the immediate necessity of pressing forward research into the physical character, languages, arts, customs, and religion of New Guinea Count Angelo de Gubernatis moved a resolution, which was seconded and carried, in favour of the establishment of an International Institute of Orientalists, with its headquarters in London It was decided that the next meeting of the Congress should be held at Geneva in 1894—the meeting to be postponed until the following year if circumstances should render such postponement necessary or desirable On the motion of Prof Ascoli, seconded by Prof Drouil, a vote of thanks to the President was cordially passed In the evening a dinner was given at the Hôtel Métropole by the Organizing Committee to the foreign members.

THE Perthshire Society of Natural Science is one of the most enterprising of British local societies, and we are glad to hear that it is about to give fresh proof of its energy by extending its museum This includes two excellent collections—the one a general or index collection, intended, by means of carefully-selected specimens, to act as a guide to the study of natural science, the other, a Perthshire collection, intended to give a complete view of the fauna, flora, and geology of the district These collections have grown so rapidly that there is not now sufficient accommodation for them It is proposed that the deficiency shall be met by the erection of a supplementary museum hall and gallery, in which the Perthshire collection will be displayed, while the present building will be devoted chiefly to the index collection

AN improved spherometer, constructed in Zeiss' optical laboratory at Jena after Prof Abbe's design, is described in this month's *Zeitschrift fur Instrumentenkunde* It is made to measure down to 0 001 mm To eliminate errors due to the indefinite nature of the base circumscribed by the three legs of the ordinary spherometer, the surface to be measured is laid upon a circular ring, and the contact rod is screwed up from below This ring has two sharp concentric edges 0 5 mm apart, the one for convex and the other for concave surfaces, made of hard steel and ground down to the same level, giving a combination which is less liable to be damaged than a single edge The ring rests without fastening on a perforated horizontal disc provided with a cylindrical projection which just fits into a hollow in the bottom of the ring The latter is thus free from strain, and can be easily replaced by another of greater or less diameter The height of the graduated contact rod is read by a micrometer microscope The first reading is taken when the contact piece touches a plate of plane polished glass laid over the ring The plate is then replaced by the surface to be measured, and its radius of curvature calculated by the usual formula

ON Thursday, the 8th inst, the Cunard Royal Mail twin screw steamer *Campania* was launched from the yard of the Fairfield Engineering and Shipbuilding Company. This is the largest ship afloat, the dimensions being length, 620 feet, breadth, 65 feet 3 inches, and depth, 43 feet It exceeds the *City of Paris* or *City of New York* by 60 feet in length and 2 feet 3 inches in breadth The launch of the *Campania* was an ideal one Although the launching weight of the ship was 9000 tons, there seemed to be not the slightest hitch At 2 45 p m Lady Burns performed the launching ceremony The huge ship immediately began to move and slowly travelled down the ways, entering the water amidst the loud cheers of some 80,000 people The Fairfield Company have every reason to be proud of this feat Not only was the weight to be launched unprecedented, but, the Clyde at this point being very narrow, the big ship had to be stopped immediately she was afloat owing to her great length. The *Campania* will be driven by two sets of triple expansion engines, each set having five cylinders arranged to drive a three-throw crank shaft, the cranks being set at the angle of 120 degrees from each other, there are two high-pressure cylinders, one intermediate, and two low pressure cylinders, the high-pressure being placed above the low-pressure cylinders These engines together will indicate about 25,000 horse-power Steam will be generated by twelve large double ended boilers with ninety-six furnaces. An auxiliary single-ended boiler is used for supplying the steam for the electric lighting and secondary purposes throughout the ship The main boilers are arranged in two groups, each group having a funnel 19 feet in diameter It is expected that the speed attained will reach twenty-two knots on the trial, and it is hoped, when the engines have settled down to their work, that this speed may be attained on the Atlantic.

THE weather has remained very unsettled during the past week, owing to the complex distribution of barometric pressure, there being during the first part of the time low pressure areas over the northern parts of the kingdom, while an anticyclone lay over France and the Bay of Biscay. These conditions caused a considerable amount of rain, especially in the north and west, although in the southern and eastern parts of the country, the weather was fair, with mist or fog in places. During this period the maximum temperatures rarely exceeded 65° in any part; on Sunday and Monday, however, the anticyclone moved eastwards, and gave place to large depressions from the westwards, rain being general, except in the south-east of England, where the maximum temperatures rose to 70° and upwards, and similarly high readings occurred in the midland and southern districts. On Tuesday a cyclonic disturbance was crossing Scotland, and heavy rain was reported there and in the north-west of Ireland. The Weather Report for the week ending the 10th instant shows that the mean temperature was below the average over the whole of the United Kingdom, and although fairly high day temperatures were registered, the night readings were below 40° generally, and in the east of Scotland they fell to within a degree of the freezing point. The rainfall for the same period was generally less than the normal, and in the south-west of England there was still a deficiency of 8 inches since the beginning of the year.

IN his report on the rain, river, and evaporation observations, made in New South Wales during 1890, Mr. Russell states that the widespread interest in rainfall records is rapidly adding to the number of observers, which now amounts to 1088. The year was conspicuous for abundant rainfall, causing heavy floods in the river Darling, far exceeding those of which there are complete accounts. The average rainfall for the whole colony was 32.73 inches, being 32.6 per cent. greater than the average for the previous sixteen years. The report contains the results of interesting experiments on the effect of forests and elevation on the amount of the fall. At Dinby, which is situated in a densely timbered country, the amount was 35.89 inches, while the mean of nine of the nearest stations gave 38.92 inches. As an instance of the effect of elevation, the average rainfall at Wallongong, half a mile from the sea, at an elevation of 67 feet, is 38.84 inches, while at Cordeaux River, six miles from the sea, it is 55.53 inches.

THE Annual Report of the Acting British Resident of Perak for the year 1891 contains monthly summaries of meteorological observations at nine stations, and a chart showing the comparative range of monthly rainfall during the years 1888-91 at Taiping. The highest recorded temperature in the shade was 97° at Kuala Kangsar and Parit Buntar in the months of March and April respectively; the lowest 62°, in February, at Taiping and Salama. The only solar thermometer, that in Taiping, registered 121° in March and May. The rainfall varied from 85.6 inches at Teluk Anson to 183 inches at Topah. It is well distributed throughout the year, the driest months being May to July.

A MOST unusual phenomenon was seen in the Maltese Islands on July 21, when a thunderstorm raged for twelve hours, and deposited three inches of rain. According to the *Mediterranean Naturalist*, it is fifty five years since rain fell in Malta in the month of July.

IN the annual report of the British Museum (Natural History) reference is made to two "principal events" relating to the conservation and arrangement of the Zoological collections. The first is the enlargement of the building which contains the collections of specimens preserved in spirits. An enlargement had been rendered necessary mainly by the reception of the *Challenger* collections, which proved to be more extensive than had been anticipated. The addition to the building is already roofed in, and may be ready for occupation within the next twelve months. The other matter of exceptional importance is the arrangement of the collection of birds' eggs. In the old Museum this collection consisted of a small number of specimens of more or less great historical value, and of an imperfect series of deteriorated specimens of the British species, which were exhibited in three table cases. The first important addition was received in the "Gould" collections, purchased in 1881; other miscellaneous series followed; and, finally, the magnificent donations of Europo-Asiatic species by Messrs. Godman, Salvin, and Seebohm, and of Indian eggs by Mr. A. O. Hume, added so much to the number of specimens, and imparted such a great value to this collection, that its systematic arrangement could be no longer delayed. At the same time the formation of a perfect series of British birds' eggs for exhibition and consultation by the public had become more and more urgent. A requisite grant having been made by the Lords Commissioners of the Treasury, Mr. Seebohm undertook the work of arranging both the general and the British series; and in the course of this year he has made such progress that about 24,000 specimens, belonging to fifteen families, are catalogued and beautifully arranged in thirteen cabinets, and that the British series can probably be opened to the public in the present year.

THE authorities of the French laboratory of physiological psychology have sent a circular to painters, sculptors, and designers, asking them to answer various questions as to their visual memory of colours and forms. Some replies have already been received, and one of the things noted in several of them is that the writers are able, when they see a painting, to perceive at a glance whether the artist has a good visual memory or not.

MR. M. A. DUMONT contributes to the current number of the *Revue Scientifique* an interesting paper on the history of the population in a small rural commune, Saint-Germain des Vaux. He has closely examined the communal registers from the early part of the eighteenth century until the present day. It is curious to see how the tendencies not only of the commune, but of its individual families, with regard to the increase or decrease of population, correspond to those of the French nation as a whole.

THE *Kew Bulletin* for September opens with a section on Caraguata fibres. Samples of the Caraguata plant were obtained through the Foreign Office from Dr. Stewart, British Consul at Asuncion, and submitted to Mr. J. G. Baker, by whom the plant is here described. The number also contains Decas III. of "Decades Kewenses," "New Orchids: Decade 3," and sections on Lagos palm oil and some vanillas of commerce.

WE learn from the *Kew Bulletin* that a handbook of Australian fungi has been prepared by Dr. M. C. Cooke, Mycologist in the Herbarium of the Royal Gardens, Kew, and published under the authority of the several Governments of the Australian Colonies. It contains a full description of all the fungi so far known to occur in Australia and Tasmania, number 2084 species. All the genera are illustrated by 36 plates, 20 of which are coloured.

MR. VICE-CONSUL SCRATCHLEY, of Philippeville, Algeria, has presented to the Museum of the Royal Gardens, Kew, an axe, scraper, and knife, such as are used in the collection of cork in Algeria. The *Kew Bulletin* says that the Museum contains numerous illustrations of the applications of cork, the bark of the cork oak (*Quercus Suber*, L.). The tree grows in Spain, Italy, South of France, and Algeria, and the first crop of cork is taken from the trunk as it stands, at the age of about thirty

years, and afterwards at intervals of from six to ten years The later crops furnish the best bark, which is used for bottle corks and similar purposes

IN his annual report to the Secretary of the Science and Art Department, Dr. V Ball, Director of the Science and Art Museum, Dublin, says that throughout the past year Major McEntry was continuously engaged in the rearrangement of the Royal Irish Academy collections Mr W F Wakeman rendered valuable assistance in preparing descriptive lists of the "Crannog finds," and Mr George Coffey made a catalogue of the Irish coins Both have been printed, and will serve as valuable records, for future reference, of the present condition and contents of these two branches of the collection They will, moreover, afford useful material in the preparation of a contemplated handbook to the collection, which now claims attention, but for which some special arrangement will have to be made In the same report Dr Ball notes that under the efficient management of Mr Moore the Royal Botanic Gardens, Glasnevin, maintained during the year their now well-established position as one of the principal centres of scientific horticulture in the United Kingdom The continued and widespread interest in the operations carried on there is amply shown by the generous support which plant growers still afford by their contributions of novelties

MR E S MORSE, Director of the Peabody Academy of Science, has been investigating the older forms of terra-cotta roofing tiles, and presents the results of his inquiry in the latest Bulletin of the Essex Institute, Salem His paper is a valuable contribution to the study of a very interesting subject The earliest known form of tile consists of two elements—a wide tile (tegula) either square or rectangular, more or less curved in section, and a narrow semi-cylindrical tile (imbrex), usually slightly tapering at one end to fit into the wider opening of the one adjoining The tegula is placed on the roof, concave face upwards, and the imbrex, placed concave face downwards, covers the lateral joint between two adjacent tegulæ. Tiles of this kind covered the roof of the very ancient temple of Hera at Olympia, the form being identical with that of tiles still used in the remote East Afterwards the form was modified in Greece and Italy. In one or other of its varieties, this tile—which has been called by Graeber the normal tile—is found all over Asia, in Asia Minor, and in the countries bordering the Mediterranean The well-known pantile combines the two elements, imbrex and tegula, in one piece It originated in Belgium or Holland, and is used mainly in those countries, in Scandinavia,, and to some extent in England The flat tile is simply a shingle in terra-cotta, and has no genetic relation to the other forms of tiles. It is used in Germany, Austria, Poland, Switzerland, France, and England Mr. Morse's paper is well illustrated, and contains a map showing the geographical distribution of these three types of tile

MR WALTER HOUGH contributes to the report of the U S. National Museum for 1890, just issued, a very good paper on the methods of fire-making Having in a previous paper discussed the apparatus of fire-making, he now deals with the handling of the apparatus. All mechanical methods of generating fire take advantage of the law that motion, apparently destroyed by friction, is converted into heat These methods can be grouped under three classes —(1) wood friction, (2) percussion of minerals, (3) compression of air Three other methods exhaust the entire range of usages in fire-making, and, with one exception, they are perhaps recent These may be arranged in the following classes —(4) chemical, (5) optical, (6) electrical These exhibit the action of friction in its highest manifestations. Each method Mr Hough examines in turn His exposition is concise and clear, and carefully illustrated

SEVERAL sponge deposits have been discovered at a distance of about 150 metres from the western shore of the island of Pantelleria (depth about thirty metres) Five Greek vessels, with two divers, obtained in three days about twenty-five quintals of sponges of the finest quality

Two papers which will be included in the forthcoming Macleay Memorial Volume were read at the meeting of the Linnean Society of New South Wales on July 27 One of them, by Prof F W Hutton, is on the Pliocene Mollusca of New Zealand It gives a complete list of the Mollusca hitherto met with in the Pliocene fossiliferous beds of New Zealand Such beds have been found only in the southern and eastern parts of the North Island About 64 per cent of the Pliocene Mollusca are also found in Miocene rocks, but the Pliocene fauna is well characterized firstly by the presence of the genera *Trophon*, *Columbella*, *Turricula*, and *Mytilicardia*, by the absence of certain genera present in Miocene strata, and thirdly by the small size of sundry species common to both formations From the recent fauna, that of the Pliocene is distinguished by the presence of from 23–37 per cent of extinct species, and of a number of genera no representatives of which up to the present time are known to inhabit New Zealand seas The Pliocene fauna, therefore, seems to be the remains of an earlier fauna disappearing rapidly before the conquering host of the recent fauna, which had invaded New Zealand some time previously The other paper is by Prof W Baldwin Spencer, and offers contributions to our knowledge of Ceratodus, with special reference to the blood vessels

AT the same meeting of the Linnean Society of New South Wales, Mr Rainbow exhibited the two sexes of an undescribed Sydney spider (*Nephila* sp), the webs of which were said to be strong enough to catch male birds

MR A C. GATTO writes in the *Mediterranean Naturalist* that the pretty moth *Deiopeia pulchella*, Beis, has occurred this year in Malta in unusual abundance On August 10, when his note was written, and for a fortnight before, it was the commonest moth to be seen on the wing in the island He does not remember ever to have had occasion to record such extraordinary numbers of any butterfly or moth This remarkable abundance he supposes to be due to the fact that the rains of the late spring caused an overgrowth of the *Heliotropium europæum*, on which the Deiopeia feeds The moth is white, with small red and black spots on the forewings, and with white underwings bordered with black It is subject to much variation, sometimes the black dottings predominating, sometimes the red ones, but it is a very characteristic form and easily distinguished

A NEW edition of Mr Alfred Gibson's well-known "Agricultural Chemistry" has been issued by Messrs Routledge and Sons. The book was originally issued more than thirty years ago, and there has been a steady demand for it ever since In preparing the present edition the author has had the help of his nephew, Mr A E Gibson, in making such changes as the advance of agricultural chemistry has rendered necessary

MESSRS MACMILLAN AND CO have issued a new edition of Mr. W. H. H. Hudson's "Arithmetic for Schools" The work has been enlarged and very carefully revised

THE University College of North Wales, Bangor, has issued the prospectus of the work to be done by its agricultural department during the session 1892–93. The fund for the promotion of agricultural education amounted, in the session 1891–92, to £1900, and was derived partly from a grant by the Board of

Agriculture, partly from private subscriptions, and partly from grants by the County Councils of Anglesey, Carnarvonshire, and Montgomeryshire A considerable sum was also contributed locally to meet the expenses of field experiments, dairy demonstrations, and Extension lectures Two things are aimed at in connection with the College scheme of agricultural education —(1) To provide at the College as complete a training in agriculture and the sciences related to agriculture as can be obtained at any of the recognized Agricultural Colleges, and especially to provide such a training as would be suitable for land agents, farmers, bailiffs, and young men who intend emigrating with a view to farming in one of the colonies (2) To make the College a centre of agricultural education for North Wales, and to organize in the six northern counties of the Principality, in connection with the College, a system of instruction to meet the special wants of each agricultural district, and supply a graduated system whereby pupils may pass from the School to the College Several local landowners and farmers have enabled the College to make arrangements by which farms in the neighbourhood of Bangor can be used by the lecturer in agriculture and the members of his classes for the purpose of practical instruction

In a paper on the Ainos of Yezo, contributed to the latest report of the U S National Museum, Mr Romyn Hitchcock refers to the arrow poisons used by the Ainos The method of preparing these poisons has been revealed to only one traveller, Dr B Scheube, who believes his information to be correct, as the accounts obtained from different localities entirely agree His account is as follows —The young side roots of *Aconitum Japonicum* are usually gathered in summer and dried in the shade until autumn The roots which contain active poison become softer, while the others grow harder, apparently a process of fermentation takes place The former, after the removal of the skin, are rubbed between two stones to a pasty mass There is no further preparation This material is either spread directly upon the arrowheads or preserved The poison maintains its activity for five months Dr Scheube adds that in every village the poison is prepared only by a few old men, not because the process of preparation is unknown to the others, but because these men have had experience in its production Prayers, magic formulas, and the like are not recited during the preparation The activity of the poison is tested by a portion being placed on the tongue To ensure its action each arrow receives portions from three different preparations Dr Stuart Eldridge has made some chemical and physiological investigations of this poison, which confirm the supposition that aconite is its active ingredient But Dr Eldridge declares that the pulp prepared as described is mixed with other ingredients, which he has been unable to identify, but which are probably inert, and the resulting mass is buried for a time in the earth On removal from the earth the poison, he says, appears as a stiff, dark, reddish brown paste, through which fragments of woody fibre are distributed, and the poison, when applied to the arrow, is mixed with a certain proportion of animal fat Mr Hitchcock secured two specimens of the poison, which are in the form of hard lumps. Specimens of the plant from which the poison is obtained were collected by Mr T Holm, and determined by him as *Aconitum Japonicum* In some parts of the country it grows in great abundance, and the fine purple flowers are very pleasant to the eye

In their very interesting account of various plants growing in and through the shells of marine mollusca (noticed by us in Nature) Bornet and Flahault called attention to some fungoid-like hyphæ, which were recorded under the names of Ostracoblabe and Lithopythium, but in the absence of any fructification or of very definite characters, their position was not more accurately determined. Dr. Bornet, on looking over the fourth part of the Berichte der deutschen botanischen Gesellschaft was struck by the resemblance of *Lithopythium gangliiforme*, B and F, to the deeper hyphæ of *Verrucaria calciseda* as represented by M Bachmann in figures 3 and 4 of plate ix accompanying his memoir (Die Beziehung der Kalkflechten zu ihre Substrat) and it occurred to him that the hyphæ found perforating the marine shells might be those of lichens To verify such an idea, Dr Bornet spent some time at Croisic towards the close of the summer of 1891 Here, of the shells gathered at low-water mark or not uncovered at each tide, a large number had the calcareous portions traversed by filaments of *O implexa* Sometimes these filaments were solitary, at other times and more frequently they were accompanied by one or more of the perforating Algæ (Gomontia, Ostreobium, Mastigocoleus, Hyella), but nothing either in or externally seemed to indicate that they were the hyphæ of a Lichen When the shells were gathered off the rocks at a height at which they were frequently out of the water, a large number were found to present discoloured patches covered with dark depressed spots formed by the spermogonia and apothecia of a Verrucaria. The shells of *Purpura lapillus* with the mollusc, or serving as a home for some hermit crab, were the more frequently attacked Some shells of Patella and Balanus were also attacked When thin sections were made, perpendicular to the surface of the shell, the outer border appeared granular and was nearly opaque, the hyphæ and the alga condensed in the gonidial layer, having caused the semicrystalline shell structure to disappear, leaving it in a powdery state But deeper in that portion of the shell which in part preserved its transparency the filaments could be seen perforating it to a considerable extent, and these presented all the characters of those described by Bornet and Flahault as belonging to *O implexa*, with the sole exception that the fusiform dilatations were not observed On decalcification the gonidia were found to be mostly supplied by *Mastigocoleus testarum*, some few by *Hyella cæspitosa* Towards the margin they were reduced to the condition of isolated cells, but deeper down, the long branches of the thallus were found little altered and most easily recognisable, presenting a most favourable example of the connection existing between the gonidial stages of the filamentous algæ M l'Abbé Hue recognized the lichen of *Purpura lapillus* as *Verrucaria consequens* (Nyl) It will be noted that the hyphæ of this Verrucaria are capable of living isolated, not except under certain conditions uniting with the algal forms, these latter requiring the presence of the open air from time to time, so that the lichen stage is not developed on the shells always submerged *Lithopythium gangliiforme*, though carefully looked for, was not met with, but its history, when known, will no doubt be equally interesting

Dr. A B Griffiths writes to us to explain, in answer to a criticism which appeared in the recent review of his book, "The Physiology of the Invertebrata," that it is extremely difficult to determine in what state of combination uric acid exists in the urine of invertebrates He, however, considers it more than probable that both potassium and lithium occur in the urine of some of these animals

The additions to the Zoological Society's Gardens during the past week include two Philantomba Antelopes (*Cephalophus maxwelli*) from Sierra Leone, presented by Mr P. Lemberg, two yellow-bellied Liothrix (*Liothrix luteus*) from China, presented by Mr J Holmes; four Poe Honey Eaters (*Prosthemadera novæ-zealandiæ*) from New Zealand, presented by Capt Edgar J Evans, R M S. *Tasman*, a Little Grebe (*Tachybaptes fluviatilis*), British, presented by Mr Thomas Riley, a Hoopoe (*Upupa epops*), a Greater-spotted Woodpecker (*Dendrocopus major*), twelve Fire-bellied Toads (*Bombinator igneus*), European, purchased

OUR ASTRONOMICAL COLUMN

DISCOVERY OF A NEW SATELLITE TO JUPITER.—A telegram from New York announces that Prof. Barnard, of the Lick Observatory, Mount Hamilton, California, has discovered a fifth satellite to Jupiter. It is of the thirteenth magnitude, with a period of revolution round the primary of 17h. 36m., its distance from the centre of the planet being 112,400 miles.

VARIATION OF LATITUDE.—Dr. Chandler, in the *Astronomical Journal* No. 273, concludes his series of very important articles on the discussion of observations with regard to the cause of the variation of latitude. The material he has used comprises more than thirty-three thousand observations, made in seventeen observatories with twenty-one different instruments, as many as nine distinct methods of observation having been employed. Out of the forty-five series in which these observations are arranged, only three show results which do not harmonize with the general law as stated in the fifth article (see "Astronomical Notes," NATURE, vol. xlvi. p. 211). The values of the three come out negative, and as they are numerically small, they can be with justice discarded, for, as Dr. Chandler says, "a mere rejection of a single discordant equation (out of a total number of 427), in two cases, and of two in the third, would convert them into positive values." Instead, then, of the ratio of the difference of the two moments of inertia to the principal one being 1° 18, and perfectly uniform as given by theory, observation suggests the value 0°·85 (for 1875), the motion not being uniform but subject to a slow retardation which "in its turn is not uniform." The first difference was soon found by Prof. Newcomb to be due to a defect in the theory, an allowance of the earth's elasticity not having been taken sufficiently into account, but with regard to the second he urges an objection "on the ground of dynamic impossibility." In such a discussion as this of course an outside opinion cannot be counted of much value, but we quite agree with Dr. Chandler that if an observed fact disagrees with the result of theory, and a flaw is found in the theory, there can be no reason why another observed fact of equal weight, but also in discord with theory, should be regarded as "impossible."

BRIGHT STREAKS ON THE FULL MOON.—In *Astronomische Nachrichten*, No. 3111, Prof. Pickering gives a brief condensed account of the investigation that has been carried out at Arequipa with regard to the systems of bright streaks, especially round prominent craters, that are visible on our satellite at the period of the second and third quarters. The instrument employed was the 13-inch, and the magnification ranged from 450 to 1120 diameters. The chief results noted were:—(1) That the streaks of the systems round many of the large craters are not oriented to the centre of the prime crater, but towards other craters whose dimensions are considerably smaller. (2) These minute craters are extremely brilliant, and rarely exceed one mile in diameter. (3) Some streaks are found to lie across or upon ridges; these are very seldom connected with small craters. (4) In the case of Copernicus, streaks are found to start from craterlets inside the rim and low up the inner side of the walls, and down the other side. The rim of Tycho also contains similar craterlets, but the streaks do not extend very far. (5) A difference in colour was noticed between the streaks systems of Copernicus, Kepler, and Aristarchus, and those of Tycho, the last-mentioned being considered whiter than the others. (6) There are no very long streaks; their general length may be reckoned from ten to fifty miles. What have been previously taken for long streaks are found, by minute observation, to be simply a series of these smaller ones connecting up, apparently, many small craters. That extending from the regions of Tycho across the Mare Serenitatis is so constructed. In seeking an explanation to account for the origin of these bright streaks, Prof. Pickering suggests that if, for example, the craterlets on the rim of Tycho were constantly emitting large quantities of gas or steam, which in other regions was being absorbed, "we should have a wind uniformly blowing away from that summit in all directions." Should other craterlets in the vicinity "give out gases mixed with any fine white powder, such as pumice, this powder would be carried away from Tycho, forming streaks." This hypothesis, besides explaining the presence of the streaks themselves, satisfies very well the fact that they can only be seen after and before the first and last quarter of the moon phase, for it is only at this time that the contrast would be best seen.

NOVA AURIGÆ.—On the receipt of Mr. H. Corder's information relative to the brightening of Nova Aurigæ, Mr. Espin made an examination of its light on August 21, and found that the star was of the 9·2 magnitude. Since then Prof. Kustner, has also observed it (August 31, 11m. 4 Bonn mean time), and reckoned it to be as bright as on March 21 last. The Astronomer Royal's photographic determination, made on August 30, accounts it to be about the 12th magnitude.

NEW OBSERVATORIES.—Mount Monnier, in the Maritime Alps, has been visited by M. Bischoffsheim and M. Perrotin, with the object of setting up a new observatory. It is proposed to raise on the summit (2800 metres altitude) an observatory, the work of which will be commenced next April. *L'Astronomie* for September also informs us that the Astronomical Observatory of Abbas Touman (lat. N. 41° 46′, long. E. Paris, 40° 32′) will be ready for work in a few weeks. The observatory is already installed with a refractor of 29 inches, and as it is situated at a considerable height, it will be used for those special stellar studies which are difficult at Pulkowa, Moscow, and Kazan.

SOLAR OBSERVATIONS AT ROME.—Prof. Tacchini, in the July number of *Memorie della Società degli Spettroscopisti Italiani*, gives in tabulated form the results of the observations made at the Royal College with reference to the prominences seen at the sun's limb during the months of April, May, and June. In the table showing the frequency of these phenomena for every 10° of latitude north and south, we find that the numbers for the three months respectively were 83, 97, and 147 for the north, and 75, 110, and 183 for the south latitudes. This shows an excess of 41 for the south, the zone in which they mostly occurred being (−50°−60°); the zone of greatest frequency for the north was (+60°+70°). The frequency at the equator was comparatively small, 26 and 23 being the numbers recorded for the zone of 10° each side.

GEOGRAPHICAL NOTES

A REUTER telegram from St. John's, dated September 11, says that the steamer *Kite*, which left that port three months ago to relieve the Peary Expedition, has just arrived there, after having successfully accomplished its object. Lieutenant Peary, who is an engineer in the United States Navy, left America early last year in command of a small expedition consisting of only five men, the object of which was to spend one or more winters in Greenland for the purpose of scientific observation, and to make an attempt to reach the North Pole across the interior of Greenland. The commander of the expedition was accompanied in this arduous enterprise by his young wife. The winter quarters of the party were fixed at McCormick Bay, whence Lieutenant Peary travelled 1300 miles northwards over the inland ice, which he found to be in a favourable condition for his journey. After making some important discoveries, the explorer returned to the quarters at McCormick's Bay, where, according to previous arrangements, he awaited the arrival of the relief expedition. Lieutenant Peary, his wife, and his five men are all well. Lieutenant Peary's great sledge journey commenced on May 15 last on the true ice cap of Greenland at the head of McCormick's Bay, and at an elevation of four thousand feet. The explorer, who took with him only one man and fourteen dogs to draw the sledge, passed along the edge of the Humboldt Glacier and then across the feeder basins of the St. George's and Osborne Glacier system. On June 26 he reached the 82nd parallel. Here the coast trended to the north-east, and then east, and finally compelled the explorer to pursue a south easterly course. After four days' march, during which the coast still stretched south-east and east, Lieutenant Peary reached the head of a great bay in latitude 81° 37′, and longitude 34°. This was on July 4, and in honour of the day he named this opening Independence Bay. The glacier terminating on its shores he called the Academy Glacier. The land here was of a red-brown colour and free from snow, and flowers, insects, and musk oxen were abundant; while hares, foxes, and ptarmigan were also seen. On July 9 Lieutenant Peary and his companion started on their return journey, taking a more inland course, and in seven days' time they were travelling over soft snow on the interior plateau, at an elevation of 8000 feet.

The explorer then again descended to the coast, covering thirty miles a day He met the *Kite*, with the relief party, on August 4, near the head of McCormick's Bay, having completed his original programme to the very letter The geographical discoveries made by the expedition include the tracing of the Greenland coasts above the 79th parallel, the termination of the continental ice-cap below Victoria Inlet, and the existence of glaciers on all the northern fiords Many valuable tidal and meteorological observations were also obtained, as well as a quantity of material for the ethnological study of the northern Eskimo, including specimens of their costumes, tents, and sledges The expedition brings home, besides a number of photographs of natives and of Arctic scenery, a large collection of the flora and fauna of the high latitudes visited

THE four Dundee whaling vessels, whose intended voyage to the Antarctic seas has been already referred to in these notes, sailed from Dundee last week Three of the vessels carry surgeons who have been specially instructed in making meteorological and biological observations They are fully equipped with appliances for collecting specimens of every kind The more strictly geographical conditions will be observed by the captains, who have been supplied with additional instruments to enable them to lay down their track with a greater degree of accuracy than would be necessary in ordinary circumstances Their long Arctic experience fits them for navigating the ice hampered waters of the South and for comparing the conditions found there with those of the better-known North Polar zone

THE railway from Jaffa to Jerusalem is now practically completed, and will be opened for traffic before the end of this month Recent events in Russia have caused a great increase in the Jewish population of Jerusalem, leading to the extension of the city beyond the walls The railway will do much to promote the prosperity of Palestine and will probably be largely utilized

THE Gilbert Islands, in the Central Pacific, have been definitely brought under British protection The group is bisected by the equator, and forms the central link in the long chain of coral and volcanic islands which stretches from the northern to the southern tropic between the meridians of 160° and 180° E The Marshall Islands, which are the most northerly of this chain, are under German control

THE Proceedings of the Royal Geographical Society for September publishes an interesting account of a journey in Sikkim undertaken by Mr C White and Mr Hoffman in July 1891, with the purpose of exploring and photographing the surroundings of Kanchinjinga The travellers crossed by the Zeumtso La pass into the Tremu Valley, the magnificent glacier in which was visited for the first time by Europeans The main glacier—fifteen miles long—is joined by the union of six smaller glaciers, and several others were observed which could not be approached The Tremu Valley was proved to be only a fortnight's journey from Darjiling, a fact which makes the almost entire ignorance of the existence of glaciers in it very remarkable.

IN the course of his travels into the interior of Iceland (*Petermann's Mitteilungen*, vol 38), Th Thoroddsen discovered an unknown lake in the unexplored region of Vatna-Jokull "The greatest part of the western edge of the Vatna Jokull is formed by a mighty glacier, whose margin stretches with faint curvature towards the southern horizon The mountain chains which reach the glacier are powerless to influence its shape. We were surprised by the discovery of a very long lake, stretching from the margin of the glacier close to us towards the south-west as far as the eye could see, and filling up the valley between us and a parallel mountain chain The narrow lake is of a milk-white colour, formed as it is by glacier ice I named it Langisjor. The glacier reaches with its steep flank to the north end of the lake, and as it is riddled with clefts it is impossible to ride round on this side The landscape round the lake is of magnificent beauty, only vegetation is quite absent The greenish-white lake is surrounded by red and yellow tuff hills, with innumerable fantastic points and summits On the other side of the chain which terminates the lake in the south stretches an extensive flat plateau, in which glitters a large watercourse, probably the Skapta, and far to the south are seen some great lava streams, dating probably from the 1783 eruption."

INTERNATIONAL CONGRESS OF PHYSIOLOGISTS

THE second International Congress of Physiologists, which took place at Liège on August 29, 30, and 31, was attended by more than 100 physiologists, including among others—Prof F Holmgren (Upsala), President of the Congress, Profs Hensen, Hurthle, Kuhne, Rosenthal, Cybulski, Kronecker, Miescher, Fredericq, Heger, Heymans, Arloing, Chauveau, Dastre, Gréhant, Hédon, Langlois, Laulanié, Morat, Wertheimer, Hamburger, Grigorescu, Wedensky, and the following English members Profs Foster, Burdon Sanderson, Schafer, Allen, Gotch, Halliburton, Horsley, Purser, Waymouth Reid, Stirling, Waller, Drs Adami, Beevor, Paton, Martin, Mott, Pye-Smith, Sherrington, Starling, Shore, Sims Woodhead, Messrs Bayliss, Burch, and Parsons

The work of the Congress was carried on in the Institutes of Zoology and Physiology, these institutions being placed at the disposal of the members by the kind courtesy of the two directing professors, whilst in addition the whole arrangements were excellently organized through the energy of the Professor of Physiology, Prof Léon Fredericq

The work of each day was so arranged that the mornings only need be devoted to the formal hearing of communications in the large lecture hall of the Zoological Institute, and the afternoons were thus left entirely free for informal meetings in the Physiological Institute, when demonstrations of special interest were shown in the rooms of the laboratory, thus adding very materially to the interest and utility of the proceedings The following list of the various communications and demonstrations will at least serve to show the large extent of ground covered by the subject-matter brought forward, and the activity with which physiological research is now being pursued

MONDAY, AUGUST 29—PRESIDENTS PROF CHAUVEAU (Paris), PROF BURDON SANDERSON (Oxford)

A *Communications*

1 Hermann—Phonophotography
2 Rosenthal Results of observations with improved calorimetric methods
3 Halliburton—Nucleo albumins
4 Starling—The fate of peptones in the blood and the lymph
5 Max Cremer—Experiments on the effects of feeding animals with certain sugars
6 Langlois—The functions of the suprarenal bodies
7 Morat—The innervation of the tensor tympani
8 Hamburger—The effect of different salts upon the properties of red blood corpuscles
9 Celine Muro—Physiological evolution

B *Demonstrations*

1. Hurthle—A new method of registering the sounds of the heart in man by means of a microphone
2 Wertheimer—(*a*) The excretion by the liver of bile introduced into the blood
(*b*) Vaso-dilatation effects of strychnia.
3 Laulanié—The cardiograph (needle method)
4 Wedensky—Demonstration by the telephone of the electrical changes which accompany the passage of nerve impulses, and the influence upon these of electrotonic alterations in nerve excitability
5 Sherrington—The cortical representation of the movements of the hallux and especially of the anus in the Macaque monkey
6 Langlois—The variations in the discharge of heat during "la maladie pyocyanique."

TUESDAY, AUGUST 30.—PRESIDENTS PROF KUHNE (Heidelberg), PROF. HÉGER (Brussels)

A *Communications*

1 Bowditch—Composite photography
2 Olivier.—Protoplasmic continuity.
3. Schafer—The structure of the insect's wing muscles
4. Schafer—The negative effects of severance of the frontal lobes of the cerebrum
5. Vitzou—(*a*) The visual centres of the dog and monkey
(*b*) The effects of total ablation of a cerebral hemisphere.

6 Wertheimer —The elimination of pigments by the liver
7 Loew —The distinction between the "active" and the "passive" albuminous material of plants
8 Sherrington —The varieties of leucocytes.

B *Demonstrations*

1 Chauveau —The changes in mammalian endocardiac pressure as recorded by the tambour and air transmission method (This classical experiment formed the main part of the afternoon's work)
2 Gréhant —(*a*) Absorption of carbonic oxide by living organisms
3. Gréhant and Martin —On the physiological effects of opium
4 Wedensky —Demonstrations with the telephone upon nerve excitation and upon voluntary muscular contraction in man
5 Zwaardemaker —The mechanism of smell

WEDNESDAY, AUGUST 31 —PRESIDENTS PROF WEDENSKY (St Petersburg), PROF GRIGORESCU (Bucharest)

A *Communications*

1 Cybulski – The use of the condensor for the excitation of muscles and of nerves
2 Hédon —The effect of removal and of transplantation of the pancreas upon the production of diabetes mellitus
3 Gotch — The increased excitability of nerve and of muscle occasioned by low temperature
4 Burch —(*a*) The apparatus for photographing the movements of the capillary electrometer
(*b*) The method of analyzing the electrometer curves obtained by the photographic method
5. Burdon Sanderson —The electrical changes in muscle as shown by the capillary electrometer
6 Fredericq —Autotomy in crabs.
7 Jacobi —The muscular sense
8 Bayliss —The functions of the depressor nerve
9 Doyon —Tetanus
10 Wedensky —The impossibility of causing fatigue in motor nerves.
11 Verworn —The effect of galvanic currents on simple living organisms
12 Moussu —The functions of the thyroid body
13 Slosse —(*a*) The functions of the thyroid body,
(*b*) Autopsy of a case of thyrodectomy in the dog
14 Kaufman —The intra-muscular circulation
15. De Boeck —The effects of partial ablation of the cerebrum immediately after birth

B *Demonstrations*

1 Waller —The discharge of heat from the muscles of man
2 Gotch —The increased excitability of the sciatic nerve of the cat produced by low temperature
3 Grigorescu —Action of certain poisons upon the central nervous system
4 Cybulski Method of stimulating muscle and nerve by means of condensor discharges
5 Mares —Nerve excitation by means of varying induced currents due to variations in the rapidity of magneto-induction
6 Wedensky —The most favourable and the least favourable frequency for effective intermittent excitation of nerve by electrical currents
7 Paton —A crystalline globulin obtained from urine.

In addition the following members showed instruments and models —

1 Lahousse —Model of the nerve centres
2 Rosenthal —Calorimeter with recent improvements
3 Laulanié —(*a*) A universal inscribing manometer
(*b*) Apparatus for studying respiratory changes
4. Morat —Recording apparatus
5 Cybulski —The Photohæmotachometer
6 Miescher and Jacquet —A recording chronometer

On Wednesday evening, at the conclusion of the proceedings, the members dined together in the large foyer of the theatre, the President of the Congress, Prof Holmgren, being in the chair

As the Congress is held every three years, the next meeting will take place in 1895, and it was decided that in response to the kind and cordial invitation of Prof Kronecker, the meeting should be held in Berne (Switzerland)

ELECTRO-METALLURGY[1]

THIS is not the first time a lecture has been delivered here on electro-metallurgy. I find that so long ago as January, 1841, there was a lecture on the subject by Mr Brand

At that time electro metallurgy was very new and very small It consisted solely of electro plating and electrotype Electro-plating had already begun to be practised as a regular industry, but it was still a question whether the new kind of plating was good, and there were not a few silversmiths who would not offer electro plate for sale because of its supposed inferiority to plate of the old style That question has long been definitely settled by the fact that every week more than a ton of silver is deposited in the form of electro-plate

Electrotype in 1841 was not so far advanced—it had not then been taken hold of by the artisan and manufacturer—it was still in the hands of the amateur

While the voltaic battery was the cheapest source of electric current, electro-metallurgy was necessarily restricted to artistic metal work, or to those applications where the fine quality of the electrotype cast outweighed the consideration of its cost, or where only a thin film of metal was required for the protection of a baser metal from the action of the air

Within this limited field, the electro deposition of copper, of gold, of silver, of iron, and of nickel, has been carried on commercially with very great success and advantage for almost the whole period of the existence of the art But beyond these bounds, set by the limitation of cost, it could not pass

Now, all this is changed—since engineer and electrician have united their efforts to push to the utmost the practical effect of Faraday's great discovery, of the principle of generating electric currents by motive power The outcome is the modern dynamo, with its result—cheap electricity The same cause that has led to electric lighting, and to the electric transmission of power, has also led to a very great development of electro metallurgic industry, and not only in the old directions but in new It is no longer a matter of depositing ounces or pounds of metal, but of tons and thousands of tons And it is no longer with metal deposition merely that electro-metallurgy now deals, but also with the extraction of metals from their ores, and the fusion and welding of metals Electro metallurgy has in fact grown so large and many branching, that it is impossible to treat it in a complete manner in a single hour

One of the latest developments is electric welding. Thus, in one of its forms, that invented by Elihu Thompson, has recently been so thoroughly explained and demonstrated by Sir Frederick Bramwell, that it is not necessary for me to do more than mention it as belonging to the subject.

There is also another species of electric welding—that of Dr Benardos—in which the electric arc is used after the manner of a blow-pipe flame, to obtain the welding of such forms and thicknesses of iron, steel, and other metals, as would be difficult or impossible to weld in any other way, and not only is the electric blow-pipe used for welding, but also for the repair of defects in steel and iron castings, by the fusion of pieces of metal, of the same kind as the casting, into the faulty place, so as to make it completely sound This new kind of electric welding, as improved by Mr. Howard, is now of sufficient importance to entitle it to the full occupation of an evening I therefore propose to leave it for detailed description to some other lecturer, and content myself with calling your attention to the interesting collection of specimens on the table, and in the Library (lent by Messrs Lloyd and Lloyd), showing the results of this process.

Even with this curtailment, the extent of the field is still too great, and I must reduce it further by omitting a considerable section of that portion which relates to the extraction of metals from their ores, and, in this connection, only speak of the extraction of aluminium

But, in the first place, I am going to speak of the deposition of copper, and you will pardon me if I treat it as if you were unacquainted with the subject.

[1] Friday evening discourse delivered by Mr J. Wilson Swan, at the Royal Institution, on May 20

One of the wonderful things about the electro deposition of copper, and in fact any other metal deposited from a solution of its salt in water, is, that bright, hard, solid metal, such as we are accustomed to see produced by means of fusion, can, by the action of the electric current, be made to separate from a liquid which has no appearance of metal about it

The beginning of every electro deposition process is the making a solution of the metal to be deposited I am going to dissolve a piece of copper, the most elementary of all chemical operations, but I want to make it quite clear where the metal to be deposited comes from—to show that it is actually in the solution, and actually comes out of it again, for that is an effect so surprising, that it requires both imagination and demonstration to make it evident There is projected on the screen a glass cell containing nitric acid Mr Lennox will put into it a piece of copper He has done so, it quickly disappears, and a blue solution of copper nitrate is formed Now, if I pass an electric current through this solution, or through some solution of the same kind, which, to save time, has been prepared beforehand, and immerse in it, a little apart from each other—the positive and negative wires coming from some generator of electric current—this will happen metallic copper will come out of the solution, and attach itself as a coating to the negative wire, and consequently that wire will grow in thickness At the other wire—the positive—exactly the reverse action will take place There, if the positive wire be copper, it will gradually dissolve, and become thinner The quantity of metal deposited on the negative wire will almost exactly equal the quantity dissolved from the positive, and therefore the solution will contain the same quantity of metal at the end of the experiment as at first, but it will not be the same metal, it will be fresh metal dissolved from the positive wire, and the metal originally contained in the solution will have been deposited as metallic copper

I will show on the screen this process in operation Here are the two wires I spoke of The electric circuit, which includes these two wires, is so arranged that on its completion the thick wire will be the positive, and the thin wire the negative Now please complete the circuit One wire (the positive) is carrying an electric current into the copper solution, and the other (the negative) is carrying the current away The solution is conveying the current between the wires, and one of the incidents of the transport of current from wire to wire by the solution, is electro chemical decomposition, or electrolysis, and the result of that is, the deposition, out of the solution, of copper, upon one wire, and the dissolving away, or entering into solution, of copper, from the other Now it can be clearly seen that the wire that was thick is now thin, and the wire that was thin is now thick

Imagine the growing wire to be an electrotype mould, and that the deposit of copper which formed on the wire has spread over the surface and formed a nearly uniform film, and that by continuing the process it has become thick, that deposit, stripped from the mould, would be an electrotype

Or imagine the negative wire to be a thin sheet of pure copper, and the positive wire to be a thick sheet of impure copper, and suppose the action carried on so far that the thin sheet has become thick by the deposition of copper upon it from the solution, and the thick one thin by its copper entering into solution, that case would represent the condition of things in electrolytic copper refining

Allow your imagination to take one more short flight, and suppose that this is not a solution of copper, but one of silver, and that the growing wire is a teapot to be silvered, and, further, suppose that the dissolving electrode is silver, and you will then understand the principle of electro-plating

It requires very little explanation to make the ordinary arrangement of electrotyping intelligible Here is a trough containing sulphate of copper solution Here is a mould that, through the kindness of Messrs. Elkington, has been prepared for me, this is connected with the negative pole of a battery—and here is a plate of copper connected with the positive pole. When I immerse the mould in the solution—at about two inches from the copper plate—the electrical circuit is completed, and the same electrolytic action that the experiment illustrated will take place. Copper will be deposited on the mould, and will be dissolved in equal quantity from the copper plate, and the supply of copper in the solution will thus be kept up As it will take a little time to obtain the result I wish to show, I will put this aside for ten minutes or so, and proceed to speak of different applications of this principle of copper deposition.

For the reproduction of fine works of art in metal, electrotype is unapproachable The extreme minuteness with which every touch of graver or modelling tool is copied by the deposited metal film, separates electrotype by a wide space from all other modes of casting Even the Daguerreotype image is not too exquisitely fine for electrotype to copy it so perfectly that the picture is almost as vivid in the cast as in the original

It is this quality that has given to electrotype a *rôle* which no other process can fill, and, so far, its practical utility is not greatly dependent on the cost of the current This applies to all those most beautiful things here and in the Library, lent by Messrs Elkington These could all have been produced commercially, even if there had been nothing better for the generation of the current than Smee's battery—a very good battery, by the way, for small operations in copper deposition It gives a very low electro-motive force and that is a defect, but in copper deposition, the half volt or so is generally sufficient to produce, automatically, the required current destiny

One of the uses of electrotype, not greatly affected by the cost of deposition, is that of the multiplication of printing surfaces In these days of illustrated periodicals, electrotype has come more and more into use for making duplicate blocks from wood engravings, which would soon be worn out and useless if printed from direct It is also employed to make casts from set-up type, to be used instead of ordinary stereotype casts, when long numbers of a book have to be printed, also as a means of copying engraved copper plates Here are examples of all these uses of the electrotype process The electro-blocks are lent by Messrs Richardson and Co, and the copper-plates by the Director General of the Ordnance Survey Office, Southampton

The plates illustrate the method employed at Southampton in the map-printing department The original plates are not printed from except to take proofs The published maps are all printed from electrotypes Here is an original plate—here the matrix, or first electro, with, of course, all the lines raised which are sunk in the original The second electro is, like the original, an intaglio Here is a print from it, and here one from the original plate Practically they are indistinguishable from each other, and bear eloquent testimony to the wonderful power of electrotype to transmit an exceedingly faithful copy of such a surface

Nickel has, of late years, come into extensive use for what is termed nickel-plating, as applied to coating polished steel and brass with nickel Nickel not only has the advantage over silver of cheapness, but also, in some circumstances, of greater resistance to the action of the air

Another metal, usually deposited in the form of a coating, is iron The electrolytic deposit of iron is peculiarly hard—so much so, that it is commonly but erroneously spoken of as *steel-facing* The deposition of a film of iron upon engraved copper-plates, as a means of preventing the wear incidental to their use in being printed from, has become almost universal Valuable etchings, mezzo tints, and photogravure plates are thus made to bear a thousand or more impressions without injury By dissolving off the iron veil with weak acid, when the first signs of wear appear on the surface of the plate, and re coating it with iron, an engraved copper plate is, for all practical purposes, everlasting

In this case, of course, the film of iron is extremely thin—one or two hundred thousandths of an inch But it is possible to produce most of the metals commonly used as coatings in a more massive form Here, for example, is an iron rod half an inch in diameter, entirely formed by electrolytic deposition I am indebted to Mr Roberts-Austen for being able to show this, and also for this other example of a solid deposit of iron, and for this beautiful specimen of electrolytic coating with iron Here also are solid deposits of silver This drinking cup is a solid silver electro deposit

These are all departments of electro-metallurgy which would have maintained a perfectly healthy industrial existence and growth without the dynamo, but now I come to speak of a branch of the subject—electrolytic copper refining—which, without that source of cheap electricity, could not have existed This is the most extensive of all the applications of electro-chemistry, and is rendering valuable assistance to electrical engineering by the improvement it has led to in the conductivity of copper wire

One of the results of this is seen in the raising of the commercial standard of electrical conductivity

Ten years ago, contracts for copper wire for telegraphy stipu-

lated for a minimum conductivity of 95 per cent of Matthiessen's standard of pure copper Now, chiefly owing to electrolytic refining, a conductivity of 100 per cent is demanded by the buyer and conceded by the manufacturer

To show the difference between the past and present state of things in relation to the commercial conductivity of copper, I am going to exhibit on the screen measurements of the resistance of six pieces of wire of equal length and equal cross section—they have been drawn through the same drawplate. Three of the pieces are new, and three are old The three new pieces are made from electrolytic copper, and are representative of the present state of things The three old pieces are taken from three well-known old submarine telegraph cables, and they show how very bad the copper was when it was first employed for telegraphic purposes, and how great has been the improvement I will take No 1 wire as the standard of comparison It is a piece of the wire about to be supplied to the Post Office Telegraph Department for trunk telephone lines It will show the very high standard of conductivity that has been reached in the copper of commerce I am indebted for it, and for two out of three of the old cable wires, to Mr Preece No 2 wire is made from electrolytic copper, deposited in my own laboratory No 3 is also electrolytic copper, but such as is commercially produced in electrolytic copper refining, it has been supplied to me by Mr Bolton, to whom I am also indebted for wire No 6—a particularly interesting specimen it is from the first Trans Atlantic cable—the cable of '58 No 4 wire is from the Ostend cable of 1860, and No 5 wire is from the old Dutch cable These wires are so arranged that I can send a small and constant current partly through any one of them, and partly through a galvonometer When this is done the result will be a deflection of the spot of light on the scale from the zero point to an extent corresponding to the resistance of the particular wire in the circuit The worse the wire is, the greater will be the deflection We will begin with the Post Office sample first I connect the galvanometer terminals to wire No 1, you see there is a deflection of ten degrees I will now shift the contacts to wire No 2—exactly the same length of wire is included—but now you see there is a deflection of slightly less than ten degrees, showing that this wire has a little lower resistance than No 1 The difference is very small—it may be 2 per cent—and 2 per cent less of it would be required to conduct as well as the No 1 wire The next is No 3 This is Mr Bolton's wire, and shows a resistance almost equal to the last

No, 1, 2, and 3 are, therefore, nearly alike, and have a degree of conductivity almost as high as it can possibly be

Now we come to the three old wires

We will take No 4 (the Ostend cable) There, you see, is a great difference Instead of the spot of light being on the tenth degree, it is upon the eleventh

We will now try No 5 (the Dutch cable) That drives the index to 17

Now I change to No 6 (the old Atlantic cable), and we have a deflection of no less than 25 degrees I suppose we may assume that this wire fairly represents the commercial conductivity of copper in 1858, for it is highly probable that for a work so important as the first Atlantic cable every care would be taken in the selection of the copper

The result of this experiment shows that the copper of that cable was extremely bad as a conductor—that, in fact, it is 150 per cent worse than the best commercial copper of to day In other words, it shows that, in point of electrical conductivity, one ton of the copper of to day will go as far as two-and-a-half tons of such copper as was used for the cable of '58

This change is largely due to electrolytic copper refining

The process of electrolytic copper refining is the same in principle as that which produced the thickening of one of the wires and the thinning of the other in my first experiment To prepare the crude copper for the refining process it is cast into slabs, these form the anodes, and correspond to the wire which in my first experiment became thin The cathodes, corresponding to the wire which became thick, are formed of thin plates of pure copper Here are plates such as are used in electrolytic copper refining works. They are portions of actual cathodes and anodes, and represent the state of things at the commencement, and at the end, of the depositing operation—an operation that takes several weeks to complete, and effect the great change these plates show In copper refining works an immense number of these plates, each having 6 to 10 square feet of superficial area, are operated upon together in a great number of large wooden vats containing sulphate of copper solution and a small proportion of sulphuric acid Electric current from a dynamo, driven by a steam-engine or water-power, is conveyed by massive copper conductors to the vats, arranged in long lines of 50 or 100 or more in series. Thick copper bars connect adjoining vats, and provide a positive and negative support for the plates, which hang in the solution opposite each other, two or three inches apart During the process the impure slabs dissolve, and at the same time pure copper is deposited from the solution upon the thin plates The deposition and dissolving go on slowly, in some cases very slowly, for a slow action takes less power, and gives purer copper than a more rapid one The usual rate is one to ten amperes per square foot of cathode surface You will better realise what these rates of deposit mean, when I say that one ampere per square foot rate of deposition gives for each foot of cathode surface, nearly one ounce of copper in twenty-four hours, and a thickness of one eighth hundred of an inch, and therefore the production of one ton of copper at that rate in twenty-four hours would require a cathode surface in the vats, in round numbers, of 36,000 square feet At the higher rate of ten amperes per square foot, which is used where coal is cheap, one tenth of this area would be required

The importance of the electrolytic copper refining industry, and the extent of the plant connected with it, may be inferred from the fact that, reckoning the united production of all the electrolytic copper works in the world, nearly one ton of copper is deposited every quarter of an hour

Very little power is required for copper deposition if the extent of the dissolving and depositing surfaces is large, relatively to the quantity of copper deposited in a given time

Some of the impurities ordinarily found in crude copper are valuable Silver and gold are common impurities, and these and some other impurities do not enter into solution, but fall down as black mud, are recovered, and go to diminish the cost of the process or increase the profit, and even those impurities which enter into solution are, under ordinary conditions, almost completely separated

Electrolytic copper refining is both an economical and an effective process The deposited copper is exceptionally pure At one time it was supposed that it must necessarily be quite pure, but this is not the case, other metals can be deposited with the copper, but it is not difficult to realise in practice a close approximation to absolute purity in the deposited copper Here is an example of the deposition of a mixed metal—brass, that is, copper and zinc deposited together, and there are in the Library a number of interesting specimens of mixed metal deposition These deposits of brass and other alloys show that more than one metal can be deposited at the same time The great enemy to conductivity in copper is arsenic, and the deposition of arsenic as well as copper is one of the things to be guarded against in electrolytic copper refining Not only are the chemical characteristics of electrolytically refined copper generally good, but its mechanical properties are largely controllable Usually electrolytic copper is melted down and cast into billets of the form required for rolling and wire-drawing This treatment not only involves cost, but the copper is apt to imbibe impurity during fusion, though, if the process is carefully conducted, the deterioration is slight

But it is evident that the re melting of the deposited copper is a thing to be avoided if possible, and the question naturally arises, why, now that deposition costs so little, may not the beautiful principle which comes into play in electrotype, and which enables the most complicated forms to be faithfully copied be taken advantage of to give to plainer and heavier objects their ultimate form?

There are several reasons why this idea is not more frequently acted upon. One is that the process of electrolytic deposition is slow, another, that knowledge of the conditions necessary for obtaining a deposit having the required strength and other qualities, is not very widespread. Moreover, in the electrolytic deposition of copper, and indeed of all metals, there is a strong tendency to roughness on the outside of the deposit, and to excrescent growths, the removal of which involve waste of labour and material These tendencies can to a very great extent be counteracted by careful manipulation and the use of suitable solutions, and they can also be counteracted by mechanical means This has been done by Mr. Elmore. He remedies the faults I have mentioned by causing a burnisher of agate (arranged after the manner of a tool in a screw cutting

lathe) to press upon and traverse a revolving cylindrical surface on which the deposit is taking place, and while it is immersed in the copper solution. The result is that it is kept smooth and bright to the end of the process.

But the use of a burnisher is not the only means available for the production of a smooth deposit. It was observed in the early days of electro-plating how great a change was effected in the character of the metal deposited by the presence of a very small quantity of certain impurities. It was found, for example, that an exceedingly minute dose of bisulphide of carbon, if put into a bath from which the silver was being deposited, caused the deposit to change from dull to bright.

I have lately had experience of a similar kind with nickel and with copper. I was working with a hot solution of nickel, and up to a certain point the deposit had the usual dead-grey appearance. Suddenly, and without doing anything more than putting in a new cathode, I found the character of the deposit completely changed. Instead of the grey, tough, adherent deposit, there was produced a brittle, specular deposit, which scaled off in brilliantly shining flakes of metal. I sought for the cause of this extraordinary change, and traced it to the accidental introduction into the solution of a minute quantity of glue.

By adding gelatine to a fresh nickel solution I obtained the same peculiar bright and brittle deposit that had resulted from the accident. I then made a similar addition to a solution of copper, and when I hit the right quantity—an exceedingly minute one—bright copper, instead of dull or crystalline, was deposited. Here are some specimens. These were deposited on a bright surface, and they are bright on both sides.

Not only is the copper made bright, under the conditions I have described, but, if the proportion of the gelatine be carried to the utmost that is consistent with the production of a bright deposit, it becomes exceedingly hard and brittle. Beyond this point the deposit is partly bright and partly dead, the arrangement of the patches of dead and bright being in some cases very peculiar, and suggestive of a strong conflict of opposing forces.

Before I leave the subject of copper deposition, I may mention that I have found the range of current density within which it is possible to obtain a deposit of reguline metal, far wider than is commonly supposed.

The rate of deposition in copper-refining is usually very slow, and it is one of the drawbacks of the process, since slow deposition necessitates large plant. But rapid deposition necessitates a larger consumption of power, and larger cost on that account, and therefore, there is a point beyond which it is not good economy to go, in the direction of more rapid deposition. Still there are cases, where, if we had the power to deposit more rapidly, it might be found useful to exercise it. The subject of more rapid deposition is also interesting from a scientific point of view, I therefore mention an unusual result I have arrived at in this direction.

Taking as one extreme, the slow rate of deposit, of one ampere per square foot of cathode—a rate not infrequent in copper-refining, I have found that the limit in the other direction is not reached by a rate of deposit one thousand times faster. I have produced, and I hope to be able to produce before you, a perfectly good deposit of copper, with a current density of 1000 ampères per square foot of cathode.

This cell contains a solution of copper nitrate with a small proportion of ammonium chloride. The plate on which I am going to produce a deposit of copper has an exposed surface of 21 square inches. Opposite, at a distance of one inch, is a plate of copper. When I close the circuit, a current of 140 ampères is passing through the solution. I continue this for just one minute. Now I wash it and remove the outer edge so as to detach the deposit, and as you see, I have a sheet of good copper—an electrotype.

To have produced a deposit of this thickness at the ordinary rate used in electrotyping operations would have occupied more than an hour.

In this experiment an extreme degree of rapidity of deposition has been shown. I do not intend to suggest such a rate of practical value. But it is at least interesting, as showing that the characteristic properties of copper are not less perfectly developed when the atoms of metal have been piled up one on the other at this extremely rapid rate than when there is slower aggregation.

I think it probable that a rate of deposit intermediate between this rate and the usual one of about 10 ampères per square foot may frequently be useful, for no doubt the slowness of the rate of deposit has often prevented electrotype from being made use of where, if the rate could have been increased ten times, it might have been used with advantage.

Here are some thick plates, deposited at the rate of 100 ampères per square foot. They are as solid and as free from flaw as plates deposited ten times more slowly.

I said that electrolytic copper refining owed its existence to the discovery and improvement of the dynamo, and that other electro-metallurgic industries had originated from the same cause. One of these industries is the electrolytic production of aluminium.

When Deville produced aluminium by the action of sodium on aluminium chloride, exaggerated expectations were entertained of the great part it was about to play in metallurgy. It was very soon found that aluminium had not all the virtues that its too sanguine friends had claimed for it, but that it had a great many most valuable properties, and, given a certain degree of cheapness, a number of useful applications could be found for it. Some of these are suggested and shown by the various articles made of aluminium, kindly lent by the Metal Reduction Syndicate, and metallurgical research is rapidly extending our knowledge of its importance in connection with the improvement of steel castings, and the production of bronzes and other alloys of extraordinary strength. The cost of aluminium produced by Deville's process was too great to permit of its use on any large scale for these purposes.

After Davy demonstrated, by the electrolytic extraction of potassium and sodium, the power of the electric current to break down the strong combination existing between the alkaline metals and oxygen, it seemed natural to expect that aluminium would also be reduced by the same means. But Davy did not succeed in producing any appreciable quantity of aluminium by the electrolytic method. Deville and Bunsen were more successful, but they did not possess the modern dynamo that has made all the difference between the small experimental results they achieved and the industrial production of to day, a production now so large that I suppose every day it amounts to at least one ton, and has resulted in a very great reduction of the price of the metal.

There are two electrolytic processes at work. One is the Hall process—employed at Pittsburg, and at Patricroft, Manchester—and now in experimental operation here. The other, the Herault process, worked at Neuhausen, is not greatly different from the Hall process—the shape of the furnace or crucible is different, and the composition of the bath yielding the aluminium may be different, but in all essentials these two processes are one and the same. They depend on the electrolysis of a fused bath, composed of cryolite, aluminium fluoride, fluorspar, and alumina. In the Hall process this mixture is contained in a carbon lined iron crucible—the cathode in an electric circuit, and between which and the anode—a stick of carbon immersed in the fused bath—a difference of potential of 10 volts is maintained. In carrying out the process on a manufacturing scale, there are many of these sticks of carbon to each bath. Here, in our experimental furnace, there is only one.

The heat developed by the passing of so large a current as we are using (180 amperes) through an electrolyte of but a few inches area in cross section, is sufficient to melt and keep red-hot the fluorides in which the alumina is dissolved.

The electrolytic action results in the separation of aluminium from oxygen. The metal settles to the bottom of the pot, and is tapped or ladled out from time to time as it accumulates. The oxygen goes to the carbon cylinder, and burns it away at about the same rate as that at which aluminium is produced. It is only necessary to keep up the supply of alumina to enable the operation to be continued for a long time. I mean, of course, in addition to the keeping up of the current and the supply of carbon at the anode.

By far the greater part of the cost of aluminium obtained by electrolysis is the cost of motive power. 20 horse-power hours are expended to produce 1 pound of aluminium. Therefore it is essential for the cheap production of aluminium to have cheap motive power.

There is one feature about the Neuhausen production of aluminium which is very striking, and that is the generation of the electric current by means of water power derived from a portion of the falls of the Rhine at Schaffhausen.

The motive for making use of water power is economy. But, apart from that, it is interesting to see water replacing coal, not only in the production of power, but also in the production of the heat required in a smelting furnace.

Here is the Hall apparatus on a small scale It is simply a carbon lined iron crucible, and a thick stick of carbon As already mentioned, the crucible is the cathode, the stick of carbon the anode.

As the process takes time to get into full operation, it was commenced some hours ago, and at the rate at which it has been working we should by now have produced several ounces of aluminium In beginning the process the charge has first to be melted This is done by bringing the carbon stick into contact with the bottom of the crucible, so as to allow the current to pass from carbon to carbon to develop heat between the electrodes.

The alumina compound, which, when melted, forms the bath, is added, in powder, little by little, and, when sufficient is melted, the carbon stick is raised out of contact with the bottom, and the electrolytic action then commences

I will now ask Mr Sample to empty the crucible and let us see the result of the operation, and while he is doing so I take the opportunity of expressing my very sincere thanks for his having so kindly and so successfully carried out this most interesting demonstration of the latest and one of the most important of all the applications of electricity to metallurgical operations

Here is the result of our experiment It is not very large certainly, but it is quite enough for our purpose, which is to illustrate the principle of a newly developed electro-metallurgical industry directly derived from discoveries made at the Royal Institution

MOUNT MILANJI IN NYASSALAND

HIDDEN in the recesses of one of the recently issued Parliamentary Papers (Africa, No 5, 1892) will be found a very interesting report on the mountain and district of Milanji, in British Central Africa, by Mr Alexander Whyte, F Z S, one of Mr. Commissioner Johnston's principal assistants in the task of ruling and developing the new British Protectorate of Nyassaland Mr Whyte was sent to Milanji by Mr Johnston in October last, and dates his report from the "Residency, Zomba, British Central Africa," in the month following Milanji is a large mountain mass in the extreme south east corner of Nyassaland, drained on the west by the head waters of the Ruo, one of the affluents of the Shiré, and on the east by the Lukuga and other smaller streams, which run into the Indian Ocean north of the Zambesi It is described by Mr Whyte as an isolated range of, for the most part, precipitous mountains, the main mass forming a huge natural fortress of weather-worn precipices or very steep rocky ascents, sparsely clothed with vegetation. Many of its gullies and ravines are well wooded, and in some of them fine samples of grand African virgin forest are met with Mr Whyte's ascent, on the 20th of October, was made up the south east face of Milanji, over steep grassy hills and across rocky streams, full of large water-worn granite boulders. Further on precipices were encountered, and it was necessary to clamber up, holding on by tufts of grass, roots, and scrub, after which a wooded gorge was entered, and welcome shade was obtained from the forest trees.

Here an interesting change in the vegetation was at once perceptible, the plants of the lower slope being mostly replaced by other species These in many cases approached the flowers of temperate climes, such as brambles and well-known forms of *Papilionaceæ* and *Compositæ*. Ferns, too, became more numerous, and now and again were encountered perfect fairy dells of mosses, Selaginellas, and balsams, with miniature water falls showering their life giving spray on the little verdant glades, while overhead hoary lichens and bright festoons of elegant long-tasselled Lycopods hung from the moss covered trees After they had passed through some dense thickets of bamboo, and climbed up an ugly barrier of precipitous cliffs, another hour's ascent, the latter part of which was through a steep grassy glen, brought Mr Whyte and his companions to the highest ridge of Milanji

Hence was a splendid view over rolling hills of grassy sward divided by belts of dark green forest, and the climate was found to be delightfully cool and bracing, with a clear dry atmosphere of about 60° Fahr Altogether two weeks were spent at three different sites on this high plateau, and good collections of its natural history were made, although rain and mist occasionally interfered with the operations of the naturalists.

The flora of the mountain proved to be of great interest, being quite distinct from that of the surrounding plains, and even from that of the lower slopes Tree ferns were found to attain a great size in the damp, shady forest, and one was measured 30 feet in height and 2 feet in diameter at its base The display of wild flowers is described as "gorgeous" Creamy-white and yellow helichrysums mingled with purple and blue orchids and irises, and graceful snow-white anemones were all blooming in wild profusion, and rearing their heads from a bed of bright green grassy sward But the most striking botanical feature of the Plateau of Milanji was the cypresses formerly apparently quite abundant, but now confined to a few of the upper ravines and valleys, where the annual bush fires, which take place in the dry months of August and September, cannot reach them In some places hundreds of these giant trees thus destroyed lay prostrate, piled one above another, in every stage of destruction One of these dead conifers was found to measure 140 feet in length and 5½ feet in diameter at 5 feet from its base The foliage of this cypress is juniper-like The timber, of a dull reddish-white colour, is of excellent quality and easily worked Ripe cones of this fine tree were procured, and, as stated in a subsequent letter, have already germinated in the experimental garden at Zomba.[1]

The fauna of the mountain was found to be of nearly equal interest to the flora, but in the short space of time available it was not possible to make so nearly a complete collection Raptorial birds were very scarce, but Passeres were plentiful The grassy lands of the summits were tenanted by a small dark brown quail, a pipit, two grass-warblers, and the ubiquitous great billed raven (*Corvultur albicollis*), which, however, was not so numerous as on the plains below In the adjoining forest bird life was abundant Bul buls, fly-catchers, warblers, finches, and honey-birds joined in chorus in celebrating the springtime and nesting season, which was then in full progress Altogether about 200 specimens of birds were obtained Of mammals few were met with The beasts of prey consisted of the leopard, the spotted hyæna, the serval, and an ichneumon Examples of three species of *Muridæ* were also obtained, and a little antelope, probably of the genus *Neotragus*, was observed, but not procured A few snakes were likewise met with

As regards the question of establishing a sanatorium on the Milanji Plateau, to which special attention had been directed, Mr Whyte has no hesitation in saying that the climate of this district contrasts very favourably with that of some of the hill stations in India and Ceylon The year is pretty equally divided between wet and dry months, the former lasting from November till May, while the other six months are stated to be fine, clear, and bracing, the thermometer at night in the months of May, June, and July occasionally falling below the freezing point. In the month of October the air was found to be delightfully pure and balmy We believe that steps have already been taken to build a small station on Milanji, but to render this of much use it will be necessary to form a road to it from the falls of the Ruo up the Lutshenya valley This could be made with fairly good gradients, and would be of great advantage as an outlet for the cypress timber, which now lies useless and decaying in the forest

We are pleased to be able to add that Mr Whyte's collections above spoken of, along with others from Mount Zomba, have already reached London, and are in the hands of Mr Sclater, to whom Mr Johnston has entrusted the task of getting them worked out and described Mr Oldfield Thomas has already commenced to determine the mammals, Captain Shelley will name the birds, and Mr Boulenger, it is believed, will undertake the examination of the reptiles and batrachians The plants will be examined in the Botanical Department of the British Museum, in which institution Mr. H H Johnston has directed the first set of specimens in every department to be deposited The zoological results will be published in the "Proceedings" of the Zoological Society of London

OBSERVATIONS OF THE PLANET MARS[2]

I OUGHT to have written to you before on the subject of the planet Mars, which I have been studying for over four months with our great equatorial My great desire to verify the

[1] Some cones of this supposed "Cypress" have also reached the Botanical Department of the British Museum, and have proved to belong to a Conifer of the genus *Widdringtonia*, probably of a new species. But this point cannot be definitely settled until more perfect specimens of the tree have been received

[2] Letter from M Perrotin to M Faye, *Comptes rendus*, September 5.

extraordinary phenomena to which I alluded in my last letter may account for this

Besides, I have gained nothing by waiting, and at the present time, after successive delays which I much regret, I am hardly further than I was a month ago. Owing, perhaps, to the images being less satisfactory, or to the phenomena in question not having recurred, nothing has been added to my first observations.

The phenomena alluded to are brilliant projections, comparable in colour and brightness to the southern pole cap, observed on three different occasions—viz., June 10 and July 2 and 3, on the western limb of the planet.

The last time, July 3, I was able to observe the several phases of this singular appearance. On that day the luminous point began to emerge on the edge of the disc at 14h. 11m. (local astronomical time), very faint at first; then I saw it gradually increase, pass through a maximum, and then diminish, to disappear finally about 15h. 6m. The facts would not have been different had it been a case of an elevation of the surface of Mars traversing the illuminated edge of the disc by the simple effect of the rotation of the planet. The phase which affected the western limb of the planet at that time, could only modify it in amount and in duration. The previous night, July 2, I had seen the crescent in a phase approaching the maximum, at 14h. 10m., and I was able to follow the bright point up to its complete disappearance at 14h. 40m.

On July 2 and 3 the things happened in the same part of the disc, about the 50th parallel of latitude, and with a retardation of half an hour against the previous day, as usual for a thing taking place in the same region of the planet.

The first observation of this kind goes back as far as June 10, when it lasted from 15h. 12m. to about 16h. 17m. This time the bright point occurred in the vicinity of the 30th southern parallel, probably in the southern portion of the isthmus Hesperia of Schiaparelli's chart.

I may add that during these observations the portion of the disc adjoining the small protuberance has always appeared to me slightly deformed and as if raised.

Such are the facts. I shall not attempt to interpret them. They presented themselves with such clearness that it is hardly possible to consider them as the result of any illusion.

On the other hand, since it is a question of projection beyond the disc of at least one or two tenths of a second of arc, that is to say, of phenomena at a height of more than 30 or 60 km., one feels overwhelmed by such numbers, to which we are not accustomed on our globe, and it is undoubtedly luminous phenomena only which could explain heights like that.

The southern snow cap has been the object of several measurements, which will be published with the drawings of this opposition. This cap has notably diminished in the last two months; it is, in fact, shifting; it is traversed by at least two black lines, a kind of crevices analogous to those which I announced in 1888 in the case of the northern cap. The first of these lines was seen at the end of June, the second on August 8.

The outline is now more irregular than in the past; in particular there is seen, between the meridians of 300° and 0° (Schiaparelli's map), a deep black hollow which grows steadily.

Although the actual conditions are not very favourable for the canals (at least for a portion of them), several are well visible; some are apparent enough to convince the most prejudiced observers.

Two of our drawings of the Great Syrtis, made at widely different dates, indicate some slight changes in the most northerly portion of this sea. They are no doubt due to mists and clouds, which have sometimes appeared to me to invade the northern regions on the east of this Great Syrtis, hiding the canals which traverse them, and only allowing us to see their most southern portion.

Our drawings of the Lake of the Sun, when compared with those of M. Schiaparelli, also indicate some changes of detail in the aspect of the lake itself and of the seas and canals surrounding it.

The most interesting observation of this month is the one I have made, on August 6, of a very bright point placed precisely a little to the north of this Lake of the Sun. This point, which struck me by its extraordinary radiance, could not be seen the next day; if it still existed—the images were not so good as the previous night—it was certainly much less luminous.

This phenomenon, and the analogous phenomena sometimes noticed on the surface of the planet, are perhaps not without some relation with the appearances of the limb which I have announced. Future observations will no doubt inform us on this subject.

I should perhaps have still deferred sending this letter if I had not, within the last few days, received from Mr. Newcomb the extract of a journal, in which it is reported that the Lick astronomers have also observed the luminous projections on the edge of the disc.

I may add that in the beginning of July I had imparted my observations to M. Andre, director of the Lyons Observatory, who happened to be on a visit to Mont Gros, and whom I had invited to come on the 5th and verify the strange appearances which I had told him of. Unfortunately, the sky remained obscured all night, and my project could not be carried out.

SCIENTIFIC SERIALS

THE *American Meteorological Journal* for August contains:—Synoptical sketch of the progress of Meteorology in the United States, by W. A. Glassford, and reprinted from the annual report of the chief signal officer for 1891. From this summary it appears that Isaac Greenwood, a professor of mathematics in Harvard College, prepared a form for observations at sea in 1728, thus anticipating the efforts of Lieut. Maury by more than a century. Observations of temperature and rainfall were begun in Charleston in 1738, and were soon followed by several other series. In 1817, J. Meigs, Commissioner of the General Land Office, proposed to Congress the establishment of meteorological stations at each of the land offices, and as this proposal was not adopted, he started a voluntary system among his subordinates, and supplied registers for the purpose. This system lasted until his death in 1822. The next service was established by the Surgeon General of the Army, in 1819, and was maintained, with modifications, until 1854, when the records were handed over to the Smithsonian Institution, and in due time were transferred to the Signal Service. The Patent Office, of which agriculture formed a division, and the Coast Survey also manifested great interest in the science. The article contains a good review of the labours of the principal American meteorologists.—Note on winter thunderstorms, by Prof. W. M. Davis. He asks whether the convectional origin of thunderstorms in summer implies a like origin for thunderstorms in winter, even though they occur then at night, and he explains the reasons which seem to favour this supposition.—Objections to Faye's theory of cyclones, by W. C. Moore. The writer attempts to show why the generally accepted theories seem to him preferable to those brought forward by M. Faye. The discussion is to be continued in a future number.—Artificial rain, by E. Powers. The writer is the author of a work entitled "War and the Weather," and he supports the view that rain can be artificially produced, and endeavours to refute the objections urged by Prof. W. M. Davis and others.

Wiedemann's Annalen der Physik und Chemie, No. 8.—On the refraction of rays of great wave length in rock-salt, sylvine, and fluorspar, by H. Rubens and B. W. Snow. A series of bolometric researches concerning the infra red rays, to determine the refractive indices of the three substances for light of various wave-lengths up to $\lambda = 80,000$. Fluorspar, though showing a lesser dispersion than the other two in the visible portion, excelled them enormously in the infra red, hence it is specially suited for the production of prismatic heat spectra.—Reflection and transmission of light in certain æolotropic structures, by H. E. J. G. du Bois. An æolotropic structure is a portion of matter, generally plane, in which it is possible to fix upon an optically favoured direction. This can be due to its coarse macroscopic or its molecular and microscopic structure. In both cases vertically incident or reflected light will be acted upon differently according as its plane of polarization is parallel or normal to the favoured direction. This action is in general unequal as regards both the amplitude and the phase of the two components. The objects experimented upon were, in the first class, bright silver wire gratings, platinum film gratings, scratched metal reflectors, and scratched glass gratings; in the second class, crystals of cobaltine and pyrites, and a loaded steel mirror. In the case of the silver wire gratings it was found that light polarized in a plane normal to the direction of the wires was let through in greater intensity

than that polarised parallel to them The contrary was observed in scratched glass gratings, while a scratched metal mirror reflected 4 per cent more perpendicular than parallel light —The limiting index of refraction for infinitely long waves, transformation of the equations of dispersion, by E Ketteler The determination of the limiting coefficient of refraction is shown to be impossible, both in practice and by the current theory Another form of the equation of motion of light is worked out, which promises a solution of the problem —On the electricity of waterfalls, by Ph Lenard Numerous observations and experiments concerning the electricity developed by water falling in drops, jets, or waterfalls have led to the following general conclusions Drops of water falling on to water or a wetted body generate electricity Water is electrified positively, air escapes negatively electrified from the foot of the fall Jets breaking up into spray make the electrification more apparent Slight impurities in the water diminish the effect considerably Other liquids and gases also produce electrification, but differing in intensity and sign The essential conditions of electrification are the concussions among the waters themselves and against the wet rock The friction against the rock and the fall of the earth-potential are of secondary importance, while no effect is due to the water's fall through air and its dispersion in it The author explains these phenomena by the sudden diminution of the water surface, and the convection of negatively charged air away from the foot of the fall A jet of water falling from an insulated tank into an insulated pail electrified the latter positively, while the negative electrification of the surrounding air grew to several hundred volts A steady increase of potential was also produced by drops of water falling at the rate of two per second Sparks were sometimes obtained from waterfalls, and in all cases the air was found to be negatively charged, though this charge was diminished if air bubbles were driven under water —Note on a phosphoroscope with spark illumination, by Ph Lenard This ingenious apparatus consists of a Ruhmkorff coil with condenser and mercury interrupter, fitted with terminals of strip zinc or zinc wire, in order to produce as much ultra-violet and phosphorescent light as possible The arm of the mercury interrupter is prolonged, and carries at its end a rectangular shade of black paper, large enough, in its mean position of rest, to hide the spark and the terminals Hence when the coil is working the sparks are not seen But if a phosphorescent substance be placed behind the terminals, it continues to glow when the screen is at its highest or lowest position, thus producing the impression as if the screen, which appears perfectly stationary, were only transparent for phosphorescent light. For lecture purposes the apparatus is placed behind a screen with an opening as large as the black paper shade The results are in general the same as those of Becquerel's phosphoroscope A brilliant green light is obtained from pentadecylparatolylketone The interval between illumination and observation is $\frac{1}{750}$ second —On the production and observation of very rapid electric oscillations (continued), by A Toepler —On the use and mode of action of the telephone for electric null methods, by A Winkelmann

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Sept 5 —M de Lacaze-Duthiers in the chair —Note on the treatment of cancer and cholera by the testiculary liquid, by M Brown-Séquard Some recent results seem to indicate that the testiculary liquid, already proved to be efficacious in cases of pulmonary tuberculosis, leprosy, and other diseases, also exerts a beneficial influence on cancer patients. This is not due to any action upon the microbes producing the disease, but to an augmentation of the powers of the nervous system, which is enabled to resume its normal functions by subcutaneous injections of the extract M. Ouspensky, a military physician sent by the Russian Government to study and cope with the cholera in the Caucasus, is reported to have "cured every patient" by this method. Whether or not this be true, there is no doubt that the injections strengthen the nervous system, which is much exhausted even in convalescents.—Observations of the comet Denning (1892, II) made at the great equatorial of the Bordeaux Observatory, by MM. G Rayet, L. Picart, and F. Courty, reported by M G. Rayet —Observations of the planet Mars, by M Perrotin [see p 482] —Reappearance of the leafy celandine of Pumeterre, by M D Clos —Observations of the new comet Brooks (C 1892), and of the new planet Wolf, made at the Observatory of Paris (west equatorial), by M G Bigourdan —Observation of the comet Brooks (August 28, 1892), made with the Brunner equatorial (0 16) of the Lyons Observatory, by M G Le Cadet —On the calculation of inequalities of a high order, by M O Callandreau —On a new form of induction apparatus, by M J Morin The induction coils usually employed in electrotherapy are constructed with two cylindrical and concentric bobbins, sliding one over the other, and giving the maximum effect when the coils coincide along their whole length There is a difficulty in reaching the zero by a regular diminution of the current This is obviated in the apparatus as constructed by M Morin The conducting wires are wound on two flat concentric rings provided with channels of appropriate form When an intermittent current is sent through the outer ring induced currents will be obtained from the inner ring The effect will be greatest when the two rings are in the same plane If one of these rings be turned round a diameter common to both the induced current will gradually diminish, and will vanish when the one ring is at right angles to the other This arrangement could be employed for obtaining alternate currents by sending a continuous current through one of the rings and rotating the other A sinusoidal current would be thus generated, the effects of which have been lately much appreciated in electrotherapy For electric lighting the number of alternations might be increased by transforming the currents into induced currents of a higher order, by Prof Henry's method, utilized recently by M Tesla —Removal of the thyroid in the white rat, by M H Cristiani (Geneva) The apparent immunity of the rat from the fatal effects of the removal of the thyroid is shown to be due to the rapid regeneration of this organ If the extirpation is total, death, otherwise inevitable, can be averted by grafting the organ in the peritoneum

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THURSDAY, SEPTEMBER 22, 1892

A 5-SENSATION THEORY OF VISION

Color Vision By E Hunt (Glasgow John Smith and Son, 1892)

THE author entitles his work, "An essay discussing existing theories, explaining views hitherto incompletely published, and comprising illustrated descriptions of important new experiments" We shall now proceed to see how the promise conveyed by the title is fulfilled In the early pages of the book he makes the statement that there are five colours which are distinct sensations, viz, red, yellow, green, blue, and purple. The last, however, he is rather less certain about as conveying his meaning, but finally adopts the name after explaining what he designates by purple These are the five colours of a 5-colour theory which he propounds, all other colours being mixtures He has felt, however, that it is no use to bring forward a theory unless he demolishes those other theories which block the way His examination of these last is chiefly confined to that of Young, which accounts for colour-vision on the assumption that there are only three colour sensations—a number which is a minimum when the fact is remembered that all colours can be produced by a simple colour, or by a mixture of two or three of the colours which are considered to be primary colours His criticism of the theory is mostly confined to a paper published by Clerk Maxwell thirty years ago, and he scarcely refers to any evidence in its support which has been brought to light in more recent years Mr Hunt has entangled himself in mixing up colour and colour sensations together, and has forgotten that in Clerk Maxwell's papers three colours were chosen empirically as approaching the colours which are perceived when the three fundamental sensations are stimulated Later work has shown that the colours thus shown are not representative of the fundamental sensations No one, for instance, would say that any green in the spectrum was the colour evoked by the stimulation of the green fundamental sensation, for it is well known that, according to the theory, at every part of this region of the spectrum all three sensations are stimulated, and the nearest approach that a retina possessing normal sensations could make to perceiving this one sensation, would be when the colour evoked was mixed with a percentage of white, rendering the colour impure We may here parenthetically remark that it is too late for Mr Hunt to quarrel with the designations of the colour constants, for they are accepted terms "Impure," for instance, may be an objectionable term to apply to a colour when mixed with white, but as what is meant by it is understood, it can only be used in that sense The position of the colour which stimulates only the red fundamental sensation is fairly well known, being near to the red lithium line The position of the colour which stimulates the violet fundamental sensation is still not absolutely settled, but it cannot be very far from the G line of the solar spectrum Moreover, recent researches show that at the extremities of the spectrum only a red or a violet sensation is stimulated, any change in colour observed being due to a slight admixture of white light, which is derived from the imperfect transparency of the prisms or reflecting surface of the grating The colour, for instance, near G, when mixed with a small percentage of white light, in excess of that already mixed with it, takes a violet hue, a colour which is associated with the most refrangible part of the spectrum As the luminosity of this part is very much less than that near G, the extra percentage of white light required to form this hue is always present The colour of any ray of the spectrum can be almost entirely freed from the white light derived from the prism by placing another prism in the path of such rays, after passing through a second slit In an eye-piece or on a screen, the ray will be seen as a well-marked line lying in a faint continuous spectrum Again, the references to the sensations stimulated in the various types of colour-blind people are not described in any detail, though the evidence which is derived from an examination of their vision is of the greatest importance for the Young or any other theory The author gives most undue weight to colour diagrams Colour triangles or circles are not intended to be the basis of a theory, but simply as illustration of it It is quite possible that Clerk Maxwell's diagrams would not tally with those based on König's observations, nor should they do so In fact a diagram may be drawn to illustrate any theory, as the author himself has done to illustrate his own

In animadverting on Clerk-Maxwell's colour equations, the author, it may be remarked, has himself made a mistake as regards certain reductions to be given to the intensities of different colours The equations are right as they stand, when it is remembered that Maxwell chose to adopt certain arbitrary units which he carried throughout them all

The author in one place endeavours to prove the superiority of a 5-colour theory over a 3- or 4-colour theory, by narrating what is seen when a spectrum is formed with—what comes to—a very wide slit to the collimator Practically he shows that this wide slit may be supposed to be made up with narrow slits, and that the spectrum formed when the wide slit is used is made up by the overlapping of the spectrum formed from the narrow slits He then adds up the colours (or colour sensations) as follows —

```
R—G—P
    R—G—P
        R—G—P
            R—G—P
--------------------
R—y—W—W—b—P
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With the 4-colour theory he has five rows for addition, and with the 5-colour theory he has six rows The last gives as the result R—2O—3Y—4b—W—W—4pe—3B—2v—P, where red, orange, yellow, lemon, white, peacock, blue, violet, and purple are denoted by the letters used as the sum of the additions He remarks "that the results obtained for the 3-colour and 4-colour theories do not agree with what is actually seen with a prism" We can well believe it! But why he confines the colours to be added up to the number of colours in the theory we are at a loss to understand. It may be taken for granted that in employing this method of proving a theory, that theory which annexes the greatest number of primary colours will give results which are closer to what is seen than even the 5-colour theory.

As to the experiments which are "new and important," there is no doubt that there is one which will prove to be highly important if it can be always repeated to give the same results under conditions which bear rigid examination The experiment is described as follows

"Very many years ago I showed experiments with rotating discs, which proved that 'persistence' does not (at any rate, wholly) take place in the way previously supposed, in the retina, or in the individual parts sensitive, as I maintain, variably sensitive, to light and colours In one of the experiments I refer to, a brightly coloured disc was covered by a black disc having sector shaped openings, such as to render the entire disc area half black and half coloured When the discs are rotated at a suitable speed, under a strong light, the entire rotating disc appears more brightly coloured than an entire disc placed near the rotating disc Thus, the colour effect of a disc, half of which is covered by black sectors, is by rotation made equal to or greater than that of an entirely uncovered disc of the same colour"

This one experiment would have caused a good deal of anxiety to those who have been at work at the general theory of vision had they known of it Fox Talbot, Plateau, and others would have had to amend their papers—for the "persistence of vision" would evidently not obey the law which they adopted after submitting it to such experimental proofs as they could devise Other experiments which the author brings forward as confirmatory of the 5 colour theory, it seems to the writer can be equally well explained by the 3-sensation theory, and probably by that of Hering

In conclusion, it seems safe to say that these two last rival theories have not been overthrown by the work under review Both have their weak points, but the number of them has not been increased by the exponent of the 5-colour theory

ELECTRICAL RULES AND TABLES.

A Pocket-book of Electrical Rules and Tables By John Munro, C E, and Andrew Jamieson, M I C E, F R S E, &c Eighth Edition, Revised and Enlarged (London Griffin and Co, 1892)

JUST eight years ago we reviewed the first edition of this electrical *vade mecum* The fact that we have now to notice the eighth edition is abundant proof that it has been found of service by the electrical public That it deserved well of those for whom it was compiled there can be no doubt The authors have been most active in collecting information from all sources, and in extending the work so as to keep the information contained in it fairly representative of the current state of industrial electricity. Since the first edition it has been almost doubled in size, and much very important matter has thereby been added

A special feature of the book as it now stands is the short accounts of various branches of electrical engineering which have been contributed by specialists Such are Dr Thompson's chapter on dynamo machinery, Mr Kapp's account of transformers, and Prof Ewing's sketch of magnetic measurements These are very valuable, and add much to the authoritative character of the work as a guide to engineers more especially concerned with electric lighting and transmission of power.

When the first edition appeared we noticed a number of points in which we thought the book required amendment Looking over the present edition, we have been struck with the very considerable improvement which has been effected in point of precision and accuracy But we have again met with some passages in which we fancy the work may be still further improved

First, on p 10, we were not able to see before, and we do not see yet, what the fact that the dimensions of resistance in electromagnetic units are those of velocity, has by itself to do with the velocity v, which is the ratio of the electromagnetic to the electrostatic unit of quantity of electricity

At p 15 it might have been well to mention the convergence of all the latest absolute determinations of the ohm upon something like 106 3 cms as the length of the column of mercury, representing it according to the usual specification

At p 42 definitions of the pound avoirdupois and standard kilogramme are given, in which the precise temperature and pressure of the atmosphere at which the weights of the standard lumps of platinum are a pound and a kilogramme respectively are carefully specified! We should like to know why there is not a reference to the hygrometric state of the atmosphere as well!

With regard to the statement with respect to density, at p 43, it is not usual, we think, to define density otherwise than as mass per unit of volume. It is therefore a quantity of dimensions ML^{-3}, whereas specific gravity is a mere numeric In cases in which specific gravity and density are numerically the same, there is still this essential difference in nature between the two quantities.

Of course, the same word *density* is used in a peculiar sense, frequently, when applied to gases, and our experience shows that nothing has a more confusing effect in the mind of an elementary student of physics and chemistry than this double use of the word It would be well to insist, as is often done by careful teachers, that it is *relative density* that is here meant, and not density in the ordinary sense

With respect to the velocity of sound in air (p 50) it might be as well to notice that it depends upon the temperature of the air

At p 127, under the heading "Impedance," impedance in its proper technical sense as $\sqrt{R^2 + n^2L^2}$ is not defined The definition is given elsewhere in the book, but there is no clue to it in the index In the last formula the exponential ϵ has fallen out from before its exponent Here we might remark that in a book of this kind, where space is of great importance, and especially with such lumbering exponents as $-\frac{RT}{L_r}$ the use of the *solidus* notation would be a great improvement

The authors will not think us inappreciative in making these remarks In a work dealing with such a multifarious set of topics it is difficult even in several editions to completely eliminate error, and we have made these notes (and some others) in case the authors may care to make use of them As we have said, the book is a useful and handy synopsis of electrical information of all kinds, and is very worthy to take the place which it seems is being accorded to it, of the electrical *Molesworth*.

G

THE MOTHS OF THE WORLD

A Synonymic Catalogue of Lepidoptera Heterocera (Moths) By W F Kirby, F L S, F E S, &c Vol I Sphinges and Bombyces (London Gurney and Jackson, 1892)

THE publication of the first volume of Mr Kirby's Catalogue of Heterocera cannot fail to be regarded as a great event amongst students of exotic moths, and should mark an epoch from which is to commence the great work of reducing the vast amount of material they have to deal with to some kind of system and order, from the state of chaos produced by the greater number of those who have taken up the subject continuing to describe innumerable species, forms, and varieties, without any systematic study or attempt to define the limits of the families and genera they placed them in So vast and scattered was the literature on the subject that it was almost hopeless to attempt to discover even how many species had been described in any given genus, or to say with any certainty that the forms to be dealt with had not been described by other authors, and if the subject in hand was the study of a local fauna, and not the monographing of a group, the only plan it was possible to adopt was to place the species in approximately the right genus and trust more or less to chance, according to the availability of large collections for consultation, that they had not been described elsewhere Students will now have no such excuse for inexact work, and, up to the end of the numerous and very remotely connected groups of families known as the Bombyces, will have a complete and easily consulted catalogue of all described species, with the localities they come from, so that they will be able to see at a glance to which species the forms they are trying to identify are most likely to belong, and having full references to the books in which they are described their labours will be lightened by almost half, as students of the European fauna who have had Staudinger's catalogue to help them will fully appreciate No one but Mr Kirby who has lived his life among the books on the subject, and has been collecting his materials for the last twenty years, as he tells us in his preface, could have made the catalogue as complete as he has done, and though it is of course impossible that such a volume could have been put together without a few errors and omissions creeping in, yet some months of work with the advantage of being constantly able to borrow the proof sheets has shown how extremely few these are

As the arrangement adopted is in the main that of the British Museum, or of some well known and approved works on special groups, and as there is also an index to the genera, there should be no real difficulty in finding the species required, and since the complete index to species and genera will take up one out of the five volumes required to complete the catalogue, it is obviously impossible that there should be a specific index to each volume It is to be hoped that Mr Kirby will be able to bring out the other volumes within the next two or three years, and will receive the support of all those interested in the subject This, indeed, he can hardly fail to do, as they will find themselves quite unable to get on without his catalogue when once accustomed to the use of it. The marking of the type of each genus by an asterisk is an addition of very great value, as compared to the catalogue of Rhopalocera by the same author, and the only serious fault to be found with the book is the upsetting of many well known names by the adoption of Hubnerian genera, and in especial those of the "Tentamen," a mere hand-list of names for that author's private use, and never published or intended to be published, and in accepting which Mr Kirby will find hardly a single lepidopterist to follow him Hubner's "Verzeichniss" stands on rather different grounds, but even that work is merely a childish collection of names, the species being classified into very heterogeneous groups solely by colour and pattern, and since the divisions which subsequent authors have been pleased to term his genera, though that name might equally well be applied to other of his sections, are neither defined nor the types indicated, it is placed out of Court according to the British Association rules, then again a few well-known generic names, such as *Cossus*, are upset as having previously been used in a specific sense If these principles were adopted and pushed to their logical conclusion every family of Rhopalocera would have to be re-named and innumerable other changes made, so that nomenclature would be vastly more confusing than it is even now, and the whole subject made unintelligible except to the few who had leisure to make a special study of it The classification adopted is in the main admirable, the *Castniidæ*, however, should perhaps be placed much lower in the scale, the *Uraniidæ* are rightly disassociated from the *Geometridæ*, of which they have hitherto been placed as a subfamily, but a better arrangement would have been to have included in the family the genus *Micronia* and allies, and to have placed it next to the *Epiplemidæ* (*Erosiidæ* auctorum) and the *Geometridæ*, but these are facts of very recent recognition The *Agaristidæ* again would come better next the *Noctuidæ*, from which they are hardly separable, and the *Syntomidæ*, which Mr Kirby calls the *Zygæninæ*, are more usually separated from the *Zygænidæ*, of which the *Chalcosiinæ* and *Thymarinæ* are considered sub-families Then again the *Lithosiinæ Nyctemerinæ* and the *Nycteolinæ* (here called *Cymbidæ*) are at most sub-families of the *Arctiidæ*, and the *Sphingidæ*, which are very rightly placed next the *Notodontidæ*, should have been preceded by a family composed of the genus *Eupterote* and allies which are still confounded with the *Lasiocampidæ*, a family with which they have little or nothing in common All these, however, are matters of very secondary importance, and the catalogue amply fulfils the one thing required of it that it should be as complete and the references as correct as possible

G F H

OUR BOOK SHELF

Grasses By C H. Johns, M A 96 pp (S.P.C K.)

THIS is a separately published appendix to the late Rev C. H. Johns's "Flowers of the Field" In its present handy form it will be acceptable to students who wish to study more minutely our common grasses.

The first three pages are devoted to general remarks on Order Gramineæ. On p 3 a list of the best fodder grasses of Europe is given; *Alopecurus pratensis*, a very valuable and generally useful grass, is omitted, whilst

Cynosurus cristatus is included. This latter species is of limited value, and in permanent pasture only.

Genera are given pp. 4-11, and the following fifty pages are occupied by an account of those species which have up to the present been found in Great Britain or Ireland. The rest of the book is devoted to the sedges. The derivations of the names of genera are mostly given, as well as the French and German synonyms of the different species discussed. The illustrations are satisfactory, and are in general given for those species which are most common. That of *Triticum repens*, on p. 32, is perhaps exceptional. The beginner very often confuses the spike of this grass with that of some varieties of rye-grass. The spikelets of the latter are set edgewise to the rachis whilst those of the former have their flat sides to the rachis; if the beginner is still in doubt the rootstock can be examined; this is stoloniferous in the case of couch-grass.

Elementary Plane Trigonometry. Clarendon Press Series. By R. C. J. Nixon, M.A. (Clarendon Press, Oxford, 1892.)

THE author in his preface informs us that in writing this book he has tried to free his mind as far as possible from all current text-books, and to base this one solely on his experience of twenty-five years. That he has done this is soon seen when glancing through the pages, for the order of arrangement and general basis differ very considerably from those usually adopted. The line of demarcation he draws between elementary and higher works lies in the use and non-use of the symbol $\sqrt{-1}$, thus avoiding here altogether the use of imaginaries. An omission which may seem rather questionable is that of the theory of logarithms, which is here excluded as it does not appertain to trigonometry proper; the beginner is not left entirely without logarithms themselves, for there are two chapters in which he can make a slight acquaintance with them, together with one on the adaptation of formulæ to logarithmic calculation. Throughout the work the author has made a strong point of giving in their fulness and generality all definitions and proofs, while he has added also numerous examples, some of which are worked out to serve as specimens, while others are accompanied with hints as to their solution.

If any fault be found in the book it is perhaps that it has been expanded to too great dimensions: excluding the answers at the end there are no less than 364 pages, which, for an elementary work of this kind, is undoubtedly a large number. At any rate the error is made on the right side. In all other respects the book can be decidedly recommended, for the propositions are all neatly proved, and the get-up, as regards the figures and letters, could scarcely be surpassed.

Paraguay: The Land and the People, Natural Wealth and Commercial Capabilities. By Dr. E. de Bourgade La Dardye. English Edition. Edited by E. G. Ravenstein. (London: George Philip and Son, 1892.)

EVERY one who has any reason to be interested in Paraguay ought to read this book, which is in most respects a model of what such a work ought to be. The author spent two years in the country, so that he had ample opportunities for making himself acquainted with its leading characteristics. His impressions, upon the whole, were very favourable, but there is not the faintest attempt to convey an exaggerated idea either of Paraguay's resources or of the use she is making of them. M. de Bourgade writes in a spirit of scientific impartiality, bringing out the facts exactly in accordance with what he believes to be the most trustworthy evidence. He begins with an account of the geographical exploration of the country, then presents a geological survey, and describes the basins of the Parana and the Paraguay, and Paraguay's vegetable and animal life and minerals. Next there are chapters on various aspects of social life—government, and laws, financial position, real property, population, and immigration. A section on "Labour" includes chapters on means of communication, the soil, stock-breeding, agricultural products, tobacco, timber, textile plants, various raw materials, yerba-maté, and the orange. On all these subjects the author writes clearly and with full information. The work is enriched with a map and illustrations, and of the translation we need only say that it has been done carefully and adequately.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Thunderstorms and Sunspots.

ABOUT six years ago Prof. von Bezold laid before the Bavarian Academy a memoir relating to lightning-flashes that had done damage to houses in Bavaria. In that kingdom the fire-insurance of buildings is entirely in the hands of the State, and a long series of statistical data on the subject was available.

Two things appeared from this inquiry—first, that those damaging lightning flashes had enormously increased in the last fifty years (to 1882), much more than the increase of houses; and second, that there was apparently some relation between the phenomena and the sunspot cycle. To each maximum of sunspots corresponded a minimum of damaging lightning flashes or thunderstorms (only in two cases one year displaced); but between each pair of minima was another secondary minimum not far from the minimum of sunspots. The curve of lightning damage, in fact, shows a double oscillation for each sunspot period, maxima of sunspots corresponding with the better defined of the two minima of lightning damage. A somewhat similar result had been arrived at by Prof. Fritz from a study of thunderstorms in the Indian Archipelago, but he considered it adverse to the idea of a causal relation between sunspots and thunderstorms.

In an earlier paper to the Bavarian Academy (1874), Prof. von Bezold, from a study of several thunderstorm records, came to the conclusion that "high temperatures and a spotless solar surface give years abounding in thunderstorms." This supposed relation between sunspots and thunderstorms does not seem to have attracted much attention of late years. The object of this note is chiefly to show some curves and figures from thunderstorm records, which, it appears to me, yield further evidence of the relation.

In the diagram herewith are two curves, one for Berlin from 1850, the other for Geneva from 1852. The numbers of days of observed thunder are taken and grouped in averages, each yearly point of the curve representing an average of five years. The vertical scale-figures are to the left. Below is an inverted sunspot curve, with scale-figures to the right. The upper points of the latter are minima, and it will be observed how maxima of the thunderstorm curves occur over them or nearly so; and similarly with sunspot maxima and minima of the other curves. There is not always exact coincidence, but a very considerable correspondence will be noticed. (I do not here reproduce the figures yielding those curves.)

It is to be regretted that the official Greenwich records do not, so far as I know, contain any tabulated series of figures relating to thunderstorms in a long course of years. From an examination of the *Greenwich Observations* and the *Weekly Return*, I am enabled to present a table of the number of days on which thunder was observed during the six months April to September in each year from 1850 to 1891. The actual figures are given in one column, and another column gives smoothed values (five year averages). In the curve made from these smooth values, we find maxima corresponding closely with the sunspot minima of 1856 and 1878, and it is now, apparently, near another pro-

nounced maximum which would correspond with the sunspot minimum of 1889 (I may mention that the number of thunder days this year is, thus far, small, and the smoothed curve seems likely to go down). The sunspot minimum of 1867 seems not to be represented in the curve.

Whether or not we may regard this curve as lending support to the view in question, it may at least prove interesting to observe how our summer thunderstorms have varied in number of late years. The Thunderstorm Committee of the Royal Meteorological Society have not yet, I understand, attacked the question of a possible relation to sunspots. May it not be said, however, that the field looks promising?

While some other Continental records of thunderstorms treated in the same way yield results similar to those for Berlin and Geneva, there are some which cannot be said to support the view under consideration (though also not positively against it). When one reflects on the unsatisfactory nature of many thunderstorm records extending over a long series of years, vitiated by such things as a change of observers, or of the mode of observation or of record, &c., this need hardly be thought surprising.

Year	Greenwich Days Thunder (Apr.–Sept.)	Smoothed Values	Year	Greenwich Days Thunder (Apr.–Sept.)	Smoothed Values
1850	8	—	1871	12	10.4
1851	9	—	1872	17	11.8
1852	11	9.0	1873	9	12.2
1853	11	10.2	1874	12	12.0
1854	9	10.4	1875	11	11.0
1855	11	10.6	1876	11	14.4
1856*	10	11.4	1877	12	14.6
1857	12	12.6*	1878*	26	17.2*
1858	15	12.2	1879	13	16.8
1859	15	12.4	1880	24	15.6
1860	9	11.2	1881	9	13.6
1861	11	9.4	1882	6	13.2
1862	6	7.8	1883	16	11.0
1863	6	8.6	1884	11	10.8
1864	7	7.6	1885	13	10.8
1865	13	9.0	1886	*8	11.4
1866	6	9.8	1887	6	13.8
1867*	13	9.4	1888	19	13.8
1868	10	8.6	1889*	23	16.2*
1869	5	9.8	1890	13	—
1870	9	10.6	1891	20	—

Minimum sunspots and maximum thunder days (smoothed values) indicated by an asterisk.

A. B. M.

The Nova Aurigæ.

THE Nova Aurigæ was observed on the night of September 14, with the Newall telescope, under favourable circumstances. It was almost exactly equal in brightness with the star 85″ nf., which of the two was brighter it was difficult to say, because of a peculiarity noted below, but its magnitude may be taken as close upon 10.3.

The spectrum, as seen with a compound prism between eye and eye piece, showed a very faint continuous spectrum, varying from C to F (or? G),

- a bright line quite, or nearly, coincident with C;
- three bright lines close together in the green, the least refrangible one seeming considerably broader than the others;
- a faint bright line in the blue (? F);

and with great difficulty I saw at times a still fainter line in the violet. I failed to make out that the bright lines had the dark companions seen in the spring. At first sight the spectrum seemed to consist of a single broad bright line in the green.

With a power of 215 (without spectroscope) I at first thought that the Nova was diffuse, and resembled a minute planetary nebula rather than a star; but on focussing more carefully, I made out that the Nova was distinctly stellar; now, however, the neighbouring stars resembled planetary nebulæ. In fact the Nova and neighbouring stars could not be focussed simultaneously. With a power 500 the effect was of course more marked. The Nova owes its visual magnitude nearly entirely to the light that gives rise to the three green lines in the spectrum, and it is interesting to note that it was possible to verify a conclusion drawn from this fact and from the nature of the chromatic dispersion of a refractor of 29 feet focal length:—the image of the Nova was distinctly more point-like than that of the neighbouring equally bright star, when each in turn was focussed as carefully as possible. H. F. NEWALL

Ferndene, Gateshead-on-Tyne.

Atmospheric Depressions and their Analogy with the Movements of Sunspots.

A SOMEWHAT prolonged absence from home has prevented me seeing until now your note on July 21, page 280, in which the writer remarks that the results of M. Camille Flammarion—published in the July number of *L'Astronomie*—"seem to confirm the view suggested by M. Faye that the constitution of [sun] spots resembles somewhat that of the cyclones with which we are familiar."

I write to point out that this is not the theory of M. Faye, but, on the contrary, is the theory of Mr. Herbert Spencer, which he published in the *Reader* for February 25, 1865, and which has since been republished in his collected essays under the title, "The Constitution of the Sun." In it Mr. Spencer first points out the untenability of M. Faye's hypothesis, and then goes on to say:—"The explanation of the solar spots above suggested, which was originally propounded in opposition to that of M. Faye, was eventually adopted by him in place of his own. In the *Comptes Rendus* for 1867, vol. lxiv., p. 404, he refers to the article in the *Reader*, partly reproduced above, and speaks of me as having been replied to in a previous note. Again, in the *Comptes Rendus* for 1872, vol. lxxv., p. 1664, he recognizes the inadequacy of his hypothesis, saying:—'Il est certain que l'objection de M. Spencer, reproduit et développée par M. Kirchoff, est fondée jusqu'à un certain point; l'intérieur des taches, si ce sont des lacunes dans la photosphère, doit être froid relativement. . . Il est donc impossible qu'elles proviennent d'éruptions ascendantes.' He then proceeds to set forth the hypothesis that the spots are caused by the precipitation of vapour in the interiors of cyclones. But though, as above shown, he refers to the objection made in the foregoing essay to his original hypothesis, and recognizes its cogency, he does not say that the hypothesis which he thereupon substitutes is also to be found in the foregoing essay. Nor does he intimate this in the elaborate paper on the subject read before the French Association for the Advancement of Science, and published in the *Revue Scientifique* for March 24, 1883. The result is that the hypothesis is now currently ascribed to him. I should add that, while M. Faye ascribes solar spots to clouds formed within cyclones, we differ concerning the nature of the cloud. I have argued that it is

formed by rarefaction, and consequent refrigeration, of the metallic gases constituting the stratum in which the cyclone exists He argues that it is formed within the mass of cooled hydrogen drawn from the chromosphere into the vortex of the cyclone Speaking of the cyclones, he says —'Dans leur embouchure evasee ils entraîneront l'hydrogène froid de la chromosphère, produisant partout sur leur trajet vertical un abaissement notable de température et une obscurité relative, due à l'opacite de l'hydrogène froid englouti' (*Revue Scientifique*, March 24, 1883) Considering the intense cold required to reduce hydrogen to the 'critical point,' it is a strong supposition that the motion given to it by fluid friction on entering the vortex of the cyclone, can produce a rotation, rarefaction, and cooling, great enough to produce precipitation in a region so intensely heated" —(*Essays*, 1891 Edition, vol 1, pp 188-9)

Churchfield, Edgbaston F. Howard Collins

Direct Determination of the Gravitative Constant by Means of a Tuning-fork A Lecture-Experiment

The following direct experiment for finding the value of the constant g has proved an instructive one for use with students beginning dynamics, and combines extreme simplicity with greater accuracy than might be anticipated

A rectangular strip of thick plate-glass with one face lightly smoked is dropped past the end of a sounding tuning fork of known pitch, and which, by means of a light attached style, traces on the smoked surface a fine rippling line whose undulations give a complete record of the relative motion From measurements of such a trace the value of g can be determined immediately with an error of not more than ½ per cent

For let l_1 and l_2 be the distances fallen through in two equal consecutive intervals of time (t) Then $\frac{l_1}{t}$ and $\frac{l_2}{t}$ are the velocities at the middles of these two intervals, and $\frac{l_2-l_1}{t}$ is therefore the velocity gained in time t, and $\frac{l_2-l_1}{t^2}$ is the acceleration

With a fork giving 384 complete oscillations per second it was found convenient to take for t the time of 30 oscillations, l_1 is then the length of any 30 consecutive waves and l_2 that of the next 30 These lengths were measured by means of a millimetre scale printed on card and held against the trace, tenths of a millimetre being estimated The value of the difference ($l_2 - l_1$) was thus determined from several measures made in different parts of the trace, and, after some preliminary trials, it was found that such measures seldom differed by more than ½ per cent from their mean, and that the means of different traces agreed about equally well among themselves Under the given conditions ($l_2 - l_1$) is just under 6 centimetres The experiment takes only a moment to perform, and the plate can be at once exhibited as a lantern slide.

In order to obtain good traces a little care must be exercised The smoking should be very light A fine bristle from a clothes- or hearth-brush, 2 to 4 cm long, stuck on with a scrap of wax, may be used as a style, and it should be inclined downwards so as to make an angle of 45° or less with the vertical face of the plate and project well under the plate before this is let fall, so as to be considerably bent while tracing By furnishing each prong with such a bristle two simultaneous tracings are obtained. Although the method is independent of the actual velocity with which the plate reaches the style, yet it is best to let the plate fall from quite close above the end of the style (within, say, 1 cm.), so that as many wave-lengths as possible may be marked on the plate The fork also should be strongly bowed with a violin bow, so as to give sharply accentuated ripples, the positions of whose crests are defined with greater precision than would be those of gentler undulations The plate itself can be conveniently let go if the upper part of its suspension is a single string with a knot at the top, and to prevent its swinging in the air or turning as it descends, it may be held against a narrow smooth backing of hard wood Without these precautions the trace is liable to show curvature and other irregularities, and indeed under any circumstances the first one or two undulations traced near the advancing edge of the plate are liable to be irregular. The more massive the plate the less is its motion affected by the pressure of the tracing style

Although as a means of finding the value of g such a method does not compare for accuracy with the use of a pendulum, yet for the converse process of determining the pitch of a fork from measures of its trace and the known value of g, it may be of utility, for, since the length ($l_2 - l_1$) is proportional to the *square* of the vibration number, the percentage error will now be halved or reduced to about 1 in 400, and I have little doubt that a careful experimenter, by attending to the causes of error, might further improve on this A M Worthington

R N E College, Devonport, September 12

A Meteor

On Wednesday, September 14, at 7h 9m p m a large meteor was seen by about twenty people, including myself, who were driving from Penmaenmawr to Conway It was first observed in the south-east just above the Conway mountain It was visible for about 30°, fell very slowly in a wavy line inclined at a small angle to the horizon, disappearing behind the mountain. It seemed to be very near the ground as it passed over the mountain.

The sky was quite bright, so that only Mars was clearly visible in it The meteor appeared to the eye about the size and brightness of Jupiter at the present time, and was of a slightly bluer tint than that planet There was no perceptible variation in size and brilliance while the meteor was in sight

September 19 Grace E Chisholm

Crater-like Depression in Glaciers.

A propos de la cavité du glacier de Tête Rousse que M Vallot et moi avons découverte et dont vous parlez dans Nature (September 1), M R von Lendenfeld vous écrit (Nature, September 15) qu'il a trouvé des dépressions cratériformes sur le glacier de Tasman, dans la Nouvelle Zélande Permettez-moi de vous signaler que de pareilles dépressions existent sur certains glaciers des Alpes et notamment sur le glacier de Gorner, où la carte suisse en indique 26 Elles sont en général à peu près circulaires, leur plus grande dimension horizontale atteint parfois 130 mètres et leur profondeur 30 mètres L'inclinaison de leurs parois varie en général de 45° à la verticale Elles reçoivent souvent de l'eau qui s'engouffre au fond dans un moulin ou qui s'écoule, par une crevasse, dans une dépression voisine Au mois d'août dernier, l'une d'elles formait un véritable petit lac glaciaire que j'ai sondé avec M Etienne Ritter au moyen d'un bateau démontable, la profondeur de l'eau était presque partout de 5 à 6 mètres, sauf dans un trou, vraisemblablement un moulin, où ma sonde est descendue jusqu'à 21 mètres Il est probable que, lorsque la pression de l'eau aura élargi le moulin par où elle s'écoule, la cavité se videra.

Les dépressions ne me paraissent avoir aucune analogie avec la cavité que j'ai vue à Tete Rousse Leur origine est assez mal connue (voir Heim, "Gletscherkunde," p 246), il est possible, comme le pensait primitivement votre honorable correspondant, qu'elles soient d'anciens moulins transformés

J'en ai vu une également sur la Mer de Glace, entre le Montanvers et le Tacul

L'étude de ces dépressions, encore très incomplète, serait très intéressante, et je les signale à l'attention de ceux qui parcourent les glaciers

Veuillez agréer, monsieur, mes civilités empressées

Thonon, le 17 Septembre André Delebecque.

GENERALIZATION OF "MERCATOR'S" PROJECTION PERFORMED BY AID OF ELECTRICAL INSTRUMENTS

The following mode of generalizing Mercator's Projection is merely an illustration of a communication to Section A of the British Association at its recent meeting in Edinburgh, entitled "Reduction of every Problem of Two Freedoms in Conservative Dynamics to the Drawing of Geodetic Lines on a Surface of given Specific Curvature" An abstract of this paper appeared in Nature for August 18

In 1568, Gerhard Krämer, commonly known as "Mercator" (the Latin of his surname), gave to the world

his chart, now of universal use in navigation In it every island, every bay, every cape, every coast-line, if not extending over more than two or three degrees of longitude, or farther north and south than a distance equal to two or three degrees of longitude, is shown very approximately in its true shape rigorously so if it extends over distances equal only to an infinitesimal difference of longitude The angle between any two intersecting lines on the surface of the globe is reproduced rigorously without change in the corresponding angle on the chart

Mercator's chart may be imagined as being made by coating the whole surface of a globe with a thin inextensible sheet of matter—sheet india-rubber for example (for simplicity, however, imagined to be perfectly extensible but inelastic)— cutting away two polar circles to be omitted from the chart, cutting the sheet through along a meridian, that of 180° longitude from Greenwich for example, stretching the sheet everywhere except along the equator so as to make all the circles of latitude equal in length to the circumference of the equator, and stretching the sheet in the direction of the meridian in the same ratio as the ratio in which the circles of latitude are stretched, while keeping at right angles the intersections between the meridians and the parallels The sheet thus altered may be laid out flat or rolled up, as a paper chart

What I call a generalized Mercator's chart for a body of any shape spherical or non-spherical, is a flat sheet showing for any intersecting lines that can be drawn on a part of the surface of the body, corresponding lines which intersect at the same angles One Mercator chart of finite dimensions can only represent a part of the complete surface of a finite body, if the body be simply continuous; that is to say, if it has no hole or tunnel through it The whole surface of an anchor ring can obviously be mercatorized on one chart It is easily seen, for the case of the globe, that two charts suffice to mercatorize the whole surface, and it will be proved presently that three charts suffice for any simply continuous closed surface, however extremely it may deviate from the spherical form

In "Liouville's Journal" for 1847, its editor, Liouville, gave an analytical investigation, according to which, if the equation of any surface whatever is given, a set of lines drawn on it can be found to fulfil the condition that the surface can be divided into infinitesimal squares by these lines and the set of lines on the surface which cut them at right angles Now it is clear that if we have any portion of a curved surface thus divided into infinitesimal square allotments, that is to say, divided into infinitesimal squares, with the corners of four squares together, all through it, we can alter all these squares to one size and lay them down on a flat surface with each in contact with its four original neighbours; and thus the supposed portion of surface is mercatorized Except for the case of a figure of revolution, or an ellipsoid, or virtually equivalent cases, Liouville's differential equations are of a very intractable kind I have only recently noticed that we can solve the problem graphically (with any accuracy desired if the problem were a practical problem, which it is not) by aid of a voltmeter and a voltaic battery, or other means of producing electric currents, as follows —

1 Construct the surface to be mercatorized in thin sheet metal of uniform thickness throughout By thin I mean that the thickness is to be a small fraction of the smallest radius of curvature of any part of the surface

2 Choose any two points of the surface, N, S, and apply the electrodes of a battery to it at these points

3 By aid of movable electrodes of the voltmeter, trace an equipotential line, E, as close as may be around one electrode, and another equipotential line, F, as near as may be around the other electrode. Between these two equipotentials, E, F, trace a large number, n, of equidifferent equipotentials Divide any one of the equipotentials into n equal parts, and through the divisional points draw lines cutting the whole series of equipotentials at right angles. These transverse lines and the equipotentials divide the whole surface between E and F into infinitesimal squares (Maxwell, "Electricity and Magnetism," § 651)

4 Alter all the squares to one size and place them together, as explained above Thus we have a Mercator chart of the whole surface between E and F

N and S of our generalization correspond to the north and south poles of Mercator's chart of the world, and our generalized rule shows that a chart fulfilling the essential principle of similarity realized by Mercator may be constructed for a spherical surface by choosing for N, S any two points not necessarily the poles at the extremities of a diameter If the points N, S are infinitely near one another, the resulting Mercator chart for the case of a spherical surface, is the stereographic projection of the surface on the tangent plane at the opposite end of the diameter through the point, C, midway between N and S In this case the equipotentials and the stream-lines are circles on the spherical surface cutting N S at right angles, and touching it, respectively

For a spherical or any other surface we may mercatorize any rectangular portion of it, A B C D, bounded by four curves, AB, BC, CD, DA, cutting one another at right angles as follows Cut this part out of the complete metallic sheet, to two of its opposite edges, A B, D C, for instance, fix infinitely conductive borders Apply the electrodes of a voltaic battery to these borders, and trace n equidifferent equipotential lines between AB and DC Divide any one of these equipotentials into n equal parts, and through the divisional points draw curves cutting perpendicularly the whole series of equipotentials These curves and the equipotentials divide the whole area into infinitesimal squares Equalize the squares and lay them together on the flat as above

If we have no mathematical instruments by which we can draw a system of curves at right angles to a system already drawn, we may dispense with mathematical instruments altogether, and complete the problem of dividing into squares by electrical instruments as follows Remove the conducting borders from AB, DC, apply infinitely conductive borders to AD and BC, apply electrodes to these conducting borders, and as before draw n equidifferent equipotentials This second set of equipotentials, and the first set, divide the whole area into squares

KELVIN

THE ACTIVE ALBUMEN IN PLANTS [1]

ONE of the most important chemical functions of plant-cells is that synthesis of albuminous matter which serves for the formation of protoplasm The *living* protoplasm, however, is composed of proteids entirely different from the ordinary soluble proteids, as well as from the proteids of *dead* protoplasm In other words, if living protoplasm dies, the albuminous constituents change their chemical character We observe that in the living state a faculty of autoxidation (respiration) exists, which is wanting in the dead condition; and Pfluger, in 1875, drew from this the conclusion that in protoplasm the chemical constitution of the living proteids changes at the moment of death.

Various other considerations force us to accept this logical conclusion Chemical changes readily occur in all those organic compounds that are of a *labile* character There exist so-called labile atom constellations that are in lively motion, and are thus prone to undergo change, the atoms falling into new arrangements which

[1] This paper was read before the Liège meeting of the International Congress of Physiologists, of whose proceedings we gave some account last week

present more stable constellations[1] We do not doubt that *vital force is a mode of motion* due to the presence of atoms in labile positions in the albuminous substance The motion ceases when there occurs a migration of the labile atoms to some stable position The aldehydes give us fine illustrations of labile combinations and stable rearrangements in other allied substances

The question now arises, can we chemically demonstrate that the albuminous substance formed by synthesis in plants is—*even before it has become protoplasm*—different from ordinary albumen? It was known long ago that the juice of plants—that is the aqueous solution in the vacuoles of the cells—contains albumen, but it was thought to be ordinary albumen It is easy to prove that this is not the case[2]

On treating living plant cells with dilute solutions of ammonia or organic bases or their salts, remarkable changes are observed These consist either in the formation of numerous minute granules as is the case on the application of most of the bases, or in the production of little globules flowing together to make relatively large drops of a substance of high refractory power, as is the case on the application of weak bases like caffein or antipyrin[3] These latter two bases in weak solution do not injuriously affect the protoplasm itself, since the cells will keep alive for a number of days in a 0 5 per cent solution of these bases, the cells are, however, soon killed by other bases and their salts The granules and globules formed in the living cells by the action of caffein have been called by Bokorny and myself *Proteosomes* They give the principal reactions of albuminous bodies, but contain in most cases an admixture of small quantities of lecithin and tannin These admixtures, however, can be removed by cultivating the objects (the alga, Spirogyra, for instance) in solutions rich in nitrates If now by such cultivation the tannin has been removed and the proteosomes then produced by treatment with caffein, we can observe that these albuminous proteosomes are capable of reducing silver from even highly diluted alkaline solutions This property is lost after treatment with dilute acids as well as after the death of the cells[4] In these cases the proteosomes become hollow and turbid, their substance appearing to coagulate and shrink

There are thus experimental grounds for the conclusion that not only the organized albumen of the living protoplasm, but also the albumen dissolved in the vacuoles—the unorganized albumen—is a different substance from the ordinary albumen, which is present in dead cells We may sum up the line of argument as follows —

I. Bases act upon the albumen of living cells, not, however, upon that of dead cells, nor upon ordinary dissolved albumen

II The action may be observed microscopically to take place in the case of various vegetable objects in the liquid portion of the protoplasm itself as well as in the vacuoles. This can be specially well observed with the alga Spirogyra when treated with caffein

III. The granules and globules into which the active albumen aggregates by the action of bases—called by us proteosomes—have the property of reducing dilute silver solutions in the absence of light, and lose this property by the action of acids

IV The active albumen in its most *unchanged* condition can be made visible by caffein or antipyrin, two bases that do not act as serious poisons to the cells. Living cells containing proteosomes, brought out by caffein when placed in distilled water regain their original condition, the proteosomes become gradually dissolved again (rapidly at 25° C), and a new application of caffein will now make them reappear

V If proteosomes are produced by caffein or antipyrin, and the death of the cells is then caused by ether vapour, &c, it may be easily observed that soon after the death of the protoplasm the proteosomes of the vacuoles are also changed in their optical and chemical properties, they become turbid and hollow, they coagulate, and they lose their property of being resoluble in distilled water

O LOEW

[1] Many examples can be cited from organic chemistry; for instance, the rapid change of the diamidoaceton as soon as it is liberated from its salts (Berichte d Deutschen Chem. Ges. 25, 1563) Compare also the article, "Chemical Motions," Biolog Centralblatt ix N 16

[2] O Loew und Th. Bokorny, Biolog Centralblatt xi 1

[3] These globules closely resemble the aggregated masses that Darwin observed after irritation of leaves of Drosera.

[4] The proteosomes produced by ammonia and various other bases preserve this property for a much longer time after the death of the cell than those produced by caffein or antipyrin.

DISCOVERY OF A FIFTH SATELLITE TO JUPITER

IN January of the year 1610 Galileo, at Padua, in Italy, discovered four satellites revolving round Jupiter, and though more than 282 years elapsed in the interval, from that time to August, 1892, no additional satellites were detected near this planet, and astronomers naturally inferred that no others existed The fact that Jupiter possessed four satellites has become familiar to every schoolboy, for it has been repeated in all the astronomical text-books published during nearly three centuries Few people therefore could have imagined that the statement would ever be controverted or rendered untenable by new discoveries In regard to the more distant planets Uranus and Neptune, there was every prospect of additional satellites being detected, but with Jupiter the circumstances were somewhat different The four satellites were so bright and so palpably visible in very small telescopes that it was scarcely thought possible that another existed small enough to remain unseen Moreover, there was a significant agreement in the relatively increasing numbers of the satellites surrounding the planets Mars, Jupiter, and Saturn Mars was known to have two satellites, Jupiter four, and Saturn eight, the number doubling itself with each step outward from the sun, and it was considered probable that the harmony of the series would not be disturbed

Now, however, the astronomical world has been excited by the announcement that a new satellite has been discovered in attendance on Jupiter, and that its distance from the centre of the planet is 112,400 miles, and its period of revolution 17 hours 36 minutes The discovery was effected by Prof. Barnard, of the Lick Observatory on Mount Hamilton in California, and, as he has already proved himself a very acute observer, especially of comets, and as he has the occasional use of what is supposed to be the most powerful telescope hitherto constructed, there is no good reason to discredit the intelligence

People will be obviously led to ask how this new satellite managed to evade detection during nearly three centuries of diligent telescopic research. How was it that one at least of the host of observers who have studied this plane and his circling moons by means of powerful glasses, did not sight the tiny orb which has now revealed itself to the watchful American astronomer? We imagine that the chief reason for this want of success is to be found in the fact that the new orb is not brighter than the thirteenth magnitude, and that, being situated close to its primary, it would therefore, in ordinary instruments, be quite obliterated in the surrounding glare. But it is perhaps rather singular that it was not detected by its shadow, which would be projected on the disc of Jupiter whenever the satellite passed between the planet and the earth, and this would be of daily occurrence. At such a time the shadow would appear as a small, black, circular spot moving rapidly from east to west across the disc, and with greater apparent velocity than the visible

markings And it is quite possible that the shadow has been observed on more than one occasion, but mistaken for an ordinary spot on the surface of Jupiter

A curious fact in connection with the new satellite is its diminutive size as compared with the four others discovered by Galileo in 1610 But there is a similar disparity in the dimensions of the satellites of Saturn, and in proof of this we have only to compare the bright *Titan* with the excessively faint *Mimas* and *Hyperion* Small as it is, however, it is certain that this new satellite of Jupiter is much larger than either of the two abnormally minute moons of Mars

American astronomers are to be congratulated on this important discovery Scientific activity in the United States has been rapidly developing in recent years, and this has been strikingly exemplified in the wide and attractive domain of astronomy W F DENNING

NOTES

THE French Association for the Advancement of Science is holding at Pau its twenty-first annual meeting The meeting began on Saturday last, when the members of the Association were cordially welcomed to Pau by the Mayor The President, M Collignon, delivered an address on the science and art of the engineer

THE autumn meetings of the Iron and Steel Institute, under the presidency of Sir Frederick Abel, began at St George's Hall, Liverpool, on Tuesday At the opening meeting the President announced that the Council had elected Mr Windsor Richards as his successor

WE are glad to announce that a new Biological Laboratory is about to be established in the Calcutta Zoological Gardens Babu Joy Gobinda Law, a member of one of the wealthy native families of Bengal, has offered R 15,000 for the buildings and fittings of this institution The primary object for which the Laboratory is founded is to investigate the action of snake-poison, and to discover, if possible, an antidote The Laboratory will, however, also be used for anatomical and pathological researches, for which the rich material afforded by the animals in the gardens will be available

THE Marine Biological Laboratory at Wood Hole, U S, has been more successful this summer than in any previous year During its season of work it had a corps of seventeen officers, instructors, and assistants, and an attendance of thirty eight investigators and sixty-two elementary students

WITH the designation of the Hopkins Seaside Laboratory, a marine biological laboratory has been established at Pacific Grove, California We learn from the *Botanical Gazette* that, through the generosity of the Pacific Improvement Company, a piece of land has been furnished, and a sum granted sufficient to erect a plain frame building, and, by the liberality of Mr Timothy Hopkins, provision is made for the equipment of the building, and for the further continuation and extension of the enterprise An elementary course of lectures on marine botany was to be given during the present season

THE weather during the past week was very fine and bright over the southern and eastern portions of the United Kingdom, until near the close of the period, when the type entirely changed, and thunderstorms, accompanied by heavy rain, occurred generally, but in the north and west the conditions were throughout far less settled. Cyclonic disturbances arrived on our coasts from the Atlantic with considerable frequency, and although they were for the most part slight and shallow, and unaccompanied by much wind, they were productive of a considerable quantity of rain. An important disturbance passed to the north of Scotland on Thursday night and during Friday, and was accompanied by strong gales on our north-west and north coasts Temperatures were high for the season over the greater part of England, and on Monday the day readings in places were higher than at any time during the month, the shade thermometer registering 72° in London Some nights, however, were exceptionally cold, the shade minimum between Saturday and Sunday falling to within one degree of the freezing point in the eastern part of England, while there was a sharp frost on the ground open to the sky The *Weekly Weather Report*, issued on the 17th inst, shows that the rainfall exceeded the mean in the north and west of Scotland and in the north of Ireland In all the other parts of the United Kingdom there was a deficit, in most of the English districts the fall was very slight

THE Report of the Meteorological Commission for the year 1891 states that complete, or nearly complete, meteorological observations have been received from forty nine stations, and that observations of rainfall have been furnished from 320 stations, the instruments are usually supplied by the Commission The Report contains diagrams showing the mean monthly rainfall corrected to date at thirty-three stations, together with the abnormal falls in the years 1888 and 1891 The rainfall in 1891 has been excessive, especially over the eastern part of the colony and over the Orange Free State, where at some places it exceeded 12 inches above the average The observer at Phillipolis states that hardly a farmer in that district but has lost one-third of his sheep, owing to the continued wet, and in some places the farmers have had to vacate their homes in consequence of the weather.

THE "Pilot Chart of the North Atlantic Ocean" for September contains tracks of the drift of the two parts of the derelict ship *Fred B Taylor*, which was cut in two by a collision on June 22, in lat 40° 19' N, long 68° 33' W The forward and after parts separated, and drifted in entirely different directions, in a manner which is quite unprecedented in the history of ship-wrecks The after end was evidently influenced more by wind than the bow portion, the latter pursued a south westerly course, which was attributable largely to the cold southerly current between the American coast and the Gulf Stream, and on August 26 had drifted to lat 38° 40', long 73° 15' The stern part took a direct northerly course until July 17, when it was ten miles north west of Matinicus Island, whence it took a westerly course, and was cast ashore on August 7 on Wells Beach, near Cape Porpoise

THE first annual convention of the American Association of State Weather Services was held at Rochester, N.Y, on August 15 and 16, in conjunction with the meeting of the American Association for the Advancement of Science, and was largely attended by representatives of the various States The subject of thermometer exposure was discussed, and a committee was appointed to consider the most suitable form of shelter and manner of exposure to be adopted throughout the country It was resolved that means should be deduced from self-registering instruments wherever practicable, in preference to the method of using eye observations. An interesting paper was read by W L Moore, of Wisconsin, on the forecasting of thunderstorms, and the question of the best methods of signalling weather forecasts, whether by flags, semaphores, spherical bodies hoisted on a staff, &c., was freely discussed, and a committee was appointed to report upon the subject at an early date. It was decided that each State service should have a separate exhibit at the World's Fair at Chicago, and not to have the exhibits collected in the building for the use of the United States Weather Bureau.

LAST year an Aino in the western part of the island of Yezo caught two bears, one of which was perfectly white This

capture created much excitement among the natives, as their chief god is a white bear, and he is supposed to dwell on an inaccessible mountain in the interior of the island, and never to let himself be seen by human beings The Ainos, therefore, concluded that the young white bear was a sort of Messiah, and after long consideration they decided that he ought to be sent as a present to the Mikado In due time he arrived at Tokio, and by the Mikado's orders he was received into the Zoological Garden Here the animal soon became ill, and Herr J L Janson was requested to do what he could for it Fortunately his treatment of it was successful At first he thought the creature must be a polar bear, but he soon convinced himself that this was a mistake, and that it was in reality an albino In the latest number of the "Mittheilungen der Deutschen Gesellschaft fur Natur- und Volkerkunde Ostasiens in Tokio," Herr Janson gives a full account of the bear, and he adds some interesting facts as to the importance attributed to white animals generally, and especially to albinos, in Japan The appearance of an albino is supposed to be a good omen for the reigning monarch The reign of a sovereign may even be known by the name of a white animal Thus the reign of one ancient Mikado is called "Hakuchi nenkan," the period of the white pheasant That of another is "Haku hōō nenkan," the period of the white phœnix The white fox is often mentioned in fables and temple-stories, and a white serpent always appears in pictures and plastic representations with Benten, the goddess of fortune As in former times among the Greeks, Romans, Persians, and Scythians, so among the Japanese, horses dedicated to the gods were generally white, and white horses are still found in connection with all the larger temples, and take part in the great annual processions The milk and butter derived from white cows were formerly held in high esteem as medicine

MR. F W. WARD, formerly editor of the *Sydney Daily Telegraph*, has sent to the Agricultural Department of New South Wales a report on recent shipments of fruit from Cape Colony to London The report is printed in the July number of the *Agricultural Gazette of New South Wales*, which recommends it as "worthy of careful perusal" The *Gazette* refers to the fact that good fruit growing districts abound in Australia, and that no better fruit can be grown in South Africa than is now being produced in many districts of New South Wales The chief mistake hitherto, it says, has been the growing of unsuitable varieties—unsuitable not alone for export, but even for ordinary home use It adds that this defect is being rapidly remedied, and that many growers, who have gained experience by their own efforts, are settling down to the work with intelligent earnestness.

WRITING of wild strawberries in Ceylon, Mr Nock says in the *Ceylon Observer* that the species *Fragaria vesca*, which grows so luxuriantly and fruits so abundantly in Jamaica, is now growing wild in many places in the Nuwara Eliya district If the soil in Ceylon were as good as it is in the Blue Mountains of Jamaica, and there was less Nilu (*Strobilanthes*), this strawberry would soon, he thinks, be as plentiful in the hill districts of Ceylon as it is there When Mr Nock was Superintendent of the Government Cinchona Plantation in Jamaica, he has given as many as twenty free tickets in one day to old women and children to gather strawberries among the Cinchona Plantations He has known them gathered by the bushel, and carried twenty-two miles to the Kingston market, where they always commanded a good price. He adds that he has this year raised seedlings of six of the best English varieties, to which he intends to give a fair trial in the Nuwara Eliya district.

THE University of Minnesota has begun the publication of a *Quarterly Bulletin*, under the management of a board of editors. The chief editor being Prof Conway M'Millan, the professor of botany to the University, is a guarantee that the interests of science will not be neglected in the *Bulletin*, and the first number contains several items of information of interest to American botanists

IN the report of the Royal Botanic Garden, Calcutta, for the year 1891–92, it is shown that the year was one of great activity as regards outdoor operations The abnormally dry season proved very trying to many exotics, and, though for a time all other work was suspended and the whole garden staff was employed only in watering plants, many casualties occurred, especially among the finer and rarer plants The attention of the staff was as usual largely directed to the cultivation and distribution of plants of economic interest The chief event of the year under this head was the introduction of the aloe, which yields "sisal hemp" (*Agave rigida*, var *sisalana*) The Director of the Royal Gardens, Kew, in June 1891, kindly obtained a consignment of plants for the Calcutta Garden from Florida, and kept these at Kew till they were strong enough to stand the voyage to Calcutta. The boxes reached Calcutta on October 29, 1891, unfortunately a considerable percentage of the plants died on the way out, and it was necessary to nurse the survivors carefully before they could be distributed Over 19,000 specimens were contributed to the Herbarium during the year from various sources, while the distribution of authentically-named specimens to other herbaria reached the high total of 10,505 sheets The chief benefactor to the Calcutta Herbarium was again the Royal Herbarium, Kew, to the Director of which institution the Calcutta one "owes a debt that can never be repaid" Among other contributors was Baron von Mueller, who again sent a beautiful collection of Australian plants. The Herbarium was also greatly enriched by further accessions of Tibetan, Chinese, and Mexican specimens, and the Saharanpur Herbarium presented 954 plants from the north west Himalaya. Dr Prain visited the Andaman Islands, Mount Parashak, and the Khasia, and was thus enabled to add valuable collections Much good work was also done by collectors employed by the Calcutta Garden

IN the second number of the *Journal of the Polynesian Society* Dr A Carroll, of Sydney, offers what he believes to be translations of some of the famous Easter Island inscriptions He is of opinion that Easter Island was at one time occupied by a pre Polynesian people from America, and that to them the inscriptions are to be attributed "While engaged in studying the languages, histories, antiquities, and inscriptions of ancient American peoples," he says, "I came upon similarities to the Easter Island characters, &c, with these as keys, discovered what certain groups expressed, and from these, proceeding upon the recognized methods of decipherment, succeeded in reading into the original languages, and from these translating into English these Easter Island inscriptions" This is very vague, and, until Dr Carroll gives some more definite information as to his methods, his claim that "another ancient writing is deciphered" will seem somewhat extravagant. Among the other contents of the number are an interesting account of some stone implements from the Chatham Islands, by Mr S. Percy Smith, and the first part of a history of the occupation of the Chatham Islands by the Maoris in 1835, by Mr A. Shand. Mr Shand's information has been derived from the Maoris themselves, many of those who supplied it having taken part in the transactions they described

MR WILLIAM KENT, writing in *Science* on the American Association for the Advancement of Science, complains that it does not adequately represent the scientific movement in the United States. He points out that while more than 2000 members attended the Edinburgh meeting of the British Association,

there were not 500 members at the Rochester meeting of the American Association, and of this number New York State contributed far more than its quota In proportion to its population, Ohio sent twice as many members as Pennsylvania, although its average distance from Rochester is greater Moreover, the several branches of science are not equally represented Mechanical and engineering science, which is developing in the country by leaps and bounds, sends to the Association only one fourth as many members as chemistry, and one-eighth as many as biology The physical sciences, Mr Kent says, are "dwarfed by the natural sciences" This he attributes to the fact that those who devote themselves to applied science have so many societies of their own that they are diverted from and lose their interest in the American Association In engineering there are four large national societies, the civil, the mechanical, the mining, and the electrical, besides numerous local societies, aggregating a membership of probably 5000 persons, not counting duplications of those who belong to two or more societies

A MOVEMENT has been started in Melbourne for the passing of a law which may tend to prevent the wanton destruction of birds in Victoria A deputation, organized by the Victoria Field Naturalists' Club and representing the Melbourne Royal Society, Royal Agricultural Society, Royal Horticultural Society, and Zoological and Acclimatization Society lately brought the subject under the notice of the Minister of Customs In introducing the deputation, Messrs G D Carter and J Bosisto dwelt upon the necessity of protecting insectivorous birds from the reckless and indiscriminate shooting which is now so prevalent, as well as human lives, which are frequently sacrificed to the inexperience of sportsmen The imposition of a gun tax as a legitimate source of revenue was also suggested Prof Kernot (Royal Society), Mr. C M Officer (Zoological Society), and Mr C Draper (Royal Agricultural Society) also emphasized these views Mr F Wisewould referred to the draft which had been drawn up by the sub committee of the Field Naturalists' Club—a draft based upon similar Acts in England and some of the Australian colonies A few new features had, however, been added, notably that which made it illegal for persons under the influence of liquor to carry firearms It was also provided that under no circumstances should a licence be given for the use of swivel guns In answer to the deputation the Minister said that he would take the draft bill which had been prepared into favourable consideration He would have an amended draft drawn up and submitted to those interested before its introduction into Parliament He was of opinion that a 5*s* tax, as proposed, was not heavy enough, since it would be worth the while of those who let out guns to pay the tax themselves

THE serum of blood used to be regarded as merely a nutritive liquid, but it has been found to play a more important part, being capable of killing disease germs, and of destroying and dissolving the red blood corpuscles of other animals These properties have been recently studied by Herr Buchner (*Munchener Med. Wochenschrift*) They are gradually lost when the liquid has been removed from the animal They are also destroyed by heating half-an-hour to 52° to 55° C (A dog's serum stops the amœba-like movements of white-corpuscles of another animal species without killing them, but this property is also lost by heating to 55°) Light also stops both actions, and diffuse daylight more than direct sunlight It is apparently albumens in the serum that are operative, but whether all the albuminoid constituents, or certain specific albumens, was not determined It is remarkable that solution of the serum with a 0·7 per cent solution of common salt does not spoil the action, whereas a similar dilution with pure water makes the serum nearly inactive But serum thus made inactive with water recovers its properties if salt solution is added, and this is the case even when the serum has been kept in the active state for four to 24 hours in ice Serum may also receive a 0 7 per cent solution of potassium or lithium chloride, or various other salts of the fixed alkalis, without losing its germicide properties Ammonium salts even stimulate the latter Herr Buchner calls the albumens in question alexines (or protective matters), he supposes they have a like action on foreign cells generally. The serum of dogs and rabbits having been mixed, the power of both alexines was weakened, but those of the rabbit more than those of the dog (to typhus bacilli) After acting some time on each other the globulicide power was quite extinguished The author finds in these facts an explanation of the antitoxical action of the serum of animals protected against disease

ACCORDING to the *Revista Financiera Mexicana*, quoted in the current number of the *Board of Trade Journal*, a deposit of onyx of considerable importance has just been discovered in Mexico, about 50 kilometres south of El Paso It is said to be of superior quality, with fine grain, and richly shaded with delicate and varied tints Blocks of considerable dimensions can be easily extracted

DR MORRIS GIBBS writes to *Science* from Kalamazoo, Michigan, that in that State there are to his knowledge six species of birds which feed on acorns Of these, the passenger-pigeon and mourning-dove swallow the acorn entire, with its shell intact, only removing the cup or rough outside covering. The white-bellied nut-hatch occasionally hoards the acorns away, and only draws on its store after some months, and when the firm shelly covering readily gives way to its sharp, prying bill The other three are the well-known blue jay, common crow-blackbird, and red headed woodpecker So far as he has been able to learn, these birds, except in rare instances, do not pick the acorns from the tree, but have to content themselves with the fallen fruit. The red head, deigning to descend to the ground, seizes an acorn, and flying with it in its bill to a spot where there is a small cavity in the dead portion of a trunk, or to a crevice in the bark, immediately begins to hammer it with its sharp-pointed bill In a couple of strokes, it has removed the outer shell or cup, and at once attacks the still green-coloured shell which directly surrounds the meat The inside, or shell proper, quickly gives way, usually nearly in halves, and the woodpecker enjoys the kernel The woodpeckers are as nearly strict insect-feeders as any birds in Michigan, unless an exception is made of the swifts and swallows, yet here is an instance of a varied diet However, the red-head is quickly satisfied in the acorn line, and soon begins circling the trunk, or more often limbs, for his legitimate food The blackbird confines himself to the ground in his efforts for acorn meats Walking up sedately to an acorn, and making no effort to seize or confine it, it strikes savagely and almost aimlessly Its bill frequently glances, and the splintered shell dances about, until at last a huge piece of the kernel is dragged out, after which the bird leaves for other quarters or begins on another acorn The jay swoops down with flaunting blue wings, and, seizing the largest acorn on the ground, flies to the nearest convenient limb or to the decayed ridge-board of an adjacent building There, firmly pressing the nut between his big, black feet, he hammers away with a vengeance, and quickly tears off nearly half of the shell, after which he proceeds to pick out the meat in small bits The cup is often left nearly perfect, the jay never making an effort to secure the nut entire, which he could easily do. Walking under the oaks, one can readily tell whether the woodpeckers, blackbirds, or jays have been at work among the acorns, by the appearance of the mutilated shell-remains lying about.

THE following arrangements have been made for science lectures at the Royal Victoria Hall during October —October 4, Sir John Lubbock on "Books" After the address he will present the prizes and certificates gained by students of the M M College, Prof. Foxwell in the chair October 11, Mr C T Dent (late President of the Alpine Club), on "The Alps in Winter" October 18, Mr F W Rudler, on "Frost and Fire," with special reference to the flood at St Gervais, and the eruption of Etna October 25, Col Swinhoe on "Some Curiosities in Nature"

LAST week we noted that Messrs Macmillan and Co had issued a new edition of "Arithmetic for Schools" This is the well-known work by Mr Barnard Smith The book has been revised and enlarged by Prof W H H Hudson

MESSRS GAUTHIER-VILLARS have issued "Bulles de Savon," a translation, by C E Guillaume, of Mr Boys' little work on "Soap Bubbles" The translator, while reproducing the main features of the book, has, with the author's sanction, adapted it for the use of French readers He has also incorporated an account of some new experiments which Mr Boys has brought to his notice

THE first number of a new German journal, which promises to be of considerable interest to non professional students of science, has just been issued in Berlin, the publisher being R Oppenheim It is entitled *Natur und Haus*, and is edited by L Staby and M Hesdorffer The articles are written in a popular style, and well illustrated

THE additions to the Zoological Society's Gardens during the past week include a Mona Monkey (*Cercopithecus mona* ♀) from West Africa, presented by Col Makins, a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mrs Palmer, a Vulpine Squirrel (*Sciurus vulpina* ♂) from North America, presented by the Hon G Carew, a Malayan Tapir (*Tapirus indicus* ♂) from Malacca, presented by Col J M Jenkins, a Great Eagle Owl (*Bubo maximus*), European, presented by Commander Ernest Rason, R N, a Black-crested Cardinal (*Gubernatrix cristatella*) from South America, presented by the Rev W B K Frances, a Small Hill Mynah (*Gracula religiosa*) from India, presented by Mr George Grigs, a Long nosed Crocodile (*Crocodilus cataphractus*) from the River Juba, East Africa, presented by Capt. F G Dunbar, R N, two —— Tortoises (*Testudo* ——), five Cinixys (*Cinixys* ——), a Puff Adder (*Vipera arietans*) from East Africa, presented by Mr D Wilson, a Pig-tailed Monkey (*Macacus nemestrinus* ♂) from Java, a White backed Piping Crow (*Gymnorhina leuconota*) from Australia, an Adorned Terrapin (*Clemmys ornata*) from North America, a Robben Island Snake (*Coronella phocarum*) from South Africa, deposited, a Red Kangaroo (*Macropus rufus* ♀), a Black-fronted Weaver Bird (*Hypotriorchis velatus*) bred in the gardens

OUR ASTRONOMICAL COLUMN

PROPOSED SCHOOL OF PRACTICAL ASTRONOMY —Mr H C Russell, Government Astronomer of New South Wales, in a paper read before the Royal Society of Tasmania, makes some very practicable, and what we think excellent, suggestions with respect to the disposal of the sum of money (£10,000) left by the late Mr Leake for the foundation of a school of astronomy The idea is for the Leake trustees to co operate with the University of Tasmania, and in this way form a complete school in which both the theory and practice of astronomy should be dealt with simultaneously In addition to the observatory being merely a school for students, Mr Russell suggests that it should take up some special line of research, and proposes that of astronomical photography This seems an excellent proposition. The work which such an observatory as this could do if thoroughly equipped with the necessary apparatus, would be very considerable, and the special advantages of climate and position, to say nothing of the unexplored state of the southern heavens, would soon render it of great importance There is no doubt that we are not yet overburdened with a surplus of observatories in the southern hemisphere, for even now there is a doubt as to how the international photographic chart of the heavens shall be provided for in this region, three observatories which have undertaken the work having been unable to carry out their plans on account of the political troubles Should this proposal be accepted, the new Leake Observatory will start under good auspices, as it will fill up a gap by taking in hand a share of the greatest modern astronomical enterprise

DOUBLE STAR MEASURES —Mr S W Burnham, in *Astronomische Nachrichten*, Nos 3113-14, gives a list of all the double star measures that he has made during the year 1891 with the 36-inch of the Lick Observatory Most of the stars here included may be classed as difficult objects, being too close for any smaller aperture, and all of them more or less unequal As Mr Burnham tells us, many of the stars are taken from his own catalogues, it being rather important to measure them at this time, since several are in very rapid motion Owing to the fact that some of these stars have not been measured since the time of their discovery, it is interesting to note the changes that have taken place Observations of these have "shown some very remarkable changes, and have shown the existence of some of the most remarkable binary systems known" Measurements have also been made of some of the closest and most difficult binaries from the discoveries of Clark, Struve, and others The epoch for the star places is as heretofore 1880

COMET BROOKS (1882, AUGUST 27) —From *Edinburgh Circular*, No 31, we make the following extract of the elements and ephemeris relating to the comet discovered by Mr Brooks at Geneva on the 27th The computations are based on four observations made between August 31 and September 5 —

Elements

$$T = 1892 \text{ Dec } 19\ 727 \text{ M T Berlin}$$

$$\left.\begin{aligned}\omega &= 269^\circ\ 24'\ 27''\\ \Omega &= 261\ \ 2\ 55\\ i &= \ 27\ 57\ \ 8\end{aligned}\right\}\text{Mean Equator, 1892 0}$$

$$\text{Log } q = 9\ 84455$$

Ephemeris for Berlin Midnight

1892	R A. h m s	Decl ° ′	log Δ	log r	Br.
Sept 21	7 2 13	+28 41 6	0 2342	0 2458	2 5
23	7 8 13	28 14 5			
25	7 14 21	27 45 0	0 2105	0 2315	3 0
27	7 20 37	27 13 1			
29	7 27 2	26 38 6	0 1860	0 2166	3 6

The brightness at the time of discovery is taken, as usual, as the unit of Br

NOVA AURIGÆ —Some short notes with regard to Nova Aurigæ are communicated to *Astronomische Nachrichten*, No 3114, which may be of interest here —On Sept 3, Dr F. Ristenpart, of the Observatory in Karlsruhe, with a 6 inch refractor, by comparing the Nova with the brightness of an accompanying star, estimates the Nova as of the 9 65 magnitude of the Bonn scale. Herr Cand F Kroeger observed the Nova on three different occasions—Sept 3, 4, and 6 Comparing it with a neighbouring star of the 9 5m (Star—Nova = + 3s 5 + 1′ 2), the Nova was found to be about "a degree dimmer than the comparison star" On Sept 4 the seeing was much better, and the Nova was about "two degrees brighter than the comparison star" On the third occasion, with excellent definition, the comparison star and the Nova were of equal brightness. These observations are all made between 12h. and 12h. 30m Kiel mean time. Prof E E Barnard has also made a very interesting observation with the 36 inch of the Lick Observatory, finding that the Nova appeared as a small, bright nebula, with a *star like nucleus* of the 10th magnitude The nebulosity, as he says, "was pretty, bright, and dense, and was 3″ in diameter Surrounding this was a fainter glow, perhaps half a minute in diameter" If this observation can be verified, it will assuredly strengthen very considerably the hypothesis that the Nova was caused by collisions of meteorites, in the same way as the stars in the Pleiades nebula are the loci of intersecting streams, as clearly shown by Mr. Roberts' wonderful photographs

ABERRATION PROBLEMS[1]

EVERYBODY knows that to shoot a bird on the wing you must aim in front of it Every one will readily admit that to hit a squatting rabbit from a moving train you must aim behind it.

These are examples of what may be called "aberration" from the sender's point of view, from the point of view of the source And the aberration, or needful divergence between the point aimed at and the thing hit, has opposite sign in the two cases—the case when receiver is moving, and the case when source is moving Hence, if both be moving, it is possible for the two aberrations to neutralize each other So to hit a rabbit running alongside the train, you must aim straight at it

If there were no air that is all simple enough But every rifleman knows to his cost that though he fixes both himself and his target tightly to the ground, so as to destroy all aberration proper, yet a current of air is very competent to introduce a kind of spurious aberration of its own, which may be called windage, and that he must not aim at the target if he wants to hit it, but must aim a little in the eye of the wind

So much from the shooter's point of view Now attend to the point of view of the target

Consider it made of soft enough material to be completely penetrated by the bullet, leaving a longish hole wherever struck A person behind the target, whom we may call a marker, by applying his eye to the hole immediately after a hit, may be able to look through it at the shooter, and thereby to spot the successful man I know that this is not precisely the function of an ordinary marker, but it is more complete than his ordinary function All he does usually is to signal an impersonal hit, someone else has to record the identity of the shooter I am rather assuming a volley of shots, and that the marker has to allocate the hits to their respective sources by means of the holes made in the target

Well, will he do it correctly? assuming, of course, that he can do so if everything is stationary, and ignoring all curvature of path, whether vertical or horizontal curvature If you think it over you will perceive that a wind will not prevent his doing it correctly, the line of hole will point to the shooter along the path of his bullet, though it will not point along his line of aim Also, if the shots are fired from a moving ship, the line of hole in a stationary target will point to the position the gun occupied at the instant the shot was fired, though it may have moved since then In neither of these cases (moving medium and moving source) will there be any aberration error

But if the *target* is in motion, on an armoured train for instance, then the marker will be at fault The hole will not point to the man who fired the shot, but to an individual ahead of him The source will appear to be displaced in the direction of the observer's motion This is common aberration It is the simplest thing in the world The easiest illustration of it is that when you run through a vertical shower, you tilt your umbrella forward, or, if you have not got one, the drops hit you in the face, more accurately, your face as you run forward hits the drops. So the shower appears to come from a cloud ahead of you, instead of from one overhead

We have thus three motions to consider, that of the source, of the receiver, and of the medium, and of these only motion of receiver is able to cause an aberrational error in fixing the position of the source.

So far we have attended to the case of projectiles, with the object of leading up to light. But light does not consist of projectiles, it consists of waves, and with waves matters are a little different Waves crawl through a medium at their own definite pace; they cannot be *flung* forwards or sideways by a moving source, they do not move by reason of an initial momentum which they are gradually expending, as shots do, their motion is more analogous to that of a bird or other self-propelling animal than it is to that of a shot The motion of a wave in a moving medium may be likened to that of a rowing boat on a river It crawls forward with the water, and it drifts with the water, its resultant motion is compounded of the two, but it has nothing to do with the motion of its source A shot from a passing steamer retains the motion of the steamer as well as that given it by the powder It is projected therefore in a slant direction. A boat lowered from the side of a passing steamer, and rowing off, retains none of the motion of its source, it is not projected, it is self-propelled That is like the case of a wave.

[1] A lecture on "The Motion of the Ether near the Earth," by Dr. Oliver Lodge, at the Royal Institution, Friday evening, April 1, 1892.

The diagram illustrates the difference Fig 1 shows a moving cannon or machine gun, moving with the arrow, and firing a succession of shots which share the motion of the cannon as well as their own, and so travel slant The shot fired from position 1 has reached A, that fired from the position 2 has reached B, and that fired from position 3 has reached C by the time the fourth shot is fired at D The line ABCD is a prolongation of the axis of the gun, it is the line of aim, but it is not the line of fire, all the shots are travelling aslant this line, as shown by the arrows There are thus two directions to be distinguished There is the row of successive shots, and there is the path of any one shot. These two directions enclose an angle It may be called an aberration angle, because it is due to the motion of the source, but it need not give rise to any aberration True direction may still be perceived from the point of view of the receiver Attend to the target The first shot is supposed to be entering at A, and if the target is stationary will leave it at Y A marker looking along YA will see the position whence the shot was fired This may be likened to a stationary observer looking at a moving star He sees it where and as it was when the light

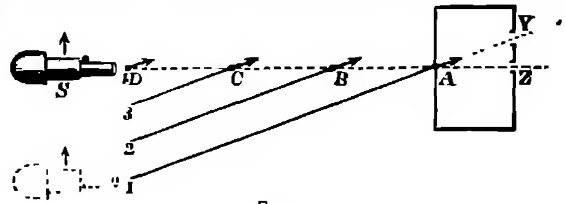


FIG 1

started on its long journey He does not see its present position, but there is no reason why he should He does not see its physical state or anything as it is now There is no aberration caused by motion of source

But now let the receiver be moving at same pace as the gun, as when two grappled ships are firing into each other The motion of the target carries the point Y forward, and the shot A leaves it at Z, because Z is carried to where Y was. So in that case the marker looking along ZA will see the gun, not as it was when firing, but as it is at the present moment, and he will see likewise the row of shots making straight for him This is like an observer looking at a terrestrial object Motion of the earth does not disturb ordinary vision

Fig 2 shows as nearly the same sort of thing as possible for the case of emitted waves The tube is a source emitting a succession of disturbances without momentum ABCD may be thought of as horizontally flying birds, or as crests of waves, or

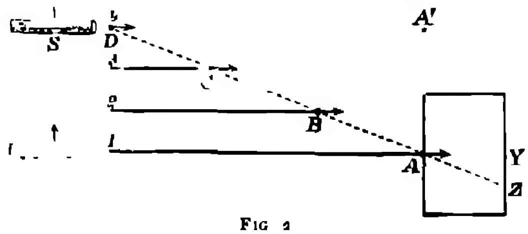


FIG 2

they may even be thought of as bullets, if the gun stands still every time it fires, and only moves between whiles

The line ABCD is now neither the line of fire nor the line of aim it is simply the locus of disturbances emitted from the successive positions 1 2 3 4

A stationary target will be penetrated in the direction AY, and this line will point out the correct position of the source when the received disturbance started. If the target moves, a disturbance entering at A may leave it at Z, or at any other point according to its rate of motion, the line ZA does not point to the source, and so there will be aberration when the target moves Otherwise there would be none.

Now Fig 2 also represents a parallel beam of light travelling from a moving source, and entering a telescope or the eye of an observer. The beam lies along ABCD, but this is not the direction of vision The direction of vision to a stationary observer is determined not by the locus of successive waves, but by the path of each wave A ray may be defined as the path of a labelled disturbance. The line of vision is YA1, and coincides with the line of aim, which in the projectile case (Fig 1) it did not.

The case of a revolving lighthouse, emitting long parallel beams of light and brandishing them rapidly round, is rather interesting Fig. 3 may assist the thinking out of this case Successive disturbances A, B, C, D, lie along a spiral curve, the spiral of Archimedes, and this is the shape of the beams as seen illuminating the dust particles, though the pitch of the spiral is too gigantic to be distinguished from a straight line At first sight it might seem as if an eye looking along those curved beams would see the lighthouse slightly out of its true position, but it is not so The true rays or actual paths of each disturbance are truly radial, they do not coincide with the apparent beam An eye looking at the source will not look tangentially along the beam, but will look along AS, and will see the source in its true position It would be otherwise for the case of projectiles from a revolving turret

Thus, neither translation of star nor rotation of sun can affect direction There is no aberration so long as the receiver is stationary.

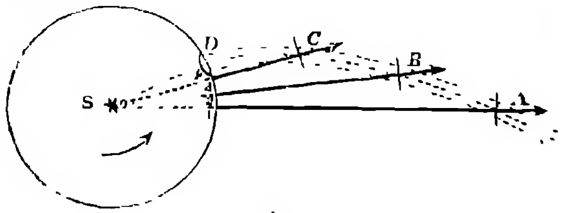


FIG 1

But what about a wind, or streaming of the medium past source and receiver, both stationary? Look at Fig 1 again Suppose a row of stationary cannon firing shots, which get blown by a cross wind along the slant IAY (neglecting the curvature of path which would really exist) still the hole in the target fixes the gun's true position, the marker looking along YA sees the gun which fired the shot There is no true deviation from the point of view of the receiver, although the shots are blown aside and the target is not hit by the particular gun aimed at it With a moving cannon, combined with an opposing wind, Fig 1 would become very like Fig 2

(N B —The actual case, even without complication of spinning, &c, but merely with the curved path caused by steady wind-pressure, is not so simple, and there would really be an aberration or apparent displacement of the source towards the wind's eye an apparent exaggeration of the effect of wind as shown in the diagram)

In Fig 2 the result of a wind is much the same, though the details are rather different The medium is supposed to be drift-

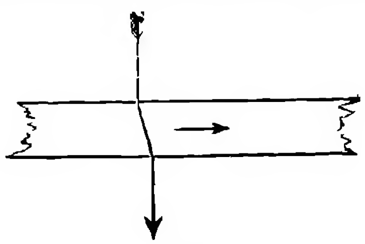


FIG 4

ing down across the field opposite to the arrows The source is stationary at S The arrows show the direction of waves *in the medium*, the dotted slant line shows their resultant direction A wave centre drifts from D to I in the same time as the disturbance reaches A, travelling down the slant line DA The angle between dotted and full lines is the angle between ray and wave movement Now, *if the motion of the medium inside the receiver is the same as it is outside*, the wave will pass straight on along the slant to Z, and the true direction of the source is fixed. But if the medium inside the target or telescope is stationary, the wave will cease to drift as soon as it gets inside, under cover as it were; it will proceed along the path it has been really pursuing *in the medium* all the time, and make its exit at Y. In this latter case, of different motion of the medium inside and outside the telescope, the apparent direction, such as YA, is not the true direction of the source *The ray is in fact bent where it enters the differently-moving medium* (as shown in Fig 4)

A slower moving stratum bends an oblique ray (slanting with the motion) in the same direction as a denser medium does A quicker stratum bends it oppositely If a medium is both denser and quicker moving, it is possible for the two bendings to be equal and opposite, and thus for a ray to go on straight. Parenthetically I may say that this is precisely what happens, on Fresnel's theory, down the axis of a water-filled telescope exposed to the general terrestrial ether drift

In a moving medium waves do not advance in their normal direction, they advance slantways The direction of their advance is properly called a ray The ray does not coincide with the wave-normal in a moving medium

All this is well shown in fig 5

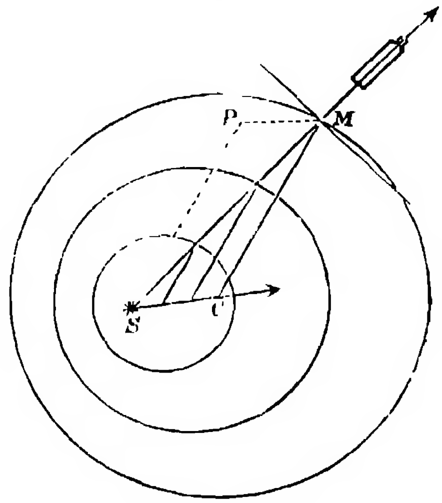


FIG 5

S is a stationary source emitting successive waves, which drift as spheres to the right The wave which has reached M has its centre at C, and CM is its normal, but the disturbance, M, has really travelled along SM, which is therefore the ray It has advanced as a wave from S to P, and has drifted from P to M Disturbances subsequently emitted are found along the ray, precisely as in Fig 2 A stationary telescope receiving the light will point straight at S A mirror, M, intended to reflect the light straight back must be set normal to the ray, not tangential to the wave front

The diagram also equally represents the case of a moving source in a stationary medium The source, starting at C, has

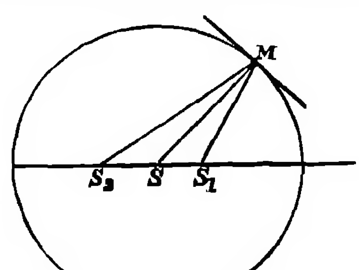


FIG 6

moved to S, emitting waves as it went, which waves as emitted spread out as simple spheres from the then position of source as centre Wave-normal and ray now coincide SM is not a ray, but only the locus of successive disturbances A stationary telescope will look not at S, but along MC to the point where the source was when it emitted the wave M; a moving telescope, if moving at same rate as source, will look at S Hence SM is sometimes called the *apparent* ray The angle SMC is the aberration angle.

Fig. 6 shows normal reflection for the case of a moving source.

The mirror M reflects light received from S_1 to a point S_2, just in time to catch the source there, as it travels steadily to the left.

Parenthetically I may say that the time taken on the double journey, S_1MS_2, is not quite the same as the double journey SMS when all is stationary, and that this is the principle of Michelson's great experiment referred to below.

For the rest of the lecture I am going to call the medium which conveys light, "ether" simply. Every one knows that ether is the light conveying medium, however little else they know about the properties of that tremendously important material.

We have arrived at this: that a uniform ether stream all through space causes no aberration, no error in fixing direction. It blows the waves along, but it does not disturb the line of vision.

Stellar aberration exists, but it depends on motion of observer, and on motion of observer only. Etherial motion has no effect upon it, and when the observer is stationary with respect to object, as he is when using a terrestrial telescope, there is no aberration at all.

Surveying operations are not rendered the least inaccurate by the existence of a universal etherial drift, and they therefore afford no means of detecting it.

But observe that everything depends on the etherial motion being uniform everywhere, inside as well as outside the telescope, and along the whole path of the ray. If stationary anywhere it must be stationary altogether. There must be no boundary between stationary and moving ether, no plane of slip, no quicker motion even in some regions than in others. For (referring back to the remarks preceding Fig. 4) if the ether in receiver is stagnant while outside it is moving, a wave which has advanced and drifted as far as the telescope will cease to drift as soon as it gets inside, but will advance simply along the wave normal; and in general at the boundary of any such change of motion a ray will be bent, and an observer looking along the ray will see the source not in its true position, not even in the apparent position appropriate to his own motion, but lagging behind that position.

Such an aberration as this, a lag or negative aberration, has never yet been observed; but if there is any slip between layers of ether, if the earth carries any ether with it, or if the ether being in motion at all is not equally in motion everywhere throughout every transparent substance, then such a lag or negative aberration must occur in precise proportion to the amount of the carriage of ether by moving bodies.

On the other hand, if the ether behaves as a perfectly frictionless inviscid fluid, or if for any other reason there is no rub between it and moving matter, so that the earth carries no ether with it at all, then all rays will be straight, aberration will have its simple and well-known value, and we shall be living in a virtual ether stream of 19 miles a second, by reason of the orbital motion of the earth.

It may be difficult to imagine that a great mass like the earth can rush at this tremendous pace through a medium without disturbing it. It is not possible for an ordinary sphere in an ordinary fluid. At the surface of such a sphere there is a viscous drag, and a spinning motion diffuses out thence through the fluid so that the energy of the moving body is gradually dissipated. The persistence of terrestrial and planetary motions shows that etherial viscosity, if existent, is small; or at least that the amount of energy thus got rid of is a very small fraction of the whole. But there is nothing to show that an appreciable layer of ether may not adhere to the earth and travel with it, even though the force acting on it be but small.

This, then, is the question before us:—

Does the earth drag some ether with it? or does it slip through the ether with perfect freedom? (never mind the earth's atmosphere: the part it plays is not important).

In other words, Is the ether wholly or partially stagnant[1] near the earth, or is it streaming past us with the opposite of the full terrestrial velocity of nineteen miles a second? Surely if we are living in an ether stream of this rapidity we ought to be able to detect some evidence of its existence.

It is not so easy a thing to detect as you would imagine. We have seen that it produces no deviation or error in direction. Neither does it cause any change of colour or Doppler effect; that is, no shift of lines in spectrum. No steady wind can affect pitch, simply because it cannot blow waves to your ear more quickly than they are emitted. It hurries them along, but it lengthens them in the same proportion, and the result is that they arrive at the proper frequency. The precise effects of motion on pitch are summarized in the following table:—

Changes of Frequency due to Motion.

Source approaching shortens waves.
Receiver approaching alters relative velocity.
Medium flowing alters both wave-length and velocity in exactly compensatory manner.

What other phenomena may possibly result from motion? Here is a list:—

Phenomena resulting from Motion.

(1) Change or apparent change in direction; observed by telescope, and called aberration.

(2) Change or apparent change in frequency; observed by spectroscope, and called Doppler effect.

(3) Change or apparent change in time of journey; observed by lag of phase or shift of interference fringes.

(4) Change or apparent change in intensity; observed by energy received by thermopile.

Motion of either source or receiver can alter frequency, motion of receiver can alter apparent direction, motion of the medium can do neither; but surely it can hurry a wave so as to make it arrive out of phase with another wave arriving by a different path, and thus produce or modify interference effects.

Or again it may carry the waves down stream more plentifully than up stream, and thus act on a pair of thermopiles, arranged fore and aft at equal distances from a source, with unequal intensity.

And again, perhaps the laws of reflection and refraction in a moving medium are not the same as they are if it be at rest. Then, moreover, there is double refraction, colours of thin plates and thick plates, polarization angle, rotation of the plane of polarization; all sorts of optical phenomena.

It may be, perhaps, that in empty space the effect of an ether drift is difficult to detect, but will not the presence of dense matter make it easier? Consider No. 3 of the phenomena tabulated above.

I expect that everyone here understands interference, but I may just briefly say that two similar sets of waves "interfere" whenever and wherever the crests of one set coincide with and obliterate the troughs of the other set. Light advances in any given direction when crests in that direction are able to remain crests, and troughs to remain troughs. But if we contrive to split a beam of light into two halves, to send them round by different paths, and make them meet again, there is no guarantee that crest will meet crest and trough trough; it may be just the other way in some places, and wherever that opposition of phase occurs there there will be local obliteration or "interference." Two reunited half beams of light may thus produce local stripes of darkness, and these stripes are called interference bands.

If I can I will produce actual interference of light on the screen, but the experiment is a difficult one to make visible at a distance, partly because the stripes or bands of darkness are usually very narrow. I have not seen it attempted before. [Very visible bands were formed on screen by three mirrors, one of them semi-transparent, arranged as in Fig. 7.]

Now a most interesting and important, and I think now well-known, experiment of Fizeau proves quite simply and definitely that if light be sent along a stream of water, travelling inside the water as a transparent medium, it will go quicker with the current than against it. You may say that is only natural; a wind helps sound along one way and retards it the opposite way. Yes, but then sound travels in air, and wind is a bodily transfer of air; hence, of course, it gives the sound a ride; whereas light does not really travel in water, but always in ether. It is by no means obvious whether a stream of water can help or hinder it. Experiment decides, however, and answers in the affirmative. It helps it along with just about half the speed of the water; not with the whole speed, which is curious and important, and really means that the moving water has no effect whatever on the ether of space, though it would take too long to make clear how this comes about. Suffice for present purposes the fact that the velocity of light inside moving water, and therefore pre-

[1] The word "stationary" is ambiguous. I propose to use "stagnant," as meaning stationary with respect to the earth, *i.e.* as opposed to stationary in space.

sumably inside all transparent matter, is altered by motion of that matter

Does not this fact afford an easy way of detecting a motion of the earth through the ether? Here on the table is water travelling along 19 miles a second Send a beam of light through it one way and it will be hurried, its velocity, instead

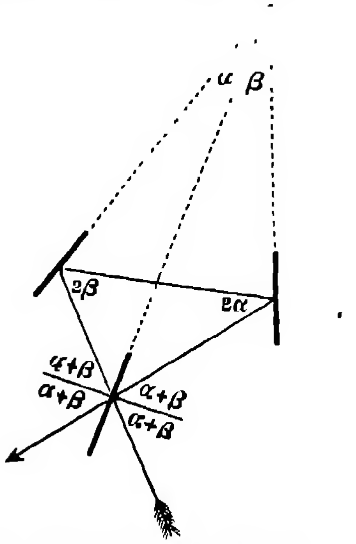


FIG 7 —Plan of interference kaleidoscope

of being 140,000 miles a second, will be 140,009 miles Send a beam of light the other way, and its velocity will be 139,991, just as much less Bring these two beams together, surely some of their wave lengths will interfere M Hoek, Astronomer at Utrecht, tried the experiment in this very form, here is a diagram of his apparatus (Fig 8) Babinet had tried another

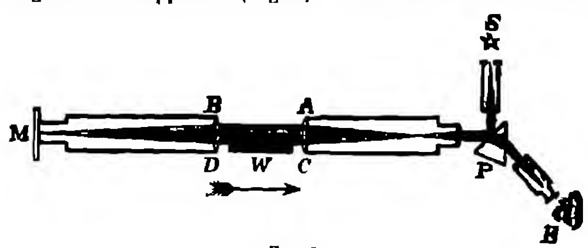


FIG 8

form of the experiment previously Hoek expected to see interference bands, from the two half-beams which had traversed the water, one in the direction of the earth's motion and the other against it But no interference bands were seen The experiment gave a negative result

An experiment, however, in which nothing is seen is never a

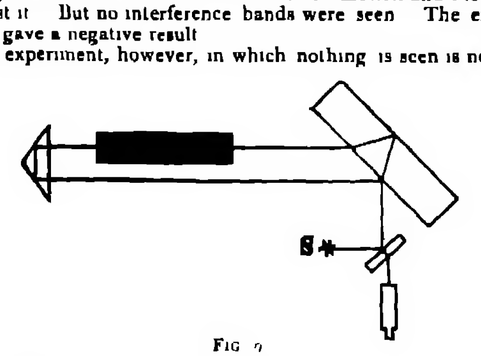


FIG 9

very satisfactory form of a negative experiment, it is, as Mascart calls it, "doubly negative," and we require some guarantee that the condition was right for seeing what might really have been in some sort there Hence Mascart and Jamin's modification of the experiment is preferable (Fig 9). The thing now looked for is a shift of already existing interference bands, when the above apparatus is turned so as to have different aspects with respect to the earth's motion, but no shift was seen

Interference methods all fail to display any trace of relative motion between earth and ether

Try other phenomena then Try refraction The index of refraction of glass is known to depend on the ratio of the speed of light outside, to the speed inside, the glass If then the ether be streaming through glass, the velocity of light will be different inside it according as it travels with the stream or against it, and so the index of refraction will be different Arago was the first to try this experiment, by placing an achromatic prism in front of a telescope on a mural circle, and observing the deviation it produced on stars

Observe that it was an *achromatic* prism, treating all wavelengths alike, he looked at the *deviated* image of a star, not at its *dispersed* image or spectrum, else he might have detected the change-of-frequency effect due to motion of source or receiver first actually seen by Dr Huggins I do not think he would have seen it, because I do not suppose his arrangements were delicate enough for that very small effect, but there is no error in the conception of his experiment, as Prof Mascart has inadvertently suggested there was

Then Maxwell repeated the attempt in a much more powerful manner, a method which could have detected a very minute effect indeed, and Mascart has also repeated it in a simple form All are absolutely negative

Well, what about aberration? If one looks through a moving stratum, say a spinning glass disk, there ought to be a shift caused by the motion (see Fig 4) The experiment has not been tried, but I entertain no doubt about its result, though a high speed and considerable thickness of glass or other medium is necessary to produce even a microscopic apparent displacement of objects seen through it

But the speed of the earth is available, and the whole length of a telescope tube may be filled with water, surely that is enough to displace rays of light appreciably

Sir Geo Airy tried it at Greenwich on a star, with an appropriate zenith sector full of water Stars were seen through the water telescope precisely as through an air telescope A negative result again

Stellar observations, however, are unnecessarily difficult Fresnel had said that a terrestrial source of light would do just as well He had also (being a man of exceeding genius) predicted that nothing would happen. Hoek has now tried it in a perfect manner and nothing did happen

Since then Prof Mascart with great pertinacity has attacked the phenomena of thick plates, Newton's rings, double refraction, and the rotatory phenomenon of quartz, but he has found absolutely nothing attributable to a stream of ether past the earth

The only positive result ever supposed to be attained was in a very difficult polarization observation by Fizeau in 1859 As this has not yet been repeated, it is safest at present to ignore it, though by no means to forget that it wants repeating.

Fizeau also suggested, but did not attempt, what seems an easier experiment, with fore and aft thermopiles and a source between them, to observe the drift of a medium by its convection of energy, but arguments based on the law of exchanges[1] tend to show, and do show as I think, that a probable alteration of radiating power due to motion through a medium would just compensate the effect otherwise to be expected

We may summarize most of these statements as follows —

Summary.

Source alone moving produces	A real and apparent change of wave length A real but not apparent error in direction. No lag of phase or change of intensity, except that appropriate to altered wave-length
Medium alone moving, or source and receiver moving together, produces	No change of frequency No error in direction A real lag of phase, but undetectable without control over the medium. A change of intensity corresponding to different distance, but compensated by change of radiating power.

1 Lord Rayleigh (NATURE, March 25, 1892)

Receiver alone moving produces {
An apparent change of wave-length
An apparent error in direction
No change of phase or of intensity, except that appropriate to different virtual velocity of light

I may say, then, that not a single optical phenomenon is able to show the existence of an ether stream near the earth. All optics goes on precisely as if the ether were stagnant with respect to the earth

Well then perhaps it *is* stagnant. The experiments I have quoted do not prove that it is so They are equally consistent with its perfect freedom and with its absolute stagnation, though they are not consistent with any intermediate position Certainly, if the ether were stagnant, nothing could be simpler than their explanation

The only phenomena then difficult to explain would be those depending on light coming from distant regions through all the layers of more or less dragged ether The theory of astronomical aberration would be seriously complicated, in its present form it would be upset But it is never wise to control facts by a theory it is better to invent some experiment that will give a different result in stagnant and in free ether None of those experiments so far described are really discriminative They are, as I say, consistent with either hypothesis, though not very obviously so

Mr Michelson, however, of the United States, has invented a plan that will discriminate, and, what is much more remarkable, he has carried it out

That it is an exceptionally difficult experiment you will realize when I say that the experiment will fail altogether unless one part in 400 millions can be clearly detected

Mr Michelson reckons that by his latest arrangement he could see 1 in 4000 millions if it existed (which is equivalent to detecting an error of $\frac{1}{1000}$ of an inch in a length of forty miles), but he saw nothing Everything behaved precisely as if the ether was stagnant, as if the earth carried with it all the ether in it's immediate neighbourhood And that is his conclusion If he can repeat it and get a different result on the top of a mountain, that conclusion may be considered established At present it must be regarded as tentative

I have not time to go into the details of his experiment (it is described in *Phil Mag* 1887), but I may say that it depends on no doubtful properties of transparent substances, but on the straightforward fundamental principle underlying all such simple facts as that—It takes longer to row a certain distance and back up and down stream than it does to row the same distance in still water, or that it takes longer to run up and down a hill than to run the same distance laid out flat, or that it costs more to buy a certain number of oranges at three a penny and an equal number at two a penny than it does to buy the whole lot at five for twopence

Hence, although there may be some way of getting round Mr Michelson's experiment, there is no obvious way, and I conjecture that if the true conclusion be not that the ether near the earth is stagnant, the experiment will lead to some other important and unknown fact.

The balance of evidence at this stage seems to incline in the sense that the earth carries the neighbouring ether with it

But now put the question another way *Can* matter carry neighbouring ether with it when it moves? Abandon the earth altogether; its motion is very quick, but too uncontrollable, and it always gives negative results. Take a lump of matter that you can deal with, and see if it pulls any ether along.

That is the experiment I set myself to perform, and which, in the course of the last year, I have performed

I take a steel disk, or rather a couple of steel disks clamped together with a space between. I mount it on a vertical axis and spin it like a teetotum as fast as it will stand without flying to pieces. Then I take a parallel beam of light, split it into two by a semi-transparent mirror (Michelson's method), a piece of glass silvered so thinly that it lets half the light through and reflects the other half, and I send the two halves of this split beam round and round in opposite directions in the space between the disks. They may thus travel a distance of 20 or 30 or 40 feet Ultimately they are allowed to meet and enter a telescope. If they have gone quite identical distances they need not interfere, but usually the distances will differ by a hundred thousandth of an inch or so, which is quite enough to bring about interference.

The mirrors which reflect the light round and round between the disks are shown in Fig 10 If they form an accurate square the last two images will coincide, but if the mirrors are the least inclined to one another at any unaliquot part of 360° the last image splits into two, as in the kaleidoscope is well known, and the interference bands may be regarded as resulting from those two sources The central white band bisects normally the distance between them, and their amount of separation determines the width of the bands There are many interesting optical details here, but I shall not go into them

The thing to observe is whether the motion of the disks is able to replace a bright band by a dark one, or *vice versâ* If it does, it means that one of the half beams, viz that which is travelling in the same direction as the disks, is helped on a trifle, equivalent to a shortening of journey by some quarter millionth of an inch or so in the whole length of 30 feet, while the other half beam, viz, that travelling against the motion of the disks, is retarded, or its path virtually lengthened, by the same amount

If this acceleration and retardation actually occurs, waves which did not interfere on meeting before the disks moved, will interfere now, for one will arrive at the common goal half a length behind the other

Now a gradual change of bright space to dark, and *vice versâ*, shows itself, to an observer looking at the bands, as a

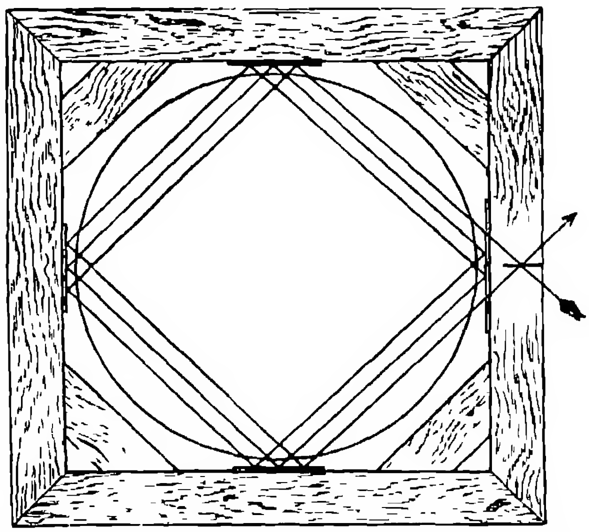


FIG 10 —Plan of steel disks one yard in diameter and optical frame, showing the light going round and round, three times each way, between the disks

gradual change of position of the bright stripes, or a shift of the bands A shift of the bands, and especially of the middle white band, which is much more stable than the others, is what we look for

At first I saw plenty of shift In the first experiment the bands sailed across the field as the disks got up speed until the crosswire had traversed a band and a half The conditions were such that had the ether whirled at the full speed of the disks I should have seen a shift of three bands. It looked very much as if the light was helped along at half the speed of the moving matter, just as it is inside water.

On stopping the disks the bands returned to their old position On starting them again in the opposite direction, the bands ought to have shifted the other way too; but they did not, they went the same way as before.

The shift was therefore wholly spurious; it was caused by the centrifugal force of the blast of air thrown off from the moving disks. The mirrors and frame had to be protected from this. Many other small changes had to be made, and gradually the spurious shifts have been reduced and reduced, largely by the skill and patience of my assistant, Mr Davies, until now there is barely a trace of them

But the experiment is not an easy one. Not only does the blast exert pressure, but at high speeds the churning of the air

makes it quite hot. Moreover, the tremor of the whirling machine, in which some four or five horse power is sometimes being expended, is but too liable to communicate itself to the optical part of the apparatus. Of course elaborate precautions are taken against this. Although the two parts, the mechanical and the optical, are so close together, their supports are entirely independent. But they have to rest on the same earth, and hence communicated tremors are not absent. They are the cause of all the slight residual trouble.

The method of observation now consists in setting a wire of the micrometer accurately in the centre of the middle band, while another wire is usually set on the first band to the left. Then the micrometer heads are read, and the setting repeated once or twice to see how closely and dependably they can be set in the same position. Then we begin to spin the disks, and when they are going at some high speed, measured by a siren note and in other ways, the micrometer wires are reset and read—reset several times and read each time. Then the disks are stopped and more readings are taken. Then their motion is reversed, the wires set and read again, and finally the motion is once more stopped and another set of readings taken. By this means the absolute shift of middle band and its relative interpretation in terms of wave-length are simultaneously obtained, for the distance from the one wire to the other, which is often two revolutions of a micrometer head, represents a whole wave-length shift.

In the best experiments I do still often see something like a fiftieth of a band shift, but it is caused by residual spurious causes, for it repeats itself with sufficient accuracy in the same direction when the disks are spun the other way round.

Of real reversible shift, due to motion of the ether, I see nothing. I do not believe the ether moves. It does not move at a five-hundredth part of the speed of the steel disks. I hope to go further, but my conclusion so far is that such things as circular saws, flywheels, railway trains, and all ordinary masses of matter do not appreciably carry the ether with them. Their motion does not seem to disturb it in the least.

The presumption is that the same is true for the earth; but the earth is a big body, it is conceivable that so great a mass may be able to act when a small mass would fail. I would not like to be too sure about the earth. What I do feel already pretty sure of is that if moving matter disturbs ether in its neighbourhood at all, it does so by some minute action, comparable in amount perhaps to gravitation, and possibly by means of the same property as that to which gravitation is due—not by anything that can fairly be likened to ethereal viscosity.

NATIVE NEW ZEALAND BIRDS

FROM a scientific point of view it is of so much importance that native New Zealand birds should be protected that many naturalists will read with interest the following memorandum, which was drawn up by Lord Onslow, the late Governor of New Zealand, and presented to both Houses of the General Assembly by command of his Excellency:—

It is admitted by naturalists that New Zealand possesses in some respects the most interesting avifauna in the world. It is a melancholy fact that, under the changed condition of existence this remarkable avifauna is passing away. Some of the species have already disappeared, whilst others are verging on extinction. Take, for example, the wingless birds of New Zealand. These diminutive representatives of the gigantic brevipennate birds which formerly inhabited New Zealand are objects of the highest interest to the natural historian. The kiwis, like their colossal prototypes the moas, once existed in very considerable numbers in almost every part of the country. At the time of the first colonization of New Zealand, fifty years ago, they were still abundant in all suitable localities. At the present day their last refuges may be indicated on the map without any difficulty. The North Island species (*Apteryx bulleri*) is still comparatively plentiful in the wooded heights of Pirongia and in the bosky groves of the Upper Wanganui. From all other localities where formerly numerous it has practically disappeared. The South Island kiwi (*Apteryx australis*) is now met with in only widely-scattered localities on the west coast. The small spotted or grey kiwi (*Apteryx oweni*), of which perhaps thousands could have been obtained a few years back, has succumbed to the ravages of the stoat and weasel, the persecution by wild dogs, and the necessities of roving diggers, and it is only now to be found in any number along the lower wooded ranges of the Southern Alps. *Apteryx haasti* is one of our rarest species, and *Apteryx maxima* is strictly confined to the wooded parts of Stewart Island.

The kakapo, or ground parrot (*Stringops habroptilus*), which was formerly so abundant in the wooded country along the whole of the West Coast Sounds and on the western slope of the Southern Alps, is becoming a scarce bird. According to Mr. Richardson, who recently read an exhaustive paper on the subject before the Otago Institute, both the kiwi and the kakapo are now confined to very restricted districts, within which, under the combined attacks of introduced wild dogs and cats, stoats, weasels, and ferrets, they are fast diminishing.

The blue-wattled crow and South Island thrush, which were every-day camp visitors when Sir James Hector explored the West Coast in 1863, are now very rarely seen; whilst in the North Island the native thrush and some of the smaller birds have disappeared altogether.

Prominent writers on zoological science, such as Prof. Newton, of Cambridge, Prof. Flower, at the head of the British Museum, and Dr. Sclater, the accomplished secretary of the Zoological Society of London, have over and over again urged the importance of some steps being taken for the conservation of New Zealand birds; and they have pointed out that it will be a lasting reproach to the present generation of colonists if no attempt is made to save some—if only a remnant—of these expiring forms for the student of the future. Thus, Prof. Newton, in his address to the Biological Section of the British Association, at Manchester, in 1887, saith: "I would ask you to bear in mind that these indigenous species of New Zealand are, with scarcely an exception, peculiar to the country, and, from every scientific point of view, of the most instructive character. They supply a link with the past that, once lost, can never be recovered. It is therefore incumbent upon us to know all we can about them before they vanish. . . . The forms we are allowing to be killed off, being almost without exception ancient forms, are just those that will teach us more of the way in which life has spread over the globe than any other recent forms; and for the sake of posterity, as well as to escape its reproach, we ought to learn all we can about them before they go hence and are no more seen."

The chief cause of the destruction of native birds is no doubt the introduction of foreign animals, against which the indigenous species are unable to contend successfully in the struggle for existence, especially under the changed conditions of life brought about by colonization. Probably the chief factor in this work of destruction is the Norway rat, whose introduction was of course unintentional, but an inevitable incident of settlement. The insectivorous and other birds introduced (whether wisely or not it is not necessary now to discuss) by our various acclimatization societies have, as it were, driven out and replaced many of the native species. These latter have succumbed to some general law of nature under which races of animals and plants yield to foreign invasion and rapidly disappear, the aboriginal races of man being no exception to this general rule. Where the causes themselves are recondite, it is, of course, difficult to find the means of counteracting them; but it is an observed law of nature that expiring races survive and linger longest in insular areas. That has been the experience of zoologists all over the world, the islands of Mauritius and Rodriguez presenting a striking instance in point. Here in New Zealand we have many similar evidences. The remarkable tuatara lizard (*Sphenodon punctatum*), supposed to be a survival from a very ancient fauna, and constituting, *per se*, a distinct order of reptilia, which years ago became extinct on the mainland (chiefly through the ravages of introduced wild pigs), still exists in very considerable numbers on the small islands lying off our coasts. The makomako, or bell bird (*Anthornis melanura*), at one time the very commonest of our birds, although still plentiful in the South Island, has absolutely disappeared from every part of the North Island, but it still exists on the wooded islands of the Hauraki Gulf and Bay of Plenty, and on the island of Kapiti, in Cook Strait. The same remarks apply with almost equal force to the wood-robin (*Miro albifrons*) and the white head (*Clitonyx albicapilla*), two species which have never inhabited the South Island at all. The stitch-bird (*Pogonornis cincta*), which forms a sort of connecting link with the avifauna of Australia, was thirty years ago very plentiful in the woods surrounding Wellington, but it had long before disappeared from the northern parts of the island. It is now

extinct all over the mainland, but it exists in comparative plenty on the little Barrier Island—presumably the only locality in the world where this species is now to be found

All these facts and considerations point to the conclusion that if an attempt is to be made to preserve these and other indigenous species, it must be by setting apart suitable islands for the purpose, and placing them under very strict protective regulations

Assuming it to be granted that it is the duty of the Government to take the necessary measures, the next question is, what islands are the most suitable for the purpose?

After making careful inquiries on the subject, and reading much that has been written by the Chief Surveyor and other local authorities, I have come to the conclusion that the two best and most readily available islands are the Little Barrier at the north, and Resolution Island at the south

1 *The Little Barrier* —This island is still in the hands of the Maoris, but the Government is in negotiation for its purchase, and, as I understand there is only a small amount at issue between the parties, I would strongly urge its immediate acquisition for the purposes indicated Not only is the Little Barrier known to be the habitat of the stitch bird, the white head, the bell-bird, and the native robin (all of which have practically disappeared from the mainland), but it has a wooded surface admirably adapted to the habits of such birds, it is easily accessible from Auckland, it would be difficult for any person to land and shoot birds there without at once attracting the attention of the many ships which are constantly passing in and out of the Hauraki Gulf

2 *Resolution Island* —This has now been proclaimed a reserve for native fauna and flora

(1) Resolution Island is just at a convenient distance from the mainland It is of considerable extent, with good harbours having deep water and safe anchorage

(2) Several of the species that it is most desirable to preserve (such as kakapo and kiwi) are known to exist there already in considerable numbers

(3) It is believed to be the final refuge of the great flightless rail (*Notornis mantelli*), only three specimens of which have ever been obtained in New Zealand, two of these being now in the National Museum, and the other in the Royal Museum at Dresden One of those in the British Museum (obtained by Mr Walter Mantell in 1849) was caught by a party of sealers at Duck Cove, on Resolution Island, and the other was captured by Maoris on Secretary Island, opposite to Dea's Cove, Thompson Sound The third was taken as recently as 1881 by a party of rabbit hunters in the vicinity of Lake Te Anau There is every reason to believe that this rare and interesting species still survives on the island which has now been set apart as a permanent Government reserve

Looking to the interests involved—the great loss to the scientific world implied in the extermination of natural forms that do not exist elsewhere, and the importance, therefore, of saving them—it cannot be denied that a heavy responsibility rests on those who, while there is yet time and opportunity, may neglect to take the necessary steps for their preservation

All that is wanted to rouse public interest in such a matter is actual knowledge of the facts There is a strong sentiment always in the public mind against the final extirpation of any living species As a proof of this one has only to read of the strong public feeling that exists in San Francisco in regard to the protection of the "sea lions" frequenting the famous Seal Rocks lying off the shore, and of the universal regret with which the Americans regard the almost complete extirpation of the herds of bison, of which at the present day only a small remnant survives under Government protection within certain "reservations" It finds further expression in the lament of all true sportsmen and naturalists on account of the disappearance, through wanton slaughter, of the large game of South Africa. Look, for example, at the quagga, which is now on the verge of extinction. Forty years ago this fine animal might be counted by thousands on every valley and plain of the Cape Colony At the present day, besides three mounted specimens in European museums, there are two living examples in the Zoological Gardens. Take these away, and the species is blotted out completely.

In urging Ministers to take this subject under their serious consideration I may remind them that on December 16, 1886, the Secretary of the Auckland Institute wrote advising the purchase of the Little Barrier Island as a Government preserve, and that the Premier, Sir Robert Stout, approved of this being done The purchase was, I believe, strongly advocated by Prof Thomas and by Mr A Reischek, the Austrian collector, both of whom had visited the island and inspected every part of it At a recent meeting of the Otago Institute a resolution was passed authorizing the Council of that body to move the Government to proclaim Resolution Island for this purpose

Resolution Island having now been so proclaimed, I would suggest that steps should be immediately taken for ascertaining to what extent Resolution Island is already stocked with kiwi and kakapo, that a sufficient supply of these and other birds be at once obtained by purchase or otherwise from the mainland before it is too late, and turned loose both on this island and on the Little Barrier, and that Captain Fairchild (who takes a keen interest in this project) should be instructed to call at these islands from time to time during the periodical cruises of the *Hinemoa*, to ascertain if the birds are thriving, and to report results, with such practical suggestions and recommendations as he may be able to make for the furtherance of this plan of conservation

I would also, at the same time, suggest that Ministers should take into consideration the propriety of including some other native birds on the list of protected species As I have already mentioned, the bell-bird formerly so plentiful, has entirely disappeared from the North Island But it is still very plentiful all over the South Island, and is a common denizen of the gardens and shrubberies in all the principal towns This is the bird that so enchanted Captain Cook by its song when his ship lay at anchor in Queen Charlotte Sound more than a hundred years ago, and, having become historical, it would be a grievous pity for the bird to die out altogether The general testimony goes to show that the protection extended to the tuis had the desired effect, this species being now more numerous everywhere than it was fifteen years ago Would it not be well to extend the same protection to its small congener the makomako, whose haunts and habits are almost precisely similar?

Then, again, there is a bird famous in Maori history and poetry—remarkable for its singular beauty, and interesting to naturalists on account of its aberrant generic characters—a species confined to a very limited portion of the North Island, from which, owing to the eagerness of natural history collectors and the inevitable progress of settlement in its native woods, it is fast disappearing

I refer, of course, to the huia (*Heteralocha acutirostris*), a bird which is naturally confined within such narrow geographical boundaries that I may describe its range as being limited to the Ruahine, Tararua, and Rimutaka Mountain ranges, with their divergent spurs and the intervening wooded valleys The white-tipped tail-feathers of this beautiful bird have been from time immemorial the chief adornment of Maori chiefs as head-plumes, and an incident connected therewith, in ancient times, led to the adoption of the name by the great ancestors of the Ngatihuia Tribe

As Ministers are aware, when selecting a Maori name for my infant son, to commemorate his New Zealand birth, I was induced, for several considerations, to give this name the preference over all others submitted to me, and I should therefore accept it as a compliment to my family if Ministers would exercise the power they possess and throw over this bird the shield of Government protection [1]

I ask this the more readily on the ground that I have been moved to do so by the chiefs of the Ngatihuia Tribe At the public function at Otaki, on the 12th September last, when I had the pleasure of presenting my son to the assembled tribes, a number of very complimentary speeches were made by the leading chiefs, and one of them, in referring to the name, said, "There, yonder, is the snow-clad Ruahine range, the home of our favourite bird We ask you, O Governor! to restrain the pakehas from shooting it, that when your boy grows up he may see the beautiful bird which bears his name."

The huia loves the deep shade of the forest, and as its home is invaded by the settler's axe it would, if protected from reckless destruction, simply retire higher up the wooded ranges, till it finally took refuge in the permanent forest reserve, which embraces all the wooded mountain-tops within its natural domain Under vigilant protection, therefore, the huia would have every chance of being preserved and perpetuated

Christchurch, Christmas Day, 1891 ONSLOW

[1] This has been done *vide New Zealand Gazette* of February 25, 1892 page 402

A CENTURY OF SCIENTIFIC WORK

EVERYONE interested in science is aware that the "Société de Physique et d'Histoire Naturelle de Genève" has won for itself an honoured place among the learned Societies of the Continent. Work of the highest interest and importance has been done by many of its ordinary members, and the list of its honorary members includes a very large number of the investigators who, in different parts of Europe, have contributed most effectually to scientific progress. Some time ago this excellent Society celebrated the hundredth anniversary of its foundation, and an interesting supplementary volume has now been issued in memory of the occasion. To this volume Dr. A. H. Wartmann contributes a sketch of the Society's history, and it may be worth while to note some of the facts he has recorded.

Nominally, the Society was founded in 1790. That is, several men of science in Geneva agreed in that year to unite in forming it. As a matter of fact, however, the first official meeting was not held until 1791. The Society was called at first the "Société des Naturalistes Genevois," and there were eight members, who met in each other's houses on the second and fourth Thursday of every month. The President was M. Gosse. A secretary and a treasurer were appointed; the annual subscription was fixed at two crowns, and an effort was made to obtain copies of the scientific journals of the time. It was felt that there ought to be more than eight members, so the honour of membership was offered to several men of science, by the majority of whom it was accepted. Foreign men of science who happened to be passing through Geneva were invited by the President to attend the meetings, and some of them were made honorary members. In the course of the first year M. Jurine made a present of his herbarium to the Society; this was the origin of its collections. One of the first objects of the Society was the creation of a botanic garden, and a site was chosen which has ever since been retained. M. Micheli presented a hot-house; exotic plants and seeds were obtained; and courses of instruction in botany were given under the Society's auspices by MM. Micheli and de Saussure.

The most eminent representative of science in Geneva at this time was Charles Bonnet. He was asked to become the patron or Honorary President of the new Society. He would have preferred the position of *confrère*, but ended by complying with the request. He died in 1793, bequeathing to the Society 300 crowns, which provided for the maintenance of a gardener and other necessary expenses in the botanic garden.

The activity of the young Society was shown in a series of labours in the physical and natural sciences—labours of which an account has been given by Vaucher, one of the founders. The question of a diploma of reception was raised, and, after much consideration, a seal was prepared. This was abandoned in 1819 in favour of a seal engraved by Bovy.

In 1792 the Society changed its name to "Société Genevoise d'Histoire Naturelle." Shortly afterwards the name by which the Society is still known was adopted.

Under an impulse due to M. d'Albert Henri Gosse, two other scientific Societies were founded in Geneva. One, created in 1803, went back to the name of "Société des Naturalistes." In 1829 it was merged in the "Société de Physique et d'Histoire Naturelle," in whose archives its papers are preserved. Many of these, according to M. Wartmann, are of some importance. The other Society was the "Société Helvétique des Sciences Naturelles," founded in 1815. Of this Society, which has continued to flourish, the "Société de Physique" may be regarded as the Genevese section. When it met at Geneva, in 1866, the two Societies united in the ceremony at the unveiling of a monument to M. Gosse.

When the number of members increased, a fixed place of meeting became necessary. They met for some years at the Société des Arts, then (from 1826) at the Academic Museum, and afterwards (from 1872) in the hall of the Société des Arts. The times of meeting were changed from the second and fourth to the first and third Thursday of every month; and in 1834 it was decided that a meeting should be held only on the first Thursday of the month.

The President holds office for a year. A Vice-President is also appointed. From 1858 to 1879 the President entered upon his duties in July, and in the following June he was succeeded by the Vice-President. Now the President and Vice-President assume office at the beginning of the year.

The Society consists of active members, emeritus members, and honorary members. The former—limited in 1822 to forty, in 1863 to fifty, in 1878 to sixty—reside in the canton. The emeritus members are members who have ceased to take an active part in the Society's work. The honorary members—limited in 1859 to seventy, in 1878 to sixty—are chosen from among men of science in Switzerland or any other part of the world. There are also "associés libres," who cannot be appointed before the age of twenty five.

Although women do not habitually attend the meetings, there is nothing to prevent them from being connected with the Society. Mrs. Somerville was an honorary member from 1834 to 1873.

Very many communications submitted to the Society have marked important stages in the development of science. At first some of the communications used to appear in foreign periodicals or in the *Bibliothèque Britannique*, which afterwards became the *Bibliothèque Universelle*. In 1820 it was decided that a collection of Memoirs should be issued, and that the task of selecting the papers should be intrusted to a Committee of Publication. This Committee still exists, its secretary being known as the corresponding secretary. The first volume, consisting of two numbers, appeared in 1821 and 1822, and in 1890 appeared the second part of the thirtieth volume. The publication of the Memoirs, many of which are accompanied with plates, is very costly, but sometimes the writers bear the whole or a part of the expense. A *Bulletin*, presenting a *résumé* of the proceedings, has been issued regularly since 1884, and an account has also been given since 1883 in the *Archives des Sciences Physiques et Naturelles*.

The funds of the Society are derived from subscriptions, gifts, and bequests. At first the amount of the annual subscription varied in accordance with the Society's needs, but in 1860 it was fixed at twenty francs. From 1829 to 1854 the Society was officially recognized by the State as the "Société Cantonale de Physique et d'Histoire Naturelle," and received an annual subsidy; but during the last thirty eight years there has been no relation of this kind between the Society and the Government. A sum of 1200 francs is paid annually by the Administrative Council for the books and memoirs with which the Society enriches the public library of Geneva.

The various collections possessed by the Society have been given partly to the Museum of Natural History, partly to the Botanic "Conservatoire." A prize of 500 francs is offered every five years for the best essay on a genus or family of plants. The sum of 2400 francs which enables this prize to be offered was left to the Society for the purpose in 1841 by A. P. de Candolle. Since 1886 the Society has reserved for itself, at a cost of 600 francs per annum, a place at the Zoological Laboratory of Villefranche, and the person who is to be allowed to take advantage of it is chosen in accordance with a fixed set of rules.

The Society now includes fifty-four ordinary members, four emeritus members, fifty honorary members, and thirty-one *associés libres*. Among the honorary members are many of the most eminent men of science in Europe and America.

THE TRANSMISSION OF ACQUIRED CHARACTERS THROUGH HEREDITY

THE bearing of insects upon this subject is very clearly brought out by Prof. C. V. Riley in a recently published paper on "Some Interrelations of Plants and Insects" read before the Biological Society of Washington. After dealing with the facts connected with the insects associated with the interesting plants of the genus Yucca and the pollination of their flowers by the Yucca Moth, and touching briefly upon certain aspects of fig-caprification, he makes the following remarks:—

"Now, when it comes to the bearing which the history of these little moths has upon some of the larger questions that are now concerning naturalists (for instance, the transmission of acquired characters, or the origin, development, and nature of the intelligence displayed by the lower animals), broad fields of interesting opinion and conclusion open up before us—fields that cannot possibly be explored without trenching too much upon your time. I will close, therefore, with a few summary expressions of individual opinion, without attempting to elaborate the reasons in detail, and with the object of eliciting further discussion, which is one of the objects of the paper. My first conviction is that insect life and development give no

countenance to the Weissman school, which denies the transmission of functionally acquired characters, but that, on the contrary, they furnish the strongest refutation of the views urged by Weissman and his followers The little moths of which I have been speaking, and indeed the great majority of insects—all, in fact, except the truly social species—perform their humble parts in the economy of nature without teaching or example, for they are, for the most part, born orphans, and without relatives having experience to communicate The progeny of each year begins its independent cycle anew Yet every individual performs more or less perfectly its allotted part, as did its ancestors for generation after generation The correct view of the matter, and one which completely refutes the more common idea of the fixity of instinct, is that a certain number of individuals are, in point of fact, constantly departing from the lines of action and variation most useful to the species, and that these are the individuals which fail to perpetuate their kind and become eliminated through the general law of natural selection

"Whether these actions be purely unconscious and automatic or more or less intelligent and conscious, does not alter the fact that they are necessarily inherited The habits and qualities that have been acquired by the individuals of each generation could have become fixed in no other way than through heredity Many of these acts, which older naturalists explained by that evasive word "instinctive," may be the mere unconscious outcome of organization, comparable to vegetative growth, but insects exhibit all degrees of intelligence in their habits and actions, and they perform acts which, however voluntary and, as I believe, conscious in many cases, as in that of our Yucca Moth, could not be performed were the tendency not inherited Every larvæ which spins or constructs a hibernaculum, or a cocoon in which to undergo its transformations, exemplifies the potent power of heredity in transmitting acquired peculiarities A hundred species of parasitic larvæ, *e g*, of the family Braconidæ, which in themselves are almost or quite indistinguishable from one another structurally, will nevertheless construct a hundred distinctive cocoons—differing in form, in texture, in colour and in marking—each characteristic of its own species, and in many instances showing remarkable architectural peculiarities These are purely mechanical structures, and can have little or nothing to do with the mere organization or form or structure of the larva, but they illustrate in the most convincing manner the fact that the tendency to construct, and the power to construct, the cocoon after some definite plan, must be fixed by heredity, since there is no other way of accounting for it This fact alone, which no one seems to have thought of in the discussion, should be sufficient to confound the advocates of the non transmissibility of acquired characteristics

"Thus, to my view, modification has gone on in the past, as it is going on at the present time, primarily through heredity in the insect world I recognize the physical influence of environment, I recognize the effect of the interrelation of organisms, I recognize, even to a degree that few others do, the psychic influence, especially in higher organisms—the power of mind, will, effort, or the action of the individual as contradistinguished from the action of the environment, I recognize the influence of natural selection, properly limited, but above all as making effective and as fixing and accumulating the various modifications due to these or whatever other influences, I recognize the power of heredity, without which only the first of the influences mentioned can be permanently operative "

FORTHCOMING SCIENTIFIC BOOKS.

AMONG Messrs Macmillan and Co's announcements are the following books —"Evolution and Man's Place in Nature," by Prof H Calderwood, "A Primer of Practical Horticulture," by J Wright; "A Text book of Tropical Agriculture," by H A Nicholls, M.D, F.L S, C M Z S, with illustrations, "The Food of Plants," by A P Laurie, "Metal Colouring and Bronzing," by Arthur H. Hiorns, "Differential Calculus for Schools," by Joseph Edwards, "The Beauties of Nature and the Wonders of the World we live in," by the Right Hon Sir John Lubbock, Bart, M P, F R.S, with illustrations, "Finger Prints," by Francis Galton, F.R S, with numerous illustrations, "Hereditary Genius an Inquiry into its Laws and Consequences," by Francis Galton, F R S, new edition, "Materials for the Study of Variation in Animals," Part I, discontinuous variation, by William Bateson, illustrated; "On Colour Blindness," by Thomas H Bickerton, illustrated (Nature series), Hygiene its Principles as applied to Public Health, adapted to the requirements of the Elementary and Advanced Stages of the Science and Art Department, &c," by Edward F Willoughby, M B, new and enlarged edition, "A Uniform Edition of Prof Huxley's Essays, Uniform with the works of Emerson, John Morley, &c, in 6 vols, comprising Lay Sermons, Addresses and Reviews, Critiques and Addresses, Science and Culture, American Addresses, Man's Place in Nature," &c, "Atlas of Classical Antiquities," by Th Schreiber, edited for English use by Prof W C F Anderson, "Researches on the Propagation of Electrical Force," by Prof Henrich Hertz, authorized translation by Prof D E Jones, B Sc, illustrated, "A Text-book of Pathology Systematic and Practical," by Prof D J Hamilton, "Electrical Papers," by Oliver Heaviside, "Pioneers of Science," by Prof Oliver Lodge, with portraits and other illustrations, "The Diseases of Modern Life," by B W Richardson, M D, new and cheaper edition, "The Theory and Practice of Absolute Measurements in Electricity and Magnetism," by Prof A Gray, Vol II, and "A Theory of Wages and its Application to the Eight Hours Question and the Labour Problems," by Herbert M Thompson

Mr Murray announces —"Explosives and Their Powers," translated and condensed from the French of M Berthelot, by C Napier Hake and William NacNab, with an introduction by Lt Colonel J P Cundill, R A, H M Inspector of Explosives, with illustrations, "Charles Darwin," a Biography, founded on the "Life and Letters of Charles Darwin," by his son, Francis Darwin, F R S, with portrait and illustrations, "The Collected Works of Werner Von Siemens," translated by E F Bamber, vol ii "Applied Science," with illustrations, "Notes by a Naturalist on H M S *Challenger*," a record of observations made during the voyage of H M S *Challenger* round the world in the years 1872 76, under the command of Captain Sir G S Nares, R N, K.C B, F R S, and Captain F T Thomson, R N, by H N Moseley, F R S, a new and cheaper edition, with portrait and numerous woodcuts, "Records of a Naturalist on the Amazons during Eleven Years' Adventure and Travel," by Henry Walter Bates, a new edition of the unabridged work, with a memoir of the author by Edward Clodd, with portrait, illustrations, and map, "The English Flower Garden Design, Views, and Plants," by W Robinson, third edition, entirely revised, with many fine additional engravings, "A Manual of Naval Architecture," for the use of officers of the Navy, the Mercantile Marine, shipowners, ship builders, and yachtsmen, by W H White, C B, F R S, third edition, thoroughly revised and in great part re-written, with 150 illustrations, "Outlines of Ancient Egyptian History," based on the work of Auguste Mariette, translated and edited, with notes, by Mary Brodrick, a new and revised edition, "The Metallurgy of Iron and Steel," by the late John Percy, M D, F R S, a new and revised edition, with the author's latest corrections, and brought down to the present time, by H Bauerman, F G S, with illustrations, "Studies in Modern Geology," by Dr R D Roberts, "The Physiology of the Senses," by Professor McKendrick and Dr. Snodgrass, with illustrations, "Outlines of Modern Botany," by Prof Patrick Geddes, "Logic, Inductive and Deductive," by Prof Minto, "Psychology A Historical Sketch," by Prof Seth, "An Introduction to Physical Science," by John Cox, and "The History of Astronomy," by Arthur Berry

Among the books in active preparation at the Clarendon Press may be mentioned —"The Logic of Hegel," translated by W Wallace, new edition, "Mathematical Papers of the late Henry J S Smith, Savilian Professor of Geometry in the University of Oxford," with portrait and memoir, 2 vols quarto, "Researches in Stellar Parallax by the Aid of Photography" (Astronomical Observations made at the University Observatory, Oxford, fasc. iv), by C Pritchard, D.D, F R.S, a supplementary volume to Prof Clerk Maxwell's "Treatise on Electricity and Magnetism," by J. J Thomson, "A Manual of Crystallography," by M H N. Story-Maskelyne, "Elementary Mechanics," by A L. Selby, "Analytical Geometry," by W. J Johnston, "A Treatise on the Kinetic Theory of Gases, by H W. Watson, D Sc., new edition, "Hydrostatics and Elementary Hydrokinetics, by G M Minchin, "A Text-book of Pure Geometry," by J W Russell, "Catalogue of Eastern and Australian *Lepidoptera Heterocera* in the Collection of the Oxford University Museum," by Colonel C Swinhoe.

and "Epidemic Influenza a Study in Comparative Statistics," by F A Dixey, D M

The Cambridge University Press promises —"The Collected Mathematical Papers of Prof Arthur Cayley, Sc D, F R S," vol v, "A History of the Theory of Elasticity and of the Strength of Materials," by the late I Todhunter, Sc D, F R S, edited and completed by Prof Karl Pearson, vol ii, Saint Venant to Lord Kelvin (Sir William Thomson), "A Treatise on Analytical Statics," by E J Routh, Sc D, F R S, vol ii, "A Treatise on the Theory of Functions of a Complex Variable," by A R Forsyth, Sc D, F R S, "The Jurassic Rocks of Cambridge," being the Sedgwick prize essay for the year 1886, by the late T Roberts, M A, "Fossil Plants as Tests of Climate," being the Sedgwick prize essay for 1892, by A C Seward, M A, "An Elementary Treatise on Plane Trigonometry," by E W Hobson, Sc D, and C M Jessop, "Euclid's Elements of Geometry, Books v and vi," by H M Taylor, "Mechanics and Hydrostatics for Beginners" (this book will include those portions of these subjects which are required for the Matriculation Examination of the University of London, by S L Loney), and "Solutions to the Exercises in Euclid, Books i-iv," by W W Taylor

Messrs Whittaker and Co announce —Prof Oliver Lodge's "Treatise on Lightning Conductors and Lightning Guards," "A Comprehensive Work on the Dynamo," by C C Hawkins and F Wallis, "Coal Pits and Pitmen," by R Nelson Boyd, M Inst C E, "Pattern-Making for Students in Technical Schools and Apprentices," by a Foreman Pattern Maker, "Fitting for Engineer Students and others," by the same author, "Electrical Experiments," by G E Bonney, "Practical Electric Light Fitting," by F C Allsop, "Electric-Lighting and Power-Distribution," by W Perren Maycock, M I E E, "How to Manage a Dynamo," by S R Bottone, "The Manufacture of Soap," by W Lawrence Gadd, F I C, F C S, "Ship's Carpentry," by M and A Mowat, "Hammered Metal Work," by C G Leland, author of "Wood-Carving" and "Leather Work" In the Library of Popular Science—"Electricity and Magnetism," by S R Bottone, "Chemistry," by T Bolas, F I C, F C S, "Geology," by A J. Jukes Browne, F G S, and other Volumes An Important Work for Medical Students—"Dissections Illustrated," a Graphic Handbook for Students of Human Anatomy, by C Gordon Brodie, F R C S, with Plates, carefully drawn and put on the stone by Percy Highley, from dissections of the human body made by the Senior Demonstrator of Anatomy at the Middlesex Hospital Medical School, the first part of which, with 17 coloured plates of the upper limb, two thirds natural size, will be issued immediately

In Mr Stanford's list attention is drawn to —A translation into English by Dr Hatch of Dr Theodor Posewitz's work on "Borneo its Geology and Mineral Resources" (the translator has added a number of references and notes, and four new maps accompany the translation), a new book by Mr Edward North Buxton, being an account of his adventures in pursuit of large game in various parts of the world (it will be entitled "Short Stalks or Hunting Camps, North, East, South, and West," and will be accompanied by a number of original illustrations), the paper on "The Fayûm and Lake Mœris," which Major R Hanbury Brown communicated to the recent Oriental Congress, with photographs by the author, diagrams, and a new map, "Castorologia or the Traditions of a Canadian Beaver," by Mr Horace T Martin, of Montreal (the work will be a handsome octavo, with a number of maps and illustrations), "The Partition of Africa," by Mr J Scott Keltie, Secretary to the Royal Geographical Society (it will be brought well up to date, and supplied with an excellent apparatus of maps), and new Editions of the following "Tanganyika · Eleven Years in Central Africa," by Captain Hore; the late Sir Andrew Ramsay's "Physical Geology and Geography of Great Britain," revised by Mr W Topley, F G S.; Prof James Geikie's "Great Ice Age," thoroughly revised; and the late Sir Charles Anderson's "Lincoln Guide," revised by the Rev A R Maddison, Librarian and Succentor of Lincoln Cathedral

Messrs. Baillière, Tindall and Cox have in the press — "A Manual of Practical Medical Electricity," by Dawson Turner, M D, F R C P Ed, M R C P Lond; "The Practical Guide to the Public Health Acts and Correlated Acts for Officers of Health and Inspectors of Nuisances," by Thos Whiteside Hime, M.D, second edition, enlarged; "Modern Therapeutics, Medical and Surgical, including the Diseases of Women and Children," by Geo H Napheys, M D, ninth edition, revised and enlarged by Drs Allen Smith and Aubrey Davis, vol i, Medical, "Diseases of the Throat and Nose," a Practical Guide to Diagnosis and Treatment, with 220 typical illustrations in chromo lithography and numerous wood engravings, by Lennox Browne, F R C S Edin, fourth edition

Messrs Williams and Norgate will publish —"Against Dogma and Free Will," by H Croft Hiller, in which the author wishes to prove from the discoveries of Weismann the impossibility of Free Will, the certainty of Science, and the uselessness of Metaphysics, and in two volumes "The Supernatural its Origin, Nature, and Evolution," by John H King, in which the author treats first of the origin and nature of Supernal Concepts, and then of the evolution of the Supernatural in various nations and its modern presentations

Messrs Gurney and Jackson have ready for immediate publication —"Odorographia," a Natural History of Raw Materials and Drugs used in the Perfume Industry, by I Ch Sawer, F L S, "The Birds of Lancashire," by F S Mitchell, second edition, revised and annotated by Howard Saunders, F L S, etc, with additions by R J Howard, and other local authorities, a fourth edition of "Destructive Distillation," by Dr Mills, F R S, and a book on "Wild Spain," by Abel Chapman and Walter J Buck, treating of the beasts and birds of the Peninsula, deer, ibex, chamois, wild boar, and lynx, and bustards, flamingoes, eagles, vultures, game, and wild fowl, with more than 150 illustrations

Messrs Sampson Low and Co, Limited, have in hand — "The Student's Chemistry," by R L Taylor, F I C, F C S, fully illustrated, and "The Glacial Nightmare," by Sir Henry H Howorth, M P, 2 vols

Messrs Cassell and Co, Limited, announce "The Dawn of Astronomy, by J Norman Lockyer, F R S, "Beetles, Butterflies, Moths, and other Insects," a brief introduction to their collection and preservation, by A W Kappel, F L S, F E S, and W Egmont Kirby, with 12 coloured plates, "Cassell's Storehouse of General Information," Vol III, fully illustrated with high class wood engravings, and with maps and coloured plates, "The Year-Book of Science" (second year of issue), edited by Prof Bonney, F R S, and containing contributions by leading scientific writers, Popular editions of Figuier's works revised by eminent British authorities, "The Insect World," "Reptiles and Birds" (new volumes), and "The Year-Book of Treatment for 1893," a critical review for practitioners of medicine and surgery

Messrs Chas Griffin and Co, Limited, will issue "Diseases of the Heart (Diagnosis of)," by A Ernest Sansom, M D, F R C P, with 13 plates and illustrations in the text, "Ruptures, a Treatise on," by J F C Macready, F R C S, with numerous plates engraved on the stone after photographs, "Clinical Diagnosis the Chemical, Microscopical, and Bacteriological Evidence of Disease," by Prof von Jaksch, of Prague, translated from the third German edition by Jas Cagney, M D, with additional illustrations, many in colours, second edition, "The Diseases of Children Medical and Surgical," by H Bryan Donkin, M B, F R C P, and Bilton Pollard, M D, F R C S, "Gynæcology," a practical treatise on, by J Halliday Croom, M D, with the collaboration of MM. Milne Murray, M B, and Johnson Symington, M D, "Midwifery," a practical treatise on, by John Phillips, M D, "A Manual of Obstetrics," for the use of students, nurses, and midwives, by Arch. Donald, M D, "Forensic Medicine and Toxicology" (a text book of), by J Dixon Mann, M D, F R C.P, "A Medical Handbook for the Use of Students," by R S Aitchison, M B, F R C P, Edin, "Inorganic Chemistry" (a Text-Book of), by Dr Dupré, F R S, and Dr Wilson Hake, second edition, revised, "Mind in Matter," by the Rev James Tait, third edition, revised and enlarged, with special reference to later Darwinism, "Biology" (a Text-Book of), by Prof. J R Ainsworth Davis, new edition, revised and enlarged, in two parts (1) Vegetable Morphology and Physiology, (2) Animal Morphology and Physiology, with additional illustrations, "Coal Mining" (a Text-Book of), by H W Hughes, F.G S, with frontispiece and 490 illustrations, reduced from working drawings; "Ore and Stone Mining," by Prof. C Le Neve Foster, D Sc, with numerous illustrations; "Dyeing" (a manual of), for the use of practical dyers, manufacturers, and students, by Dr Knecht, Chr Rawson, and Dr. R Loewenthal, with numerous illustrations and specimens of dyed fabrics,

"Oils, Fats, Waxes, and Allied Materials, and the Manufacture therefrom of Candles, Soaps, and other Products," by C R Alder Wright, D Sc, F R S, with numerous illustrations, "Painters' Colours, Oils, and Varnishes" (a practical Manual), by Geo H Hurst, with illustrations, "Applied Mechanics (an Elementary Manual of), for first year students, by Prof A Jamieson, F R S E, with very numerous illustrations, and "Griffin's Electrical Price Book," for the use of electrical, civil, marine, and borough engineers, local authorities, architects, railway contractors, &c, edited by H J Dowsing

MESSRS SWAN SONNENSCHEIN AND CO's list contains — "Text Book of Embryology Man and Mammals," by Dr Oscar Hertwig, translated and edited from the third German edition by Dr E L Mark, fully illustrated, "Text-Book of Embryology Invertebrates," by Drs Korschelt and Heider, translated and edited by Dr E L Mark and Dr W M Woodworth, fully illustrated, "Text Book of Comparative Geology," adapted from the work of Dr Kayser, by Philip Lake, fully illustrated, "Text Book of Palæontology for Zoological Students," by Theodore T Groom, fully illustrated, "Text Book of Petrology," by F H Hatch, D Sc, a revised and enlarged edition of "An Introduction to the Study of Petrology, with 86 illustrations, "Handbook of Systematic Botany," by Dr F Warming, translated and edited by M C Potter, fully illustrated "Practical Bacteriology," by Dr Migula, translated and edited by H J Campbell, M D, "The Geographical Distribution of Disease in England and Wales," by Alfred Haviland, M D, with several coloured maps, "A Treatise on Public Hygiene and its applications in different European Countries," by Dr Albert Palmberg, translated, and the English portion edited and revised, by Arthur Newsholme, M D, fully illustrated, "The Photographer's Pocket Book," by Dr E Vogel, translated by F C Conrad, illustrated, "The Recrudescence of Leprosy and the Report of the Leprosy Commission," by William Tebb, "Roaring in Horses its Pathology and Treatment," by P J Cadiot, translated by Thomas J Watt Dollar, M R C V S "Introductory Science Text-Books" additions—Introductions to the Study of "Zoology," by B Lindsay, illustrated, 'The Amphioxus," by Dr B Hatschek and James Tuckey, illustrated, "Geology," by Edward B Aveling, D Sc (Lond), illustrated, "Physiological Psychology," by Dr Th Ziehen, adapted by Dr Otto Beyer and C C Vanliew, with 21 illustrations, "Biology," by H J Campbell, M D "Young Collector Series" additions—"Flowering Plants," by James Britten, F L S, "Grasses," by W Hutchinson, "Fishes" by the Rev H C Macpherson, and "Mammalia," by the Rev H C Macpherson

THE SOCIETY FOR PROMOTING CHRISTIAN KNOWLEDGE has nearly ready for publication —"Star Atlas," gives all the stars from 1 to 6 5 magnitude between the North Pole and 34° south declination and all nebulæ and star clusters which are visible in telescopes of moderate powers, translated and adapted from the German of Dr Klein, by the Rev E McClure, M A, new edition brought up to date, with eighteen charts and eighty pages illustrative letterpress "Vegetable Wasps and Plant Worms," by M C Cooke, LL D, illustrated "Our Secret Friends and Foes," by Prof Frankland, F R S

MESSRS LONGMANS AND CO are preparing for publication —"The Ruined Cities of Mashonaland being a Record of Excavations and Explorations, 1891–92," by J Theodore Bent, F R G S., with numerous illustrations of Mashonaland, and of the author's interesting discoveries of the remains of a prehistoric people at the Zimbabwe ruins. An English translation of Wüllner's "Lehrbuch der Electricitat," in 2 vols, translated and edited by G W de Tunzelmann, B Sc, with 310 illustrations. The English editor has added much new matter, and by some changes of arrangement and mode of presenting the subject has endeavoured to make it a truthful representation of the present state of electrical science "Chemical Lecture Experiments," by G S. Newth

MESSRS LAWRENCE AND BULLEN will publish —"Matriculation Chemistry," by Temple Orme

MESSRS. J AND A CHURCHILL promise "Physiology" (Student's Guide Series), by E H Starling, M D. Lond, with 100 illustrations, "A Guide to the Science of Photo-micrography," by Edward C Bousfield, second edition, with 34 woodcuts and frontispiece, "Chemical Technology or, Chemistry in its application to Arts and Manufactures," with which is incorporated "Richardson and Watts' Chemical Technology," edited by Charles Edward Groves, F.R S., and William Thorp, B Sc vol. ii Lighting—Sections Stearine, by Mr John McArthur, Candles, by Mr Field, Oils, Oil Fields, Lamps, by Boverton Redwood, Gas, by Chas Hunt, Electric Lighting, by Prof Garnett, "Commercial Organic Analysis," by Alfred H Allen, F I C, F C S A treatise on the properties, proximate analytical examination, and modes of assaying the various organic chemicals and products employed in the arts, manufactures, medicine, &c, with concise methods for the detection and determination of their impurities, adulterations, and products of decomposition Vol iii, Part 2, Organic bases, cyanogen compounds, albuminoids, &c "Wilson's Anatomy," edited by Prof Henry E Clark, eleventh edition, with 26 coloured plates, and 492 woodcuts, "Morris's Anatomy," a treatise by various authors J B Sutton, H Morris, J N Davies Colley, W J Walsham, H St John Brooks, R M Gunn, A Hensman, F Treves, W Anderson, and W H A Jacobson, with more than 500 illustrations, many being coloured, "Ambulance Lectures," to which is added a Nursing Lecture, in accordance with the regulations of the St John Ambulance Association, by John M H Martin, M D, third edition, with 60 engravings, 142 pp, and an English edition of Tommasi Crudeli's well known work on the Climate of Rome

MR LEWIS'S announcements are —"Various Forms of Hysterical or Functional Paralysis," by H C Charlton Bastian, M D, F R S, "Diseases of the Skin Their Description, Pathology, Diagnosis and Treatment," by H Radcliffe Crocker, M D, F R C P, second edition, with numerous illustrations, "A Text book of Ophthalmology," by Dr Ernest Fuchs, translated from the German by A Duane, M D, in one large octavo volume, with 178 illustrations, "Public Health Laboratory Work," by H R Kenwood, M B, with illustrations, "Hygiene and Public Health," by Lucius C Parkes, M D, third edition, with numerous illustrations, "A Handbook of the Diseases of the Eye and their Treatment," by Henry R Swanzy, M B, F R C S I, fourth edition, illustrated with wood engravings, colour tests, etc "A Pharmacopœia for Diseases of the Skin," edited by James Startin, third edition, and "The Sanitary Inspector's Handbook and Text book for Students preparing for the Examinations of the Sanitary Institute, London," by Albert Taylor, with illustrations

MESSRS G PHILIP AND SON have in the press —"British New Guinea," a compendium of all the most recent information respecting our Papuan Possession, by J P Thomson, with valuable scientific appendix dealing with the Geology, Fauna, Flora, &c, illustrated with numerous engravings and photographs, and a coloured map, "Christopher Columbus," by Clements R Markham, C B, forming vol vii of the World's Great Explorers and Explorations, with 25 illustrations and numerous coloured maps, "The Development of Africa," a Study in Applied Geography, by Arthur Silva White, illustrated with a set of 14 coloured maps, specially designed by E G Ravenstein, F R G S, second edition, revised to April 1892, "Atlas of Astronomy," a Series of Seventy-two beautifully executed Plates, with Explanatory Notes, by Sir Robert Stawell Ball, F R S, "Astronomy for Every Day Readers," and a Popular Manual of Elementary Astronomy, by B J Hopkins, with numerous illustrations

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Sept 12 —M. Duchartre in the chair —On the heat of combustion of glycolic acid, by M Berthelot —Note on several new facts relating to the physiology of epilepsy, by M Brown-Sequard If by epilepsy is understood a group of reflex convulsive movements, it is invariably induced in guinea-pigs by cutting one of the sciatic nerves. If, however, the section has been made in the lower part of the thigh, the convulsive manifestations often are confined to the side of the lesion, and the animal retains consciousness. This is due to the regeneration of the nerve, which takes place rapidly, and which stops the development of the disease, or even cures it altogether. Generally, the greater the number of nerve fibres severed, the stronger is the tendency towards epileptic fits. A set of absolutely decisive facts have shown that a violent attack can be produced which is due to the spinal marrow alone. This epilepsy as displayed in guinea pigs is absolutely equivalent to the idiopathic or cerebral disease in man. Clinical as

well as experimental facts show that epilepsy has no special seat in the brain, but that all parts of the nervous system, central or peripheral, may give rise to it.—The meadows in the dry summer of 1892, by M. A. Chatin.—Absolute positions and proper motions of circumpolar stars, by M. F. Gonnessiat.—On a problem of analysis involved in the equations of dynamics, by M. R. Liouville.—On a recurring series of pentagons inscribed in the same general curve of the third order, which can be constructed with the sole help of the straight edge, by M. Paul Serret.—On the calorific distribution of the heat of the sun at the surface of the northern and southern hemispheres of the terrestrial globe, by M. le Goarant de Tromelin. It is sometimes thought that the fact of the sun being eight days longer in the northern hemisphere than in the southern, is the principal cause of the inequality of the distribution of heat in the two hemispheres. It can, however, be shown that the quantities of heat received by two symmetrical elements of the earth's surface, or by two caps symmetrical with respect to the earth's centre, are the same during the durations of the earth's journey comprised between two pairs of opposite vectors. Hence the total heat received by the northern hemisphere during spring and summer is equal to that received by the southern hemisphere during autumn and winter. The true cause of the difference of mean annual temperature in the two hemispheres lies in the difference of loss by radiation. By the law of cooling bodies, if two bodies have the same mean temperature, but different extremes, the one with the greatest extremes will lose most heat by radiation. Thus the southern hemisphere, which is nearer the sun in its summer and further away in its winter than the northern, will lose the greater quantity of heat.—Theory of a condenser interposed in the secondary circuit of a transformer, by M. Désiré Korda.—On the thermal variation of the electrical resistance of mercury, by M. Ch. Ed. Guillaume. The relation between temperature and conductivity was determined by comparing the resistance of a mercury standard of about one ohm at different temperatures with another standard maintained at a constant temperature, with a special arrangement to eliminate the resistances of the contacts. The formula deduced was—

$$\rho_T = \rho_0(1 + 0.00088879T + 0.00000102221T^2),$$

and the value of the standard mercury ohm—

$$106.3 \frac{\text{cm}}{(\text{microlitre})^{\frac{1}{2}}} \text{ Hg at } 0^{\circ}$$

—On a ptomaine obtained from a cultivation of *Micrococcus tetragenus*, by M. A. B. Griffiths. This Micrococcus, found associated with human phthisis, gives rise to a ptomaine if cultivated on peptonised gelatine for several days. This ptomaine is a white solid, crystallizing in prismatic needles. It is soluble in water, giving a feeble alkaline reaction. It forms a chlorohydrate, a chloroaurate, and a chloroplatinate, all crystallizable. Nessler's reagent gives a green precipitate, tannic acid a brown one, slightly soluble. The formula appears to be $C_5H_8NO_2$. It is a poison, and produces death in thirty-six hours. It is undoubtedly the product of the decomposition of the albumin by the microbe.—On echinochrome, a respiratory pigment, by M. A. B. Griffiths. Mr. McMunn discovered a brown pigment in the perivisceral fluid of certain echinoderms in 1883. This was separated by desiccating the fluid and dissolving out by chloroform. The formula of echinochrome is $C_{102}H_{99}N_{12}FeS_2O_{12}$. It serves a purpose in the body of the echinoderm analogous to that of hæmoglobine in the human body, but is not so highly developed as the latter. The respiratory pigments in the lower animals not only carry oxygen to the tissues, but also retain oxygen in combination till taken up by the cellules. Hence echinochrome, like hæmocyanine, chlorocruorine, and similar bodies, is more stable than hæmoglobine.—Physiology of the pancreas, experimental dissociation of the external and internal secretions of the glands, by M. J. Thiroloix.—Influence of some deleterious gases on the progress of anthrax infection, by MM. A. Charrin and H. Roger.—Contribution towards the aseptic method in hypodermic therapeutics, by M. Barthélémy.—On the construction of a luminous fountain with automatically variable colours, by M. G. Trouvé.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—The Locomotive Engine and its Development: C. E. Stretton (Lockwood).—Universal Atlas, Part 18 (Cassell).—Life Histories of North American Birds: C. Bendire (Washington).—Traité Encyclopédique de Photographie: C. Fabre. Premier Supplément (Paris, Gauthier-Villars).—VI. Jahresbericht (1890) der Ornithologischen Beobachtungsstationen im Königreiche Sachsen: A. B. Meyer u. F. Helm (Berlin, Friedländer).—Elementary Physiography: R. A. Gregory (Hughes).—Dynamometers and the Measurement of Power: J. J. Flather (New York, Wiley).—A Manual of Veterinary Physiology: Veterinary Captain F. Smith (Baillière).—Australische Reise: R. v. Lendenfeld (Innsbruck, Wagner).—Medical Microscopy: Dr. F. J. Wethered (Lewis).—A Dictionary of Terms used in Medicine, &c.: R. D. Hoblyn, 12th edition, revised by J. A. P. Price (Whittaker).—The Sea and the Rod: C. T. Paske and Dr. G. Aflalo (Chapman and Hall).—A Lecture Course in Elementary Chemistry: H. T. Lilley (Simpkin).—Modern Science in Bible Lands, popular edition, revised: Sir J. W. Dawson (Hodder).—A Handy Book for Brewers: H. E. Wright (Lockwood).—Reports from the Laboratory of the Royal College of Physicians, Edinburgh, vol. iv. (Pentland).—The Fauna and Flora of Gloucestershire: C. A. Witchell and W. B. Strugnell (Stroud, James).—Observations of Double Stars made at the U.S. Naval Observatory, Part 2, 1880-91: Prof. A. Hall (Washington).—Experimental Evolution: Dr. H. de Varigny (Macmillan).—Oriental Cicadidæ, Part 6: W. L. Distant (London).—Paraguay: Dr. E. de B. la Dardye (Philip).—Advanced Building Construction (Longmans).—Transactions and Proceedings of the New Zealand Institute, 1891, vol. xxiv. (Wellington).—Sea-sickness, Voyaging for Health, Health Resorts: Dr. T. Dutton, 3rd edition (Kimpton).—Bulles de Savon: C. V. Boys, traduit de l'Anglais par Ch. Ed. Guillaume (Paris, Gauthier-Villars).—Up the Niger: Capt. A. F. Mockler-Ferryman (Philip).—Earth Burial and Cremation: A. G. Cobb (Putnam).—A Vertebrate Fauna of Lakeland: Rev. H. A. Macpherson (Edinburgh, Douglas).—Contributions to Horticultural Literature: W. Paul (Waltham Cross, Paul).

PAMPHLETS.—Music in its Relation to the Intellect and the Emotions: J. Stainer (Novello).—Sadi Carnot et la Science de l'Énergie: M. G. Mouret (Paris, J. Carré).—Appendix to the Catalogue of the Flora of Nebraska: H. J. Webber.—Maryland's Attitude in the Struggle for Canada (Baltimore).—Memorial of J. Lovering (Cambridge, Massachusetts, Wilson).

SERIALS.—Quarterly Journal of Microscopical Science, August (Churchill).—Journal of the Royal Microscopical Society, August (Williams and Norgate).—Transactions of the Academy of Science of St. Louis, vol. v., Nos. 3 and 4 (St. Louis).—Notes from the Leyden Museum, vol. xiv. Nos. 3 and 4 (Leyden, Brill).—Economic Journal, No. 7 (Macmillan).—Journal of Morphology, vol. vi. Nos. 1 and 2 (Boston, Ginn).

CONTENTS

THURSDAY, SEPTEMBER 29, 1892

THE SPEECH OF MONKEYS

The Speech of Monkeys By R L Garner (London Heinemann, 1892)

IT is somewhat unfortunate, and is certainly not a little embarrassing to the critic who desires to take Mr Garner seriously, that he has chosen to present to the world "this first contribution to science on the subject" of the speech of monkeys in the form of popular and chatty anecdotes, with reflections thereon suitable for the delectation of elderly spinsters This is the style of writing to which we refer, and of which the book before us largely consists

"I shall long remember how this dear little monk (Pedro the Capuchin) would cuddle up under my chin, and try so hard to make me understand some sad story which seemed to be the burden of his life I have frequently been entertained by a like speech from little Dodo, who was the Juliet of the Simian tribe She belonged to the same species as the others, but her oratory was of a type far superior to that of any other of its kind that I have ever heard At almost any hour of the day, at the approach of her keeper she would stand upright and deliver to him the most touching and impassioned address The sounds which she used, and the gestures with which she accented them, as far as I could determine, were the same as those used by Dago and Pedro in their remarks to me as above described, except that Dodo delivered her lines in a much more impressive manner than either of the others I have not been able up to this time to translate these sounds literally, but their import cannot be misunderstood My belief is that her speech was a complaint against the inmates of the cage, and that she was begging her keeper not to leave her alone in that great iron prison with all those big, bad monkeys who were so cruel to her"

This is the anecdotal style, the heading of the chapter in which Dodo is introduced running thus "Dago talks about the Weather—Tells Me of His Troubles—Dodo in the 'Balcony Scene,'" &c It is not easy, we repeat, to deal with this kind of thing in a spirit of serious criticism And then we have passages of which the following is a sample —

"I assert that all mammals reason by the same means and to the same ends, but not to the same degree The reason which controls the conduct of a man is just the same in kind as that which prompts the ape That same faculty which guided man to tame the winds of commerce, taught the nautilus to lift its tentacles and embrace the passing breeze That psychic spark which dimly glows in the animal bursts into a blaze of effulgence in man The one differs from the other just as a single ray of sunlight differs from the glaring light of noon. If man could disabuse his mind of that contempt for things below his plane of life, and hush the siren voice of self conceit, his better senses might be touched by the eloquence of truth But while the vassals of his empty pride control his mind, the plainest facts appeal to him in vain, and all the cogency of proof is lost. He is unwilling to forego that vain belief that he is Nature's idol, and that he is a duplicate of Deity Held in check by the strong reins of theology and tradition"—and so forth for another page, and a half

These be the reflections suitable for the delectation of elderly spinsters. We must excuse ourselves from criticising Mr Garner's remarks on reason in animals, for there is no evidence in his book that he has, by a careful training in psychology, earned for himself the right of expressing a scientific opinion on this difficult question

And yet Mr Garner is at work upon an interesting and important problem in the elucidation of which scientific results will be of great value, and he is working on the right lines, namely, those of experiment and observation in close contact with phenomena It is worth while therefore, to dig out from his volume the few results of scientific value he has at present reached, to endeavour to set them in their true light, and to encourage him in the further prosecution of his labours

It is well known to all observers that animals emit sounds expressive of their emotional states, and that these sounds convey, and are often apparently intended to convey, an intimation to their fellow creatures of such emotional states No one who has watched a dog growling, a cat swearing, or a lamb bleating, can question this elementary fact The present writer has lately been observing and making experiments with young chicks Towards the close of the first week there were at least five well-distinguished sounds the soft "cheep" of contentment, the more excited note of unusual satisfaction, the complaining "weep-weep" of slight discomfort, the sharper cry when they were caught up, for example, by a strange hand, and, quite distinct from all the rest, the danger 'churr" There can be little doubt that these several sounds, as emitted by one of the chicks, were of suggestive value to its little brothers and sisters And they were quite spontaneous and not the result of imitation, for the chicks had never seen any of their kind Had these chicks been reared in the ordinary way, and not as experimental orphans, their hen mother would no doubt have given opportunity for observing that by certain sounds she could call her brood's attention to things good to eat And there can be little doubt that a dog can call its companion's attention to something worriable, though whether there are differentiations, *e g*, for cat and rat, we cannot say We have ourselves been unable to detect such differences in our own dogs

It is thus a matter of familiar observation that animals emit sounds which are of suggestive value, and that these sounds are in some cases suggestive of emotional states, and in others of external objects It is to such sounds as emitted by monkeys that Mr Garner has mainly directed his attention Let us give in his own words some of his results —

"Standing near the cage of a little Capuchin, I imitated a sound which I had translated 'milk,' but from many tests I concluded it meant 'food,' which opinion has been somewhat modified by many later experiments which led me to believe that he uses it in a still wider sense It is difficult to find any formula of human speech equivalent to it While the Capuchin uses it relating to food and sometimes to drink, I was unable to detect any difference in the sounds. He also seemed to connect the same sound to every kindly office done him, and to use it as a kind of 'shibboleth' More recently, however, I have detected in the sound slight changes of inflection under different conditions, until I am now led to believe that the meaning of the word depends somewhat, if not wholly, on its modulation"

Again —

"I approached the cage [of another Capuchin], and uttered the sound which I have described and translated

'drink' My first effort caught his attention and caused him to turn and look at me; he then arose and answered me with the same word, and came at once to the front of the cage. He looked at me as if in doubt, and I repeated the word; he responded with the same, and turned to a small pan in his cage which he took up and placed near the door, through which the keeper usually passed his food, returned to me, and uttered the word again. I asked the keeper for some milk, which he did not have, but brought me some water instead. I allowed the monkey to dip his hand into the glass, and he would then lick the water from his fingers and reach again. I kept the glass out of reach of his hand, and he would repeat the sound earnestly, and look at me beseechingly, as if to say, 'Please give me some more.' I was thus convinced that the word which I had translated 'milk,' must also mean 'water,' and from this and other tests I at last determined that it meant 'drink' in its broad sense, and possibly 'thirst.' It evidently expressed his desire for something with which to allay his thirst. The sound is very difficult to imitate, and quite impossible to write exactly."

We submit that these passages seem to indicate that Mr. Garner has not yet, in this matter, reached results which have much definiteness and precision. It would seem that the Capuchin emits sounds which are mainly expressive of a craving for something, and perhaps vaguely indicate that this something is water or other drink; though with regard to this objective implication we must remember that one of the capuchins "seemed to connect this sound to every kindly office done him."

This is one of the nine words or sounds belonging to Capuchins. Another is the sound which Mr. Garner has translated "food." Of it he says:—

"I observed that this sound seemed to be a salutation or peace making term with them, which I attributed to the fact that food was the central thought of every monkey's life, and that consequently that word would naturally be the most important of his whole speech."

Another sound which was emitted by a monkey when a storm was going on, and which, when reproduced by the phonograph, made the little fellow look out of window, Mr. Garner translated "weather," or thought that it "in some way alluded to the state of the weather." But he does not seem quite clear about it.

"I am not sure," he says, "how far it may be relied upon as a separate word. It was so closely connected to the speech of discontent or pain, that I have not been able since to separate the sounds, and I finally abandoned it as a separate word; but reviewing my work, and recalling the peculiar conduct of this monkey and the conditions attending it, I believe it is safe to say that he had in mind the state of the weather."

Three other sounds are plainly emotional in their nature—(1) an alarm sound, used under stress of great fear, high in pitch, shrill and piercing; (2) a sound written thus "e-c-g-k" expressive of apprehension; and (3) a sound which is like a guttural whisper "c-h-t" expressive of the approach of something which the monkey does not fear.

Such are some of the sounds which Mr. Garner misnames (as we think) the "speech" of monkeys, and concerning which he exclaims:—

"Standing on this frail bridge of speech, I see into that broad field of life and thought which lies beyond the confines of our care, and into which, through the gates that I have now unlocked, may soon be borne the sunshine of human intellect. What prophet now can foretell the relations which may yet obtain between the human race and those inferior forms which fill some place in the design, and execute some function in the economy of nature?"

This, however, is one of those reflections which savour of the prattle of the parlour tea-table rather than the sober discussion of the study. We should rather say that Mr. Garner's investigations, if followed up in a spirit of critical accuracy, give promise of enabling him to extend our knowledge of the sounds emitted by monkeys—sounds which, we gather from his descriptions, are mainly, if not entirely, of emotional origin, but which may perhaps carry with them a more or less definite objective import. We are of opinion that such extension of our knowledge of these emotional or other sounds may prove a definite and valuable contribution to science, and we therefore heartily wish Mr. Garner all success in the prosecution of his inquiry.

C. Ll. M.

BEE-KEEPING.

Bees for Pleasure and Profit. By G. Gordon Samson. (London: Crosby Lockwood and Son, 1892.)

"HOW doth the little busy bee, &c.?" asked Dr. Watts a hundred and fifty years ago. So long as straw skeps predominated, the problem was insoluble. The bees improved each shining hour in perfunctory fashion, building crooked combs, confusing brood with honey, exhausting their republic with superfluous swarms, dying finally in the smoke-reek of an old pair of corduroys, enriched for malarious exhalation by more than one generation of bucolic wearers. With frame hives came an Earthly Providence to answer the pious query; to control the economy of the hive, to prescribe the number of drones, multiply or restrict the queens, straighten out the combs, combine defective stocks into a single opulent society, disintegrate an overgrown community into new and independent nuclei, supplement the tardy growth of brood or honey, increase fourfold the productiveness of every hive. It is as an adept in Providential operations that Mr. Samson writes. He renounces scientific erudition; and his allusion to "powerful microscopes," his reliance on "wonderful provisions of Nature," his belief that by confining their visits to one kind of flower in a single journey the bees prevent the hybridization of species, show his disclaimer to be correct; but apiarian science was brought up to date last year in Mr. Cowan's admirable book (NATURE, vol. 43, p. 578), leaving room for just such a practical treatise on manipulation and management as Mr. Samson is competent to give.

No repetition can exhaust the interest attaching to the strange life-history of the hive bees. While the solitary bees are created male and female, there appears in the gregarious bees a third sex, the workers or neuters (not *neutrals*, as Mr. Samson calls them), having rudimentary ovaries and spermatotheca, incapable of laying eggs, with the ovipositor modified into a sting; themselves, in queenless hives, sometimes developed into more advanced yet still imperfect females, known as fertile workers, and producing only drones. In ordinary cases a single queen is the mother of the entire hive, bearing drone eggs only in her virgin state, fecundated once for all by a solitary nuptial act for the production of more

than half a million of offspring During twenty-one days as egg, larva, pupa, the infant bee resides in the comb, fed by its older sisters on a paste of brood-food or chyle, to which in the case of workers honey is added after the first three days For a week after emergence the young bee remains at home in order to secrete wax, which is detached from the wax pockets by others, it is then promoted to the office of nurse, for a fortnight or three weeks afterwards it gathers honey, spends its maturity in the difficult work of comb-building, dies at the end of six or seven weeks, unless winter hibernation arrests its labour and prolongs its life The moral of its unique biography has been pointed by many writers, the social lesson of its communistic orderliness, the industrial ideal flowing from its co-operative toil and profit, the political example impressed by the curious completeness with which, at once a red republican and an ardent cavalier, it combines extremest democratic sturdiness with devoted personal loyalty

The common hive bee, as distinguished from the Bumble, Carpenter, Mason, and other bees, belongs to the genus Apis, of which one species only, *A mellifica*, is indigenous to Britain During the last few years the Ligurian, Carniolian, and Syrian bees have been largely introduced, from amongst which the cross known as Syrio-Carniolian bears the palm for fecundity, docility, honey-gathering, and hardiness through the winter With a swarm of these and a ten-frame hive the tyro may begin bee-keeping In manipulating he must not wear gloves, they make the fingers clumsy, and the sting, painful at first, causes diminishing inconvenience on each successive infliction, till the system is inoculated by the acid, and the sting is harmless In creating their new home the bees require assistance, one or two frames of brood-comb from the parent hive, with a limited number of drone cells, must be inserted As the frames fill, the master, utilizing the fact that honey is always stored above the brood, places "supers" over the frames, removing them as fast as they are filled, while the full-charged combs from below are placed in an extractor and the liquid honey is withdrawn As much as 100 pounds of honey have sometimes been thus obtained in one season from a single hive The honey harvest begins with the blooming fruit trees in early spring, and slackens after the lime trees fade, but in heather districts a rich autumn store is raised, and Scottish bee-keepers, having reaped the early crop from bean and clover, send their hives by rail or boat to a considerable distance, to be placed upon the heath-clad moors in early August When an unfavourable winter has depopulated the hives, it is possible to build up one strong colony out of two or more weak stocks, retaining only the youngest and most prolific queen The bees will resent the coalition, and a general fight will impend, but if sprinkled with thin syrup and with flour their power of discerning Trojan from Tyrian is cancelled by the identity of appearance and o scent.

> "Just so the prudent husbandman, that sees
> The idle tumult of his factious bees,
> Powders them o'er, till none discern his foes,
> And all themselves in meal and friendship lose.
> The insect kingdom straight begins to thrive,
> And all work honey for the common hive."

Mr. Samson does well to press the economic value of bees not only as honey-makers, but as fruit-setters. In cold sunless springs their agency is essential to the fertilization of the bloom, in districts adjoining a large apiary the fruit trees are invariably laden with heavy crops, deteriorating as we remove further from its neighbourhood, and instances are well authenticated from the cider counties in which a general destruction of bees by a long and variable winter has been followed by the loss of the apple crop Both fruit and honey are at present for the most part imported from abroad, if fruit is to be largely cultivated in the small holdings of the future, it must be sustained and enriched by bee-keeping

In this, as in other industries, there are occasional difficulties baffling to all but experts Queens will refuse to be reared, supers will remain unfilled, stocks will need stimulation in the spring and building up in early winter, foul brood, deadliest of bee maladies, will infect the hive In all such complications and for many more Mr Samson offers full and clear instruction Portable in form and cheap of cost, his book should form part, along with "smoker," bee veil, queen cage, "driving irons," and "doubling box," of every bee-keeper's equipment

W TUCKWELL.

A NEW COURSE OF CHEMICAL INSTRUCTION

A New Course of Experimental Chemistry, with Key By John Castell-Evans, F I C (London Thomas Murby)

THE basis of the course of instruction here put forward consists in making the student perform an experiment with a definite object in view The result of the experiment is carefully withheld, and must be discovered by the student himself In this way he is led to acquire knowledge by his own exertions, and theoretically at least such a method has more to recommend it than any other In practice, however, the time required to rigorously carry out this system is no doubt an obstacle to its general adoption.

If with the author we lay down the law that "the student must not be allowed to use any chemical *name* or *term* until he has discovered for himself the *thing* or *process* represented by it," to acquire but a moderate knowledge of the chemistry of to-day appears well-nigh an impossibility It was thus a matter of interest to see how a work based on this system could be comprised within reasonable limits of space The author, however, does not seem to intend the above restriction to be literally enforced To go no further than the first lesson, we find the student employing the ordinary chemicals, phosphorus, ammonium nitrite, potassium chlorate, &c, things which he makes no attempt to discover, only in the case of the more important processes and substances usually met with in a chemical course is any such attempt made.

The book consists of two parts The first part contains a series of experiments and problems, the latter being set upon a course of lectures which are intended to be given concurrently with the laboratory instruction, and which deal more especially with the physical aspect of the subject Outlines of these lectures, results of the experiments, and full solutions of the problems are to be found in the Key, which may be obtained separately or bound up with the

two parts The experiments start off with the commonly occurring phenomena of combustion, and lead up to the laws of chemical combination, the determination of chemical equivalents, vapour densities, &c

Part II consists of qualitative and quantitative analysis taken together, no attempt being made to separate the two The results of the experiments are here carefully withheld from the student, and are given in the Key A useful table for the detection of the positive radicles is published separately, and may be used in connection with this part

The book can be recommended as a trustworthy one, and, apart from the novelty of the system adopted, as a storehouse of knowledge useful to the chemist, it will be appreciated by many a teacher

The problems are actual examples met with in the laboratory, and appear to be free from the artificial exercises so common in text books It is also noteworthy that they, as well as the lectures, are concerned to a considerable extent with the energy changes as well as with the material changes which constitute chemical phenomena

In glancing at the tables of physical constants to be found as answers in the Key, it is frequently noticeable that these magnitudes are given to an accuracy which is altogether fictitious For example, to express heats of vaporization or absorption coefficients to one part in thousands of millions, or to give a boiling point such as that of bromine to one thousandth of a degree Fahrenheit, tends to create an erroneous idea of the accuracy with which such determinations can be made In one or two instances the information is not quite up to date Hydrofluoric acid, for instance, is still formulated H_2F_2, and Bunsen's values for the absorption coefficients of hydrogen and oxygen are still given, although they have been superseded by the observations of Winkler and Timoféef Van der Waals's work might have been included in the otherwise serviceable account of the kinetic theory of gases, and it is somewhat unfortunate that the author insists upon the narrow view that specific gravity has no other meaning than that which is perhaps more correctly attributed to relative density

The printing and the woodcuts are hardly up to the standard usually attained in books of this kind

J W R

OUR BOOK SHELF

Die Pflanze in ihren Beziehungen zum Eisen Von Dr Hans Molisch Iron in its Relations to Plant-life 8vo, 119 pages, with one coloured plate (Jena Gustav Fischer, 1892)

AN interesting essay on the presence, function, and form of iron in plants, embodying the results of previous investigators and of the author's experiments and researches extending over several years Though the outcome of much labour, Dr Molisch regards it as preliminary to more extended inquiries, and the whole subject as being yet in its infancy He discusses the determination of the presence in the vegetable cell of iron in loose combinations and in dense combinations, or what he terms the masked condition He then describes the occurrence and distribution of iron in plants in loose and dense combinations, and enters somewhat fully into the description of a new method he claims to have discovered for proving the existence of iron in the masked condition, even when it is present only in infinitesimally small quantities This is done by soaking the objects one or more days or weeks in saturated aqueous liquor potassæ, and then, after quickly washing them in pure water, subjecting them to the usual reagents He further claims to have proved that iron is not one of the constituents of chlorophyll There is also a short chapter on healing vegetable chlorosis by the use of chloride of iron, sulphate of iron, and other salts of iron W B H

Up the Niger By Captain A F Mockler-Ferryman (London George Philip and Son, 1892)

SEVERAL years ago complaints were made about the conduct of various British subjects in the territories placed under the Royal Niger Company The British Government accordingly sent Major Claude Macdonald to inquire into the matter He was accompanied by Captain Mockler-Ferryman, who in the present volume gives a full account of the proceedings of the Mission During the entire journey, which extended over more than 3000 miles, nothing "of a blood-curdling nature" occurred, so that any one who is attracted to books of travel mainly by the chance of finding them full of sensational narratives, need not trouble himself with Captain Mockler-Ferryman's pages On the other hand, those who like to read about remote regions and their native inhabitants, will find in this book much to interest them The author is an accurate observer, and notes in a clear and unpretending style the facts by which his attention has been most strongly attracted His descriptions of the native tribes of the Niger country, so far as he himself observed them, are particularly good, and will not only please the general reader, but be of service to ethnologists and anthropologists A capital chapter on music and musical instruments, prepared from materials collected by the members of the mission, is contributed by Captain C R Day, and the value of the volume as a whole is much increased by a map and illustrations

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications*]

Density of Nitrogen

I AM much puzzled by some recent results as to the density of *nitrogen*, and shall be obliged if any of your chemical readers can offer suggestions as to the cause According to two methods of preparation I obtain quite distinct values The relative difference, amounting to about $\frac{1}{1000}$ part, is small in itself, but it lies entirely outside the errors of experiment, and can only be attributed to a variation in the character of the gas

In the first method the oxygen of atmospheric air is removed in the ordinary way by metallic copper, itself reduced by hydrogen from the oxide The air, freed from CO_2 by potash, gives up its oxygen to copper heated in hard glass over a large Bunsen, and *then* passes over about a foot of red hot copper in a furnace This tube was used merely as an indicator, and the copper in it remained bright throughout The gas then passed through a wash bottle containing sulphuric acid, thence again through the furnace over *copper oxide*, and finally over sulphuric acid, potash, and phosphoric anhydride

In the second method of preparation, suggested to me by Prof Ramsay, everything remained unchanged, except that the *first* tube of hot copper was replaced by a wash-bottle containing liquid *ammonia*, through which the air was allowed to bubble The ammonia method is very convenient, but the nitrogen obtained by means of it was $\frac{1}{1000}$ part *lighter* than the nitrogen of the first method. The question is, to what is the discrepancy due?

The first nitrogen would be too heavy, if it contained residual oxygen. But on this hypothesis something like 1 per cent would be required. I could detect none whatever by means of alkaline pyrogallate. It may be remarked the density of this nitrogen agrees closely with that recently obtained by Leduc, using the same method of preparation.

On the other hand, can the ammonia-made nitrogen be too light from the presence of impurity? There are not many gases lighter than nitrogen and the absence of hydrogen, ammonia, and water seems to be fully secured. On the whole it seemed the more probable supposition that the impurity was hydrogen, which in this degree of dilution escaped the action of the copper oxide. But a special experiment appears to exclude this explanation.

Into nitrogen prepared by the first method, but before its passage into the furnace tubes, one or two thousandths by volume of hydrogen were introduced. To effect this in a uniform manner the gas was made to bubble through a small hydrogen generator, which could be set in action under its own electromotive force by closing an external contact. The rate of hydrogen production was determined by a suitable galvanometer enclosed in the circuit. But the introduction of hydrogen had not the smallest effect upon the density, showing that the copper oxide was capable of performing the part desired of it.

Is it possible that the difference is independent of impurity, the nitrogen itself being to some extent in a different (dissociated) state?

I ought to have mentioned that during the fillings of the globe, the rate of passage of gas was very uniform, and about ½ litre per hour.

RAYLEIGH

Terling Place, Witham, September 24

Recent Spectroscopic Determinations

IN the September number of the *Philosophical Magazine* Mr. Michelson has published determinations, by a most interesting method, of very close double and multiple lines. In any attempt to interpret his results, it is necessary to bear in mind the profound modifications which the internal motions of a gas—the rectilinear motions of the molecules between their encounters, as well as the motions going on within each molecule—had undergone within the Geisler's tubes upon which he experimented.

In a gas under ordinary circumstances the rectilinear journeys of the molecules take place indifferently in all directions, and where this is the case it follows from the well known relation between the surface of a sphere and that of its circumscribing cylinder, that the effect of the velocities which happen to lie between ν and $\nu + \delta\nu$ is to substitute for each line of the spectrum of the gas a band of uniform intensity and without nebulous edges, the width of which can be calculated. This width, for example, is .04 of an Angstrom or Rowland unit (the tenthet metre), in the yellow part of the spectrum and for velocities of the molecules which lie in the neighbourhood of two kilometres per second, which is about the average velocity of molecules of hydrogen at atmospheric temperatures. Hence with all the velocities that prevail among the molecules, the effect of the rectilinear motions under ordinary circumstances is that each line will be symmetrically widened and rendered nebulous. To this effect Mr. Michelson calls attention.

But in the residual gas of a Geisler's tube through which electricity is passing, the case is altogether different. Here the rectilinear motions of the molecules are not alike in all directions, but preponderate in some: a state of things which must at least double the lines, and may introduce greater complications.

Moreover, different lines may be differently affected, since the behaviour of the gas varies according to its position between the electrodes, as is evidenced by the observed differences in the form and colouring of the striæ, &c., in the several parts of a Geisler's tube.

We must also be on our guard in another respect, when we attempt to interpret the results, since the distribution of the heat energy of a gas between the rectilinear motions of its molecules and the motions within the molecules, which in the case of ordinary gas is a fixed ratio, is certainly largely departed from in gas through which electricity is passing. Until the laws of the new distribution are understood, the temperature of the gas, judged of by its behaviour to neighbouring bodies, will give us little information.

It is to such events as are referred to above, or others which like them may arise from the special circumstances under which the vapour of sodium was in Mr. Michelson's experiments, that we must apparently turn for an explanation of the doubling of the constituents of the principal pair of sodium lines which he has detected; since he found that "the width of the lines, their distances apart, and their relative intensities vary rapidly with changes in temperature and pressure."

The method of investigation which Mr. Michelson has so successfully applied appears to be by far the most searching means yet discovered of experimentally investigating the intricate and obscure phenomena which present themselves in Geisler's tubes, and we seem justified in hoping for great results from it.

G. JOHNSTONE STONEY

9, Palmerston Park, Dublin, September 22

Printing Mathematical Symbols

EVERYONE who has had to correct printers' proofs of mathematical formulæ must be painfully alive to the pitfalls into which the non-mathematical compositor continually blunders. To such as know the extreme difficulty of getting such formulæ properly set up, there have doubtless occurred from time to time suggestions for such simplifications of notation as shall render the composition less liable to derangement. One most sensible step of the kind I allude to is the introduction by Sir G. Stokes of the solidus notation for quotients, whereby

$$\frac{dy}{dx} \text{ is now written } dy/dx$$

The immediate purpose of this letter is not to propound any wholesale scheme of reform, but to advocate one other simple step, and to induce some of my *confrères* to give the world their own suggestions.

Exponentials are a continual stumbling-block to the compositor, and to the printer's reader, who, when he comes to an expression like

$$A\epsilon^{-ax},$$

does his best to make it look a little straighter and turns it into

$$A\epsilon - ax,$$

or into

$$A_\epsilon - ax,$$

or perhaps worse.

The reform I advocate is to write the thing as follows:—

$$A \exp[-ax],$$

the square brackets being possibly omitted in all cases when their omission would occasion no confusion. One gain in this notation is the reduction of the whole of the symbols to one level, so not breaking the line of type.

Another useful reform, though one on which I fear the probability of agreement is less likely, is the use of the Continental notation for inverse trigonometrical functions, writing, for example,

$$\text{arc tan } x,$$

instead of

$$\tan^{-1} x$$

for the angle whose tangent is x. Our notation is not only liable to continual misprinting, but is very confusing to Continental readers, who again and again read the latter expression as meaning

$$(\tan x)^{-1}, \text{ or cotan } x$$

I have even seen it reprinted in a German technical journal as

$$\tan - 1x$$

SILVANUS P. THOMPSON

Technical College, Finsbury, September 22

A so-called Thunderbolt

DURING a short storm in Liverpool this summer, I noticed one flash as peculiarly sharp and noisy, and subsequently in the correct bearing from my house the ground was reported as having been struck by a thunderbolt. I examined the place, which was on the greensward of a lake, where the ground was penetrated by a number of fairly clean cut almost vertical holes down which a walking-stick could be thrust. People sheltering near the lake reported a ball of fire and a great splash up of the

water The odd circumstance about the damage was that it occurred on a simple grass slope, about half way between a tall boat house on the one side and a drinking fountain standing on more elevated ground on the other Small trees also were in the neighbourhood, and there was no apparent cause why the flash should have selected this particular spot, though indeed it was not within any of the ordinarily accepted "areas of protection" A gentleman—Mr Hewitt—proposed digging for the meteor, and although fairly convinced that it was nothing but an ordinary flash, we thought it just possible that an accidental meteorite might have fallen during the thunderstorm, in which event a flash down the rarefied air of its trail would be a natural consequence It may be just possible that the popular belief in thunderbolts has some such foundation

At any rate the excavation was made, with the result of proving that it was an ordinary flash and that the lightning made use of a surface drain pipe, about four feet deep, to get at the water of the lake

I enclose Mr Hewitt's report OLIVER J LODGE

DURING a thunderstorm on the afternoon of Sunday, July 3, 1892, what is described as a "ball of fire" was seen by several persons to descend to the ground, near the south end of the lake in Sefton Park, and immediately afterwards a column of water, about sixty feet high, was shot up from the lake On examining the spot where the ball of fire was seen to descend, several clean cut holes were observed, and a sod was also found at a little distance from the spot.

A few days afterwards an excavation was carefully made The sod being removed, the holes were traced down to a surface drain pipe four feet below the surface At this drain the holes terminated, and the pipe was found shattered The important holes were found to be six, the largest being seven inches in diameter, the others about two inches No meteoric matter was found, but it seems curious that this effect was brought about by a flash of lightning only in an open space of sloping grass, when there were trees and houses close by

Aigburth, Liverpool GEORGE H HEWITT

Peripatus Re-discovered in Jamaica

MRS E M SWAINSON has been so fortunate as to find on Beacon Hill, near Bath, three specimens of *Peripatus*, which she has sent to the Institute of Jamaica The species is doubtless identical with that found by Gosse many years ago at the other end of the island Of the two specimens which we have studied, one has 36 pairs of legs, and is dark pinkish-brown, with the ends of the antennæ pure white, in striking contrast, the other is smaller and darker, without white ends to the antennæ, and with only 29 pairs of legs The third example, which we have still alive, is larger, but dark in colour Full details will be given elsewhere later on, and it may suffice for the present to state that the species is very closely allied to *P Edwardsii* from Venezuela, as described by Sedgwick, but differs in the greater number of legs and the white tipped antennæ of certain individuals (probably the females), in the only slightly curved (not hooked) claws, in the differentiation of the papillæ into two distinct kinds on the dorsal surface, and apparently in other minor matters There is no dark dorsal line The genital orifice is between the penultimate pair of legs, and the jaws are almost precisely as in *Edwardsii* The Jamaican species being evidently new, it is proposed to call it *Peripatus jamaicensis*

M GRABHAM

September 5 T D A COCKERELL

Reflection on Valley Fog

A LETTER from an observer at the Lick Observatory appeared in NATURE on August 25, reporting the reflection of mountains in a valley fog I was therefore much interested to note the following in the *Yorkshire Herald* of September 7 —

"SIR,—Possibly it may interest your readers to hear of a natural phenomenon I noticed this morning before 6 a m Overlooking, from Leyburn, the valley of Wensleydale, it appeared as though more than half of the dale was filled with water, like a great lake with rising hills on either side, and these hill-sides, above the level of the (apparent) flood, were distinctly reflected in it The sun was shining brightly at the time, but almost immediately the mist began to disperse, and the mirage faded away What struck me as unusual was the extraordinary distinctness of the reflection Yours, AN EARLY RISER September 5, 1892"

In both cases the reflecting film seems to have been near its vanishing point J EDMUND CLARK

Impure Water in Bread

SOME accurate answers to the following questions would be desirable, in view of public health

(1) What bacilli—if any—can survive in the amount and duration of the heat of baking in the interior of unfermented bread?

(2) What is the further effect of the carbonic acid of fermentation?

(3) What is the effect of the water being highly carbonated without fermentation, as in aerated bread?

W M I P

The Comets of Brorsen (1846 VII) and Brooks (1892 "d")

THE elements of Brooks's comet "1892 *d*," as computed by Berberich from four observations made between August 31 and September 5, bear a strong resemblance to those of Brorsen's comet of 1846, calculated by Oudemans, the figures being —

	Comet Brorsen (1846 VII)	Comet Brooks (1892 *d*)
T	1846 June 5 479	1892 Dec 19 727
	° ′ ″	° ′ ″
ω	260 12 50	269 24 27
☊	261 53 12	261 2 55
i	29 18 17	27 57 8
Log q	9 80188	9 84455

Brorsen's comet of 1846 was visible to the naked eye on May 14 of that year It was supposed to be revolving in an elliptical orbit, with a period of about 400 years W F DENNING

Bristol, September 22

NOTE ON THE PROGRESS OF THE DIOPTRIC LENS AS USED IN LIGHTHOUSE ILLUMINATION

FRESNEL, in 1820, devised and constructed a lens for first order lights of 920 mm radius It was composed of a plano convex lens, with five refracting prisms concentric with it, and four segments of rings in the corners all gradually decreasing in breadth as they receded from the centre The separate pieces of which these lenses were made up were cemented together and mounted in metallic frames 30 inches square

In 1835, the late Mr Alan Stevenson introduced the French apparatus into Great Britain In doing so he made several improvements, one of which was that he increased the height of the lens from 30 to 39 inches, at the same time diminishing the thickness of the glass This refractor had eight prisms above and eight prisms below the central lens From that time Alan Stevenson's lens was almost universally used until a comparatively recent date, when a revolution in the size of lenses took place

A few years ago inventors were trying to obtain greater power by increasing the diameter and volume of the flames, but Messrs Stevenson pointed out, in 1869, that after a certain point an increase of diameter of the luminary not accompanied by a corresponding increase of the radius of the apparatus was a mistake, as the light became ex-focal and divergent, and that the proper way to secure greater power was to enlarge the *diameter* of the apparatus In 1885 they had a lens made to their design of 1330 mm radius, and having a height of 5 feet This lens, which was named "Hyper-radiant," was tried at the South Foreland against other lenses, and with a large 10-ring gas burner it was found to give a light from one and a half to twice as intense as the ordinary lenses which were pitted against it, with the same large burners in their foci, thus proving conclusively that to get the power out of large burners it was imperatively necessary

to increase the diameter of the apparatus. In 1883 Messrs. Stevenson got an offer from Messrs. Barbier for a lens of 1840 mm. focal distance.

All refracting lenses from the day of Alan Stevenson were cylindrical for fixed lights and plano-convex for revolving lights, and no alteration of any moment has been made in the mode of their construction until 1888, when, instead of making the lenses cylindrical or plano-convex, I proposed to give them a spherical form, that is to say, circular not only in the horizontal but also in the vertical section. This design was carried into practice in the apparatus for one of the Fair Isle Lighthouses. The introduction of the spherical refractor has made practicable the construction of very much larger and consequently more powerful apparatus, and occupying much less space both in the daylight size and diameter of lantern, and, hence, diameter of tower. It has rendered practicable the quadrilateral arrangement with hyper radiant lenses which have already been erected at Fair Isle, the lenses being cut so as to give two flashes from each side of the quadrilateral. An experimental lens made for Mr. Wigham is to be tried in Ireland. It is 2m. focal distance, and the spherical refractor is 7 feet 6 inches diameter, and will give one flash from each side of the quadrilateral. M. Barbier says that in making this lens he was attempting to give the most powerful flash possible, and he adopted the spherical refractor. In this case, however, the spherical refractor has been carried, in my opinion, rather far, except in the view of economy in keeping the angles of the whole apparatus within reasonable limits, which is only possible (in an apparatus of 4m. diameter) by the use of the spherical refractor, and by its being made to subtend a great angle. When I proposed this form I pointed out that there was a loss of efficiency if it subtended more than 40°, now M. Barbier has made the spherical portion subtend 64°, or 24° farther, and 8° farther than any spherical refractor yet made. The great amount of light which I experimentally found re-

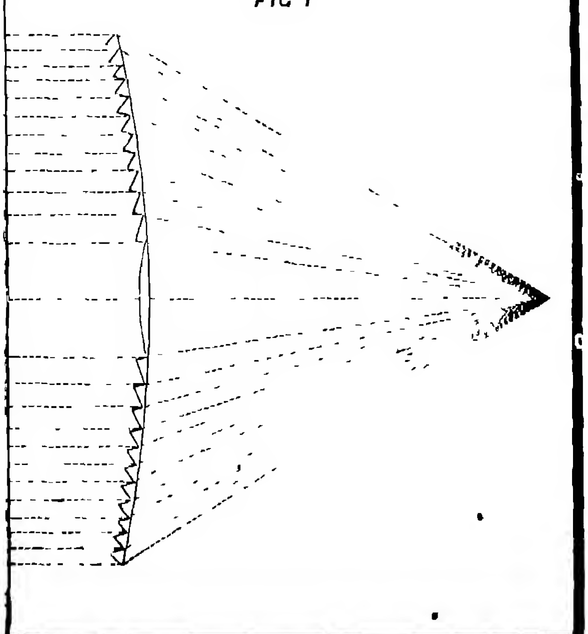


FIG. 1.

turned from the inner face of the spherical refractor made for Fair Isle, however, shows that up to 20°, and perhaps farther, it is ample to make up for any loss of light caused by the greater divergence which takes place *in* the spherical refractor, and which would be a *small* source of loss in a revolving light, but would better illuminate the nearer sea in a fixed arc.

Equiangular Refractor.

To obviate the loss of light at the outer face of the lenses, especially those remote from the focal plane—a

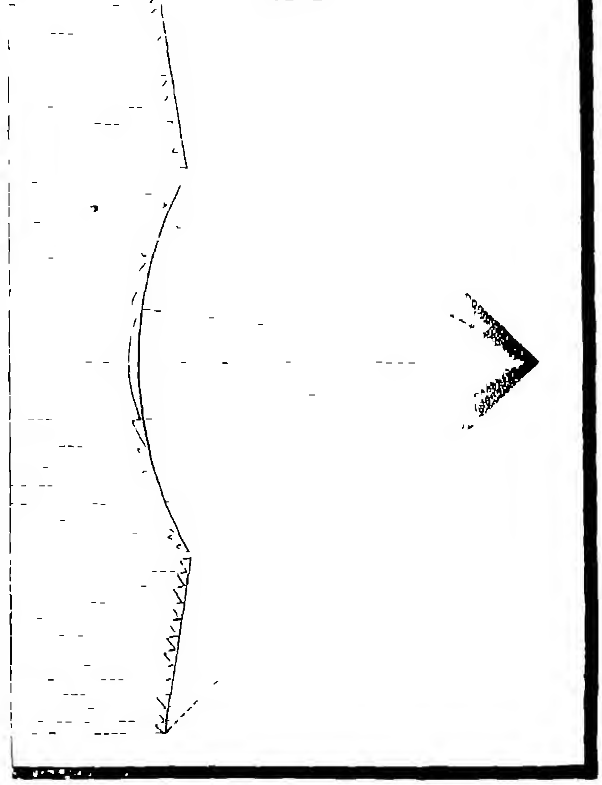


FIG. 2.

loss which stops the refractor being carried with due regard to efficiency farther than 30° to 40° in the cylindrical form, and 20° in the spherical form—it will be found that the most efficient form is a refractor which I proposed, with the inner face of each lens doing equal work with the outer face, or nearly so—and by a careful study of such a refractor it will be found that the locus of the centres of curvature of each refracting lens lies outside the refractor, and at points below the focal plane, and more and more remote from the lens, as the lenses are more and more remote from the focal plane, and that the inner face of the refractor ought, in fact, to be a parabolic curve (Fig. 1). This can very closely be approximated to by a circular curve with a suitably chosen centre on the focal line produced, but the centre is so far distant that when the spherical form and the equiangular form are used in combination (Fig. 2), the inner face of the equiangular prisms above and below it may, with sufficient accuracy, be made straight and leaning outwards in place of being vertical as in Fresnel's form. By the combination of the spherical refractor and the equiangular, or a refractor of the equiangular form alone, the defect in Fresnel's refractor, namely the loss of light at emergence from the lenses, especially those remote from the focal plane, is avoided, and the refractor may thus be made to subtend an angle which has hitherto been considered inexpedient, with glass of the ordinary

refractive index of 1 53 The equiangular prisms cause less loss of light by absorption and reflection than either the spherical or Fresnel refractors, and also act on the light so that ex-focal light is better dealt with, thereby reducing the divergence

CHARLES A STEVENSON

MODERN DYNAMICAL METHODS

A DYNAMICAL system is said to possess a *given* number of degrees of freedom, when it is capable of assuming the *same* number of independent positions The position of the system, in any possible configuration, is capable of being determined by a definite number of independent quantities, which are equal to the number of degrees of freedom of the system These quantities are called the co-ordinates of the system

When the system possesses six degrees of freedom, the motion may be completely determined by expressing in mathematical language a principle which may be conveniently termed the *principle of momentum* This principle is specified by the following two propositions — (i) *The rate of change of the component of the linear momentum, parallel to an axis, of any dynamical system, is equal to the component, parallel to that axis, of the impressed forces which act upon the system*, (ii) *the rate of change of the component of the angular momentum about any axis, is equal to the moment of the impressed forces about that axis* Since the motion of the system may be referred to any set of fixed or moving rectangular axes, the above-mentioned dynamical principle furnishes six equations connecting the six co-ordinates, which, when integrated, will determine the latter in terms of the time and the initial circumstances of the motion

The various ways of expressing this dynamical principle in mathematical language are explained in treatises on dynamics and a variety of special forms and particular cases are obtained, by means of which the solution of numerous problems can be simplified For example, Euler's equations, for determining the motion of rotation of a single rigid body about its centre of inertia, is a particular case of the second proposition, whilst Kirchhoff's equations, for determining the motion of a single solid in an infinite liquid, is a special form of both propositions

When a conservative system possesses seven degrees of freedom, the motion may be completely determined by means of the principle of momentum combined with the principle of energy The first principle, as we have already shown, furnishes six equations, whilst the second furnishes one, hence, we have a sufficient number of equations for determining the motion

When a dynamical system possesses more than seven degrees of freedom, the principles of momentum and energy are insufficient to determine the motion, and under these circumstances, the most convenient method to adopt is to use Lagrange's equations, but inasmuch as these equations are double-edged tools, which are apt to cut the fingers of the unwary, their employment requires considerable care

The kinetic energy of a dynamical system can be expressed in a variety of different forms, but it will only be necessary to mention the following three In the first form, it is expressed as a homogeneous quadratic function of velocities, which are the time variations of the co-ordinates of the system This form, which will be denoted by T, is called the *Lagrangian form*, it is the only one which it is permissible to use when employing Lagrange's equations, and many mistakes have been made by persons who have attempted to use some other form.

In the second form, which is called the *Hamiltonian form*, the kinetic energy is expressed as a homogeneous quadratic function of the momenta of the system If θ be any co-ordinate, and Θ the generalized momentum of type θ, it is known that

$$\frac{\partial T}{\partial \dot\theta} = \Theta \qquad (1)$$

whence Θ is a linear function of the velocities Hence, if the velocities be eliminated from the Lagrangian expression for the kinetic energy by means of (1), it follows that the latter will be expressible as a homogeneous quadratic function of the momenta Θ, which is the Hamiltonian form We shall denote this form by $\mathfrak{T}$

Lagrange's equations are

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot\theta}\right) - \frac{\partial T}{\partial \theta} = - \frac{\partial V}{\partial \theta} \qquad (2)$$

where V is the potential energy, and if the elimination be performed, we shall obtain

$$\frac{d\Theta}{dt} + \frac{\partial \mathfrak{T}}{\partial \theta} = - \frac{\partial V}{\partial \theta} \qquad (3)$$

we have also the reciprocal relation

$$\frac{\partial \mathfrak{T}}{\partial \Theta} = \dot\theta \qquad (4)$$

Equations (3) and (4) are Hamilton's equations of motion

The third form of the expression for the kinetic energy is of special importance in hydrodynamics and other branches of physics It sometimes happens that a quantity occurs which can be recognized as a momentum, or as a quantity in the nature of a momentum, whilst the velocity corresponding to this momentum is either unknown or would be inconvenient to introduce This occurs in problems relating to the motion of perforated solids in a liquid, when there is circulation, and is a particular case of Dr Routh's theory of the "Ignoration of Velocities"[1] We therefore require a form of Lagrange's equations in which certain velocities are eliminated, and are replaced by the corresponding momenta

Let the co-ordinates of the system be divided into two groups, θ and χ, and let κ denote the generalized momentum corresponding to χ Then

$$\frac{\partial T}{\partial \dot\chi} = \kappa \qquad (5)$$

By means of (5) all the velocities $\dot\chi$ can be eliminated from the expression for the kinetic energy, and it is remarkable, that the result of the elimination does not contain any products of the form $\kappa\dot\theta$ The expression for T may accordingly be written

$$T = \mathfrak{T} + \mathfrak{K} \qquad (6)$$

where $\mathfrak{T}$ is a homogeneous quadratic function of the velocities $\dot\theta$, and $\mathfrak{K}$ is a similar function of the momenta κ

Equation (6) is therefore a mixed form, which is partly Lagrangian and partly Hamiltonian We now require the corresponding form of the equations of motion in which all the χ's have been eliminated from Lagrange's equations

From (1) it follows that the generalized momentum Θ is a linear function of the velocities $\dot\theta$, $\dot\chi$, and if the latter velocities be eliminated by means of (5), it follows that Θ is expressible as a linear function of $\dot\theta$, κ Let the portion which is a linear function of the κ's be denoted by $\bar\Theta$, then it can be shown, that if

$$L = \mathfrak{T} + \Sigma(\bar\Theta\dot\theta) - \mathfrak{K} - V \qquad (7)$$

the equation of type θ is

$$\frac{d}{dt}\frac{\partial L}{\partial \dot\theta} - \frac{\partial L}{\partial \theta} = 0 \qquad (8)$$

[1] Having regard to the object of the theory, I think the phrase "Ignoration of Velocities" is better than "Ignoration of Co-ordinates."

whilst that of type χ is

$$\frac{d\kappa}{dt} - \frac{\partial \mathfrak{I}}{\partial \chi} = 0 \tag{9}$$

We have also the additional equations

$$0 = \frac{\partial \mathfrak{T}}{\partial \theta} + \Theta \tag{10}$$

$$\chi = \frac{\partial \mathfrak{K}}{\partial \kappa} - \Sigma\left(\theta \frac{\partial \Theta}{\partial \kappa} \right) \tag{11}$$

Equations (7) to (11) were first given by myself in a paper published in the Proc Camb Phil Soc for 1887, and it will be observed that they include the equations of Lagrange and Hamilton A form of the modified Lagrangian function, which is equivalent to (7), was given by Dr Routh a few years previously, but it is not of much practical use, owing to the fact that the elimination of the velocities χ has not been performed

It sometimes happens that the *co-ordinates* of the type χ do not enter into the expression for the energy of the system, in which case they are called *ignored co-ordinates*,[1] under these circumstances it follows from (9), that all the momenta κ are absolute currents A top spinning about its point under the action of gravity is one of the most familiar examples of ignored co-ordinates, and one which illustrates several important dynamical theorems

When there are ignored co ordinates, the steady motion of the system, and the stability of the steady motion, can very easily be investigated For if we suppose that all the co-ordinates θ have constant values, (8) reduces to

$$\frac{\partial \mathfrak{K}}{\partial \theta} + \frac{\partial V}{\partial \theta} = 0$$

There are as many equations of this type as there are co ordinates θ, and an examination of this system of equations will show whether steady motion is possible, and if so, will determine the necessary conditions which the co ordinates θ and the constant momenta κ must satisfy

It can also be shown that the steady motion will always be stable when $\mathfrak{K} + V$ is a minimum (see Proc Camb Phil Soc May 1892)

We have therefore the following simple rule for determining the steady motion of a dynamical system when there are ignored co-ordinates Eliminate all the velocities corresponding to these co ordinates from the expression for the kinetic energy of the system, so that the latter is expressed in terms of the velocities $\dot\theta$ and the momenta κ Let $\mathfrak{K}$ and V be that portion of the *total* energy which does not depend upon the $\dot\theta$'s, then the conditions of steady motion are, that $\mathfrak{K} + V$ should be stationary, and the steady motion will be stable provided this quantity is a minimum

The preceding theorem also enables us to deduce by a very concise method all the results connected with the steady motion of a liquid ellipsoid, which is rotating about a principal axis under the influence of its own attraction It also enables us to examine the stability of these different cases of steady motion, for disturbances which produce an ellipsoidal displacement

A B BASSET

THE PASSAGE OF GRANITE ROCK INTO FERTILE SOIL

HAVING for the last three or four years paid particular attention to the natural formation of soil, I venture to believe that a concise account, or rather summing up, of the results of my researches, and of the mass of my observations—in one typical direction—may be of interest to the readers of NATURE As indicated in the heading, the making of soil from granite is the only section of a very large subject which will be briefly considered in this paper

The agents concerned with the turning of granite (or any other rock) into a fertile soil may be shortly classified as mechanical, chemical, and vital The first-named produce the largest results in bulk, and the principal mechanical agent with which we have to deal is frost The second and third classes of forces are extremely important, as it is by their actions that the raw material of plant-food is prepared, though unfortunately poisons also are brought into being through their activity These last named classes, however, likewise materially aid the action of frost (or, in tropical countries of varying temperatures) in the mechanical separation of rocky matter To render my descriptions as little confusing as possible I will endeavour, without regard to classification, order, or divisions, to trace the history of a granite soil as I have observed it in many localities in Scotland, from the practically unbroken rock into the condition in which it has been made by nature fit to bear the most luxuriant crops But first of all I must remind my readers of two or three geological facts about granite It is a holocrystalline (*i e* wholly crystalline) igneous rock, composed essentially of orthoclase, quartz, and mica In its most typical condition the last-named mineral is always of the biotite or magnesia-mica species Besides these essentials we always find (in Scotch granites at least) plagioclase, other species of mica than the essential, apatite as an endomorph, *i e* locked up in the mass of other minerals, and magnetite, and almost invariably, if not always, a little pyrites, and more or less hornblende, &c

A rough mineralogical analysis of Kemnay granite taken from the lowest working of the well-known quarry in Aberdeenshire gave the following percentages —

Orthoclase felspar	42 00
Quartz	22 00
Biotite-mica	20 00
Plagioclase felspar	9 00
Hornblende	3 25
Muscovite mica	2 00
Magnetite (and Ilmenite)	1 00
Pyrites	0 50
Apatite	0 25
Total	100 00

The first change which comes over granite is the peroxidation of some of the iron always present in its mass This sets in, and increases to the greatest extent, of course, where air and water can most readily enter The surface of the rock becomes browned with the hydrated ferric oxide formed, and brown skins, of a deeper colour than the surface generally, coat the walls of the original rock joints But in the mass of the rock, away from these primary fissures, there are areas which are more permeable than others from the surface, and through these, streaks of ferric oxide—anhydrous first, afterwards hydrated—are produced Those lines of rust are the beginnings of a new set of joints, which have not yet been properly recognized in geological literature, and which I will here call weather joints to distinguish them from the primary joints of consolidation and rock movements. The first oxidation streaks of the coming weather fissures are invisible to the eye, but can be determined under the microscope They gradually increase in width above as they extend their lines beneath, and they afford passages through which water can more readily percolate than in the surrounding fresher areas, and as a consequence planes along which frost can more powerfully act By

[1] I must confess that I do not like the phrase *speed co-ordinates*, introduced by Prof. J J Thomson, for it conveys absolutely no meaning to my mind. I have no sympathy with the attempts, which have occasionally been made, to introduce short words of Teutonic origin into scientific nomenclature, as the words in question appear to me to be singularly deficient in point.

the constant multiplying of the weather joints, which are first marked out by oxidation as already indicated, and afterwards made definite and widened from the most exposed rock surface inwards by frost, one of the first steps in soil formation is accomplished. As those fissures are increased the uppermost portion of the rock is separated by them into distinct pieces, which latter are again in their turn broken up by the formation of weather joints in the same way as the original. The great bulk of a soil has been produced in this way.

While the oxidation of the iron, as I have observed, is very likely the first change to set in in every case, it is never left for any lengthened period to promote, by itself alone, the decomposition of the rock. Very soon the work of carbonation is seen to be progressing alongside of it, though at a considerably slower rate. The carbonic acid gas of moist air, dissolved in the penetrating water, attacks the felspars, the biotite, and the hornblende. The way in which it brings about the decomposition of these minerals is interesting. Certain molecules succumb much more easily to the action of the carbonic acid than others, and the result is that scattered points of weakness from the thorough decomposition of these are brought into being in different parts of the mineral, and those decomposed portions warp round about the other and fresher molecules, as shown in the annexed diagram, which has been constructed from what I have observed in decomposed felspars.

The clay of decomposed felspar has great plastic and warping power. I have observed only 15 per cent of pure clay in a mass hold the 85 per cent of other and different constituents together in a plastic union as if the whole had been pure clay. There are two or three other hitherto unknown facts connected with the natural decay of felspars which I have ascertained from my re-

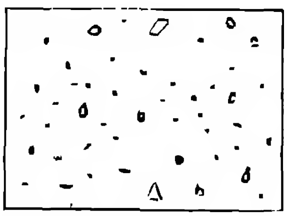


Diagram of kaolinized felspar × 260. The whole ground mass is kaolin or pure clay; the bodies scattered through this are parts of the original felspar not yet decomposed.

searches. I have noted two processes of decomposition—that which occurs when the carbonic acid is in excess or can obtain free access to the mineral, and that which takes place when either of the opposite conditions prevails. In the first case the felspar—supposing it to be *orthoclase*—has the molecules of its body which are affected completely broken up into clay, solid secondary or colloid silica, and carbonate of potash. In the second case, where for some reason a sufficient supply of carbonic acid cannot get within "chemical" distance of the felspar molecules, clay is produced as before—only more slowly—but the potash of the molecule is carried off in two sections, part as a carbonate, and part as a soluble silicate.[1] From the *plagioclase*-felspar the same conditions produce similar results, except that the soluble silica which would be produced here is of course in combination with sodium. I have found the soluble silica of soils *always* in the form either of silicate of potassium or sodium, and very frequently both of these occur mixed together.

Biotite, by the continued action of carbonic acid, oxygen, and water, loses magnesia (taken out as carbonate) and iron (removed either as oxide or carbonate) and becomes eventually the white or yellow muscovite variety which undergoes no further chemical change. In biotite, however, the chemical change usually takes place much more uniformly through the mineral body than ever happens in the case of the felspars.

Hornblende by carbonation, oxidation, and hydration yields lime as carbonate until the whole of that base is taken out, a trace of magnesia as carbonate (the bulk of this base is almost invariably left in the insoluble residue), the chief portion perhaps of its iron as oxide and carbonate, manganese as hydrated oxide, and any trace of sodium and potassium which it may contain as carbonates, or partially when conditions are less favourable as soluble silicates. The residue left after the hornblende has lost the above can generally be determined as some variety of chlorite (hydrated silicate of magnesia, iron, and alumina), which in the course of time by further loss of iron becomes an impure serpentine, and this later on a steatite or magnesia clay, to which the greasy feel of soils is due.

The *pyrites* of the granite rock is slow to change, but it also is eventually acted on, by water and oxygen particularly, the latter combining with its substance here and there to form a sulphate, which has a great mission in the physiology of the soil.

I have said that the *apatite* occurs as an endomorph. It is set free to dissolve slowly without change in ordinary carbonated water when the minerals which hold its microscopic needles in their substance are broken up, mechanically or chemically. The *magnetite* and *ilmenite* grains of the granite rock are only altered with provoking slowness. Their function, however, in the work of the soil is, as far as I can see yet, of no importance. Traces at least of another mineral occur very frequently in granites. This is tourmaline, the history of which in soils I have been investigating for the last half-a-dozen years with some success.

The chemical changes which I have been mentioning begin first on the exposed surfaces of the rock and along the faces of the primary joints. Then oxidation occurs in streaks and bands through the rock mass, and around those areas carbonation is most active. In fact oxidation opens up the rock for further change, chemical as well as mechanical.

Frost is the principal agent of disintegration or mechanical breaking up in this country, but a relatively minute portion of the work is accomplished by heat and cold, the friction of percolating water, changes in the degree of humidity of the atmosphere, the pressure exerted by roots, and so on.

No sooner does a fraction of the surface percentage of the exposed rock portion undergo chemical change than a new element in the making of soil comes into play—that, namely, of organic matter, first living, and then dead and living. We will deal first with the living matter. On the partially decomposed surface of rock, fungal and algal spores (the latter of a lowly type) settle and live and grow in symbiotic union as lichens. There are many different kinds of rock-lichens, but the vegetative physiology of all is identical. The surface of the growth which lies next the stone is engaged in parts, during moist weather at least, in the imbibition of water, with the exceedingly meagre amounts of mineral matters dissolved in it from the surface of the rock. Those absorbing areas of the under surface appear to be also superficial breathing organs, for they certainly excrete carbonic acid gas, which of course will join with the atmospheric carbonic acid in helping the work of decomposition of mineral bodies. And it appears to me—though here I am not certain—that these absorbing areas are less generally found over the quartz of the granite, which is not capable of chemical change, than over the decomposable minerals. The lower absorbing areas of the lichens are in their functional relations common to internal fungal and algal

[1] See also in this connection my article on "The Action of Lime on Clay Soils," NATURE, Jan. 29, 1890.

members, and the upper surface of the colony is also a common absorbing (and transpiring) tissue, though here it is only the atmosphere gases which are taken in to the interior There is not the slightest doubt but that the fungal members utilize the nitrogen of the air, there is none in the rock for them to receive, and that the algal members absorb carbonic acid gas from the air taken in, and combine it with the elements of water to make carbonaceous food, for that again is not presented to them from the rock, the lichen growth cannot any more than is the case with higher plants utilize the carbon of the mineral carbonates in the manufacture of carbohydrate or hydrocarbon food

In reproduction, separate spores of algæ and fungi are produced from the lichen, and some of these may germinate above the parent community and unite to form a fresh colony upon the old, or a new colony may be produced from foreign spores In any case we find generation after generation of lichens forming on the same favourable spot, but succeeding generations are partially parasitic and saprophytic in nature, as is shown by the manner in which their lower absorbing surfaces or prolongations act on the lichen growths beneath them By and by, when perhaps a score of lichen colonies have formed one above the other—the newer slowly extinguishing the life of the older—a vegetable considerably higher in the scale of being comes forward and caps the last lichen This is some variety of moss Spores of mosses, carried to the stone surface, germinate there in moisture, and if upon lichens, the moss plantlet develops into the adult Its rhizoids pierce their way through the substance of the lichens, and many get down to the decomposing stone surface, while some never leave the lichen bodies The action of the moss rhizoids on living and dead lichens, also, I think, shows that that plant can be a parasite and a saprophyte as well as a normal vegetable feeder, and in this respect, except in its not utilizing the nitrogen of the air, resembles the later lichen growths

In this way, by the succession of lichens and mosses (and afterwards higher plants), the essential organic element of soils becomes early incorporated with the mechanically and chemically disorganizing rock

The dead organic matter changes in different ways first, very slowly and very indifferently, by the action of air and water, and second, rapidly, by the spreading through its mass, where air has free access, of bacteria and other lowly fungi which are saprophytic, but can also assimilate nitrogen from the atmosphere, as is shown by their increasing, and not simply maintaining the original amounts of nitrogen left by their predecessors By the first method of change the organic matter becomes the tougher former of humus, and humic and other related acids arise from it, by the second the mild, dry, or friable humus is produced and little or no humic acid A very careful investigation shows that those bacteria which have the power of removing from the dead organic matter the elements of their nutrition give out by the decay (which occurs rapidly) of their bodies when they die the nitrogen and other elements in an active state The nitrogen of the dead bacteria forms readily nitrate of lime or potash by contact with these bases

Now to give a short summary here Oxidation of iron is the first change perceivable in granite, then creation and multiplication of weather joints, and carbonation follows, next humus is formed by lichens, and then higher plants, following this, fungoid germs, capable of assimilating aerial nitrogen, become abundant, finally all the three processes, mechanical, chemical, and organic, go merrily on together and contribute all in their proper shares to the formation of an ever-deepening soil, capable of supporting the luxuriant life of the highest plants The humic acid which is formed by the inorganic decay of humus has a certain decomposing action, but it gradually changes to carbonic acid, with the action of which, in this connection, we have already dealt Well, to apportion the shares of the work done further By disintegration or mechanical action, the great rough mass of the soil is produced By oxidation and carbonation, soluble minerals capable of entering the plant are prepared, and insoluble matters like secondary silica, pure clay, and steatite, are brought into being By the action of living matter, rock decomposition is hastened, and nitrogenous substance is brought into the soil By the presence and action of dead organic matter, rock decomposition is also forwarded, and a field for aerial nitrogen-assimilating germs is prepared The table below gives a list of the materials found in the youngest granite soil on which nothing higher than rock-mosses are growing

Granite minerals in fairly fresh condition	About 80 per cent
Clay and insoluble secondary silica	About 3 per cent
Soluble silica	Not determinable
Carbonates of potash, soda, lime, magnesia, iron, and phosphate of lime	About 2 per cent
Sulphates of above, except iron	Not determinable
Sulphate of iron	Merest trace
Peroxides of iron and manganese	About 3 per cent
Humus	12 per cent
Total	100 per cent

Later on, as the soil deepens, we find some curious changes proceeding, which I will briefly indicate Sulphates are now produced in considerable quantities Wherever iron-containing minerals are brought into contact with organic matter, sulphate of iron tends to form as well as carbonate (humate ?), and possibly other compounds, and the pyrites which was slow to change at the beginning now produces sulphate of iron with greater rapidity The dissolved sulphate of iron coming into contact with the carbonates of the alkalies and alkaline earths liberated from the felspars, hornblende, &c, as already explained, causes a double decomposition The ferrous sulphate becomes a carbonate, and the carbonates of lime, potash, soda, &c, become sulphates The iron carbonate, where exposed to air, readily oxidizes to ferric oxide, the chief colouring ingredient of the soil

Now, in the finished soil, which, it must be remembered, is when produced from granite a loam, we have the following approximate composition, as fairly typical of a good granite soil such as may be found in the valley of the Don in Aberdeenshire —

			Per cent
Insolubles	Pure clay and steatite	about	10
	Quartz and secondary silica	,,	20
	Muscovite	,,	4
Substances capable of transformation	Orthoclase	,,	30
	Plagioclase	,,	4
	Biotite	,,	9
	Magnetite ?	,,	0·5
	Hornblende	,,	2
	Hematite and limonite (ferric oxides) and manganic oxide	,,	9
	Pyrites	,,	0·5
	Humus and animal organic matter, fungi, &c	,,	5
Injurious solubles	Humic acid	,,	0·5
	Soluble silicate	,,	0·3
	Ferrous sulphate[1]	,,	0·5
Non-injurious solubles	Phosphates of lime, magnesia, potash, soda, &c	,,	0·3
	Sulphates of lime, potash, soda, magnesia, &c.	,,	0·8
	Nitrates of lime, potash, soda, magnesia, &c	,,	0·3
	Carbonates of lime, potash, soda, magnesia, &c	,,	0·1
	Chlorides of above	,,	Trace.
Water and air (mechanically held) in dry summer perhaps about		,,	3·2
	Total		100·0

[1] More than 0·1 per cent is injurious.

In conclusion I have to point out, as shown by my investigations commenced four years ago, that farmyard manure laid on to the land is only rendered properly available to the crops by the action of bacteria as indicated above in connection with the natural humus. The inorganic forces have little action upon it, except in producing humic acid and other injurious matters

The most of the soluble mineral substances in a mature soil, it may also be mentioned, are in the form of sulphate They originate from the primary minerals as carbonate, but are soon altered, mainly by the ferrous sulphate The sulphate unfortunately is not the most suitable form in which minerals can be presented to plants for absorption, for the simple reason that, being so stable in chemical union, it causes the loss of too much of the plant's energy in the interior of its body before it can be decomposed It must be remembered that green plants decompose the compounds which enter their system before they utilize their elements or simpler forms in the elaboration of food ALEXANDER JOHNSTONE

Edinburgh, August 5

THE IMPERIAL INSTITUTE AT ST PETERSBURG[1]

IN November, 1885, some months after the publication of Pasteur's discovery for the treatment of hydrophobia, an officer of the Russian Guards was bitten by a rabid dog This officer having been sent to Paris to undergo the treatment, his Highness Prince Alexander Petrowitch d'Oldenburg established, at his own expense, a provincial laboratory at St Petersburg, where Pasteur's treatment could be duly carried out This establishment, however, soon proved to be too small for scientific investigations to be properly carried out therein, and it was decided to build a large laboratory in which researches might be made under the best possible conditions, accordingly the same enlightened nobleman bought a piece of ground of 37,464 square metres in extent, on which the present Institute is built

The buildings comprise physiological, pathological, chemical, bacteriological, and epizootological sections, with their laboratories, under the direction of such men as Neucki, Winogradsky, and others There is also a department where Pasteur's treatment is carried out, together with a small hospital for infectious cases Each section is complete in itself, and all the arrangements are on the newest principles and on a very large scale The expenses are defrayed partly by the Prince of Oldenburg and partly by public subscription, and the whole Institute compares favourably with any Institute in France or Germany

The directors of the Institute publish every two or three months a volume embodying the scientific results obtained in the laboratories, and the first two numbers have now been published As might be expected after what has just been said, their contents are of wide and varied interest Neucki publishes some chemical researches on the microbe producing inflammation of the mammary glands of milch cows and goats, and his paper will specially interest those who in this country have followed the remarkable researches of Dr E Klein Winogradsky gives an account of the various nitrifying organisms discovered by him in the soil of different countries This author quotes the researches of Prof and Mrs. Frankland, and of Prof Warington, and though to some extent contradictory, Winogradsky's researches agree with those of the English observers in all essential particulars This paper is certainly the most important which has as yet appeared on this vexed question The results obtained by Pasteur's treatment in St Petersburg form the subject of a paper by Kraiouchkine, and it may be mentioned that the treatment appears to have been as successful at St Petersburg as in Paris

The other papers refer to the chemical and physiological effects of tuberculin (Bujwid, Helman), to the transformation of nutritive media by the bacillus of diphtheria, and to the chemical composition of this micro-organism (Dzierzgowski and Rekowski), while Blachstein endeavours to draw a distinction between the bacillus coli communis and the bacillus typhi abdominalis, based on the chemical decompositions produced by these organisms in the media in which they grow Lastly, Mizerski and L Neucki give a critical *résumé* of the methods used to estimate the quantity of hydrochloric acid contained in gastric juice

The researches which form the subjects of these papers are varied enough, and whilst congratulating their authors we may express the hope that the Institute will have a long and prosperous career Our good wishes must be tinged with regret for ourselves—regret that there should not be a similar Institute in England, and regret also that there should be in this country a class of people who will oppose the establishment of such an Institute until a Bishop or Royal Duke has died of rabies

M ARMAND RUFFER

[1] "Archives de Sciences Biologiques publiées par l'Institut Impérial de Médecine Expérimentale à St Pétersbourg," Vol 1, No 1 et 2

NOTES

LAST week much anxiety was felt as to the health of Sir Richard Owen On Monday his condition was better, and the improvement was maintained on Tuesday

THE herbarium of the British Museum has acquired, by presentation from the widow, the very valuable collection of Muscineæ, made by the late Mr George Davies, of Brighton It comprises upwards of 20,000 specimens of mosses, hepaticæ, and lichens, partly gathered by Mr Davies in Great Britain and on the Continent, partly communicated to him from New Zealand, Samoa, India, the West Indies, and America

PROF HIERONYMUS has been appointed curator of the Royal Botanical Museum at Berlin

THE Exhibition of the Photographic Society of Great Britain was opened on Monday at the Gallery of the Royal Society of Painters in Watercolours It will remain open till November 10

WE regret to have to record the death of Mr George Croom Robertson He was fifty years of age, and only lately, in consequence of ill health, resigned the professorship of Mind and Logic at University College, London, to which he was appointed in 1866 Prof Robertson was well known as a brilliant teacher of the subjects to the study of which he devoted his life, and as the editor of *Mind* He was associated with Prof Bain in the editing of Grote's "Aristotle," and was the author of the volume on Hobbes in Blackwood's series of "Philosophical Classics" He also contributed to the latest edition of the "Encyclopædia Britannica"

DR GEORGE DIXON LONGSTAFF died at Wandsworth on Friday last in his ninety-fourth year When a young man he was assistant to Dr Hope, Professor of Chemistry at the University of Edinburgh, and he is believed to have been the first teacher of practical chemistry to medical students in this country. He was one of the founders and a vice-president of the Chemical Society of London

Students of folklore will be sorry to hear of the death of Reinhold Kohler, librarian at Weimar, where he was born in 1830 He died on August 15 Dr. Kohler was a man of great learning, well known as an authority on the subject in which he was chiefly interested.

THE American Academy of Arts and Sciences has published an excellent "Memorial" of Joseph Lovering, who was a Fellow of the Academy from 1839 to 1892, Corresponding Secretary from 1869 to 1873, Vice-President from 1873 to 1880, and President from 1880 to 1892. Mr. Lovering was born on December 25, 1813, and died on January 18, 1892. The "Memorial" consists chiefly of speeches delivered, and letters read, at a meeting held for the commemoration of his life and services, with a biographical sketch by Prof. J. P. Cooke, Secretary of the Council, and a list of Prof. Lovering's publications. At this meeting the chair was taken by Dr. A. P. Peabody, who said that there was a certain fitness in his leading the proceedings, as Mr. Lovering had been his pupil. Speaking of Prof. Lovering as a teacher of physical science, Prof. J. P. Cooke said: "He was one of the best lecturers I have ever known, and I have known the greatest masters of my time."

DURING the past week the weather has been of a decidedly cyclonic type; large disturbances have reached us with considerable frequency from the Atlantic, and have mostly passed to the northward of Scotland. The winds have been moderate to strong from the south-west, but have at times attained the force of a gale at places in the north and west, while on Tuesday they were boisterous in all parts of the United Kingdom. The rainfall has been somewhat heavy in the north and west, but light in the southern parts of the kingdom, where, during the first part of the period, the weather was generally fine, with occasional mist or fog in the mornings. The temperature has, on the whole, been mild, the day readings ranging from 60° to 65° over most parts, while in the extreme south they have exceeded 70° on several occasions. The *Weekly Weather Report* published on the 24th instant shows that some of the night minimum temperatures during that week were very low for the time of year, the shade thermometer falling to 25° in the east of Scotland, and to between 28° and 31° in most other parts.

AMONG the valuable discussions which appear in the *Repertorium für Meteorologie*, issued under the authority of the St. Petersburg Academy of Sciences, is one in vol. xiv., by B. von Nasackin, on the Storms of the Baltic, being in fact a continuation of similar works (by other authors) for the Black and White Seas. The data used in the discussion are taken chiefly from lightkeepers' journals and stations on the coast. The general results show that the yearly frequency of storms differs considerably in different years, and the number of storms at individual stations also varies considerably. In the western part of the Gulf of Finland and in the south of the Baltic storms are much more frequent than in the other parts. The mean wind direction lies between south and west, and the principal storms occur from the same direction, and also between west and north. The maximum number occurs almost everywhere in December, and the minimum in August.

Das Wetter for August contains an article by Dr. R. Assmann on the treatment of persons apparently killed by lightning. The different effects on persons struck would prove that the intensity of the flash is subject to considerable fluctuations, and recent photographs of lightning, in fact, show that in addition to the principal flash there are always weaker ones branching out in all directions, like the roots of a tree. It may therefore well be assumed that the intensity of the latter is considerably less than that of the principal current. He quotes a case near Berlin in the summer of 1891 where a number of soldiers were struck by lightning; among them an officer, and a bugler holding his horse, were both struck. The officer shortly afterwards recovered, while the bugler was to all appearances dead, but the officer at once adopted the method of artificial respiration as applied to the apparently drowned, by which means the bugler was gradually brought back to life. Dr. Assmann states that there can be little doubt that if this method were applied soon after the stroke, and continued for at least a quarter of an hour, many of those apparently killed might be restored to life.

A VALUABLE paper by Prof. E. W. Hilgard, on the relations of soil to climate, has been published by the U.S. Department of Agriculture. Soils being the residual product of the action of meteorological agencies upon rocks, it is obvious, as Prof. Hilgard says, that there must exist a more or less intimate relation between the soils of a region and the climatic conditions that prevail, or have prevailed, therein. Prof. Hilgard discusses, both from a theoretical and from a practical point of view, some of the more important phenomena dependent on this correlation, and their effects on the agricultural peculiarities of the chief climatic subdivisions.

HERR K. FLEGEL gives, in the *Allgemeine Zeitung* for September 12, an interesting account of archæological discoveries he has made this summer in the island of Kalymnos, near the coast of Asia Minor. At a height of about 220 metres, not far from Emporio, he found the remains of an ancient fortress which seems to belong to the same class of buildings as those of Mycenæ and Tiryns. The remains, which are comparatively well preserved, include Cyclopean walls and a tower. A gateway (1½ metre in breadth), the forecourt, a cistern, and a stone oil press survive. In the valley of Vathy, Herr Flegel came upon the remains of walls of an acropolis, which he describes as older than the fortress of Emporio.

IN the new instalment of the proceedings of the Liverpool Geological Society (Part 4, Vol. VI.), Mr. J. J. Fitzpatrick has some interesting notes on the Deep Dale Bone Cave near Buxton. In a paper read before the society in 1890, Mr. Fitzpatrick called attention to this cave, and described the various objects of interest which had been found in it up to that time. In his present paper he gives an account of the results of more recent researches carried on by Mr. W. Millet, of Buxton, by whom the cave was discovered. At the entrance is a refuse heap, three feet thick at the top, extending ten feet on either side of the entrance, and sixty feet down to the stream at the bottom of the dale. Among the objects found in this refuse heap are bones of the horse, stag, Celtic shorthorn (*Bos longifrons*), dog, pig, sheep, goat, wild boar, three flint flakes, a piece of bronze with Celtic pattern, fragments of pottery, including Samian ware, pseudo-Samian ware, Romano-British ware, coins of the Emperor Claudius, and female ornaments, including fibulæ, earrings, brooches, and rings. At the bottom of the heap were found two flint arrow heads. In the second chamber of the cave a hole, eight feet deep, has been dug. The upper bed, three feet thick, is composed of dark clay, with angular fragments of limestone. The second bed, which is from six to sixteen inches thick, consists of broken fragments of stalagmite, limestone, and gravel. In this a human jawbone has been found. The third bed, the thickness of which has not been ascertained, consists of a stiff yellow clay, containing large pebbles, two of which have been artificially pointed at one end. The human jawbone has twelve teeth, with the enamel and dentine in an admirable state of preservation. There were originally fourteen teeth, the two "wisdom teeth" not having been developed at the time of the death of the person to whom the jawbone belonged. The mark of the weapon which gave what was perhaps the death wound is distinctly visible. The weapon penetrated deeply into the bone in a slanting direction, with an upward inclination, and the blow must have been struck from behind. Another object found in the second chamber is a small bronze box, filled with

grey ashes, supposed to be the ashes of a cremated person The lid is moulded with the raised zigzag pattern common in Roman ornamentation, the hollow parts being let in with red and green enamel In the lower chambers, as stated in Mr Fitzpatrick's former paper, the following mammalian remains have been found —A skull of the brown bear (*Ursus arctos*), a skull of the Celtic shorthorn (*Bos longifrons*), teeth of the reindeer (*Cervus tarandus*), and of the red deer (*Cervus elaphus*), part of the skull of the wild boar (*Sus scrofa*), and some human bones

THE July number of the *Korean Repository* opens with an article by the Rev Dr Edkins on the Persians in the Far East He shows from native sources that at a very early period the influence of Persian ideas penetrated into China. The wide acceptance of these ideas was due in part to the doctrine of a future life, but Dr Edkins attributes even more importance to the worship of the god of fire as the special ruler of the hearth and the god to be worshipped by newly married people This, he says, is so adapted to the natives of Eastern countries with their strong family instincts, that it has easily kept its place and still has a firm hold on the popular mind In another article a writer who signs himself "Viator" indulges in much enthusiastic admiration of Korea and the Koreans He is especially emphatic in his praises of the scenery around Seoul, with its "grand amphitheatre of granite hills" "The city wall," he says, "climbing over the most precipitous ridges, the sentinel peaks of Nam San, with its chevelure of fine trees, and the bold castellated rocks of Poukan, which on the south and north respectively keep guard over the capital, with many other points both within and without the walls commanding varied and extensive views, would alone in any tourist frequented land make Seoul a show place of the guide-books" The ordinary Korean he describes as "a docile and happy creature"

WE learn from *La Nature* that MM Olivet, of Geneva, have brought out a new system of electric heating applied to conservatories, which may prove very useful where a motor force is at one's disposal A dynamo, worked by some motor, sends the current into receivers of special metallic composition, which become rapidly heated, but without exceeding a certain temperature A heated air current is set up as with steam-heating The advantages of the system are Absence of all unwholesome gas or vapour which might injure the plants, simplicity of construction in the parts conveying the energy, perfect safety as regards heat, which can be regulated at will, convenience and rapidity in starting and extinction, and cleanliness

MR A C MACDONALD, of the Agricultural Department of Cape Colony, refers with much regret (in the official publication of the Department) to the senseless way in which the ant bear is being exterminated This animal, he says, is one of the few indigenous four footed friends of the Cape farmer "Its food is the ant, more especially the white ant, an insect which feeds on our crops and the succulent herbage of the veld, and which does much greater damage than is generally supposed Although the ant has numerous enemies (among which is reckoned the koran, a bird which I am happy to say is now being preserved on some farms solely for this purpose), yet none are so destructive to its welfare as the ant-bear It is only when on the surface of the ground that the ant runs any danger from its winged foes, but above or below ground it is always within reach of the ant-bear But it is not only as a destroyer of ants that the ant-bear is of value to the farmer A large percentage of the seeds of our herbage, after they have dropped off the plant on the hard ground, lose their germinating power from being exposed day after day to the scorching rays of the sun The ant-bear, as it goes scratching about for ants, covers a large number of seeds with loose earth, in which congenial bed they will retain their reproductive power for a long period, awaiting the moisture from the skies to shoot out and propagate their kind And yet this animal, harmless in other respects, is being slowly but surely exterminated For its skin, which is valued at about 15s, and also for its flesh, which resembles superior pork, it is sought after by the natives With the white race 'sport' is the inducement, this fun taking the form at times of forcing the poor brutes out of their holes by flooding with water, or drowning them and digging them out afterwards"

PROF G C CALDWELL, of Cornell University, has been making oleomargarin a subject of careful investigation, and presents the results of his researches in a valuable paper in the September number of the Journal of the Franklin Institute He thinks that if made of unsuitable materials oleomargarin may contain germs of disease, and that the process of manufacture ought to be carefully inspected by capable officials, but there is no positive proof, he says, that it is now, or ever has been, made of such materials, or that any disease has ever been communicated to man by its use He is also of opinion that, when properly made from fresh and clean materials, it differs but slightly in healthfulness from butter He records, however, a rather significant incident which has recently come to his knowledge At an asylum for blind children, in Louisville, Ky, where good butter had been supplied, good oleomargarin butter was substituted No notice was given of the change, and even if the appearance of the substitute would have betrayed it, the blind children could not have seen it There was no evidence that they were in any way conscious of the change, but it was observed that they gradually ate less and less of the new butter and finally they declined it altogether No bad effect on their health could be discerned They made no complaint in answer to the inquiry as to the reason for not eating the butter other than that they did not care for it It was as if it did not adapt itself to any need of the system "This," says Prof Caldwell, "certainly must be allowed to count against the complete fitness of oleomargarin as a substitute for butter"

A FIELD NATURALISTS' CLUB was formed last year in Trinidad, and seems likely to do much useful work It publishes a journal, and in the third number, which we have received, gives reports of its meetings from the beginning In the meeting on January 8 Mr Mole announced that he had found a *Peripatus Edwardsii* in the St Ann's Valley, and Mr Urich stated that he also had found a specimen of the same species at Azouca

THE report of the Government Central Museum, Madras, for 1891 92, has been published In an interesting appendix Mr. H Warth, the officiating superintendent, gives an account, among other subjects, of the tin district in Burma The tin bearing deposits are, he says, of two kinds First, there is the tin gravel which is found in all or most of the valleys, a mixture of rough white quartz pebbles with sand, garnet, black tourmaline, and grey cassiterite The thickness of the gravel varies from 1 to 6 feet, and the yield of cassiterite may be put down as at least ¼ per cent or 1 pound of cassiterite (tin dioxide) in 400 pounds of gravel There are washings going on at many places, but some valleys have been more or less exhausted The work suffers also under the disadvantage that the greater part of the country is quite uninhabited, that food has to be brought from a distance, and that there is always danger of sickness. Chinamen are the chief workers The second kind of tin-bearing deposit is the original eruptive rock, which is weathered so that it is possible to wash out the grains of whitish cassiterite which it contains Mr Warth visited the principal deposits of this kind near Malewun in July 1891 He took samples from several excavations and washed them The mean is a yield of only 0 04 per cent. of impure wash tin.

Thus one pound of impure tin dioxide requires 2500 pounds of weathered rock. The rock is traversed by a series of parallel veins of white quartz indicating the origin of all the white quartz pebbles in the tin-bearing gravels, these gravels being nothing but the accumulation, during probably thousands of years, of the washings from the elevated outcrops of tin-bearing eruptive rock. The original tin-bearing deposit of weathered rock has been washed during a good many years. It requires a very good supply of water and very large deposits, otherwise the labour would be far too great and such works could not compete with those in the gravels. Among the rock specimens of the district are also grey limestones from Mount Tampra, three days' canoe journey from Lenya. This mountain Mr. Warth found fringed with caves which most likely owe their origin to the action of the sea. As they are now 160 feet above the sea, it appears that the land has been raised that much in comparatively recent time. If so, then the time during which most of the tin gravels formed was also comparatively limited.

THE third part of the tenth annual report of the Board of Fishery for Scotland has just been issued. It deals with the scientific investigations carried on during 1891. First there is a general statement of the results achieved; then comes a series of general reports; and these are followed by papers recording biological investigations. Finally, Dr. T. Wemyss Fulton gives an account of contemporary scientific fishery investigations in this and other countries. The following are the papers dealing with biological investigations:—On the food of fishes, by W. R. Smith; observations on the reproduction, maturity, and sexual relations of the food fishes, by Dr. T. W. Fulton; additions to the fauna of the Firth of Forth, part iv., by Thomas Scott; contributions to the life histories and development of the food and other fishes, by Prof. McIntosh, F.R.S.; on two large tumours in a haddock and a cod, by Prof. Prince and Dr. J. L. Steven. We may note that the volume is enriched with many admirable plates.

MESSRS. R. FRIEDLÄNDER AND SON, Berlin, have just issued the sixth annual report (for 1890) of the ornithological stations of observation in the kingdom of Saxony. The report has been prepared by A. B. Meyer and F. Helm, who have evidently spared no pains to make their work thorough and accurate. In an appendix observations relating to other animals in Saxony, besides birds, are recorded. There is also a list of the birds which up to the present time have been observed in that country, with notes as to their geographical distribution elsewhere.

THE Clarendon Press has reprinted Mr. J. G. Baker's "Summary of New Ferns discovered or described since 1874."

A WORK on "The Great Barrier Reef of Australia, its Products and Potentialities," by Mr. W. Saville-Kent, is to be issued by Messrs. W. H. Allen and Co. The barrier reef of Australia, represented by a vast rampart of coral origin, extends for no less than twelve hundred miles from Torres Straits to Lady Elliot Island on the Queensland coast. Between its outer border and the adjacent mainland it encloses a tranquil ocean highway for vessels of the heaviest draught. To the naturalist, and especially to the marine biologist, the entire barrier is described as "a perfect Eldorado, its prolific waters teeming with animal organisms of myriad forms and hues, representative of every marine zoological group." The author's object will be to render an account, in clear and popular language, both from a commercial and from a biological standpoint, of the most attractive subjects connected with the barrier region. There will be sixteen plates in chromo lithograph, with grouped illustrations produced from original water-colour drawings by the author, and forty eight plates in photomezzotype from original negatives.

THE New Zealand Institute has published its Transactions and Proceedings during 1891 (vol. xxiv., seventh of new series). The volume is edited by Sir James Hector, and contains many papers of considerable interest and value. The papers presented in the Transactions are grouped under the headings of Zoology, Geology, Botany, and Miscellaneous. The Proceedings include those of the Wellington Philosophical Society, the Auckland Institute, the Philosophical Institute of Canterbury, the Otago Institute, the Westland Institute, the Hawkes Bay Philosophical Institute, and the Nelson Philosophical Society.

THE *Journal of Botany* for September gives an account of the results of M. J. Bornmuller's botanical exploring expedition in Persia. The flora of the district visited is a very abundant one, but not many new forms were gathered. The mountain sides of Kuh Jupar, at a height of between 2900 and 3000 metres, were covered with dense forests of an undescribed species of *Ephedra*.

THE number of the *Oesterreichische Botanische Zeitschrift* for September is almost entirely devoted to the discussion of the question of botanical nomenclature, and the opinions on the various disputed points, of the leading English and Continental botanists.

MESSRS. CROSBY LOCKWOOD AND SON announce the following works:—"The Microscope: its Construction and Management," by Dr. Henri von Heurck, Director of the Antwerp Botanical Gardens, translated from the French by Mr. Wynne E. Baxter, F.R.M.S.; "Electric Ship Lighting: a Practical Handbook for Electrical Engineers and others," by J. W. Urquhart; "Toothed Gearing: a Practical Handbook for Office and Workshop," by a Foreman Pattern Maker, author of "Pattern Making," &c.; "The Mechanics of Architecture: a Text-book for Students," by E. W. Tarn; "The Visible Universe: Chapters on the Origin and Construction of the Heavens," by J. E. Gore; "The Health Officers' Pocket Book: for Medical Officers of Health, Sanitary Inspectors, Members of Sanitary Authorities, &c.," by Edward F. Willoughby, M.D. (Lond.); "The Art and Science of Sail Making," by Samuel B. Sadler, practical sail maker; "The Complete Grazier and Farmers' and Cattle Breeders' Assistant: a Compendium of Husbandry, originally written by William Youatt, thirteenth edition, entirely re-written, considerably enlarged, and brought up to the present requirements of Agricultural Practice," by William Fream, LL.D.; "Farm Live Stock of Great Britain," by Robert Wallace, professor of Agriculture and Rural Economy in the University of Edinburgh, third edition, thoroughly revised and considerably enlarged; "Tramways: their Construction and Working," by D. Kinnear Clark, M.Inst.C.E., new edition, thoroughly revised, in one volume; "The Wood-worker's Handy Book: a Practical Manual embracing information on the Tools, Materials, and Processes employed in Wood-working," by Paul N. Hasluck; "The Metal-worker's Handy Book: a Practical Manual embracing information on the Tools, Materials, and Processes employed in Metal working," by Paul N. Hasluck; "Practical Lessons in Roof Carpentry," by Geo. Collings; "The Steam Engine: a Practical Manual for Draughtsmen, Designers, and Constructors, translated from the German of Herman Haeder, revised and adapted to English Practice," by H. H. P. Powles.

MESSRS. BELL AND SONS are about to publish the following books:—"The Student's Hand-book of Physical Geology," by A. J. Jukes-Brown, with numerous diagrams and illustrations, second edition, revised and much enlarged (Bohn's Scientific Library); "Sowerby's English Botany,' Supplement by N. E. Brown, of the Royal Herbarium, Kew (to be completed in eight

or nine parts), "Fungus Flora," a classified text-book of Mycology, by George Massee, author of "The Plant World," with numerous illustrations, 3 vols, vols i and ii, "The Framework of Chemistry," Part I, by W M Williams

UNIVERSITY COLLEGE, Liverpool, has issued its prospectus of day classes in arts and science, and of the evening lectures, for the session 1892-93

PART 48 of Cassell's *New Popular Educator*, with title-page and contents to vol viii, has been issued The next monthly part of the work will form the first part of a technical series of Cassell's *New Popular Educator*, published under the title of Cassell's *New Technical Educator*

MESSRS DULAU AND CO have published a catalogue of works on electricity, galvanism, and magnetism—works which they offer for sale

FOUR lectures on Cholera will be delivered by Dr E Symes Thompson in Gresham College on October 4, 5, 6, and 7, at six o'clock p m The lectures will be free to the public

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mrs Trafford Rawson, a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, presented by Mr A de Turckheim two Tigers (*Felis tigris* ♂ ♀) from India, presented by the Maha Rana of Oodeypore, a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr Hugo Marshall, a Three striped Paradoxure (*Paradoxurus trivirgatus*) from Java, presented by Mr Douce, a Jackdaw (*Corvus monedula*), British, presented by Lt Col R F Darvall, F Z S, a Common Fox (*Canis vulpes*), British, presented by Mr Lucius Fitzgerald, an Indian Cobra (*Naia tripudians*), an Indian Rat Snake (*Ptyas mucosa*) from India, presented by Mr Arthur H Cullingford, F Z S, a Common Boa (*Boa constrictor*) from St Lucia, W I, presented by H E Sir Walter F Hely Hutchinson, K C M G, a Common Chameleon (*Chamaeleon vulgaris*) from North Africa, presented by Miss Withers, two Tarantula Spiders (*Mygale*, sp inc) from Demerara, presented by Mr H Strong, a Black headed Lemur (*Lemur brunneus* ♀) from Madagascar, a Duyker Bok (*Cephalophus mergens* ♂) from South Africa, two Demoiselle Cranes (*Grus virgo*) from North Africa, four Emus (*Dromaeus novae hollandiae*) from Australia, deposited, an Indian Chevrotain (*Tragulus meminna*) from India, two Violet Tanagers (*Euphonia violacea*) from Brazil, a Shag (*Phalacrocorax graculus*) British, purchased, three Wild Swine (*Sus scrofa*) born in the Gardens

OUR ASTRONOMICAL COLUMN

THE VARIATION OF LATITUDE AT PULKOVA —*Astronomische Nachrichten*, No 3112, contains two communications on the variation of the latitude at Pulkova, the first by Mr B Wanach, who discusses some old observations, and the second by Mr S Kostinsky, who has continued the former's recent observations made before July, 1891. During the years 1890 and 1891, Mr Wanach obtained some very definite results with regard to this question by using the large Pulkova transit instrument in the Prime Vertical, and the object of the present discussion is to find out if any like result can be discovered The observations used are those of W Struve made between the years 1840-55, O Struve 1858 9, Oom 1861 63, and Nyren 1879 82 If we employ those made in the years 1840 42 it is at once noticed that to satisfy the conditions a variation in the height of the pole of ±0" 1 has to be assumed, while the maxima and minima occur at different months of the year, the latter on September, 1840, May, 1841, March, 1842, and the former on January, 1841, September, 1841, and October, 1842 The observations from 1843 63 present no direct fluctuations in the value of the mean pole height, but show that it remains constant or is proportional to the time during the whole period Taking the values of the mean pole height for the years 1879 82, as obtained from a similar curve, it is found that a single sinus curve is not sufficient for the comparison, secondly, that the mean pole height is not the same as it was in 1841 and 1891, but is about 0" 15 greater, thirdly, that the chief maximum on March, 1881 coincides with the chief minimum on September, 1880, that is, exactly coincides with the phases of the pole height It also happens that the series, which take more than two years, give only one distinct maximum and minimum (instead of two, as would be expected) Coming now to Mr S Kostinsky's work, whose observations were made by W Struve's method with the aid of a large transit instrument by Repsold, the variation of latitude is clearly shown With the aid of the curve, which accompanies the paper, the maximum of the latitude occurs on October 4, 1891 Owing to the observations not being quite complete, the epoch of minimum is uncertain, but the curve shows that it will take place somewhere before the end of the month of May 1892 Comparing this curve with that obtained by Mr Wanach in the year 1891, we have for the dates of the greatest and least values of the latitude—

Max in 1890, September 14	$\phi = 59\ 46\ 18\overset{''}{.}39$	
Min ,, 1891, April 15	17 79	
Max ,, 1891, October 4	18 44	
Min ,, 1892, May 20-31 (about)		

DOUBLE STAR OBSERVATIONS —The second part of Appendix I to the *Washington Observations for* 1888 contains the observations of double stars made at the United States Naval Observatory during the period 1880-1891, by Prof Asaph Hall These observations have been made with the intention of carrying on the work that was begun with the same instrument in 1875 The stars here observed are mostly known binaries Some are of special interest on account of their short periods, while again the motion of others will be found to be very slow This volume will be welcomed by all double star observers, for in such a work as this a strict comparison of observations is needful in such measurements as are here dealt with The form in which the observations are printed is the same as was the case in 1881 The star's name is first given, followed by its right ascension and declination, and its magnitude In the first column the date of observation in years and decimals of a year is given, while in parallel columns the sidereal time of observation to the first decimal of an hour, position angle, distance, and weight of observation are similarly inserted, in two other columns the magnifying power employed and occasional notes are added for reference The volume concludes with an index of all the stars observed The numbers of the stars are for the most part those of the Struves, but Prof Hall, in recording those faint stars in the Pleiades, has referred them to Bessel's list of fifty-three stars in this group Bessel's stars themselves he has numbered in the order they appeared in the *Astronomische Untersuchungen*, first volume, p 237

SOLAR OBSERVATIONS AT ROME —In the August number of the *Memorie della Società degli Spettroscopisti Italiani*, Prof Tacchini contributes, in tabulated form, the results of the solar observations made at the Royal Observatory during the second three months of this year Considering first the faculæ, they seemed most numerous on the southern hemisphere, there being an excess of 13 Latitudes 20° to 10° north, and 20° to 30° south, were the zones of greatest frequency, the number recorded being 49 and 50 respectively Taking the whole numbers for both hemispheres the table shows a distinct increase, the numbers for the three months being 71, 75, and 97 With reference to the spots, the two hemispheres seem to have been evenly distributed, the numbers seen amounting to 48 and 46 respectively The zones of greatest frequency were found to be ± 10° ± 20°, the number of spots recorded being 29 and 22; but in zone −20°−30° as many as 19 were noted, the number in the corresponding zone of the northern hemisphere amounting only to eight The record of eruptions for this period is not very high, six only being seen in the northern and three in the southern hemisphere, the zone of maximum frequency for the northern hemisphere is + 10° + 20°, the same as that for spots, the six observations occurring in this zone alone, for the southern hemisphere the three eruptions were observed in each of the 10° zones included between −10° and −40°.

GEOGRAPHICAL NOTES

As the result of recent explorations by Lieutenant Fromm in the southern part of German East Africa, it appears probable that the difficulties which beset navigation on the Rufiji and Rovuma rivers are not so serious as has hitherto been supposed The resources of the country traversed by these rivers are reported to consist mainly of india-rubber in the forests An examination of a coalfield reported by Arabs as existing on a tributary of the Rovuma showed that the valuable coal seams were practically confined to the Portuguese side of the frontier

IN a recent number of *Petermann's Mittheilungen*, Dr Karl Grissinger publishes an interesting investigation of the physical conditions of the Weissensee in Carinthia The paper is accompanied by a bathymetric chart, which shows that the lake belongs to the same class as the long, narrow, deep lakes of Scotland, and by a remarkable diagram of temperature changes The latter is constructed so as to show the diurnal change of temperature at all depths from hour to hour for four consecutive days, and is in a high degree interesting and instructive Diurnal change of temperature becomes imperceptible at a depth of 37 metres, and the hour of maximum temperature is retarded as the depth increases Thus the surface maximum occurs about noon, while that at a depth of 25 metres is not attained until 8 a m of the following day

A RECENT official estimate of the coast line of the United States, including islands, indentations, and estuaries, gave as the total 90,900 miles Of this the Atlantic Ocean accounted for 36,500 miles, the Gulf of Mexico for 19,100, the Pacific Ocean for 8900, and Alaska for 26,400 Considering only the general coast lines, neglecting estuaries, bays and islands, the Atlantic margin measured 2000 miles, the Gulf of Mexico and Pacific Ocean 1800 each, and Alaska 4800, a total of 10,400 miles

M J GAUTIER has elaborated a system of photographic surveying, which is attracting considerable attention in France in view of the approaching revision of the cadastral survey of that country By means of a specially mounted camera, a series of twelve views are taken from one point, so as to comprise the entire horizon A set of signals, the position of which is carefully arranged, enable the various plates to be afterwards fitted together The map is subsequently traced out on waxed linen by a sharp point, a faintly printed copy of the photograph serving as a basis

THE uncertainty of communication with the Upper Nile valley makes it difficult to determine the precise weight to give to reports of events happening there But it appears highly probable that an expedition from the Congo Free State has at last succeeded in establishing a station at Wadelai, or some other point within the British sphere of influence The natural outlet of the region is of course down the Nile, and it is scarcely in accordance with the principles of geography that a prosperous development can ensue with so difficult an outlet as that to the Congo The practical aspects of the case are in their present stage more political than physical, and in this stage they are likely to remain for some time

ON Tuesday the *Times* printed the following telegram, dated September 26, from its Calcutta correspondent -Mr Conway's mountaineering party, which left Askoley on July 31, reached the foot of the Baltoro Glacier after four days' march, and proceeded up the glacier for four days They then climbed a peak north of it 20,000 feet high, which they named Crystal Peak, and hoped to get a view of the great peak "K²," but it was hidden by a neighbouring peak They then went another day's march up the glacier and climbed a pass to the east of Crystal Peak 18,000 feet high From this they saw "K²," but discovered that the map was altogether wrong in the representation of the neighbourhood of that peak They also found the Baltoro Glacier considerably longer than the map makes it A high peak not marked on the map stands at the very head of the glacier This Mr Conway named the Golden Throne They determined to try the ascent, and went one march further up the glacier and then were stopped by a snowstorm, during which they sent the coolies down to collect firewood They reached the foot of the Golden Throne on August 18, and then worked up behind the peak, climbing over 2000 feet through a very broken icefall. It took four days to establish and victual a camp above the ice-fall, at a height of 18,000 feet They moved next day to a camp 19,000 feet, and the day following to one about 20,000 feet high Thence, on the 25th, they started for a real climb, and having reached a point over 23,000 feet high, they found they were on a mountain entirely cut off from the Golden Throne, which was still 2000 feet above them The peak they ascended—which they named the Pioneer Peak—commanded a magnificent view, especially in the Hunza direction, where they could see to the distance of at least 200 miles They suffered from the great altitude, but not severely, and they could have climbed at least a thousand feet higher, and perhaps more They slept that night in their camp 20,000 feet above sea level They were obliged to descend next day as their provisions were exhausted Bad weather commenced on the 27th, and continued, putting an end to climbing for the present season Mr Conway has gone to Leh, for the purpose of comparing his barometer with the standard there, and accurately reckoning the height of the Pioneer Peak He expects that the comparison will show that they attained a height at least a thousand feet above Schlagintweit's 22,230 feet in Nepaul, which is the highest climb hitherto authentically recorded He will then return to India

THE IRON AND STEEL INSTITUTE

THE autumn meeting of the Iron and Steel Institute was held last week in Liverpool, under the presidency of Sir Frederick Abel The meeting was fairly successful on the whole, although the weather marred some of the excursions, and the last day's sitting was simply wasted time The following is a list of the papers read —"On the Manufacture of Iron in its Relations with Agriculture," by Sir Lowthian Bell, "On an Apparatus for Autographically Recording the Temperature of Furnaces," by Prof W C Roberts Austen, "On the Alloys of Iron and Chromium,' by R A Hadfield (Sheffield), "On the Liverpool Overhead Railway," by J H Greathead, "On the Engineering Laboratories in Liverpool,' by Prof H S Hele Shaw, "On the Failures in the Necks of Chilled Rolls," by Charles A Winder (Sheffield), "On a New Process for the Elimination of Sulphur," by E Saniter (Wigan), "On the Elimination of Sulphur from Iron," by J F Stead (Middlesborough) A paper on the basic Siemens process, by Mr Kupelwieser, of Witkowitz, was also on the list, but was adjourned until the Spring Meeting of next year

Upon the members assembling in St George's Hall, on Tuesday, September 20, they were welcomed by the Mayor of Liverpool, and the reception formalities being disposed of, Sir Frederick Abel gave a short address, in the course of which he commented on the papers about to be read, and also stated that Mr E Windsor Richards, of Low Moor, had been elected by the Council to be President of the Institute, in succession to himself, during the coming two years during which the presidential term lasts

The first paper on the list was Sir Lowthian Bell's contribution, which he read from MS, the paper not having been prepared in time to be printed Those who are accustomed to attending meetings of this kind know how difficult it is to follow the reading of a paper even when they have the help of a printed copy, but when one has to depend upon one's hearing only, in a large room and amidst many disturbances, the task is hopeless So far as we could gather, the author treated his subject *ab ovo*, and much of the first part of the paper might be found in various elementary text books The main point of interest was a description of an apparatus which has been devised for arresting and securing certain products which are to be extracted from the fumes of blast furnaces using raw coal The chief of these by-products is sulphate of ammonia, and the author pointed out how necessary it was to the harmonic working of an economic system that this sulphate of ammonia should be collected and returned to the earth as a fertilizer Of course, there is no gainsaying this part of the argument, and, as it is perfectly possible to collect the fumes and products of combustion, the question resolves itself into one of profit and loss Sir Lowthian quoted figures which would, in these lean times, make the ironmaker's mouth water, and almost convert the iron itself into a by-product, but unfortunately, as it appeared afterwards during the discussion, the selling prices which the author had taken were by no means those of the present day Mr Snelus spoke of the remarkable fertilizing properties of sulphate of ammonia and

nitrate of soda. He had spread one half of a newly sown lawn with a mixture consisting of one part of sulphate of ammonia to three parts of nitrate of soda—four cwt. to the acre—and had grass an inch long, whilst the unspread part was quite bare.

The next paper taken was that of Prof. Roberts Austen, in which was described a modification of the Le Chatelier pyrometer, which has been introduced for the purpose of securing autographic records of temperature. The apparatus was exhibited at the council table, and has been constructed under the directions of the author for Mr. I. P. Martin, of Dowlais, in order that a continuous record might be kept of the temperature of the stoves in which the blast is heated for the iron smelting furnaces. It will, of course, be understood that the apparatus is suitable for recording temperatures under other conditions, and it can hardly fail to afford valuable assistance to those engaged in many branches of manufacturing industry, and in the scientific investigating of processes; in fact, in many branches of metallurgical inquiry, and also in the study of steam engine economy, there has been no want more widely felt in times past than that of a trustworthy means of ascertaining high temperatures. The author had previously described an apparatus he had before devised, and that shown was the result of a desire to simplify the design. The original apparatus consisted of a camera containing a reflecting galvanometer of the Deprez and D'Arsonval type of about 200 ohms resistance. A thermo junction is connected with this galvanometer, and the amplitude of the deflection of a spot of light from the mirror affords the basis in calculating the temperature to which the thermo junction has been raised. An autographic record of the temperature may then be readily obtained if the spot of light from the mirror falls into a sensitized photographic plate actuated by an astronomical clock, or by other suitable mechanism. Such an appliance as this, though well adapted for conducting investigations, is not sufficiently simple for industrial purposes, and the author determined that it was necessary to simplify the part which receives and records the spot of light; and also to arrange for attaching several thermo junctions, so that there would be one for each furnace, and each might be brought in connection with the recording apparatus in turn. In order to effect these changes the original moving plate was replaced by a clockwork revolved cylinder, to which was attached sensitized paper. In the apparatus shown provision was made for placing any one of six centres of heat, such as hot blast stoves or furnaces, in connection with the galvanometer, and for obtaining within the period of the revolution of the cylinder a record of the temperature of any one, or of all the six sources of heat. The records will, of course, be intermittent, the duration of the test in any particular case being subject to the will of the operator; or the shifting of the electrical contact from furnace to furnace could be carried on by clockwork. The apparatus would then be entirely independent of manual adjustment.

In the discussion which followed the reading of the paper the most important point was that raised by Dr. W. Anderson, the Director General of Ordnance Factories, who asked what was the durability of the thermo couple, and whether the intensity of the current would alter owing to changes in the metals after exposure to high temperature. It will be remembered that the metals used are platinum and rhodium. Mr. T. Parker also asked if the couple was protected. Sir Lowthian Bell, who has had considerable experience with the Le Chatelier pyrometer in practical use at the Clarence Iron Works, said that in regard to durability and constancy of record, the device was most successful. He had only had to renew three or four couples, and they certainly would give accurate readings for the space of several weeks. He had proved this by comparing new and old couples, and also by testing at known temperatures. The author subsequently stated that the couples were put naked in the blast, and did not require protection unless subject to the impact of a shower of metal, in which case they were placed in a porcelain sheath.

Mr. Greathead next read his paper on the Liverpool Overhead Railway. This is a new railway which follows the "Line of Docks," and extends for a distance of about six miles. It is composed, for the whole distance, with the exception of a length of a few hundred feet, of an iron viaduct of uniform height, and which is continuous from end to end; unless some of the swing bridges on its course be open. The railway itself has been previously described, but the rolling stock has not, we believe, before been dealt with. Electricity will supply the motive power, there being a generating station situated about the middle of the line, where there will be four engines working up to 100 horse power, each driving a separate Elwell Parker dynamo. The current will be carried along the line by a steel conductor placed on porcelain insulators. Hinged collectors of cast iron, sliding upon this conductor, will make the connection between the motors on the train and the generating dynamos. There will be no separate locomotives, the motors being on the cars, two cars forming a train to seat fifty six passengers, the total weight being about forty tons. The signals will be worked by the trains themselves through an automatic device. The total cost of the railway is to be £85,000 per mile.

The second day, Wednesday, September 21, was opened by the reading of Mr. Hadfield's paper. This is a production of the kind that brings despair to the heart of those who prepare brief notices of these meetings. It consists, with the appendices, of over eighty three pages, besides numerous sheets of tables, diagrams, &c. It begins with Vauquelin, and ends with a bibliography—*ab ovo usque ad mala*, as the author himself says; but the difficult part of the matter is that throughout the whole treatise there is not a part that could well be left out without disadvantage to the reader. Having said so much it will be evident that we can give but a very faint indication of the contents of Mr. Hadfield's paper. It is well known that he has made a special study of the alloys of iron and chromium, generally known as chrome steel, and his success as a practical steel maker has been most marked. He has now put the results of long research and experiment at the disposal of all steel makers, and we cannot do better than refer those interested in the subject to the original work, which will duly appear in the volume of the proceedings of the Institute. It is noteworthy that chromium appears not to be in itself a hardener of steel, but that it acts indirectly by influencing the action of carbon upon the iron. Some of the photographic reproductions of chromium steel projectiles attached to the paper are very interesting, as showing what punishment this metal will stand. The shells go through nine inches of compound armour and eight feet of oak backing without apparent damage, the points being as sharply defined as in the shell as it comes from the shops. At a range of eighty yards two six-inch shells went through the thickness of armour mentioned, the striking velocity being 1825 feet per second, and the energy 2250 foot tons. One projectile altered ·01" in diameter and the second ·013". One of these projectiles was fired through another 9" plate without apparent damage. A 13·5" projectile, also of Hadfield's make, was fired at a target consisting of two armour plates with 20" of oak between. The first plate consisted of 18" of compound armour backed by 6" of wrought iron. Next came the 20" of oak, and then a 10½ wrought iron, and finally a 2" wrought iron plate. This gave a total of 36½" of steel and iron, besides the oak. The penetration was complete, but the illustration shows the projectile to have been broken into three parts. The striking velocity was 1950 feet per second, and the energy on impact 34,280 foot tons. The weapon was a 63-ton B.L. gun.

In the discussion which followed this paper—which the author read in abstract, having previously distributed printed copies—Prof. Roberts Austen pointed out that the author's researches supported the views taken by himself and Osmond as to the dual form in which iron exists. This was shown by the diagrams showing the rate of cooling which accompanied the report. In these, when the cooling was from a high temperature, 1320° C., the curve was continuous throughout, but when the cooling was from about a thousand degrees, there was a point of recovery indicating recalescence. The diagrams formed part of a report by Mr. Osmond on Hadfield's chromium steel, which the author had incorporated in his paper. Prof. Roberts-Austen said he had arrived at the same results working independently. Another point worth recording is that remarked upon by Mr. Vickers, who dwelt upon the difficulty of deciding whether the effects noted in the steel were due to carbon or chromium, as it seemed impossible to separate the one from the other, the chromium invariably disappearing with the carbon. Mr. Vickers also started the old question of hardening by oil or water, a process which he advocates. Dr. Anderson put the matter in its true light by pointing out the danger from untrustworthiness due to the hardening process, defects being sometimes set up of which there was no outward indication. This, of course, refers to metal in large masses, such as gun hoops, &c. Mr. F. W. Webb, the Mechanical Engineer to the London and North-Western Railway, gave high praise to chromium steel, saying

he used it entirely for springs and also with advantage for tyres. He likewise found it an excellent material for tool steel.

Mr. Winder next read his paper on the failure of chilled rolls. The breakage of rolls is one of the most annoying of the many troubles with which the producer of manufactured iron has to contend. This is a matter which has hitherto received too little attention, it being generally considered to be in the nature of rolls to break, and nothing man could do would prevent it. It is as evident as like produces like, that if some rolls will last for considerable periods of time, others of exactly similar description, and working under the same conditions, would stand equally long. Sometimes four or five rolls—the author instances eleven in a fortnight—will give out one after another, until at last one will be found to accomplish the work. Mr. Winder, as a roll founder, endeavours to bring some sort of order into the process of manufacture. He points out that when a train of rolls is hard at work in the present day they will turn out as much as 1000 tons a week, and the passing of this great weight of red- and white-hot billets or blooms will be almost equal to putting the rolls into a furnace. The necks of the rolls are, however, kept cool by water, so that the lubricant may not be burnt off, and the sudden cooling thus caused produces a molecular change in the metal which, the author considers, accounts for much of the mischief. In order to overcome this difficulty it is recommended that there should not be too sudden a reduction of the diameter of the body of the roll where the neck is formed. That, in brief, appears to be the author's opinion, and doubtless his advice is good; in fact, it follows one of the cardinal laws observed by good iron founders in the casting of other articles besides rolls. A good practical discussion followed the reading of the paper. We think that foundry practice is a little behind in this country, and in this respect we might, with advantage, take a hint or two from American methods, perhaps more especially in regard to smaller castings than chilled rolls, which often fail unaccountably in the United States also. The advice to roll founders to cast with a bigger head should not be, but apparently is, necessary. Prof. Turner's remarks were to the point, and it would be of advantage if he would make his researches in this direction more fully public.

Prof. H. S. Hele Shaw was the author of the last paper read on the Wednesday of the meeting. The Walker Laboratories form part of University College, Liverpool, and are among the most recent and best arranged establishments of the kind. They have been erected under the guidance of the author of the paper, who occupied the chair of Engineering Science when the school was in a far less magnificent form. We have not space to follow the author in his description of the buildings, or the method of instruction. The latter appears to be framed in a manner calculated to turn out good engineers, a class which cannot be too large for the welfare of the country, although complaints are growing daily that they are already too numerous for their own advantage.

The last day of the meeting was Thursday, September 22, when two papers were read. The first was the contribution of Mr. Saniter, and in it he described the process by which he proposes to remove sulphur from iron by calcium chloride and lime. The experiments quoted go to prove that lime alone removes a considerable quantity of sulphur from iron if the contact is sufficiently prolonged; and, further, that a mixture of calcium chloride and lime completely eliminated the sulphur in the space of half an hour. Chloride of calcium is a by-product of the manufacture of ammonia, of soda (by the ammonia process), and of Weldon's bleaching process. The author states that the production amounts to many thousands of tons, of which only ten per cent. finds useful employment, the remainder running to waste. The subject is one of considerable importance, and no doubt the process will be freely criticized when it comes up again for discussion at the next spring meeting.

Mr. J. E. Stead's paper on the same subject—the elimination of sulphur from iron—was a much more imposing contribution, covering 40 pages of the proceedings. It dealt broadly with the whole question, and forms a most valuable contribution to the literature of the subject. At the conclusion of the reading of his paper Mr. Stead said that since it had been written he had had further light thrown on the matter by experiment and otherwise. He therefore proceeded to read from a MS. certain fresh matter, which appeared to occupy as much space as the paper itself. No doubt Mr. Stead will weld the original paper and the additions into one harmonious whole, which will then form a standard work of reference on a subject which has come to the fore so much within the last year or two. We congratulate Mr. Stead upon his courage in dealing with this matter in the way he has, and especially upon the practical disclaimer of infallibility which the appendix to his paper supplied.

There was no discussion of these papers, their consideration being adjourned until the spring meeting of next year. The matter should be well thrashed out, as speakers will have had an opportunity of consulting authorities, marshalling facts, or even making fresh experiments. It is to be hoped that in the future more discussions will be arranged on similar lines.

The proceedings closed with the usual votes of thanks to those in Liverpool to whom the Institute was so largely indebted for the success of the meeting.

There were several excursions during the week. The chief of these were to the Manchester Ship Canal, the Vyrnwy Water Works, the Lancashire and Yorkshire engineering shops at Horwich, the Liverpool Overhead Railway, and Laird's shipyard. A visit was also paid to the Walker engineering laboratories, where Prof. Hele Shaw had collected some very interesting models for the occasion. The most striking of these was an exceedingly intelligent chain-making machine which has recently come over to this country from the United States. The whole of the operations are automatic, reels of wire going in at one end of the apparatus, and coming out one continuous length of chain at the other, and this without human intervention of any kind. The machine may, in the ingenuity of its design, rank with Laycock's horsehair loom, which we described in connection with the visit of the Institution of Mechanical Engineers to Sheffield of two years ago. It is really surprising to see what complicated operations mechanism may be made to perform by means of cams, levers, and springs. Mr. Laycock's loom exhibited perhaps a higher intelligence than the chain-making machine, inasmuch that it would select suitable hairs from a bundle, and would refuse to continue the work unless the proper kind were supplied. The chain-making machine, on the other hand, has to deal with a more stubborn material and has to connect each link. We do not know the name of the inventor of this machine, but the chain is known as "Triumph Chain."

FUELS AND THEIR USE

At the annual meeting of the Society of Chemical Industry held in London on July 20, the chair was occupied by Dr. J. Emerson Reynolds, F.R.S. He chose, as the subject of his presidential address, "The modern developments in regard to fuels and their use"—a subject, as he explained, which had occupied much of his attention. The address was one of popular, as well as of scientific, interest.

After some preliminary remarks, Dr. Reynolds said:—

The fuel question is one which concerns those of us who live on the western side of St. George's Channel even more seriously than it does you, as our coal beds have been washed away in ages past, and of native fuel there is practically none save peat; hence industries which require large quantities of cheap coal cannot flourish in Ireland under existing conditions. It is, therefore, our interest to watch closely the development of improved and economical methods of using such fuel as we can obtain from other countries, and apply them in the utilization of our bulky but abundant peat. It is evident that no other fuels need be considered save coal, peat, and petroleum; hence, my remarks can take somewhat the form of a trilogy, minus the dramatic element, precedence being given to the solid fuels, and the first place necessarily to coal.

The Royal Commission on Coal Supply, which commenced its sittings in July, 1866, and reported in July, 1871, after inquiring into all probable sources of coal in Great Britain, arrived at the conclusion that not more than 146,480 million tons were available at depths not exceeding 4000 feet from the surface. Therefore, at our present rate of increase of population and of coal consumption, our supply would not last for 230 years. But Mr. Hall, one of Her Majesty's Inspectors of Mines, who has special experience of coal mining, forms a much lower estimate of the supply practically available with our present means, and considers 170 years as the more probable duration of our coal beds. This estimate is based on fuller information than that possessed by the Royal Commissioners; we are therefore justified in concluding that the inhabitants of Great Britain 170 years hence will have little, if any, home raised coal to burn if we continue to use it in our present wasteful fashion.

It was pointed out by the Royal Commissioners in 1871 that we cannot suppose 'the production of coal could continue in full operation until the last remnant was used, and then suddenly cease In reality a period of scarcity and dearness would first be reached This would diminish consumption and prolong duration, but only by checking the prosperity of the country' 'Much of the coal included in the returns could never be worked except under conditions of scarcity and high prices A time must even be anticipated when it will be more economical to import part of our coal than to raise the whole of it from our residual coal-beds' As the area of coal bearing strata in North America is fully seventy times greater than ours, it is easy to see where our future supplies must come from The rate of increase in the use of coal has been greater than the Commissioners anticipated in 1871, and Mr T Foster Brown, C E, President of Section F of the British Association at Cardiff last year, has placed on record his opinion that at the end of only fifty years from the present time the increased cost of coal will be severely felt Pessimism is never pleasant, nevertheless we cannot afford to ignore reasonable inferences from fairly ascertained facts

I apprehend that there are few ordinary consumers likely to be influenced in avoiding waste by the knowledge that we are within measurable distance of the end of our store of British coal, as that calamity may still be some generations off But the case is very different with large consumers, the inevitable, if gradual, increase in the cost of coal has effectually arrested the attention of those directly concerned in our great industries or anxious for the maintenance of that manufacturing supremacy to which this country chiefly owes its wealth and power Keen international competition in trade has quickened the effort to get the utmost work out of fuel, and therefore to diminish waste

No such considerations have, however, produced any effect on the domestic conscience A spasmodic increase in cost of coal stimulates the use of various economical devices which are almost wholly given up when prices fall back nearly to their former level A small residual effect is left, which, though slight, is on the right side But that economy in the domestic use of coal which could not be effected by a patriotic desire to avoid the too rapid exhaustion of our coal beds, or by a fear of permanently dear coal, is likely to be brought about by the growing nuisance of large towns, namely, fog, for whose increase our 'hearths and homes' are in a greater degree responsible than the much abused factory chimneys The primary consideration in seeking to cope with the fog demon no doubt is to avoid the production of solid particles during the combustion of any fuel we may use, hence that method which avoids the formation of smoke at any time, and is both more convenient and economical, must ultimately 'hold the field' As you well know, various suggestions have been made for the purpose of avoiding the production of smoke, and it has even been proposed that the use of non flaming coal should be made compulsory in all large towns, notwithstanding the difficulties known to attend the combustion of anthracite or similar substances in open grates But even if the fog demon could be satisfactorily exorcised by such means, the fact would remain that the combustion of any solid fuel in an open grate is a most wasteful proceeding On the other hand, closed grates or stoves have not been popular in these countries How, then, can we combine economy in the use of coal with smokeless combustion and domestic convenience? The answer is sufficiently obvious—we must more or less completely gasify the coal prior to its complete combustion

The late Sir William Siemens showed us long ago how to convert coal completely into gas by means of his great 'producer' furnaces, and demonstrated the applicability of the comparatively poor 'producer' gas to operations requiring very high temperatures as well as to the minor work of steam raising Siemens showed that when so used one ton of coal can perform as much work as 1 7 tons directly burned. In such comparisons the 'producer' gas was, of course, burned at a short distance from its source and under the regenerative system This mode of using coal seems to be the most economical of which we have practical experience, but the gas which is produced seldom contains less than 65 per cent of useless nitrogen, and therefore is not rich enough in combustible matter for general distribution

The Wilson method of gasifying coal and that employed by the Leeds forge, permit the production of a richer gas The Wilson process involves the formation of a certain proportion of 'producer' gas in raising the temperature of the coal up to the point at which it can decompose steam, and then affords a mixture of carbon monoxide and hydrogen, or so called 'water gas' The former can be used for steam raising or furnace work in the immediate vicinity of the producer, while the water gas can be transmitted through mains as readily as ordinary town gas, and loses nothing by carriage save its initial heat Thus one general method affords two qualities of fuel and gasifies the coal in an economical manner.

Whether by the Siemens method in its modern form or by the more or less complete conversion into rich water gas, a great saving in coal can now be secured in almost all large operations requiring the command of high temperatures, and the use of such gaseous fuel is so steadily extending that we may expect in the near future to reach the maximum practicable economy of coal in our greater industries and of smoke abatement as well

Between the complete conversion of coal into gas and the very partial process included in the production of ordinary illuminating gas is a wide gap which needs to be bridged over in the interests of the small manufacturer and the domestic consumer alike before we can secure that economy in the use of coal which we know to be necessary For it must be granted at once that our ordinary 16 candle illuminating gas is seldom an economical fuel at an average price of 3s per 1000 cubic feet, though it is capable of being so used as to effect distinct saving under special circumstances As an example of its economical use, even near the price stated, I may cite the case of the kitchen of St John's College, Cambridge, where gas and steam have been substituted for coal, and an annual saving effected amounting to about £80 But in establishments which cannot be systematically conducted coal gas at 3s is too expensive a fuel Several solutions of this important practical problem have been proposed, one group of suggestions involving the supply of two distinct gases, an illuminating and a fuel gas, and therefore requiring two sets of street mains, but the progress of electric lighting is so rapid that gas companies would not be justified in outlay of capital on a second set of mains Another proposal is to supply one gas of high calorific value but low illuminating power at a cheap rate, and this gas, when used for lighting, to be charged at the point of consumption with vapours of suitable hydrocarbides But the true solution involves a compromise much on the lines along which gas managers are at present apparently working

You are aware that the average produce of 16 candle gas per ton of coal is about 9500 cubic feet By the introduction of steam to a small extent the volume of gas can be materially increased, but at the expense of the illuminating power In order to compensate for this loss, rock or other oils are injected along with the steam, and the illuminating power is maintained An objection to this practice is that carbon monoxide is present in such gas, but it is also found in many samples of ordinary coal gas, and provided the gas has a strong and characteristic odour, so that its escape can be readily detected, no risk need attend its use The supply of the richer bituminous coals is steadily diminishing, hence the practice must grow of supplying a modified water gas instead of coal gas as we have hitherto known it Better far, in the interests of producer and consumer alike, that the inevitable change in the character of the gas manufacture should be carried out with the full knowledge and assent of the public after due Parliamentary inquiry, and in such a manner as to secure the maximum advantage without undue interference with the great monopolies enjoyed by the gas companies So many satisfactory methods are known by which the illuminating power of a gas can be increased at or near the burner, and gas as an illuminant is moreover being so certainly displaced by the electric light that the objections hitherto urged against the supply of gas of high calorific value but low illuminating power have almost ceased to have any practical force On the other hand, the supply of a cheap gas of the kind I refer to would prove a great boon to small manufacturers as well as to the domestic consumer, and competent gas engineers inform me that no real difficulties lie in the way

The rapid extension of electric lighting in our large towns brings us within measurable distance of some such sweeping change in the character of gas used, in its applications, and in its mode of employment, while the existing mains would serve for its conveyance, and comparatively trifling alterations in our domestic appliances would only be necessary

It is in this direction, then, that the best prospect of solving a considerable part of the smoke fog difficulty seems to lie, and

it is in the same direction that we are to look for true economy in the use of coal. The completion of the system of electric lighting in towns is therefore to be desired by the community, not only on account of its great and obvious advantages for illumination, but because it will render possible the provision and distribution of a cheap gas for heating purposes; and the shareholders in gas companies of such fortunate towns should specially rejoice, as herein lies a good prospect not merely of maintaining, but of considerably increasing, their dividends. Gas companies would not only become purveyors of heat energy for domestic use, but for manufacturing purposes as well, not excepting the production of the electric light.

Hence, our duty to posterity and our own immediate interests coincide in requiring the use of more economical methods of using coal, and that which gives promise of the greatest number of advantages involves the conversion of coal as far as possible into gaseous fuel.[1]

I turn now from coal to peat, which is, as you know, a much less mineralized solid fuel. It is obvious that the question of peat utilization is one of much importance in Ireland, as nearly one-seventh of the island is bog. About 1,250,000 acres are mountain bog, and 1,575,000 acres are occupied by flat bogs, which occur over the central limestone plain of the country and stretch away to the north-west. This store of peat is an asset which may become valuable when you shall have exhausted your coal beds some 170 years hence. We would naturally desire to realize a portion of our assets at a much earlier date, as nearly all the coal used in Ireland must be brought from the eastern side of St. George's Channel. In this fact I think you have some explanation of the depressed industrial condition of the country, as manufactures involving the use of much fuel can only flourish in Ireland if the margin of profit be considerable; where the margin is small and competition keen (as in the greater industries), they must go under in the struggle with manufacturers having cheaper fuel at command. I grant at once that this is no adequate explanation of the absence of many chemical manufactures which do not involve large consumption of fuel, but it is the inevitable result in the cases to which my remarks apply.

Peat alone, however well prepared, compares very unfavourably with coal in several particulars:—

It is a very bulky fuel, in its ordinary condition occupying rather more than five times the space of an equal weight of coal.

2. It contains from 15 to 25 per cent. of water and seldom less than 10 per cent. of ash.

3. At least 2½ tons of average peat are required to perform the same work as one ton of average Staffordshire coal in ordinary fireplaces or furnaces.

Hence the general use of ordinary peat is attended by the disadvantages of requiring much greater storage room than coal, of producing a light and troublesome ash, and requiring more than thirteen times the bulk of coal to produce the same thermal effect. The last-mentioned consideration practically precludes its use in ordinary furnaces where heat of high intensity is required.

Now the force of the first objection to the use of peat, that of bulk, can be materially diminished by mechanical compression. Many excellent examples of compressed peat have been produced at various times, the most coal-like product I have seen being that of Mr. Hodgson, of Derrylea, who compressed, thoroughly disintegrated, and dried peat in heated cylinders, and by partially carbonizing under pressure secured the cementation of the material. Moreover, the ash of such compressed peat was not so bulky as that of the ordinary fuel.

I need scarcely say that the intensity of the heat obtainable with compressed peat is greater than with the loose material, but the actual thermal effect is not much altered, save in so far as the material is drier and therefore less heat is lost in evaporating moisture.

Extended comparative trials of coal and of good dense peat in steam engines have shown that the work done by one ton of peat was not more than 45 per cent. that of one ton of coal; hence if coal were 18*s.* per ton, peat could not compete with it under the most favourable conditions unless delivered at not more than 8*s.* per ton. Now the peat used in these trials did not contain more than 12 per cent. of moisture, but as dug from the bog it seldom contains less than 35 per cent. of water, even when cut from a comparatively dry bog; it must then be stacked and air-dried. The present price of ordinary turf delivered at the bog is about 7*s.* per ton; when to this is added the cost of handling this bulky fuel, and carriage for fifty miles, the cost exceeds 45 per cent. of that of coal even at inland towns; hence there is no real economy in the use of peat of the common kind in ordinary furnaces and grates instead of imported coal.

But the public are led by promoters of peat manufacturing companies, and others who should know better, to suppose that by certain processes of disintegration and compression peat can be made to approach very closely in fuel value to an equal weight of coal. There is no doubt that a better-looking and denser product can be obtained by these means, and one which requires less storage room; but unless artificially dried as well, the actual heating effect of the fuel is not materially altered. I have no doubt that the cost of winning and treating the rough peat could be much reduced by the use of suitable labour-saving machinery; but all methods with which I am acquainted involving artificial drying as well as mechanical compression, have cost so much that the product could not compete with coal at the ordinary level of prices. As I have already said, the Irish peat forms a valuable asset, but one not capable of being realized on any considerable scale at present; at least when used as fuel in the ordinary way as a substitute for coal. But it is possible to so burn peat that it shall compare much more favourably with coal, and this solution of the problem is obtained by converting rough peat into gas.

You doubtless remember that in 1872 the cost of coal advanced even beyond the panic prices which prevailed for a week or two about the beginning of the present year. But the coal famine of 1872 lasted for a considerable time, and serious efforts were then made in Ireland for the utilization of peat. It soon became evident that the continuance of dear coal meant the suspension of several industries and their probable loss to the country; hence, leaving to others the attempts to convert peat into a suitable fuel for general domestic use, I took up the industrial side of the problem.

I saw that the best chance for economically applying peat for most manufacturing purposes lay in gasifying the material in a Siemens furnace, as two special and important advantages must obviously be gained thereby:—(1) The use of peat in the rough state without artificial drying; (2) The avoidance of the injurious effects of abundant ash by burning the peat gas at some distance from its source, and under such conditions that the comparative value of coal and peat should be nearly in the proportion of their percentages of carbon. I therefore moved the Royal Dublin Society to appoint a committee of engineers and other scientific men to have the value of peat tested in the way proposed. The outcome was that the directors of the Great Southern and Western Railway of Ireland, acting on the recommendation of the able locomotive engineer, Alexander Macdonnell, C.E., decided to erect a complete Siemens regenerative gas furnace for working up scrap iron in their engine factory at Inchicore. This furnace was supplied only with rough peat, often containing as much as 38–40 per cent. of water, but no difficulty was found in keeping the welding chamber at a bright white heat for months at a stretch. The average consumption of fuel was 5.09 tons of peat for each ton of iron forged from scrap to finished work. Before the Siemens furnace was built the ordinary air furnace fed with coal was employed, and the average consumption per ton of iron was 4.96 tons of coal. I need scarcely say that peat is practically useless in such a furnace. Therefore peat used in the gas furnace as compared with coal in the ordinary welding furnace not only proved in practice to answer extremely well, but performed 97 per cent. of the work done by an equal weight of coal. As the price of peat was about half that of coal at the time, Mr. Macdonnell estimated that a saving of £4 7*s.* 9*d.* per ton of finished forgings was effected. If therefore the coal beds were exhausted we have a good substitute in peat for operations in which a very high temperature is required, provided the fuel is used in the gas furnace or according to some similar plan.[1]

The above remarks refer to work done twenty years ago. Now, thanks to the valuable investigations of Mr. Ludwig Mond, F.R.S., detailed in his Presidential Address of 1889, the pro-

[1] Since the above was written I have seen a short abstract of Mr. Valon's address to the Institute of Gas Engineers, in which I am glad to find that he takes a somewhat similar view of the situation to that expressed above.

[1] Of course the comparison is more favourable to coal when the latter is used in the Siemens furnace, as it is found that a ton of iron required an average of three tons of coal, therefore the work done by peat was about 60 per cent. of that by coal under the same conditions.

duction of ammonia from peat along with gas according to his method will probably pay for gasifying the fuel and materially facilitate the utilization of peat.

Much to my surprise and regret this work remains the sole practical outcome of our efforts in the direction of peat utilization during the fuel famine of 1872, so far as Ireland is concerned. Manufacturers now know how they can economically use peat for high temperature operations, and Dr Bindon Stoney, F R S, has suggested that peat should be gasified at the bogs and carried to convenient centres of industrial activity. This could undoubtedly be done, especially if instead of 'producer' gas a fuel were manufactured approaching water-gas in composition, and such a gas of good calorific power can be manufactured from peat. Thus, as in the case of coal, peat could be made economically to provide light and heat energy as well for domestic use as for manufacturing purposes. Would that we could apply even a small portion of the energy stored up in peat to stimulate those who should be most active in utilizing in the best and most economical way the abundant material almost at their doors!

If, then, there are many and great advantages in converting our bulky solid fuels into gas and distributing them in that form for heating purposes or supplying power by means of gas engines, it is clear that such advantages must be confined for the most part to towns or special manufacturing centres unless the gases are condensed to the liquid form, and so rendered portable to considerable distances, but nature has already done a great part of this work for us in providing the wonderful material we call petroleum. I do not think 'wonderful' is too strong an adjective to apply to this material, whether we consider its nature, speculate as to its probable origin, or attempt to measure its value in the world's work, and in this, the concluding section of my address, I propose to sketch in broad outline the main points of public interest which relate to this, the most important of our liquid fuels.

The views of geologists as to the nature of the general process by which petroleum is formed are elaborately discussed in the eighth report of the United States Geological Survey, and the conclusions are there carefully summarized (page 506). In substance they are as follow:—That petroleum is derived from organic matter by a process of slow distillation at comparatively low temperatures; that the organic matter was not in all cases of vegetable origin, but was in some instances derived from animal substances in contact with limestone; and, finally, that the stock of petroleum in the rocks is practically complete. It follows, of course, that the supply is exhaustible, but geologists do not even guess at its duration.

In contrast with all this is Mendeléeff's view that petroleum is not a product from organic material, but is chiefly formed by the action of water at high temperatures on carbide of iron, which he supposes to exist in abundance within or below the earth's crust. The cracks and fissures caused by the upheaval of mountain chains permit water to reach the heated carbide at great depths, and carbides of hydrogen result in accordance with the general equation—

$$3\,Fe_mC_n + 4\,mH_2O = mFe_3O_4 + C_{3n}H_{8m}$$

The hydrocarbides then distil up and condense within the cooler sedimentary strata. The occurrence of petroleum in active volcanic areas, as in Sicily and Japan, is held to accord with this hypothesis, which latter is also consistent with the remarkable fact that rock oil is usually found in the vicinity of mountains. But my chief reason for referring to this attractive hypothesis is that it permits us to suppose the hydrocarbides are still being formed within the earth's shell, especially beneath the geologically modern mountain chains, and that the supply of petroleum is practically inexhaustible. Whether that view can be sustained we must leave further evidence to decide, and now return after this digression to the consideration of the material itself.

The porous strata saturated with petroleum often lie at considerable depths below the surface soil of the district, and the oil is in many cases prevented from rising by a bed or shell of almost impervious material. In boring for the oil this enclosing shell is penetrated and the result often is the ejection of a column of liquid rising as a fountain of several hundred feet into the air. This violent expulsion of petroleum is due in great part to the pressure of pent up gases, and the crude liquid always contains some of these gases in solution. In some instances gas only issues, and a so-called 'gas well' is obtained, from which are emitted enormous volumes of marsh-gas and its lower homologues, as well as hydrogen. Some of these American gas wells afford from 10 to 14 million cubic feet per day, delivered at a pressure of as much as 400 pounds to the inch. Such gas is a fuel of high value and, as you know, has been largely utilized for industrial and domestic purposes at such great industrial centres as Pittsburg.

One million cubic feet of the natural gas obtained from the Trenton limestone at Findlay, Ohio, are said to do the same amount of work in heating as about 60 tons of Pittsburg coal. Some of these gas wells have been exhausted, but others have continued in full productiveness for several years. Although this natural gas is compressed and transported in cylinders to considerable distances, it evidently must remain of almost exclusively local value; not so the liquid petroleum which issues along with it or in its immediate neighbourhood. This is the most portable of all fuels obtainable in nature, and therefore is the most convenient means by which light and heat can be transmitted to all parts of the world—hence it is of greater practical interest to us than the natural gas.

You are aware that the hydrocarbides of which the American petroleum consists chiefly belong to the saturated group C_nH_{2n+2}, whereas those of Russian petroleum are mainly benzenoid hydrocarbides of the general formula C_nH_{2n}, isomeric with the olefines, but really hydrogenized aromatic compounds of the naphthene series. Petroleum from both sources affords some of the lower homologues of marsh gas, hence in the process of refining crude petroleum by distillation the first products consist largely of butane, pentane, and hexane, which are separated and condensed by pressure, the product being used for refrigerating purposes, owing to its high volatility. Between 80° and 120° American petroleum affords a spirit of specific gravity about 0·75, and above 130° the illuminating oils are obtained, whose gravities vary about 0·8, while the residue which is not vaporized at 300° includes the heavier lubricating oils, which are also admirably suited for use as fuel, and are cheaper than those generally used for lighting purposes. During this process of refining by simple distillation there is always more or less decomposition in progress, hydrocarbides of high molecular weight being resolved into simpler ones at a comparatively high temperature; and when crude petroleum or its constituents are rapidly heated, this resolution can be carried so far as to convert a large proportion of the oil into permanent gas, valuable alike for illuminating and heating purposes. Thus petroleum is a fuel which can be permanently gasified with facility, and is no doubt wholly converted into gas just prior to combustion in our common lamps.

Several methods are employed for the conversion of oil into rich gas, and storing the latter for distribution through tubes in the ordinary way. In one class of such processes the oil alone is rapidly heated to a temperature of from 800° to 1000° in iron retorts, as in the methods of Pintsch and Keith, thoroughly described by Dr Armstrong in vol iii of our Journal. The yield of gas seldom exceeds 130 cubic feet per gallon, as liquid hydrocarbides of low boiling points are condensed chiefly during the compression of the gas into cylinders for use in railway carriages. The gas is rich in carbon compounds, including methane, ethylene, and crotonylene, and its illuminating power, even after compression, is seldom less than forty-five candles. I may add that Mr Ivison Macadam has given in vol vi of our Journal (p 199) a valuable series of observations on the gas-producing power of various oils treated by a process very similar in plan to that of Pintsch.

Another mode of converting petroleum into gas includes the use of steam, as in the process of Messrs Rogers, of Watford, who inject the oil into red hot retorts by means of steam, the latter appearing to facilitate the permanent change of the petroleum without the formation of much carbon monoxide. The gas so produced is said to amount to about 140 feet per gallon of heavy oil used, and has, according to Mr. Rowan (this Journal, vol vii), the following composition:—

	Per cent.
Hydrogen	31·61
Marsh-gas	46·17
Illuminants	16·29
Carbonic oxide	0·14
Nitrogen	5·06
Oxygen	0·73

This gas is stated to have an illuminating power of fully 56 candles, and to lose little either by standing or by carriage to considerable distances.

As such petroleum gas has about 3.5 times the illuminating power of 16 candle coal gas, it follows that, so far as illuminating purposes are concerned, the gas producible from one gallon of oil by this process is equal to some 525 cubic feet of coal gas of 16 candle value. I shall later on refer to the heating value of this petroleum gas but I have now justified the statement with which this section commenced, viz., that petroleum is virtually liquefied gas in a peculiarly portable condition. Hence in all states petroleum can be used as an illuminant as well as a fuel, whereas coal and peat can only be used as illuminants in so far as they can afford carburetted gas.

Let me now proceed to justify the further statement that petroleum is the most concentrated, and, on the whole, the most portable of all the natural fuels met with in considerable quantities.

Weight for weight the efficiency of liquid petroleum in steam-raising is much greater than that of coal. The estimates of relative value necessarily vary with different portions of the crude material used, and with the quality of coal employed in the comparative trials, hence some of the statements of results are often rather vague. Thus M. d'Allest found that one pound of refined petroleum evaporated 12.02 pounds of water, while only 6.5 pounds were evaporated per pound of a rather poor steam coal. The American results with crude petroleum and Pittsburg coal give respectively 15 and 7.2 pounds of water per pound of fuel. Prof. Unwin has recently compared petroleum with Welsh coal in steam-raising, the oil being injected by a steam jet through a highly heated coil and then burned perfectly with a clear flame. In his trials with a not particularly efficient boiler he found that 12.16 pounds of water were evaporated per pound of petroleum, and this result he considers about 25 per cent. better than that afforded by the steam coal. These results agree with those of M. d'Allest so far as the effect of petroleum is concerned, but the coals compared were different in value for steam-raising. Hence for an average coal the proportion is nearly three to two, in other words the practical heating effect of one ton of coal can be obtained by the combustion of only two-thirds of a ton of petroleum, while the comparison with the heavy oils would probably be still more in favour of liquid fuel. Petroleum has another advantage over coal in the matter of storage room, as one ton of the liquid occupies only four-fifths of the space of the same weight of coal, so that the bulk of the petroleum required to perform the same work in heating as one ton of average coal is little more than half that of the latter. It follows that a steamer constructed to carry 1000 tons of coal could, if provided with suitable tanks, carry 1200 tons of petroleum, equal in fuel value to about 1900 tons of coal. In addition, the liquidity of petroleum permits it to be pumped and conveyed long distances by gravitation in tubes so that its transport in bulk and in detail is easy. Therefore petroleum is not only a much more concentrated fuel than coal, but it is eminently portable as well and convertible with much greater facility into permanent gas. Against these advantages must, however, be set the inflammability of petroleum, and consequent greater risk of fire.

Now we have to consider the question of relative cost of petroleum used as fuel in liquid or gaseous form as compared with coal, the latter being our standard for reference as in the case of peat. We have already seen that about two-thirds of a ton of petroleum can do the same amount of work in heating as one ton of coal, therefore petroleum, when burned directly, cannot economically replace coal unless two-thirds of a ton of the liquid can be purchased for less than the cost of one ton of coal. We know the cost of ordinary lamp petroleum in these islands is at present far beyond that limiting value, even the heavy oils which are not good enough for lamps, and yet are too 'thin' for lubricants, only compare favourably with coal where the latter has to be carried long distances, and is therefore dear. However, all practical difficulties having been overcome in the use of these heavy oils for steam raising, a comparatively small advance in the general price of coal would at once render them economical for industrial use as fuel.

But when we compare petroleum gas with ordinary coal gas the comparison is much more favourable to the liquid fuel, unlike coal, petroleum is already more than half way on the road to conversion into gas. As you know, one ton of coal affords about 9500 cubic feet of 16 candle gas. On the other hand, one ton of oil of sp. gr. 0.85 can afford about 21,000 cubic feet of gas, having an average illuminating power of 60 candles, or the equivalent of about 70,000 cubic feet of 16 candle value, and this rich gas admits of preparation on the small scale suited to country places, while the retorts used in the production of the gas can be heated by petroleum. The petroleum gas of some 60 candle power is said to be producible at about 6s. per 1000 cubic feet. If we were to assume that the calorific value of the gas is directly proportional to its illuminating power the cost would correspond to about 1s. 7d. per 1000 cubic feet of 16 candle coal gas. But the facts do not justify the assumption, as the calorific value of methane is known to be greater than that of the heavier carbides to which the high illuminating power is due, hence the comparison is probably less favourable to petroleum gas by about 25 per cent., though further experimental evidence is wanting on this point. However, even after this deduction, petroleum gas is the cheaper fuel as well as illuminant.

The necessary links between the elements of the trilogy on coal, peat, and petroleum are now, I think, sufficiently evident. If we desire to use each fuel in such a way as to develop most economically and conveniently its store of heat energy, we must first partially or perfectly gasify it. The newest member of the triad—petroleum—is the one which lends itself most easily and completely to such treatment, in consequence of its physical condition and chemical characters. It is also the material that we must expect to facilitate the production of cheap gaseous fuels from coal and peat which shall at the same time possess sufficient illuminating power for most purposes. Chemical industries would probably benefit to a greater extent than others by the supply of cheap fuel of the kind in question, hence I have ventured to tax your patience by dwelling on this topic in your presence to-day.

SUGAR-CANE BORERS IN THE WEST INDIES.

MR. BLANDFORD'S report on sugar-cane borers, published in the *Kew Bulletin* for July and August last, deserves more than a passing notice.

The report contains a plate of the insects in question, which will render their identification easy.

The first is a caterpillar and moth, *Chilo saccharalis*, the second a weevil, *Sphenophorus sacchari*, but the principal attention in the report is paid to the shot borer, *Xyleborus perforans*, a beetle which has lately caused considerable loss to growers of sugar canes in Trinidad. These losses have been so large that on some estates thirty per cent. of the sugar crop has been destroyed, and in some fields fifty per cent., presumedly by the devastations of this beetle.

This beetle *X. perforans* is to be found over a very large area in the tropics, it is the same species that has done so much damage to wine and beer casks, it has been found in India, the Malay Archipelago, Madeira, Mauritius, North and Central America, Brazil, Guiana, Peru, and probably in Australia, so that no sugar-producing country can consider itself free from the fear of its ravages.

Mr. Blandford's report is interesting and valuable, not only for the amount of information it gives relative to this most destructive insect, but also for the way in which he points out what remains still to be investigated on the subject, so that it not only furnishes valuable information to the planter in the West Indies, but also tells him what course his further investigations should take, and it might well serve as a model to future observers in drawing up similar reports.

"The chief subject for investigation," to quote Mr. Blandford, "is the relation of the insect's attacks to the health and condition of the canes, whether it (the shot borer, *X. perforans*) is a true destroyer, or merely a follower and manifestation of antecedent and more serious injury." this question, Mr. Blandford says, "I do not attempt to solve, it can only be studied in all its bearings by observers on the spot," and he further gives a list of definite points which require inquiry and solution.

There is no doubt that the presence of *X. perforans* is usually accompanied by the sugar-boring caterpillar, *C. saccharalis*, and the weevil, *S. sacchari*, and also with fungoid growths, which may of themselves account for the acidification of the juices of the cane, which is apparent in canes attacked by the shot borer, but whether or not the shot borer attacks healthy canes is a question on which there is much diversity of opinion, and we hope that bringing the question before our readers will lead to

more observations and experiments to decide this important question, as "while there is no proof, there is a strong presumption that *X. perforans* cannot begin the attack." Still there is much difference of opinion, as the Trinidad Commission, which investigated the subject, "believes that the beetle is the primary cause of the disease, and that it is immaterial whether the cane is healthy or not," others believe that it is only canes which are "already physically weakened by other causes which are attacked by it."

The Transparent Cane and Caledonia Queen enjoy an entire immunity from the attack, "even when growing side by side with badly infested Bourbon canes, and varieties raised by seed show no signs of being attacked." It is therefore suggested that perhaps the Bourbon cane, enfeebled by long cultivation on the same lands and degenerated by careless ways of propagation, has become powerless to resist the attacks, and planters in their investigation must consider the possibility of attacks "being favoured by constitutional weakness which in no way implies want of care in cultivation, but perhaps the reverse."

The enemies of the shot borer are still to be found.

An important lesson taught by this report to the planter is the necessity of varying the description of canes grown and the great value of the new seed canes raised in Barbados.

S. N. C.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, Sept. 19.—M. Duchartre in the chair.—On the white rainbow, by M. Mascart. This phenomenon, usually known under the name of Ulloa's circle, is explained not on the untenable assumption of water vesicles, but of very minute drops as constituting the mist upon which it is seen. The diminution of the diameter of the drops causes a displacement of the first maximum of the interference fringes which produce the supernumerary arcs. The relative intensities of the various colours retain equal values long enough to make the rainbow appear achromatic, with perhaps a slight red coloration along the outside. The radius of such a circle has been known as small as 33° 30'.—Observations of the new planet Wolf (1892, Sept. 13), and of the planet Borrelly-Wolf (Erigone?), made at the observatory of Paris (west equatorial), by M. Bigourdan.—On a recurring series of pentagons inscribed to the same general curve of the third order, by M. Paul Serret.—On the production of the spark of the Hertz oscillator in a liquid dielectric instead of air, by MM. Sarasin and De la Rive. The two balls of 3 or 4 cm. in diameter between which the Ruhmkorff discharge takes place in the Hertz oscillator, were plunged into an insulating fluid. This was, in the first place, olive oil, contained in a cylindrical vessel, 20 cm. in diameter, pierced laterally to admit the end branches of the oscillator. Sparks 1 cm. long were obtained, giving a characteristic sound, louder than that of a discharge through air. The effect on the resonator is notably increased by the arrangement, most brilliant sparks being produced. The interferences of the electric force by reflection from a plane metallic surface give the same results as in air. During the discharge, the oil is carbonized and loses its transparency, but without affecting the intensity. Similar experiments were made with essence of terebenthine and petroleum, but the oil proved the safest and most advantageous medium.—The action of bromine in presence of aluminium bromide on the cyclic chain carbon compounds, by M. W. Markovnikoff. It has been shown that a small quantity of bromide or chloride of aluminium added to the bromine produces a vivid reaction with the carbon compounds of the aromatic series, usually resulting in substitution products of a crystalline form. Further experiments show the generality of the reaction for all the hydrocarbons of the series C_nH_{2n} which were examined. It has been studied chiefly as regards the naphthene (hexacarbon) series, and may be expressed by the general equation—

$$C_6H_{12-n}B_n + Br_{12-n} = C_6B_6-n + 6HBr$$

The rule seems to be that the action of the bromine on the naphthenes at the ordinary temperature takes place principally on the hydrogen atoms of the cyclic chain, transforming them into benzene nuclei, in which all the hydrogen atoms are replaced by bromine, whilst the lateral chains remain intact. It is found that besides the bodies of the aromatic and naphthene series, the hydrocarbons of the paraffin series also react easily in presence of $AlBr_3$.—The rotatory power of fibroin, by M. Leo Vignon.—Experimental researches on the bulb centre of respiration, by MM. J. Gad and G. Marinesco.—Influence of continuous and discontinuous electric light upon the structure of trees, by M. Gaston Bonnier. Out of three lots of plants, one was submitted to a constant electric illumination, another to an illumination alternating with twelve hours' darkness, and a third was left to develop in ordinary daylight. The experiments were carried out in the electric pavilion of the Central Markets at Paris. The temperature was pretty constant (between 13° and 15°), the light was given by arc lamps in shades, and the trees—pines, beeches, oaks, and birches—were surrounded by glass, the air being gradually renewed. It was found that continuous electric light produced considerable modifications of structure in the leaves and shoots of the trees. The plants breathed, assimilated, and secreted in a continuous manner, but they appeared as if encumbered by this continuity, and showed a simpler structure. The shoots were very green, the leaves more open, less firm, and smaller. Differentiation was less decided in every respect. In the specimens exposed to intermittent illumination the results were very similar to those obtained under normal conditions.—On the discovery of the line of no declination, by M. W. de Fonvielle. From an inspection of geographical maps preceding or contemporaneous with the discovery of America it appears certain that Columbus was the first to discover the variation of the compass. Indeed, it was the rapidity with which the observed declination diminished which produced consternation among his seamen, whom he could only save from a panic by persuading them that the pole star had changed its place, while the needle remained a true guide. The stratagem succeeded, but Columbus suspected that the radius of curvature of the earth was different at the Sargasso sea, and that the line of no declination represented a natural frontier between the territories of Europe and Asia. This natural frontier was adopted by the Pope Alexander VI. in his division of the new world between the rival aspirants. Columbus himself found that the line did not coincide with a meridian during his third voyage, but the illusion guided even Magellan, and was only dispelled by Halley's magnetic chart in 1700.

CONTENTS.

THURSDAY, OCTOBER 6, 1892

NATURAL SELECTION AND ALTERNATIVE HYPOTHESES

Animal Coloration an Account of the Principal Facts and Theories relating to the Colours and Markings of Animals By F E Beddard, M A, F R S (Swan Sonnenschein & Co)

THE theory of natural selection has been pre eminent for over thirty years as the most generally accepted explanation of organic evolution It has, and has had throughout, many critics, but its position is strengthened by the fact that these critics invariably accept the principle as accounting for something, while most of them make it clear that they reject all other proposed substitutes, except those for which they are individually responsible Sometimes the attempt to formulate an alternative hypothesis, or to apply it to the facts of nature, breaks down as soon as it is undertaken A curious instance of this is to be found in Semper's "Animal Life," which begins with very large anticipations —all the "popular cant" of the Darwinian is to be "put out of court as useless", a selective explanation can never be a real one, but for the latter we are to consult the subsequent pages But as case after case is examined, the author is constrained to admit that his real explanation is not forthcoming, and that, although he never will think much of selection, it is the only cause he has to offer Semper would appear to have written his preface before he considered the materials from which he proposed to write his book

Mr Beddard's work does not open in this ambitious manner, but he is far bolder in offering alternatives to natural selection, and in applying them Further consideration would probably have brought him to Semper's admission, at least as regards many of his suggestions Indeed, the number of these suggestions, and the confidence with which they are brought forward, are clearly due to haste and want of sufficient reflection, which also leave their mark upon the scheme of the volume and the number of contradictory statements to be found in it Nor is this to be wondered at when the amount and variety of work which the author accomplishes is borne in mind But the result will be to confuse the beginner and the untrained student Principles which are supposed to be refuted in one part, are subsequently introduced with considerable enthusiasm as the heads of the main sections of the work, and are later on again treated with scant courtesy In fact some readers will rightly infer that the author is a profound sceptic as to the value of the scheme he nevertheless adopts. Others may perhaps be led to suppose, by the arrangement of the book, that the author is sceptical of his own scepticism. Even the very fairness of the author in giving the arguments in favour of views he rejects, will be, such is the system pursued, a cause of confusion to a reader These sources of difficulty are not only apparent in the general scheme, particular explanations are disputed in one part, and adopted a little further on without a word of explanation

The chief value of the book lies in the fact that it is straightforward, and speaks out on points of great difficulty and dispute Arguments of which echoes have been already heard, perhaps, in the report of some conversation which is supposed to have taken place, or which have been crudely stated in the publications of unknown writers, are here met with in a form in which they can be dealt with For thus stating the opinions which are vaguely supposed to be held, perhaps vaguely held, by others, every Darwinian owes a debt of gratitude to the author

The main aim and purpose of the book would appear to be a criticism of natural selection as applied to the explanation of the colours of animals, and the proposal of alternative explanations

Some of the difficulties which the author finds in the theory of natural selection appear to follow from his conception of the process itself Thus, on p 12, he speaks of polymorphic species appearing in two or more well marked forms, and of those extreme cases of variation known to entomologists as "varieties," and concludes, "In fact, if colouring were really constant for a given species, there would be no chance for natural selection", thus implying that natural selection depends upon such pronounced divergences, instead of upon those minute differences which distinguish the individuals of every species He then continues, "Supposing that a marked variety occurs in a wild species, there is, first of all, a considerable chance against its reaching maturity, secondly, there is a considerable chance against its finding a mate, thirdly, the hereditary influences on both sides are against the perpetuation of the variety These appear to be more potent causes of the comparative fixity of colours in wild animals than the unfitness of the varieties to live" It has already been pointed out that the "marked variety" is of little importance for natural selection as compared with the individual difference But if the objections urged were valid there would appear to be little chance of a "marked variety" existing in any numbers and persisting from generation to generation, side by side with the normal form and yet numbers do persist As to the first of the alleged objections, the chances are against *every* individual, but not equally so, if there be anything in natural selection So far from this objection being valid, it is but the expression of a fact upon which natural selection rests, the fact that many more individuals of every species are born into the world than can by any possibility survive Were this not so all selection would cease The second difficulty certainly does not apply to minute individual differences which occur in vast numbers To take the simplest case, let us suppose that the individuals of a species are divided, as regards any character, into two equal groups—the one above, the other below the mean It is clear that each individual would stand as good a chance of mating within the limits of its own group as within those of the other The third objection does not appear to me to hold in the case of "marked varieties" any more than with individual differences The total hereditary influence of the varying side, allowing even considerable force for atavism, is certainly in favour of the variation Furthermore, experience shows us that among the offspring will be some that vary even further than their parent Those

who accept the Darwinian principle do not expect heredity to achieve more than this—to offer the materials which can be accumulated by natural selection.

Interesting as is the study of such "marked variations" and the statistics of their occurrence in nature, the great principle of natural selection, whether applied to the evolution of animal colouring or to any other character, is not greatly affected thereby, but rather demands such exact numerical investigations as those published by Galton upon man, by Wallace upon various animals, by Weldon upon *Crangon*, and by Lloyd Morgan upon bats.

Another objection to the natural selection argument is given on p. 25, and it too turns on the author's conception of the mode in which this principle operates. Recapitulating Weismann's argument that longitudinal stripes have been replaced by oblique ones in certain larvæ, on account of the more perfect concealment afforded by the latter, he points out that some species "have, on the contrary, remained at a stage of coloration which is, *ex hypothesi*, disadvantageous." The longitudinal striping was never disadvantageous, but only relatively less advantageous, in certain species, and under certain conditions. The failure of a species to take this line of evolution may have been due to many causes, the development of other modes of defence, the nature of its peculiar environment, or may be solely due to the kind of selection exercised by its foes.

The author sees far-reaching conclusions against the principle of natural selection in the admission that pigment as a cause of colour was originally non-significant, and is so still in many cases (colours of certain lower forms, colours of blood, fat, &c.). He argues (pp. 68-70) that as colour did not arise by natural selection, it must be a normal product of the organization, and its disappearance in cave-dwelling forms cannot be due to the cessation of selection, but must follow as the direct effect of surroundings, although he does not even hint at the mode in which such effects are supposed to be wrought. But these conclusions are by no means warranted by the original admission. The first appearance of pigment in the skin of the ancestor of a group of species which are now coloured was certainly a normal product of the organization; but the fact that this variation subsequently spread over all the individuals of the ancestral species, and of those to which it gave rise, will be claimed by Darwinians as the result of selection. And so strong are the tendencies of variation in other directions that partially or completely albino races can be produced by man in a relatively short period of time, while such individuals are far from uncommon in nature in spite of selection. The facts support the opposite conclusion that the absence of colour from the skin would be the normal result of organization for the average individual, were it not for the strong and continuous action of selection. There are other instances of the disappearance of colour in addition to that which has occurred in caves, and in some of these the conclusion appears inevitable. The whiteness of birds' eggs laid in dark holes certainly cannot be traced to the direct action of surroundings, any more than the colour of eggs laid in open nests; and natural selection being prevented by man, the colour is disappearing from the eggs of the domestic fowl, just as it is lost in other species when prevented by darkness.

It is certainly true that colour "must be there before it can be acted upon, and modified in this or that direction according to the needs of the animal." But this objection, which has been familiar since the earliest days of natural selection, is less formidable than it appears to be. Colour must have been present in the skin of some individual ancestor certainly, but its *existence*, as well as its modification, in the normal individual of the species is to be explained by selection.

It is hardly necessary to point out that this argument does not apply to colours which still remain non-significant and are excluded from selection; but these are precisely the colours which are unaffected by the changes of environment alluded to above; the blood of cave-dwelling vertebrates remains red like that of others; the yolk of eggs laid in holes does not differ in appearance from that of those laid in open nests.

A similar argument as to seasonal change of colour in arctic animals may be answered in the same manner.

The author's difficulties appear to arise in part from his inadequate conceptions of the struggle for existence. Speaking of certain night feeding caterpillars, he says (p. 102): "It may be suggested that they prefer to feed early in the evening, when their colours, if conspicuous, would be readily seen. If this is so, it does not much matter, for the birds would—the bulk of them at any rate—have gone to roost." Or speaking of *Mimnonectes*, an Amphipod crustacean which bears a remarkable likeness to a *Medusa* well defended by stings, he objects to attribute any significance to so wonderful and detailed a superficial resemblance, because "a school of whales or a shoal of pelagic fish, rushing through the water and devouring all before them, could hardly be supposed to stop and analyze carefully the advantages or disadvantages of selecting or rejecting a given animal as food." On p. 115 he remarks: "If Mr. Poulton is right in assigning a protective value to the bright-coloured wings of butterflies, 'as a conspicuous mark easily seized by an enemy, and yet readily tearing without much injury to the insect,' it seems unnecessary to pay much attention to the supposed utility of protective colours, such as are shown by the *Kallima* or the Green Hairstreak."

The author scoffs at natural selection as an "easy" road to an explanation, as "the very simple hypothesis of a need for resemblance to the environment." It may at any rate be maintained that this method of meeting it is very far from profound.

It is only possible to give a very brief account of the causes which the author would propose to substitute for natural selection. The merits of each proposal lie in its application, and the consideration of this means a discussion of each particular case.

In support of the "effects of food upon colour," a number of examples are quoted, many of which are so inherently improbable and so imperfectly supported by details, that it is impossible to accept them as evidence. I am very far from disputing that changes of colour may be directly produced by certain foods, although the significance of such changes in the evolution of animal colouring is a very different matter. When the author proceeds to

apply this principle he falls into errors which a little consideration would have avoided Thus, on p 21, the following sentence occurs —"Seeing that pigment has been proved in so many cases to be alterable by changes in the food, it is not surprising to find that as a rule the colours of larvæ are totally different from those of the adult form," implying that the difference of diet accounts for the difference of colour,—a conviction stated even more strongly on the next page It is quite sufficient answer to this hasty conclusion to point out that the colours of the imago are just as dependent on the larval food as the larval colours themselves, and that they have made their appearance long before the imago has had the opportunity of feeding Again, in speaking of the "strong superficial likeness" of the Drone-fly (*Eristalis tenax*) to a bee, the author hints at likeness of food as a possible explanation (p 232) "It is an interesting fact, in connection with the resemblance between this fly and a hive bee, that it feeds upon pollen and honey This fact *may* have some significance in relation to the effects of food upon form and coloration" But the form and coloration of *Eristalis* depend upon the food absorbed by its "rat-tailed" larva, living in putrid mud, under conditions utterly unlike those of the larval bee

Under the consideration of light as a cause of colour an extremely bad piece of reasoning is adopted from Werneburg (p 62), who argues that light has an important influence on the formation of pigment during the pupal period By selecting favourable instances and describing them with an enthusiasm which borders on inaccuracy (*e g*, speaking of *U sambucaria* as "bright yellow") and by neglecting all others, he makes it appear that there is something to be said for this view

In the section on "Variable Protective Resemblance in Chrysalids," the results of recent work are given very inaccurately, the golden colour of pupæ is explained as due to "thin films of air or some gas," and it is even suggested that "intense light may cause some gas to be given off in greater abundance" But it was shown years ago that the appearance is due to some lowly refractile liquid, and, in fact, alcohol answers the purpose very well indeed Gases do not appear to have the power of entering the intervals between the cuticular lamellæ, perhaps because the latter come together and obliterate the chinks on the evaporation of the fluid Again, it is stated that "the pupa was also made to assume a light colour upon one half and a dark colour upon the other" As a matter of fact the invariable failure of the pupa to do this formed the basis of some of the principal conclusions reached It was also surely unnecessary to quote an ignorant assumption of Eimer's on the subject—an assumption which was not even original, and has been disposed of long ago

In favour of the effects of climate reliance is placed on Scudder's conclusion that melanism is only found in the butterflies south of New York, albinism only to the north (p 55) And yet in Europe melanism is especially prevalent among the northern moths, from which we may infer that the American observations, however they are to be explained, are not direct effects of climate

He suggests that the blackness of a lizard on one of the Canaries may be due to moisture, but these islands are about as dry as small oceanic islands can be All the lizards seen by the present writer in Teneriffe and Grand Canary, some three or four species, were dark in colour and harmonized with the tint of the dark dry volcanic rocks on which they were seen, and among which they almost invariably escaped when pursued

One suggestion is very remarkable After giving reasons why he does not consider that the resemblance of *Volucella* to humble-bees, &c, is to be explained as a case of aggressive mimicry, the author suggests (p 228), "If wasps and bees have the same unintelligible liking for keeping pets that another group of Hymenoptera—the ants—have, the whole series of facts may prove to have a very different meaning, but one which is not quite in accord with the theory of mimicry on the part of the *Volucella*" The keeping of pets by ants is so very far from being unintelligible in some of the most important cases (*Aphides*, Lycænid larvæ, &c) that we may fairly expect an explanation in other instances But even if the author's suggestion were valid it would still fail to account for the very point at issue—the great superficial resemblance of *Volucella* to Hymenoptera

On p 92 he is quite prepared entirely to dispose of all advantages in the struggle for existence in favour of fertility, this alone is enough to prevent extermination. Speaking of the wonderful disguise of Geometer larvæ (and if this be not the result of selection it must be admitted that the principle fails indeed) he says, "In the meantime the excessive fertility of the parent moths appears to be a sufficient guarantee against extinction, apart from any subsidiary advantage to be gained by colour protection" It is sufficient reply to this statement to point out that the fertility of these small-bodied moths is very far from excessive when judged from an insect standard, that if the larvæ are offered to any insect-eating animals they are when detected, devoured with the greatest avidity, but that if offered motionless on their natural food-plant they are often passed over, that insect eating animals, especially when rearing their young, are by no means fed to repletion, so as deliberately to refuse the food they evidently relish

It is very confusing after this candid avowal to read a few pages further on (p 97), "On the whole, it seems more profitable to a caterpillar to adopt protective resemblance to its surroundings as a means of escaping its foes, at any rate, this is what actually occurs 'The main purpose in life of a caterpillar,' says Mr Scudder, 'next to feeding, is *not to be seen*.'"

Many quite irresponsible suggestions, which it would have been wiser to have withheld unless accompanied by at least some evidence, are made or adopted from other writers Of this nature are the remarks of Leydig on the colours of *Helix nemoralis*, and the author's suggestion that the dark variety of the female Silver-washed Fritillary may be due to the moisture of wooded districts

Of some of the author's suggestions we may use his own words, and say, "This explanation has an air of reasonableness, which might lead to the inference that it had been amply tested by actual experiment" (p. 64) Others however, including some which have been quoted here, certainly appear to lack this "air of reasonableness."

The author is especially candid and straightforward in bringing forward the evidence in favour of an explanation he is about to attack. After thus fairly showing the strength of the opposed position, he proceeds to reject it for reasons which will strike the instructed and uninstructed reader alike as singularly inadequate. Examples of this method occur continually throughout the volume. As an example may be selected his treatment of the opinion that the light of phosphorescent organs enables certain deep sea animals to see. He admits the existence of eyes, the prevalence of phosphorescence, the intensity of the light emitted, the existence of "lens-like transparent bodies serving to concentrate the rays of light," the fitness of the light to illuminate the prevalent colours. In spite of all these facts the author believes that all deep-sea colours are unseen and meaningless for the following remarkable reason:—"The presence of well-developed eyes, or the total absence of these structures, are, as has been explained, intelligible on the theory of abyssal light; not so the existence of eyes in an intermediate condition. The inevitable conclusion, therefore, from these facts appears to be that the brilliant and varied coloration of deep sea animals is totally devoid of meaning; they cannot be of advantage for protective purposes, or as warning colours, for the simple and sufficient reason that they are not seen" (p. 37). The author carries this conclusion to its logical end, and, pointing to the resemblance of deep-sea forms to their shallow-water allies, and the existence of protective resemblances in both, he maintains that "if natural selection has been the cause in the one case, it ought to be in the other. The question therefore is pressing: need natural selection be responsible for the coloration of the shallow-water forms?" (p. 38). A somewhat large conclusion to base on the fact that the eyes of certain deep-sea animals are in process of degeneration! The author admits that the *absence* of eyes is no argument for his views; and yet, in every such instance, a gradual process of degeneration has been passed through. He gives us no reasons for rejecting the opinion that the cases upon which he bases such startling conclusions are merely tending in the same direction; indeed, elsewhere (p. 11) he insists on the probability that such biological changes are still progressing. It is indeed most probable that light is far from widespread or intense on the floor of the ocean, and that, therefore, eyes to be of use must be unusually efficient, while, unless absolutely necessary, they are likely to disappear. We meet, in fact, with a case somewhat parallel to that of beetles on oceanic islands in tempestuous zones, where selection operates in opposite directions—towards unusual powers of flight, when flight is a necessity, and towards the total loss of any such capacity when it is unnecessary. Thus, among deep-sea fish we find eyes of immense relative size, as well as those which are degenerate. And the phosphorescent organs of certain fish (*Ceratias*) appear to emit a light which is invisible to the degenerate eyes of the possessor, but serves to attract other and better endowed fish upon which the *Ceratias* feeds. The frequency of this degeneration among the deep-sea Crustacea, which impressed the writer so profoundly, may very probably be due to conditions of life which render vision less necessary for them than for many other groups, and this is especially probable since many shallow-water genera are sightless, as is abundantly shown in the book itself (p. 36).

On pages 115, 116, the author adopts Prof. Weldon's objection to the usually received interpretation of the whiteness of certain eggs, and the under-sides of fish, porpoises, &c., which are seen from below, on the ground that snow-flakes appear almost black when seen from beneath against the bright sky. The original suggestion is due to neither Mr. Wallace nor to the present writer, but to Erasmus Darwin, writing very nearly one hundred years ago. The objection entirely misunderstands the hypothesis, at any rate so far as the eggs are concerned. If an egg lay exactly over one of the interstices in the nest, it would, of course, shut out the sky altogether, and when viewed from some distance through the opening would appear dark like the nest itself. There would be no question of its appearing against a back-ground of sky. As a matter of fact, no such continuous back ground can be seen through the nest at all. Minute bright points are seen through the interstices of the nest, and those of the leaves and branches above and below it. The hypothesis in question suggests that part of the bright white side of an egg, viewed obliquely from below through an interstice, may be mistaken for one of these bright points. The hypothesis may be erroneous, but it is not to be set on one side by a criticism which fails to understand it. In the case of the fish, the question is complicated by the absorption of light by the layer of water.

The reader who finds that the above-quoted criticism is held to be destructive by the author, may be excused strong language when he meets with the following sentence only seven pages further on:—"Among pelagic fish it is common to find the upper surface dark-coloured and the lower surface white, so that the animal is inconspicuous when seen either from above or below."

The chapter on Warning Coloration is one of the most valuable parts of the book, for in it we meet with a solid contribution to the subject in the form of some interesting experiments conducted by the author upon the animals in the Zoological Gardens. Many of the results are of extreme interest, and are a further proof of the difficulty of the investigation, and the great care with which it must be conducted if the conclusions are to be depended upon. It has been already suggested that some of the results may be perhaps explained by the fact that the insect eating animals chosen for experiment are restricted to a very monotonous or very scarce insect diet. In some rather extensive experiments made by the present writer upon a marmoset, it appeared that the animal possesses a most keen appreciation of the meaning of warning characters, but the individual in question was accustomed to be fed on a very varied diet. The discussion of the details given in this chapter cannot now be attempted, but it may be safely affirmed that there is nothing which is fatal to the theory of warning colours, when we admit, as we are of course bound to do, that even unpalatable animals have their special enemies, and that the enemies of palatable animals are not indefinitely numerous.

Further criticism of the arguments is rendered impossible on the present occasion by the exigencies of space. Certain obvious misstatements call for correction, such as

the description of the jet black larva of the Peacock Butterfly as "dusky greenish" (p 21), the assertion that the present writer discovered uric acid in the excreta of Vanessid imagos (p 41), the implication that leaf-mining larvæ eat only the deeper tissues of the leaf instead of everything between the upper and lower cuticle (p 63), the description of "red eye-like markings upon the blue underwings" of the Eyed Hawk Moth (p 134), in which red and blue should of course be transposed

The book is well printed, misprints such as "Tortorix" for "Tortrix" (83), "freshly-moulded" for "freshly-moulted" (67), "distinction" for "distinctive" (185) being fortunately uncommon

The coloured plates are good, although it would have been a pleasure to see the wings of one of the resting *Volucella* in Plate IV folded one over the other in a very characteristic attitude The antennæ of the *Kallima* shown at rest in Plate II would have been concealed, and the same applies to the figures of the Buff tip and Lappet Moths The worst figure is that of the Bee Hawk Moth on p 245, in which an entirely wrong notion of the opaque border to the wings is conveyed The source of the figures is not mentioned

EDWARD B POULTON

SUNSHINE

Sunshine By Amy Johnson, L L A (London Macmillan and Co, and New York, 1892)

THIS book is likely to puzzle any one who may by chance pick it up and glance casually over the pages, more especially if he should happen to first open it towards the end and find two chapters headed "Tommy's Dream," concluding with a conversational account of how "the nurse puts baby into a bath, generally too hot or too cold, and scrubs away as if he were a wooden doll Poor baby's skin is red all over, and he screams with pain," &c On the other hand, in the early part of the book, several familiar figures, such as pictures of ice flowers, or diagrams of the action of simple lenses, of total reflection, of the rainbow, &c, show that "Sunshine" is, in spite of the nursery episode, in reality connected with physical science As a matter of fact the authoress has taken a number of easy experiments and every-day observations, and has amplified and explained them in a simple and often very charming manner, adopting for the purpose the conversational form as between herself, called teacher, and, judging by the number of Christian names of the children addressed, a host of youngsters

The conversational style is out of fashion just now, but no objection can be taken on that account What is of far more importance is the general effect produced upon the mind of the child The writer of this notice well remembers how the attempt was made to beguile him into being interested in conversations between a horridly precocious child Willie and his papa Willie always said the right thing, and always made the right mistakes, so that much instruction was to be gathered from the answers and corrections of his papa The writer, no doubt, did acquire some general information, perhaps he did not resent the attempted deception, but he is sure that he would like to have punched Willie's head, or to have made him suffer in some way that is pleasing to the boyish imagination In the present instance the risk of arousing open hostility on the part of children who may receive instruction from the pages of "Sunshine" is largely reduced by the fact that the conversation is very one-sided, the children are made to say very little in these talks—they are not quite lectures, but more lectures than conversations Whether "teacher" says too much, or in the attempt to appeal to the imagination rather than the reasoning faculties of her audience rambles too far afield, is a question of taste Many parts of the book demand the highest praise, though in some the authoress seems to have gone beyond reasonable bounds For instance after a most clear and excellent illustration of the method by which the distance of the moon from the earth is determined, in which the children are made to find by folding paper how far it is from the table to a ball hanging up in the room, the imagination of the reader is stimulated as follows —

"At the beginning of our 'talk' about the moon, I tried to impress upon you what old travellers you were Do you remember how far you have been each year? (585,000,000 miles) And you, Tom, are——?" "Seven" "What age are you, Percy?" "Eight" "And you, Minnie?" "Nearly eight" "You shall work that sum out for me on your slates We will neglect the travelling since last birthday Multiply 585,000,000 by 8, Percy Four thousand six hundred and eighty millions of miles, you say Have you felt any pain or sickness? Are you willing then to accompany me for a little 'out' to call on our next neighbour, the moon? It is only 240,000 miles, and would take us a little over three hours and a half at earth's usual rate of travelling Do you think your mothers would trust you with me if I guaranteed to bring you safely back again? Most of you say 'Yes' What is it that Ethel is saying to you, Lucy?" "She wants to know if we are really going, or if it's 'only pretending'" "That is a question which Ethel must decide for herself Those who are going with us must be ready in time, or they will be left behind Before we make a journey it is usual to consider, not merely the distance, but a few other matters also, such as—'What to take with us,' 'How long we shall be away,' 'Where we can get lodgings,' Whether we should take shawls, umbrellas, &c,' and so many other considerations, that I am afraid we can't go to day Make all inquiries at home, and let me know how many of you are prepared to go"

As has been stated, the imagination rather than the reason is being constantly appealed to, and for the purpose the most picturesque language is employed Perhaps the most striking example is to be found in a chapter headed, "The Mill with Stained Glass Windows" A beam of sunlight is made to pass through a condenser and into a slit Then slips of coloured glass, red, green, and violet, are placed edge to edge over the slit, and the red-green-violet line of light is looked at through a scratch in a piece of smoked glass The resulting diffraction phenomenon is the mill with stained glass windows The upper story with violet windows has a greater number closer together than the second story with the green windows, and there is the same difference between this

and lower story with the red windows. From this result by a simple step the coloured bands seen when white light is employed are readily explained. Of course, and wisely so, no attempt is made to explain why with monochromatic light the windows are seen at all. In the same manner most of the phenomena described or which can be observed by following the clear and simple directions are stated to be what they are, rather than proved or explained. The authoress, guided by her own experience as a schoolmistress, is probably right in continually pointing out fresh phenomena of interest, which may or may not be immediately forgotten, rather than in wearying the child with difficult arguments which could at best be imperfectly understood, and which would be sure in many cases to awaken a feeling of disgust. In short, Sunshine is a kindergarten and not a school.

Simple and homely language is employed with the greatest propriety, but occasionally it tends to be vague or even to produce a wrong impression. One or two actual mistakes may be referred to in order that they may be corrected in a future edition.

Thus, it is stated that as a rainbow entirely vanishes when the sun is as much as 42° above the horizon we can never see one at noon. "In the summer" should obviously be added. The reader is told to spin a top carrying a disk painted half yellow and half blue and he will see green. There is a confusion here between the colour obtained by adding two colours as by spinning, and that which is the result of mixing pigments. As is well known, green is not produced under these circumstances, but white or nearly white. The four chapters on soap bubbles, which contain much that is sure to please, are supplemented by some special instructions, which, however, are not quite correct. Fig. 167 is an illustration of an experiment purporting to measure the surface-tension of a soap bubble by the depression of the water level in a quill tube dipping into a glass of water. As the bubble is drawn much larger than the two hands, the pressure within it would not produce any depression of the water below the general level. It would not even visibly affect the capillary elevation. Then it is stated that the surface tension of pure water is 16.62 grains per square inch. It is, as a fact, a little over three grains per linear inch. The confusion becomes greater in the passage, "We know exactly how much energy it (the elastic film of water) has—16.62 grains per square inch. A tube of 1-inch bore will lift up 16.62 grains of water."

There is one serious fault in the book. Serious because an experiment is described as though it were being performed to an audience which is not only impracticable and impossible, but which would require in a soap-film a property different in kind to that which it possesses. A school-slate frame with one end removed is hung up so that the remaining end is uppermost. A knitting needle is cut of such a length that it will slide freely in the groove made to hold the slate. From the knitting-needle a pill-box is hung by threads. The object is to weigh a letter. A soap-film is spread over the frame as far as the knitting-needle.

"See how the film is stretching, the knitting-needle is bringing it down like a blind. Now we place a letter in the balance. I know that it weighs just half an ounce, so I can mark on the slate-frame with my blue pencil the place where the knitting-needle stops for half an ounce. I see I was not mistaken in what would take your fancy! I will hang it up here. You shall make one for yourselves, and spend what time you please with it. You will not then easily forget how elastic the film is."

Now the surface tension of a soap film is so small that if the knitting-needle and pill box weighed nothing the slate frame chosen must have been eight or nine feet across, and the knitting-needle the same length; or if the letter and the pill box weighed nothing the knitting needle, if of steel, must have been a great deal finer than any in ordinary use. But even if the experiment were being performed on a minor planet, instead of at Manchester, where with diminished gravitation the half-ounce knitting-needle and pill box would only just be sufficient to balance the tension of the soap film, the description would give the false impression that like a metal or other spring the tension of the soap film increases as the film is stretched, and so is able to rest steadily at some point which depends on the stretching weight. One obviously invented experiment described with all the circumstance and detail that this is, is sufficient to shake one's faith in the genuineness of other demonstrations.

C. V. B.

STRETTON ON THE LOCOMOTIVE.

The Locomotive Engine and its Development. By Clement E. Stretton, C.E. (London: Crosby Lockwood and Son, 1892.)

THE author of this work is well known to the railway world as one who has long taken a great interest in everything pertaining thereto. No one probably has a better knowledge of the history and development of the locomotive. It is with much pleasure we welcome the volume before us. The author very properly gives to Trevithick the name of "Father of the Locomotive," he having used high-pressure steam, the smooth rail, and the blast pipe, some years before either Hedley or Stephenson began to experiment. It is a pity so many men connected with the early progress of the locomotive should have been lost to fame; all did their share—the few only have been handed down to posterity. William James, for instance, certainly should not be forgotten, he having had a large share of the work in proving the locomotive to be a suitable machine for hauling trains, as against the system of fixed engines and rope haulage, and to him is largely due Stephenson's success on the Liverpool and Manchester Railway.

Richard Trevithick was born April 13, 1771, in the parish of Illogan in Cornwall. He was a mechanical genius in many ways. His first engine was made in the year 1803. This engine ran on four wheels, the boiler was arranged horizontally and had a wrought iron return fire-tube; the cylinder was 8¼ inches in diameter, and the piston had a stroke of 4 feet 6 inches. It was arranged horizontally, the crosshead driving a shaft in front of the boiler by means of a return connecting-rod. This

shaft carried a heavy flywheel, and was connected to the carrying wheels of the engine by means of spur gearing The exhaust steam was discharged into the chimney, ensuring an efficient supply of steam

In the year 1808 Trevithick laid down a circular railway in a field which now forms the southern half of Euston Square. The locomotive exhibited had a vertical cylinder, the crosshead being coupled direct to the hind pair of wheels This engine weighed about ten tons, and ran at an approximate speed of ten to twelve miles per hour From these data it will be at once seen that Trevithick was before either Hedley or Stephenson with the invention of the locomotive engine, since both Hedley's and Stephenson's experiments date from the year 1813

The volume under notice is full of historical data having reference to these early experiments The author has taken great pains in arranging the matter Further on in the book, chapter iii, another most interesting subject is dealt with "The Battle of the Gauges" will long be remembered by engineers The standard gauge of railways in this country is 4 feet 8½ inches, measured between the heads of the rails This peculiar dimension appears to have been originally due to the tramways in use at the collieries where the original experiments were carried out by Stephenson and others, and was adopted for the railways when first projected and locomotives used The great exception to this standard was the seven-feet gauge of the Great Western Railway This railway, when projected by Mr Brunel, was intended to eclipse the narrow-gauge of railways, both in speed and comfort when travelling This competition, however, is claimed by the author as having been the means of hastening the growth and perfecting the locomotive Looking at the question from the present day, the 4 feet 8½ inch, or standard gauge, is certainly too narrow, the power of the locomotive has gradually been increasing since Stephenson's day, and a point will soon be reached when radical changes must be made in locomotive design, in order to increase the power still more. On the other hand, the now obsolete seven-feet gauge of Brunel was too large The Indian engineers have adopted the gauge of 5 feet 6 inches for the standard of that country This dimension appears to be a "happy mean," and one with which locomotive engineers may revel in large journals and free steam and exhaust ports in locomotives fitted with inside cylinders

It is amusing to read that American engines commenced their competition with the English engine in the year 1840, when some were imported to work the trains up the Lickey incline of one in thirty-seven on the Birmingham and Gloucester Railway These engines were made by Messrs Norris and Co, of Philadelphia, weighing slightly under eleven tons The author tells us they thoroughly beat the English engine of that day doing this particular service.

Every locomotive engineer knows what the Stephenson link motion is—the apprentice in his first year generally prides himself on having mastered its details, yet, for all this, the author tells us to call this old friend by another name! It seems that this gear is really due to Mr William Howe, an employé of Messrs R. Stephenson and Co, and was adopted by them and first fitted to an engine for the North Midland Railway in the year 1842 It may here be noted that the question of valve gear generally is not sufficiently described or illustrated in this volume The index contains several references, but these are very superficial This becomes all the more apparent when the Joy valve gear is fully described and illustrated, besides a diagram showing results of working

The Joy valve gear is in the opinion of many an unsuitable gear for a locomotive It must be evident that any gear which derives its valve motions principally from the vertical movements of the connecting-rod cannot give a good distribution of steam, for the reason that the vertical movements of the connecting rod are affected by those of the driving axle The driving-axle is not always in the same position as regards the frames and cylinders owing to the undulations of the road, the oscillation of the engine, and the varying condition of the springs, a movement of half-an-inch above and below the normal position of the driving-axle is quite within the limits of actual practice This movement is sufficient to affect the true movement of the valve, indeed, it is enough to destroy the lead either on the front or back ports as the case may be Besides this objection, the Joy gear has nominally a uniform lead for all degrees of expansion, whereas it is usually considered necessary to increase the lead for higher grades of expansion and speed of engine Some locomotive engineers are willing to risk this defective steam distribution in order to take advantage of the undoubted improvements in design the adoption of this valve gear allows These mainly consist in the increase in length of the driving-axle bearings for engines with inside cylinders, there being no eccentrics to find room for between the crank webs The cylinders can be consequently placed closer together, and the steam chest arranged either above or below the cylinders, as the case may be, without the use of rocking shafts or intermediate gear

Chapter IV deals with modern locomotives for main line trains. Many well-known engines are illustrated and described, and we naturally find the Compound Locomotives of Messrs Worsdell and Webb included in the number The author evidently is not enamoured with the compound locomotive, saying that "facts" are in favour of the simple engine It is here to be noted that no locomotive superintendent in this country, excepting the patentees of the respective systems, has adopted the compound system. What this is due to is uncertain, because the two-cylinder type of compound locomotive known as the Worsdell system has certainly given good results in India and other countries, comparing favourably with the simple engine The "Gladstone" locomotive, designed by the late Mr. William Stroudley, is among those illustrated This raises the interesting question as to the wisdom of using large leading coupled wheels for express work, many engineers prefer a bogie in front, deeming it safer But when the London and South Western Railway practically copy Mr Stroudley's arrangement of wheels in their latest engines for mixed traffic, one is apt to be surprised at the change coming from the "bogie" head quarters, and to surmise that anything will do. There is, however, nothing new in the adoption

of large leading coupled wheels, many engines were running in India of this design before Mr Stroudley adopted it, and the whole question can be narrowed down to the comparative life of tyres under different types of engines, there can be no doubt that a four-wheeled bogie or a Bissel truck in front saves the tyres of the leading coupled wheels, a larger mileage being obtained from them before they require to be returned

Chapter V includes a description of the sand blast arrangement for sanding the rails to prevent the slipping of the driving wheels This apparatus, small as it is, has left its mark on the design of express locomotives The single engine has again come to the front for express work with marked success, the latest design of Midland and Caledonian engines being examples

This volume taken as a whole is most interesting, and should be of value to all connected with the railway system of this country as a book of reference

N J LOCKYER

OUR BOOK SHELF

Sketches of British Insects By Rev W Houghton, M A, F L S, M S L (London O Newmann and Co, 1892)

It is satisfactory to find that there is sufficient demand for elementary books on entomology to render necessary a new edition of Mr Houghton's "Sketches of British Insects," and for those who, as dwellers in the country, wish to gain some insight into the insect life around them few better books could be found The differences between the several orders of insects and the main distinctions of the families are plainly and intelligibly set forth, though in a few instances the definition of terms and sections is somewhat faulty, thus, "Arthropod" would be more fitly translated "with jointed feet" instead of "with feet at the joints," and the numerous exceptions are not enough insisted on, there being for instance many insects with aquatic respiration and crustacea with aerial In Lepidoptera the tongue is often completely absent, whilst in butterflies the forelegs are never wanting, as stated, though in certain families they are rudimentary in both sexes or in the male only, and again the two pairs of spurs on the hind tibiæ are present in the vast majority of moths and also in many skippers The insects selected for description are well chosen, either as being conspicuous and typical of their families or as illustrating by their peculiarities some principle of adaptation to surroundings, though in many cases the classification is not according to modern ideas, thus, the clearwings (*Sesia*, &c) have no affinities with the beehawks (*Hemaris*), which belong to the *Sphinges* and the snouts (*Hypena*) are *Noctues* not *Pyrals* The account in the Introduction of the structure and metamorphoses is especially simple and clear, and the small volume is on the whole an admirable sketch of British insect life, though the coloration of the plates might have been made much less crude without adding materially to the cost of production.

The Birds of Lancashire By F S Mitchell Second Edition. Revised and Annotated by Howard Saunders (London Gurney and Jackson, 1892.)

We are glad to welcome a new edition of this book, which we reviewed shortly after the publication of the first edition NATURE, vol xxxii p 241) The task of preparing a new edition (in the absence of Mr. Mitchell from England) was undertaken by Mr. Howard Saunders, and it is scarcely necessary to say that he has discharged his duty thoroughly He has no personal connection with Lancashire, but he has had much help from local authorities, especially from Mr R J Howard, of Blackburn, and with their aid he has brought the book, as far practicable, up to date Several species have been added to the list, and there is a new index

Borneo Its Geology and Mineral Resources By Theodor Posewitz Translated from the German by Frederick H Hatch (London Edward Stanford, 1892)

The original work, of which this is a translation, has been reviewed in NATURE (vol xl p 49), so that it is unnecessary now to do more than record the fact that an English rendering of the book has been published Dr Hatch has done his work most conscientiously, and the translation is likely to be much appreciated by students of geology and mineralogy, and by all who have any reason for being specially interested in the material resources of Borneo

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

"A New Course of Chemical Instruction"

I AM much interested in the article in NATURE for September 29, entitled "A New Course of Chemical Instruction," especially as the writer, in the criticism of the book in question, whilst thinking that the method there advocated has theoretically more to recommend it than any other, doubts whether practically the time required is not an insurmountable obstacle

For four years I have been able to teach beginners in Chemistry on a method very closely allied to the one here proposed, that is to say, one in which no experiment is performed without a definite object in view—the final object being the solution of a given problem and no idea being given to the pupil of what the result will be, and I am glad to be able to say that the time required is *not* such a serious drawback as might be supposed, whilst the intense interest aroused and the training in scientific methods of work amply compensate for the slower acquirement of chemical facts

I have not the advantage of being acquainted with Mr Castell-Evans' book, so that I am not quite sure how nearly my work would agree with his course, but the fundamental principle is undoubtedly the same, and is the one laid down by Dr Armstrong in the report of the British Association Committee on Chemical Teaching, where he advocates the teaching of Chemical method rather than Chemical facts

What generally appals the beginner in Chemistry is the multitude of facts to be remembered, it seems a mere question of memory, and in consequence so dull and uninteresting, that the explosion or "burst up" is the one point to be looked forward to in the lesson By this new method the pupils themselves are put into the position of discoverers, they know why they are at work, what it is they want to discover, and as one experiment after another adds a new link to the chain of evidence which is solving their problem, their interest grows so rapidly, that I have seen at a demonstration lesson a whole class rise to their feet with excitement when the final touch was being put to the problem which it had taken them three or four lessons to solve Facts learned with so much interest are not forgotten and form a solid basis which it is true is slowly laid, especially at first, but it is interesting to see how much more quickly and easily later facts are assimilated, each one fitting itself in with the knowledge already acquired, and even when it becomes a ques-

tion of reading the account of work which it is impossible for the student to repeat for himself, the methods adopted are quickly understood and easily remembered, because the general methods of analysis and synthesis have, in an easy form, not only been used, but discovered by the student himself

This method of course breaks down where an elabbrate ex amination syllabus is imposed upon the beginner from the outset, and even where this is not the case, every teacher must adapt the method to his own conditions, only and always keep ing the fundamental principle in view

For the beginner in Chemistry whether he is later to specialise in this subject or not, experience has convinced me that the teaching of facts must give way to the teaching of method if a sound basis is to be laid in chemical science, whilst the subject opens the whole question of the value of Chemistry teaching from the educational point of view GRACE HEATH

The Temperature of the Human Body

THERE is a problem partly physiological and partly physical which I shall be grateful if any reader of NATURE can throw light upon

1 *The physiological* —I am assured by medical opinion in which I have confidence that the temperature of the human body is invariable from pole to equator of the earth The question I want to ask, assuming this to be true, is this What is the action in the body which exactly and everywhere counter-balances the radiation and conduction of heat in the one case from the body and in the other to the body? I thought at first that perspiration might have something to do with it, but my medical authority assures me that at the equator a man who perspires freely has exactly the same temperature as one that perspires little, although the former will be in good and the latter in bad health

2 *The physical* —Treating the animal as a heat engine, one is apt to think of the source of heat as the animal heat engendered by the combustion going on in his frame, and the refrigerator as the surrounding air at lower temperature—in the experience of most of us The animal then does work at the expense of this heat during its transfer from source to refrigerator, as in an ordinary engine On the other hand, the animal in equatorial regions must, if the physiological statement above be a fact, be often the coldest of surrounding bodies Does he also do work at the expense of the heat of combustion in his body, and if so is this vital action an exception to the second law of thermodynamics? If not, does he do work at the expense of the heat which is conducted into his body from hotter surrounding bodies, which heat, when he is doing no external work, still does not raise the temperature of his body?

Rugby L CUMMING

Comet II 1892 (Denning, March 18)

THIS comet is still a tolerably easy object in my 10 inch reflector and will doubtless continue to be visible during the greater part of the ensuing winter It is now approaching the earth, and its brightness is increasing slightly During the next two months it will traverse Orion

I observed the comet on September 30, when it was in the same field as the 6th mag star Piazzi VI 144 (Lalande, 12546) By differential observations with that star I found the place of the comet to be

	G M T	α	δ
	h m	h m s	° ′
1892, Sept 30	12 50	6 25 51	+14 11

The theoretical brightness, as given in Schorr's ephemeris, was 0·62, but to my eye the comet seemed quite as plain as in March last The nucleus was, perhaps, not so distinct, but the surrounding nebulosity appeared to be more extended than on previous occasions

The comet will be close to ζ Orionis (the southernmost star in the belt) about November 14, and passes very near β Orionis (Rigel) on November 30 W F DENNING

Bristol, October 2

Cirro-stratus

A RATHER perfect example of one variety of this cloud was seen here in the afternoon of September 27 A rapid fall of the barometer until 5 A M, accompanied by a high wind, had been followed by a steady rise, the wind moderating some hours later At 2 p m, with a westerly light air, the sheet of cirro-stratus which overspread the sky appeared in the form of a series of very perfect undulations, stretching nearly north and south These were about fourteen in number, crowded together towards the east The lower surface of the sheet was sharply defined, and could be followed with ease in its successive rise and fall The cloud filaments could be also traced, preserving their perpendicularity to the wave fronts and conforming to the undulations of the lower surface with a closeness which I had not before observed, although sheets of cirro stratus are common here The whole system was drifting slowly to the east

J PORTER

Crawford Observatory, Queen's College, Cork

A New Habitat for Cladonema

WILL you kindly allow me through your columns to note a habitat for this genus not given in Allman or Hincks. Several weeks ago I received some sponge from Mr Sinel, of Jersey, and on examining it with a hand-lens detected four polypites of Cladonema, one, at least, of which is still alive

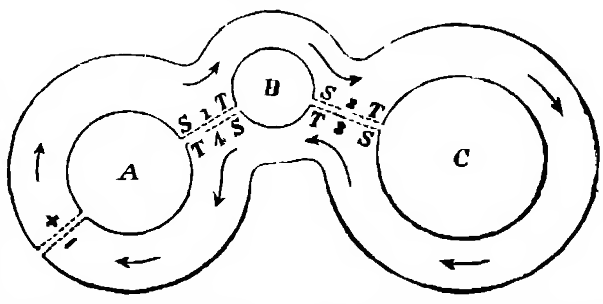
HENRY SCHERREN

5 Osborne Road, Stroud Green, N

TO DRAW A MERCATOR CHART ON ONE SHEET REPRESENTING THE WHOLE OF ANY COMPLEXLY CONTINUOUS CLOSED SURFACE

IF a solid is not pierced by any perforation, its surface is called simply continuous, however complicated its shape may be If a solid has one or more perforations, or tunnels,[1] its whole bounding surface is called "complexly continuous", duplexly when these is only one perforation, $(n+1)$-plexly when there are n perforations The whole surface of a group of n anchor-rings (or "toroids") cemented together in any relative positions is a convenient and easily understood type of an $(n+1)$-plexly continuous closed surface

Let the diagram represent a quadruplexly continuous closed surface made of very thin sheet metal, uniform as to thickness and homogeneous as to quality throughout To prepare for making a Mercator chart of it, cut it open between perforations C and B, B and A, A and outer space, in the manner indicated at $\frac{2}{3}$, $\frac{1}{4}$, and $\pm$ Apply infinitely conductive borders to the two lips separated by the cut at $\pm$, and apply the electrodes of a voltaic



battery to these borders By aid of movable electrodes of a voltmeter trace, on the metallic surface, and a very large number $(n-1)$, of equidifferent equipotential closed curves between the + and − borders Divide any one of these equipotentials[2] into parts each equal to the

[1] A "hole" may mean a deep hollow, *not* through with two open ends The word "tunnel" is inappropriate for the aperture of an anchor ring Neither "hole" nor "tunnel" being unexceptionally available, I am compelled to use the longer word "perforation"

[2] Two sentences of my previous article ("Generalisation of Mercator's Projection") in § 3, and in last paragraph but one, are manifestly wrong, and must be corrected to agree with the rule given for dividing into infinitesimal squares, in the present text

infinitesimal distance perpendicularly across it to the next equipotential on either side of it, and through the divisional points draw curves, cutting the equipotentials at right angles. These curves are the stream lines. They and the $(n+1)$ closed equipotentials (including the infinitely conductive borders) divide the whole surface into $n\ m$ infinitesimal squares, if m be the number of divisions which we found in the equipotential. The arrows on the diagram show the general direction of the electric current in different parts of the complex circuit, each arrow representing it for the thin metal shell on either far or near side of the ideal section by the paper.

Considering carefully the stream-lines in the neighbourhoods of the four open lips marked in order of the stream 1, 2, 3, 4, we see that for each of these lips there is one stream-line which strikes it perpendicularly on one side and leaves it perpendicularly on the other, and which I call the flux-shed-line (or, for brevity, the flux-shed) for the lip to which it belongs. The stream lines infinitely near to the flux-shed, on its two sides, pass infinitely close round the two sides of the lip, and come in infinitely near to the continuation of the flux-shed on its two sides. Let F_1, F_2, F_3, F_4 (not shown on the diagram) be the points on the + terminal lip from which the flux-sheds of the lips 1, 2, 3, 4 proceed, and let G_1, G_2, G_3, G_4, be the points at which they fall on the - lip. Let S_1, T_1, S_2, T_2, &c., denote the points on the four lips at which they are struck and left by their flux shed lines.

Let p_1, l_1, p_2, l_2, p_3, l_3, p_4, l_4, p_5 be the differences of potential from the + lip to S_1, from S_1, to T_1, T_1 to S_2, ... S_4 to T_4, and T_4 to the - lip. Measure these nine differences of potential. We are now ready to make the Mercator chart. We might indeed have done so without these elaborate considerations and measurements, simply by following the rule of my previous article, but the chart so obtained would have infinite contraction at eight points, the points corresponding to S_1, T_1, ... S_4, T_4. This fault is avoided, and a finite chart showing the whole surface on a finite scale in every part is obtained by the following process.

Take a long cylindric tube of thin sheet metal, of the same thickness and conductivity as that of our original surface, and on any circle H round it, mark four points, h_1, h_2, h_3, h_4, at consecutive distances along its circumference proportional respectively to the numbers of the m stream-lines which we find between F_1 and F_2, F_2 and F_3, F_3 and F_4, F_4 and F_1 on the + lip of our original surface. Through h_1, h_2, h_3, h_4 draw lines parallel to the axis of the cylinder.

Let now an electric current equal to the total current which we had from the + lip to the - lip through the original surface be maintained through our present cylinder by a voltaic battery with electrodes applied to places on the cylinder very far distant on the two sides of the circle H. Mark on the cylinder eight circles, K_1, K_2 ... K_8, at distances consecutively proportional to l_1, p_2, l_2, p_3, l_3, p_4, l_4, and absolutely such that l_1, p_1, &c., are equal to the differences of their potentials from one another in order.

Bore four small holes in the metal between the circles K_1 and K_2, K_3 and K_4, K_5 and K_6, K_7 and K_8 on the parallel straight lines through h_1, h_2, h_3, h_4, respectively. Enlarge these holes and alter their positions, so that the altered stream-lines through h_1, h_2, h_3, h_4 (these points supposed fixed and very distant) shall still be their flux-sheds. While always maintaining this condition, enlarge the holes and alter their positions until the extreme differences of potential in their lips become l_1, l_2, l_3, l_4, and the differences of potential between the lips in succession become p_2, p_3, p_4. In thus continuously changing the holes we might change their shapes arbitrarily, but to fix our ideas, we may suppose them to be always made circular. This makes the problem determinate, except the distance from the circle H of the hole nearest to it, which may be anything we pleased, provided it is very large in proportion to the diameter of the cylinder.

The determinate problem thus proposed is clearly possible, and the solution is clearly unique. It is of a highly transcendental character, viewed as a problem for mathemetical analysis, but an obvious method of "trial and error" gives its solution by electric measurement, with quite a moderate amount of labour if moderate accuracy suffices.

When the holes have been finally adjusted to fulfil our conditions, draw by aid of the voltmeter and movable electrodes, the equipotentials, for p_1 above the greatest potential of lip 1, and for p_5 below the least potential of lip 4, and between these equipotentials, which we shall call f and g, draw n-1 equidifferent equipotentials. Draw the stream-lines, making infinitesimal squares with these according to the rule given above in the present article. It will be found that the number of the stream-lines is m, the same as on our original surface, and the whole number of infinitesimal squares on the cylinder between f and g is $m\ n$. Cut the cylinder through at f and g, cut it open by any stream-line from f to g, and open it out flat. We thus have a Mercator chart bounded by four curves cutting one another at right angles, and divided into $m\ n$ infinitesimal squares, corresponding individually to the $m\ n$ squares into which we divided the original surface by our first electric process. In this chart there are four circular blanks corresponding to the lips 1, 2, 3, 4 of our diagram, and there is exact correspondence of their flux-sheds and neighbouring stream lines, and of the disturbances, which they produce in the equipotentials, with the analogous features at the lips of the original surface as cut for our process. The solution of this geometrical problem was a necessity for the dynamical problem with which I have been occupied, and this is my excuse for working it out, though it might be considered as devoid of interest in itself. KELVIN.

THE RECENT ERUPTION OF ETNA[1]

THE southern flank of Etna has been the site of three consecutive eruptions, remarkable for the diversity of the phenomena they presented.

On March 22, 1883, after several violent shocks of earthquake, the ground was rent open in a N.E. and S.W. direction, almost on the continuation of the big rift formed in the eruption of 1879, and near Monte Concilio a most interesting eruptive apparatus was formed. Very quickly, however, the eruption was arrested, but the eruptive energy had not had sufficient vent, as evidence of which were the frequent shocks which followed it and persisted, until on March 18, 1886, the ground was again split open as a prolongation of the rift of 1883, giving rise to an imposing eruption, during which an enormous quantity of lava was poured forth. This eruption from the very beginning manifested a great explosive force. The fragmentary materials were projected to an extraordinary height from several craterets formed along the rift, most of which, however, soon became quiet and were buried by the ejectamenta of the others, remaining alone the one twin crater now called Monte Gemmellaro. After this eruption the geodynamic phenomena and the volcanic activity at the central crater remained exceedingly feeble up to the last few days, so that this actual eruption did not present any grand display of premonitory phenomena.

On the evening of July 8, at about 10.30, the central crater of Etna began to send up a dense column of vapour, charged with dust, lapilli, and large rock fragments, which rose as an imposing mass with the

[1] This paper was written in Italian, and sent as a letter to Dr. H. J. Johnston Lavis, who has kindly translated it for NATURE, as requested by the author.

characteristic pine-shape of explosive eruptions, and illuminated by lightnings.

After half an hour this phenomenon ceased, and the smoke-plume was swept away by the higher currents of the atmosphere. I was able to ascertain in my excursion to the summit of Etna, in company with Mr. Rudler, curator of the Museum of Practical Geology of London, that the central crater was much modified by the short eruption. It presented two mouths, separated by a partition, whilst its upper edge was much broken down, so that it was enlarged. The ejected materials were composed of fragments of very much altered lavas that fell chiefly to the westward. During the night the ground was in a state of tremor, and at 2.45 a.m. of the 9th, a strong shock of earthquake was felt all over the Etnean region, producing slight damage to the walls of buildings.

Towards 1.20 p.m., without any further shock sensible in the inhabited regions, the southern flank of Etna was which is to the south of the new craters it divided in two principal branches and precipitated itself on the plain from which rises Monte Gemmellaro, forming three cascades of living fire. It here spread out, and the two branches, directing their course to the south, threatened Nicolosi, Belpasso, and Pedara. The more eastern ramification, when it reached the neighbourhood of Monte Albano, began to slow down and was already on the 12th advancing about two metres per hour, but increasing the breadth of its front and its thickness. On the other hand the western branch, which was invading the cultivated land, advanced in the steeper ground over fifty metres the hour, as I observed in my first visit on July 11. This stream was of a bright red colour, slightly covered by scoria. Near Monte Concilio it had filled up a valley, assuming a thickness of over 40 m. From Monte Ardicazzi we had presented to our view an immense expanse of fire from which rose crests and hills all in

FIG. 1.—Taken by Sig. Ledru on July 17. (No. 1, 2) are craters No. 1 and 2. (No. and 4) craters No. 3 and 4 in process of formation.—(m) Crateriform vent at the north base of crater No. 1.—(a) Monte Nero about one km. west of the craters.

rent open, and I could observe from Acireale a dense curtain of smoke rush up in great vortices, accompanied by continual rumblings. Towards evening one could see that the lava had advanced very rapidly in a southern direction. At the upper part it was observable that several jets, arranged in a linear manner, of fragmentary materials were being shot up to a great height, especially at three main points on the new and great rift. The explosive force of this eruption was much less than that of the eruption of 1886, in which the fragmentary ejecta were shot up to a height of 1200 metres, whilst in the present case the height rarely exceeded 500 metres. This fact depends on the great altitude and the great size of the new fissure, which afforded a free escape for the energy of the volcano, and gave forth a much greater quantity of lava. The lava in less than three days travelled more than four kilometres, and having surrounded Monte Nero, candescent, divided by deep depressions. It appeared like the sea in a tempest, the waves of which in their fury were suddenly petrified. From the crests were constantly being detached fresh incandescent masses which rolled down and choked the depressions, whilst new gushes raised the masses of scoria into new hills of fire. Amidst the phonolitic noise of the lava in movement, I noticed gigantic puffings produced by the escape of the vapour of H_2O, which, accumulating amidst the mass of the lava, formed gigantic bubbles which rose and burst, allowing the escape of the compressed gas.

The eruption was very active during the following days with short intervals of diminution or marked increase. Remarkable phenomena were the blasts which shook the doors and windows at Nicolosi, Acireale, and Catania, and, at localities nearer the point of eruption, even the walls.

On July 16 I started again, with my brother Giovanni, to approach the site of eruption. From Monte Caprioletto, which is about 1200 m distant, we could observe not only the three principal craters above mentioned, but also two others lower down, which so far had not grown to any important size.

Approaching still farther, we stopped at about 300 m off on the west, on a plain upon which grows the *Astragalus Siculus*, the bushes of which are now covered by large lapilli, and in part are burnt. The crater, which for brevity we will call No. 1, gave forth large and continual bursts of dust and scoria from its summit, and also from other points on its northern wall at the base of which issued a jet of light-grey vapour, which came from a little imbutiform crater separated from the main one by a partition of small size; from this were ejected a little dust and occasionally stones. The explosions of No. 1 were not accompanied by loud noises (*boati, bellowings*), but

Also in this last crater the explosions took place from several points of its funnel-shaped cavity, and we saw, at about mid-day of the 17th, much of its southern side destroyed by several bursts that took place from that point.

Both of these craters, already of considerable height, had an elliptical base, and specially No. 1, the maximum diameter of which is in the direction of the great rift, along which they are distributed.

The third crater, which we will call No. 3, adjoining the preceding one, presents a large depression to the south. It gave forth frequent bursts of incandescent lava fragments, with a constant noise resembling the constant discharge of much musketry, and accompanied by yellowish-white vapours. The emission of dust was rare, and only occurred when the eruptive bursts scored the north side of the crater. The fragments of incandescent lava, which in this crater were not accompanied by a trail of dust, often

Fig. 2.—By Sig. Ledru on August 19, at 100 m. to the north-east of the craters. (*S*) Crater of August 11. (*d*) Crater to the west which was in activity only on July 9. (1) Crater No. 1.

by strong and continual roarings like the sea in a tempest. Crater No. 2, more regular in form, gave forth frequent eruptions of dust, with many incandescent projectiles. In the moments of calm between one explosion and another, a slight white vapour escaped. The first burst of the explosion might be compared to a gigantic pointed jet preceded by black dust and sand, which rose with great rapidity in consequence of the great ascensional velocity, which was gradually impeded by the resistance of the air; then the column of black smoke charged with dust began to open out the immense vortices of compressed vapour which, always rising, assumed an imposing and characteristic aspect. The pieces of scoria were followed by a trail of dust both in their rise and fall, and when they struck the flanks of the mountain as they rolled down, they raised a cloud of dust and gave forth a characteristic sound. When they were numerous the mountain became all covered by a yellow dust.

were torn asunder in the air, being reduced to fragments.

The discharge of smoke from this crater occurred from the highest part, then there was the point at which occurred the numerous explosions of lava, then another jet of smoke, in its turn followed by another point lower down, from which occurred the explosions of the incandescent projectiles that gradually formed a crater, which we will distinguish as No. 4.

In general, while we were moving about to the westward of the craters on the morning of the 17th, the eruption was exhibiting comparatively little energy. Gradually, however, the explosions increased in violence, and the ejecta became more numerous. It is worthy of notice that the smoke, according to the place whence it issued was white, blue, light or dark grey, black, yellow, and even iridescent. Approaching nearer the craters, we attempted to encircle them on the north, when we found numerous

little fissures in the ground in a direction approximately parallel to that of the main rift These, often over a metre in breadth, are choked by the loose materials forming the surface, and in part obstructed by the loose materials forming their sides Higher up we found a wide cleft, which, starting from a higher point, was prolonged downwards towards the craters and was lost beneath the lava Upon this fissure were arranged a series of crateriform elevations, some of which were extinct, and others still presenting a little solfataric action On July 9, at the commencement of the eruption, lava and fragmentary ejecta also issued by this cleft, but it seems, the same day, to have become obstructed, and the tongue of lava which menaced the Casa del Bosco stopped, and the eruptive phenomena were diverted to the other more eastern fissure

It is absolutely impossible to accept the statement that this cleft represents the fire vents of the eruption of 1766, re-ejected, or are pieces of rock detached from the walls of the volcanic chimney Certainly from the last source are derived quartzites, which we collected amongst the ejected materials from this crater This quartzite is semi-vitreous, very similar to that which we collected from the craters of the eruptions of 1883 and 1886 These facts evidently showed that all these three eruptions have traversed similar strata and that all have arisen over the same principal cleft In fact the new eruptive apparatus formed at the base of the Montagnola about 1900 m above sea level, lies on the northern prolongation of the rift of 1886, in a plain gently inclined toward the south, and which towards the east presents a marked slope, so that the new craters are much higher on their eastern side In the great paroxysmal eruptions, and when a large rift opens at the surface of the earth, it is generally the rule that the eruptive mouth from which the lava flows without much explosive force is situated

FIG 3—Taken by Sig Modo on July 13, 1892, at 150 m to the north west of the craters Craters No 1 and 2 (a) Monte Nero (m) Little northern crater

and that the solfataric phenomena which the cleft now exhibits are only due to the near vicinity of the new volcanic outlet, for—putting aside the fact that in visits anterior to the present eruption I had never found any sign of such, and this is confirmed by people accustomed to the locality—it is easy also to be convinced from the nature of the materials composing these craterets These materials are so new as to leave no doubt as to their origin, and consist, those higher up, specially of blocks of old lava torn from the sides of the cleft, lower down they are principally scoria and other loose materials of recent formation

Approaching still nearer, we were able to distinguish clearly that amongst the ejected materials of No 1, besides the number of fragments of molten lava, there are often blocks of a dark grey colour that were already consolidated before their final ejection, which are either projectiles that have fallen back in the crater and have been at its lowest extremity The higher one goes along the fissure the less is the amount of lava that issues, but the greater is the explosive action, which higher still itself in turn diminishes In the present eruption we have good examples of this In fact, the small northern crater gave forth only dust, and very few fragments of new lava, and with little energy No 1 crater emitted much dust and also much lava, No 2 more lava than dust, and Nos 3 and 4 exclusively lava The materials of the little northern crater (Fig 3) are for the most part fragments of ancient lava, which lose their predominance in crater No 1, and gradually disappear as one descends lower and lower At the same time, as the old lava has a light bluish-grey colour and the fragments of the newer lava are much darker, the different craters exhibit different colours. This difference also depends in part upon the degree of fineness of the materials that compose the craters In fact the northernmost crater at the beginning

of the rift had not sufficient power to eject large materials, but lifted them up and kept them in continual movement, reducing them to fine dust, which was easily carried out by the vapour. No 3, on the contrary, continually ejected large lumps of lava, often shooting them a considerable distance, whilst Nos 1 and 2 exhibited intermediate stages, quite confirming what has been said above.

Whilst we were there the eruption increased little by little. The ground commenced to vibrate, and at 3.47 p.m. we

Fig 4.—Taken by Sig Mordà on July 18, 1892, at 300 m to the north west of the craters. (1 and 2) craters No 1 and 2 (a) Monte Nero (d) Craters to the west which were in activity only on July 9.

felt a strong earthquake shock, followed by other frequent oscillations of the ground of less intensity but often very perceptible. In this new period of great activity general to all the craters the phenomena exhibited by No 2 were worthy of remark. It no longer ejected dust, but pieces of hot lava with stronger explosions, which were more frequent but of shorter duration. Between one explosion and another there was slow evolution of white vapour, similar to that which rises from the fire-mouths and

Fig 5.—Taken by Prof Riccò on July 20, west of the craters. (1, 2, 3) craters No 1, 2, and 3

surface of the running lava. This floated above the crater, slightly disturbed by the wind, and when an explosion occurred it assumed a curious vibratory movement, rising a little, and then rapidly descending; then immediately was seen the first jet of solid materials, which, in its vertiginous upward course by vortex movement, sucked in the air over the crater edge, and the white vapours were drawn down, so looking as if they were being reabsorbed. This phenomenon, which attracted our attention when I was with you on Stromboli and the members of the Geologists' Association,[1] would show that within crater No 2 there is pasty lava, which is pushed up by the vapour in it; then the magma swells up, bursts, and the lava falls.[2]

In this parasitic crater of Etna, however, the phenomena were on a much larger scale, as also were the smoke vortex rings which we looked down upon when we were together at Stromboli. Likewise the explosions were far louder, reverberating as a low-pitched roar by the echo of

Fig. 6.—Taken by Prof Riccò on July 20, to the north west of the crater. No 1, 2, and 3 (a) Monte Nero.

the valleys, and they were audible in all the Etnean region, at Catania, Acireale, Giarre, and farther still for some dozens of kilometres from the craters. The air-shocks that accompanied these reports were very interesting. They represented a large undulation of the air, spreading with great velocity, reaching great distances, and contemporaneous with the audible vibrations.[3] While there we felt the blow on our bodies, and especially our chests and in the ears; at the Casa del Bosco we detected the shock against the walls, which trembled, and

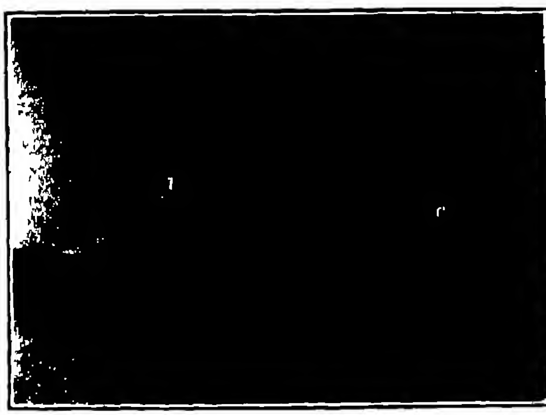


Fig 7.—Taken by G Platania from the north north-east of the craters, July 30, 1892. (1) Crater No 1 (c) Craters which were in activity only on July 9. The craters No 2, 3, and 4 are hidden behind crater No. 1

farther off at Catania and Acireale we heard the rattling of the windows and doors, which, strongly shaken,

[1] G Platania "Stromboli e Vulcano, nel Settembre del 1889. Riposto 1889." This phenomenon I have often observed at Vesuvius, and I quite agree with Signor Platania as to its cause, as I have been able to look in the crater and watch the whole process.—Johnston-Lavis.

[2] The lava in this case is very like the boiling up of a viscous liquid in a long test-tube.—Johnston-Lavis.

[3] I have some doubts about the two mechanical disturbances travelling exactly at the same rate. When blasts are fired in a long tunnel the air-stroke is felt before the sound.—Johnston-Lavis.

give the impression of an earthquake, so that several times the people of these towns have rushed out into the streets On July 14 I observed in Acireale that the large undulations of the air-blows which were propagated beyond 333 m per second, like sonorous vibrations, often arrived unaccompanied by noise, and strongly shook doors and windows

These reports, these air-blows, and the abundant ejection of incandescent lava still further prove that in No 2 crater there was pasty lava which swelled and burst, as we deduced from its effect on the white vapours

This period of great activity, in which the thick shower of lava fragments projected from the different craters to great heights and spread over an area of 500m radius, reached its maximum about midnight, and then gently declined a little In the same manner the eruption continued during the following days with great energy, but with a very gradual diminution in its intensity, interrupted more or less by strong spasms The lava continued to advance, but diminished in velocity, while it extended in breadth and depth The eastern branch very soon stopped, and also the western one, after having continued its destruction of very fertile ground This having crossed the road known as the St Leo, finally

Monte Nero Crater No 4 Crater No 3 Crater No 2 Crater No 1

FIG 8 —Taken by G Platania on July 30 from the north east of the craters. No 4 is still very little, but in part hidden behind a prominence of the ground

stopped, whilst the new lava that continues to issue forms new ramifications and flows, which pass quite close to the earlier ones, and now actually are in contact with them, increasing the area covered In the first paroxysm of the eruption the lava issued in great gushes all along the rift Soon at the upper part commenced the dejection cones, and lower down the fire vents, and the lava flowed in abundance, and with explosions also in points where now are the craters, as, for example, Nos 3 and 4 Later, when the explosive force had diminished, the lava issued without explosions, almost silently from different vents at the south end of the fissure on which are aligned the craters These vents, therefore, have during the eruption varied in number and form Some have assumed the function of dejection craters as occurred in Nos 3 and 4, which gave passage to much lava as a current Others have ceased to eject scoria, to send forth only torrents of lava, as, for example, the little mouth to the east of No 4, the scoria rim of which exists only to the north, of about 20m high, whilst the south rim has been swept away by the current Some of the mouths have been refilled by the lava flows, and whilst some have become extinct new ones have been formed

In the last week of July, crater No. 2 assumed, for some days, a new phase Its explosions had become rare, long, and very grand, and the large mass of vapour, mixed with dust, brought back to my mind the eruption of Vulcano when we stood on the crater edge and watched and photographed the whole process, and stood our ground amidst showers of bombs and other projectiles (1888–90)[1] By this it lost the beautiful regular truncated cone form that it had at the beginning, and became irregular and broken-down towards the north, like No 1

At the commencement of August the eruption already seemed much diminished, craters No 1 and 2 had ceased to eject stones little by little, gradually becoming blocked, and the enclosed lava was slowly cooling In fact, on the recommencement of a period of renewed energy, the explosive force could no longer find an escape by them, so that on August 1 a new crater opened in a point higher up where the cleft to the west, which had only acted at the commencement of the eruption, joined another great rift on which the craters were formed Then on August 9 occurred another violent eruptive spasm, which could not clear away the material that obstructed the craters, but opened a new way, always on the main cleft, between Nos 1 and 2, and exactly at the north base of the last of these craters Here a little funnel-shaped depression was formed which for a short time ejected enormous masses This new crater, however, soon passed into the solfataric stage as Nos 1, 2, and 3, and there remained in an energetic state of activity only the crater of August 11 and No 4 That one which on August 21 measured in diameter only about 50 m, and had a height of about 60 m, later became elongated towards the S S W, and its grand and beautiful explosions, which I watched quite closely, in company with Mr Rudler, on August 29, 30, and 31, were specially localized on the southern edge, so that they tended all the more to give it an elongated form on that more western cleft that was only in activity the first days of the eruption No 4, meanwhile, which I approached, ascending upon No 3, gave forth frequent eruptions of hot lava cakes at regular intervals (about fifty per minute), accompanied by globes of yellowish vapour, and a noise similar to that which accompanies the globes of vapour from the locomotive when it commences to move

By unanimous consent of all the studious inhabitants of Etna, the new craters have been called the Monti Silvestri, in honour of that well-known vulcanologist, the lamented Prof Orazio Silvestri, who studied our volcano with so much fervour, registered so assiduously every slight disturbance, and described its paroxysms so well and with such originality, that his loss has been deeply felt by all men of science GAETANO PLATANIA

14, Via S Giuseppe, Acireale,
September 7

NOTES

THE Harveian oration will be delivered by Dr J H Bridges at the Royal College of Physicians on Tuesday, October 18, at four o'clock

THE Medical Session in London was opened on Monday, and introductory addresses were delivered in some of the schools attached to hospitals A particularly interesting and suggestive address was delivered at the Westminster Hospital by Dr Mercier, who dealt with various aspects of the problems connected with crime, pauperism, and insanity Sir John Lubbock addressed the students at St Thomas's Hospital

ON Friday last Sir George Murray Humphry, F R S, delivered an interesting address at the opening of the first session

1 "South Italian Volcanoes," by Johnston Lavis, Naples, 1891 "I Projettili Squarciati di Vulcano," by G Platania. (Roma 1891)

of the Queen's Faculty of Medicine in connection with Mason College, Birmingham. The union of the two institutions is likely to be of great service both to medicine and to pure science in the Midlands.

A MARINE biological station has been established at Bergen, in Norway, the funds having been raised by private donations and by subscriptions from learned societies. It will be under the control of Dr. J. Brunchorst, and will supply ten places for Norwegian and foreign workers.

WE regret to learn that M. Henri Douliot, who had been commissioned by the French government with a botanical expedition to the western coast of Madagascar, has died there of fever.

DR. B. L. ROBINSON has been appointed Curator of the Herbarium of Harvard University, Cambridge, U.S.A., in succession to the late Prof. Serreno Watson.

MR. WALTER L. COLLINGE, late Assistant Demonstrator in Zoology in St. Andrew's University, has been appointed to the vacant Demonstratorship in Zoology and Comparative Anatomy and Botany in Mason College, Birmingham.

A CIRCULAR appeal, dated September, 1892, and signed by Mr. E. C. Pickering, Director of the Observatory of Harvard College, has been issued, inviting the wealthy to consider the opportunity offered for a donor of 200,000 dollars "to have his name permanently attached to a refracting telescope, which, besides being the largest in the world, would be more favourably situated than almost any other, and would have a field of work comparatively new." The telescope in question would be placed in the station established by Harvard College Observatory, near Arequipa in Peru, at an altitude of more than eight thousand feet. "During a large part of the year," says Mr. Pickering, "the sky of Arequipa is nearly cloudless. A telescope station having an aperture of thirteen inches has been erected there, and has shown a remarkable degree of steadiness in the atmosphere. Night after night atmospheric conditions prevail which occur only at rare intervals, if ever, in Cambridge. Several of the diffraction rings surrounding the brighter stars are visible, close doubles in which the components are much less than a second apart are readily separated, and powers can be constantly employed which are so high as to be almost useless in Cambridge. In many researches the gain is as great as if the aperture of the instrument was doubled. Another important advantage of this station is that, as it is sixteen degrees south of the equator, the southern stars are all visible." The circular continues: "The planet Mars, when nearest the earth, is always far south. The study of the surface of this and of the other planets is greatly impeded by the unsteadiness of the air at most of the existing observatories. Even under the most favourable circumstances startling discoveries—relating, for example, to the existence of inhabitants in the planets—are not to be expected. Still, it is believed that in no other way are we so likely to add to our knowledge of planetary detail as by the plan here proposed." We venture to hope that the wealthy donor for whom Harvard is looking will soon be found.

BARON LEON DE LENVAL, of Nice, offers a prize of 3,000 francs to the inventor of the best application of the principles of the microphone in the construction of a portable apparatus for the improvement of hearing in deaf persons. Instruments for competition should be sent to Prof. Adam Politzer, or Prof. Victor von Lang, Vienna, before December 31, 1892. The prize will be awarded at the Fifth International Otological Congress at Florence in September, 1893. If no instrument is judged worthy of the prize, the jury reserve the right of announcing another competition, unless Baron Lenval decides to dispose of the prize otherwise. The following are the members of the jury:—Prof. Adam Politzer (President), and Prof. Victor v. Lang, Vienna; Dr. Benni, Warsaw; Dr. Gellé, Paris; Prof. Urban Pritchard, London; Prof. St. John Roosa, New York; Prof. Grazzi, Florence.

THE weather during the past week has been much disturbed by several depressions, which have caused heavy rainfalls over the whole of the kingdom, with hail and thunderstorms in many places. On the morning of September 30 the amount of rain measured on the south coast was an inch and a half, or about half the average for the month; and on the west coast, especially at Liverpool, much damage has been done by floods, occasioned by the excessive amount of rain. Temperature has been low for the season, the daily maxima rarely exceeding 60° in any part of the country, while in the north and west the readings have been much lower; frost has been recorded in the shade in the east of London, and the nights have been very cold generally. For several days a cyclonic area was situated over the United Kingdom, and strong winds were experienced on some coasts; a temporary improvement, however, occurred on Tuesday, although conditions remained very unstable. The *Weekly Weather Report* of the 1st inst. shows that the rainfall was in excess everywhere. In the south-west of England it amounted to 1.2 inch; but there was still a deficiency of 7½ inches since the beginning of the year. The temperature was below its mean value in all districts except the south of England and the Channel Islands, the deficiency being greatest in Scotland and Ireland.

SOME results of seven years' meteorological observations on the Pic du Midi, at a height of about 9500 feet, have been recently published by M. Klengel. The annual mean temperature is $-2°.2$ C. The annual variation, $14°.3$, is only one degree less than at Tarbes on the plain, and is about that of the Sonnblick (which is some 800 feet higher than the Pic). April is abnormally cold ($-6°.2$), and this is attributed to the fact that the Pic stands in Van Bebber's fifth depression-path, which is most frequented in that month. While Pip's Peak represents the extreme continental type of high mountain climates, and Etna the oceanic type, in nearly the same latitude, the Sonnblick and the Pic du Midi represent transition types. The maximum zone of precipitation on the Pic lies at about 7700 to 8000 feet; above this there is marked diminution. The results in general show that even at a height of nearly two miles the distribution of land and water on the earth's surface has a considerable influence on climate.

A SHOCK of earthquake, lasting from three to five seconds, was felt at Huelva, between twelve and one o'clock on the morning of September 29. According to a Reuter telegram, three shocks were noticed, the first being weaker than the succeeding disturbances. The direction of the seismic wave was taken from north to south, and the subterranean rumblings were heard very distinctly over a large area. The inhabitants were greatly terrified, but nobody was injured. Many windows were smashed, but beyond this the damage was insignificant.

A CURIOUS instance of globular lightning is referred to in the *Meteorologische Zeitschrift* for September 1892. On August 7, during a thunderstorm at Altenmarkt, near Fürstenfeld, while the priest was administering the sacrament, the church was struck by lightning, followed by a loud explosion. A panic immediately ensued, and the congregation rushed out, notwithstanding the assurances of the priest that there was no danger. There was nothing to show how the lightning entered the church, but it is supposed it was by the conductor leading from the steeple. It is said to have been a large globe, tapering towards the upper part, and after the explosion it left a strong sulphurous smell. The explosion was very loud and shook the building.

The last number of the *Berichte der Deutschen Botanischen Gesellschaft* contains an interim report on the progress of the negotiations concerning the nomenclature of genera, started by a committee of botanists at Berlin to supplement the decisions of the International Botanical Congress held at Paris in 1867. The proposals submitted last April to the consideration of 329 German and Austrian and 377 foreign botanists were the following:—(1) The year 1752 to be taken as the initial date for priority in names of genera, and 1753 for the names of species. (2) Nomina nuda and semi nuda to be rejected. Drawings and dried specimens without diagnoses to establish no claim to priority of a genus. (3) Similarly sounding generic names to be retained, even if differing only in the ending or by a single letter. (4) The names of the subsequent great or well-known genera to be preserved, even if they ought to be rejected by the strict rules of priority, especially in cases where no change in the names used up to the present can be proved. 360 replies had been received up to the time of the report, amongst them being 157 from Germany, 63 from Austria, and 19 from Great Britain and Ireland. The great majority expressed approval, at least, of the first three proposals. The botanical authorities of the British Museum favour the suggestions, those at Kew are against them.

M. G. Trouvé has built a luminous fountain for Mme. Patti, at her residence at Craig-y-Nos, an account of which appears in No. 11 of the *Comptes rendus*. "The weight of this fountain is about 10,000 kgr., and the basin measures 6 m. in diameter. The illuminating power is represented by four incandescent lamps of 110 volts, each consuming 6 amperes. Thus the total electric energy amounts to 2640 watts; this gives, at three watts per candle, a light intensity of over 800 candles. The lamps are centred at the focus of four parabolic reflectors grouped under the glass chambers whence the water springs. As in the chamber fountains, the metallic ajutages, which would have cast shadows, are eliminated. The water which falls from the upper to the lower basin is utilised to drive a small bucket-wheel, which governs the rotation of two superposed discs, concentric or otherwise, made of coloured glasses, which turn in the same or in the opposite sense, with equal or unequal velocities as required, between the reflectors and the glass. This combination of two discs with opposite rotations renders possible a variation in the play of colours of the liquid sheaves, which succeed each other with the unexpectedness of the kaleidoscope. The motive power can be chosen at pleasure. It may be hydraulic, electric, or by clockwork, of forms and dimensions in keeping with the character of the decoration. These fountains need neither expenses of installation nor costs of maintenance, and their price depends solely upon their artistic perfection and their importance. Hitherto the construction of luminous fountains has only been hindered by the impossibility of sufficiently illuminating the jets. To-day the problem is reversed. Since the light can be projected without sensible loss to great heights, the only difficulty will be to give a sufficiently high pressure to the water."

The Manchester Field Naturalists' and Archæologists' Society closed the out door session by a visit to Buxton on Saturday, September 24. The field meetings were well attended during the session, and the introduction of an itinerary for each excursion, detailing the natural history features of the district, was of service. The president, Mr. Charles Bailey, F.L.S., usually gave the address upon the botanical specimens observed. At Buxton, the chairman of the directors of the Winter Gardens conducted the party through the grounds, and undertook to convey to his colleagues the desire of the Society that the county ferns and native phanerogams, so far as they will live at the altitude of the gardens, which are a thousand feet above the sea, should be introduced.

At a meeting of the Norfolk and Norwich Naturalists' Society, held in the Norwich Museum on September 27, Mr. Southwell exhibited, by permission of Mr. T. Ground, of Moseley, Birmingham, a Siberian pectoral sandpiper (*Tringa acuminata*), killed at Yarmouth by that gentleman on August 29, which he believed to be the first European example of this bird hitherto recorded.

The administrative report of the Marine Survey of India for the official year 1891-92 has been published. Dr. A. Alcock, Surgeon-Naturalist to the Survey, shows that in his department the year has been by no means unproductive. He expresses his belief, however, that the results would be tenfold greater, both from the scientific and from the economic points of view, if, in the survey of inhabited coasts, the naturalist could follow the ship from camp to camp ashore, visiting it at short, convenient intervals for medical purposes, but otherwise devoting all his time to systematic exploration of the grounds worked by the fishermen—grounds of marvellous richness still quite unexplored and unappreciated.

Among the animals Dr. Alcock has specially observed is the red ocypode crab, which swarms on all the sandy shores of India. The bigger of its two chelæ, or nippers, bears across the "palm" a long finely-toothed ridge, and on one of the basal joints of the "arm," against which the "palm" can be tightly closed, there is a second similar ridge. When the "palm" is so folded against the base of the "arm," the first ridge can be worked across the second, like a bow across a fiddle, only in this case the bow is several times larger than the fiddle. The remarkable resemblance of the whole arrangement to the stridulating apparatus of many insects led Prof. Wood Mason some time ago to infer a similarity of function, and he asked Dr. Alcock to observe the crabs, and to listen for the sounds which he supposed them to be capable of making. Dr. Alcock is now able to give facts which establish the truth of Prof. Wood Mason's idea. The sounds can be heard, and their effects seen, if one crab, which may be called the intruder, is forced into the burrow of another, which may be called the rightful owner. The intruder shows the strongest reluctance to enter, and will take all the risks of open flight rather than do so, and when forced in he keeps as near the mouth of the burrow as possible. When the rightful owner discovers the intruder he utters a few broken tones of remonstrance, on hearing which the intruder, if permitted, will at once leave the burrow. If the intruder be prevented from making his escape, the low and broken tones of the rightful owner gradually rise in loudness and shrillness and frequency until they become a continuous low-pitched whirr, or high-pitched growl, the burrow acting as a resonator. Dr. Alcock concludes that the use of the stridulating organ appears to be that a crab, when it has entered its burrow, may be able, by the utterance of warning notes, to prevent other crabs from crowding in on top of it.

Dr. Fritz Noetling has been investigating the amber and jade mines of Upper Burma, and sets forth the results of his inquiry in the new number of the Records of the Geological Survey of India. The strata in which the amber is found belong to the tertiary formation, probably to the lower miocene. Dr. Noetling does not think that Burmese amber would be received with much favour in Western markets—first, because it does not include the milky-white, clouded variety which has for a long time been so much appreciated in Europe; second, because of its fluorescence. This is the bluish tinge which appears when the amber is looked at under a certain angle—a tinge which is sometimes so strong that fine yellow pieces seem to be of an ugly greenish colour.

Dr Noetling has formed a higher idea of the value of the jade mines of Burma There are two different groups of jade mines—pit and quarry mines The former are situated along the bank of the Uru river, beginning at about Sankha village, and extending for a distance of about forty miles farther down The quarry mines near Tammaw village are situated eight miles west of the Sankha village, on the top of a plateau rising to about 1,600 feet above the level of the Uru river The Tammaw mines afford the best opportunity for the study of the geological conditions under which the jade is found It there forms a vein of considerable thickness in an igneous rock of blackish-green colour The jade is a purely white crypto crystalline mineral, much resembling the finest marble, containing here and there green specks of various sizes, which form the jade proper The jade vein is separated from the black rock by a band of a soft and highly decomposed argillaceous mineral The strike of the vein is approximately north to south, and the dip at about an angle of 20°, varying considerably towards east There are at least 500 men engaged every season in working the quarry mines at Tammaw The mining operations are carried on in the rudest fashion No blasting powder being available, the rock is heated by large fires, and, having cooled down, is broken in pieces by means of enormous iron hammers The operations in the pit mines are less difficult The miner simply digs a pit and selects boulders of jade from the stuff dug out. Good pieces of jade are sometimes found in the laterite, which forms beds of varying thickness along the Uru These pieces have superficially undergone a certain discolouring in such a way that the original green or white is changed under the influence of the hydrated oxide of iron into a dark red colour Specimens of this kind are generally known as "red jade" Dr Noetling says that the jade mines form a most valuable property He has no doubt that besides the Tammaw jade vein others will be discovered We know now that jade is intimately associated with a dark igneous rock (trap), and Burma abounds in rocks of this kind

Mr Otis T Mason contributes to the latest report of the U S National Museum (for 1890) an interesting study of the ulu, or woman's knife, of the Eskimo The ulu is found throughout the Eskimo region, from Labrador to Kadiak, and consists of a blade and a handle or grip with or without some form of lashing The blade is either a thin piece of slate ground to an edge, a bit of cherty or flinty rock chipped to an edge, a scrap of steel or iron from wrecks of whaling vessels, or good blades made and sold to the Eskimo by traders who visit their country The handle varies greatly in material, form, and finish In form alone the specimens from each typical area are unique Some of the ulus in the U S National Museum are as coarse as savagery could make them, others are very beautiful The same locality furnishes both and intervening kinds, but some areas supply only coarse work The problem has to some extent been complicated by white influence. The ulu has survived in civilized countries under two well known forms—the saddler's knife and the kitchen knife The saddler thus perpetuates, for cutting leather, an implement designed to be used with skins from which the hair has not been removed The kitchen chopper is the woman's knife deprived of nearly all its ancient and primitive offices, consigned to a single one, which it scarcely had at the beginning The saddler's knife may be seen in the hands of leather-cutters represented on Egyptian monuments An excellent series of illustrations, grouped in accordance with the regions from which the specimens come, adds greatly to the interest and value of Mr Mason's paper

It is a common experience in daily life that milk has in itself little or no tendency to putrefaction, and that it may even to some extent preserve certain substances that are readily decomposed, such as meat This property has lately been investigated by Herr Winternitz, in Strasburg Of the three chief constituents of milk, viz., casein, fat, and milk sugar, the first proved as liable to putrefaction as the meat or pancreas extract experimented with, the fat, too, had no preservative influence Milk-sugar, on the other hand, in accordance with what is known regarding the power of carbohydrates to retard putrefaction, acted as strongly as cane-sugar Nothing definite was ascertained as to the nature of this action It was proved, however, to take place in the alimentary canal as well as outside of the system

Rats at Milnthorpe, Westmoreland, seem to have found a fresh outlet for their predatory impulses Mr G Reade, in a letter quoted in the new number of the *Zoologist*, says that the ripe gooseberries in his garden there were disappearing very rapidly this year, and he supposed that the mischief was being done by blackbirds However, his attention was called to a large rat taking the berries off with his mouth and dropping them to other rats below Presently another climbed the tree and helped to gather the berries In a little time both came down, each with a berry in its mouth, having a curious appearance Mr Reade saw the performance several times repeated Then he placed a wire cage under the tree, and in three days caught nine of the intruders

The electric light seems to have an extraordinary attraction for lepidoptera On August 19, as he records in the new number of the *Entomologist*, Mr D S Stewart had an opportunity of noting this fact At the Eddystone lighthouse exhibited in the Botanic Gardens at Old Trafford (the same lighthouse as was shown at the Naval Exhibition), he saw great numbers of moths Before ascending, he says, one could see them from below, flashing in and out of the rays in hundreds, and when the top was reached, the place was found to be full of them—"some, apparently dazzled by the light, frantically flying in all directions, buzzing and banging in your face, up your sleeves, down your neck, everywhere In every sheltered niche and cranny four or five were to be seen together, and especially was this so on the staircase, which was strewn with their partially cremated remains, the result of their all too successful attempts at self immolation"

A valuable paper on the breeding habits, eggs, and young of certain snakes, by O P Hay, is printed in the latest volume (xv) of the Proceedings of the U S National Museum, and has also been issued separately Mr Hay notes that, although serpents have made a deep impression on the human mind, very little accurate information has been accumulated concerning some of their habits His paper embodies the results of a good deal of careful personal observation

The Nova Scotian Institute of Natural Science has changed its name to the Nova Scotian Institute of Science, and has secured an Act of Incorporation It has now begun the second series of its "Proceedings and Transactions," the first part of vol i having just been issued Among the papers in this part are "Notes on the surface geology of South Western Nova Scotia," by Prof. L W Bailey, "Steam boiler tests as a means of determining the calorific value of fuels," by D W Robb, "Analyses of Nova Scotia coals and other minerals," by E Gilpin, jun, "The Magdalene Islands," by the Rev Dr G Paterson, "Notes for a Flora of Nova Scotia," Part I by Prof G. Lawson

Messrs. Williams and Norgate are about to publish a work entitled the "Cry of the Children," by "Free Lance." It deals with education in a wide sense, but more especially it advocates the necessity of a scientific training

PART I of a new work on practical physics, by Prof W F Barrett, of the Royal College of Science for Ireland, will shortly be published by Messrs Percival and Co It will treat of physical processes and measurements, and the properties of matter

THE University Correspondence College has issued its calendar for 1892 93 The Principal, in his report, shows that the college has been in many ways remarkably successful

THE calendar of the Imperial University of Japan for 1891 92 affords ample evidence that the authorities of this important institution are doing everything in their power to secure that it shall meet the needs of the present age We may note that in the college of science the following seven courses, each of which extends over three years, have been established Mathematics, astronomy, physics, chemistry, zoology, botany, and geology

IN the last sentence of the fourth paragraph of Lord Kelvin's article on "Generalization of Mercator's Projection Performed by aid of Electrical Instruments" (NATURE, September 22, p 491), for "three" read "two" For corrections in paragraph 3, and in the last paragraph but one, see article "To Draw a Mercator Chart, &c," in the present issue

AN interesting new compound, the silver salt of the little known imide of sulphuric acid, SO_2NAg, has been obtained by Dr Wilhelm Traube, in the laboratory of the University of Berlin, and an account of its properties, together with a considerable amount of fresh information concerning both the amide and imide of sulphuric acid, are contributed by him to the current number of the *Berichte* Regnault long ago obtained a solid substance, which he regarded as a mixture of the neutral amide of sulphuric acid $SO_2(NH_2)_2$ with ammonium chloride, by leading ammonia gas into a solution of sulphuryl chloride SO_2Cl_2 in ethylene chloride

$$SO_2Cl_2 + 4NH_3 = SO_2(NH_2)_2 + 2NH_4Cl$$

The separation of the two substances, however, was but imperfectly effected, so that our knowledge of the amide itself is very vague Dr Traube now shows that the amide may be isolated without difficulty by the following process The sulphuryl chloride is dissolved in fifteen times its volume of chloroform, which exerts no chemical action upon it, and dry ammonia gas is led through the liquid until the latter becomes saturated The products of the reaction separate during the passage of the gas in the form of a white solid The whole product is then agitated with water until the precipitate dissolves, the aqueous solution is separated from the chloroform and afterwards boiled in contact with oxide of lead or silver until all chlorine is removed from it Upon filtering and evaporating the resulting liquid a syrup is eventually obtained, which only crystallizes with difficulty and would appear to consist of neutral sulphamide $So_2(NH_2)_2$ It is an extremely deliquescent substance whose solution in water and dilute acids is not precipitated by salts of barium or by platinic chloride Only after prolonged boiling with hydrochloric acid does decomposition occur with the gradual deposition of barium sulphate The effect of boiling in the presence of acids would appear to be its conversion into ammonium sulphate Sulphamide possesses the power of combining with the oxides of mercury, lead, and silver, to form white solid substances Thus if mercuric nitrate, lead acetate, or ammoniacal silver nitrate are added to the aqueous solution of the amide these white solid compounds are precipitated The mercury compound is insoluble in dilute nitric acid, while the lead and silver compounds are readily soluble, forming solutions which are perfectly indifferent to barium salts It was from the compound containing silver that the interesting silver imide was obtained Upon heating the silver compound to the temperature of 170–180° until ammonia ceases to be evolved, and extracting the residue with hot water feebly acidified with nitric acid, the new compound SO_2NAg separates upon cooling in long acicular crystals Analyses have proved its composition to be that stated, and from its reactions it must be regarded as being the silver salt of sulphimide SO_2NH The crystals are only soluble with difficulty in cold water, but more freely in hot water and readily in dilute nitric acid The solution is not precipitated by barium nitrate Even after removal of the silver by means of hydrochloric acid barium salts yield no precipitate, indeed, it requires long boiling with concentrated acid to effect any precipitation It would appear that the solution left after removal of the silver contains sulphimide itself, and Dr Traube is continuing his experiments with a view to the isolation of the latter compound

THE additions to the Zoological Society's Gardens during the past week include a Grivet Monkey (*Cercopithecus griseoviridis* ♀) from South Africa, presented by Mr W. Howard a —— Lark (*Alauda coelivox*) from China, presented by Mr Gervase F Mathew, R N, F Z S, two Common Kestrels (*Tinnunculus alaudarius*), British, presented by Mr L Bergasse a Herring Gull (*Larus argentatus*), British, presented by Mr H H Johnson, a Tuatera Lizard (*Sphenodon punctatus*), from New Zealand, presented by Capt G Eriksen, four Smooth Snakes (*Coronella laevis*) British, presented by Mr E Penton, F Z S, six American Green Frogs (*Rana halecina*), four Noisy Frogs (*Rana clamata*), from Canada, purchased, one Concave casqued Hornbill (*Dichoceros bicornis*), from India, received in exchange, three Wild Swine (*Sus scrofa*) born in the Gardens

OUR ASTRONOMICAL COLUMN

COMET BROOKS (AUGUST 27, 1892) —*Astronomische Nachrichten*, No 3119, contains the elements and ephemeris of Brooks's comet calculated by F Ristenpert, assuming an elliptical orbit and the unit of brightness on August 31 5 as the unit of Br —

Elements

T = 1892 Dec 28 2870 M T Berlin

$$\omega = 252\ 4'\ 23''\ 0$$
$$\Omega = 264\ 34\ 45\ 3$$
$$i = 24\ 43\ 17\ 1$$
$$\log q = 9\ 994136$$

Ephemeris for 12h Berlin M T

1892	R A app h m s	Decl app ° '	Log r	Log Δ	Br
Oct 6	7 45 22	+24 47 5			
7	48 30	24 26 9	0 2204	0 1763	3 71
8	51 40	24 5 6			
9	54 51	23 43 6			
10	7 58 4	23 20 9			
11	8 1 18	22 57 4	0 2077	0 1542	4 35
12	8 4 34	22 33 3			

This comet on the 11th inst will be found situated in the constellation of Cancer It will lie very nearly on a line joining the stars κ Gemini and δ Cancri, being about a third of the distance nearer the former than the latter

COMET 1892 II (MARCH 18) —The following ephemeris for Denning's comet we take from the *Astronomische Nachrichten*, No 3118 —

12 *Berlin Mean Time*

1892	R A app h m s	Decl app ° '	Log r	Log Δ	Br
Oct 6	6 23 9	+11 54 0			
8	22 0	11 6 3	0 4250	0 3604	0 64
10	20 43	10 17 9			
12	19 19	9 28 8	0 4300	0 3539	0 65
14	17 48	8 39 1			
16	16 9	7 48 9	0 4349	0 3478	0 65
18	14 23	6 58 4			
20	6 12 29	6 7 6	0 4398	0 3423	0 65

Nova Aurigæ —In some further notes that we have referring to the brightness and the spectrum of the Nova, we find that most observers estimate the star's magnitude to lie between 10 and 10 5 Herr Belopolsky, who has examined the star spectroscopically, has been able to see one or two lines, a later estimation of the brightest gave a wave length of 501, while the second line proved too variable in brightness to allow of a sufficiently correct mea urement

To *Astronomische Nachrichten*, No 3118, Mr H Seelinger contributes a very important article, in which he suggests an hypothesis which may be said to approach that put forward by Mr Lockyer some time ago He assumes (and a very fair assumption too) that the cosmos contains innumerable more or less elongated forms of very thin and small particles, and that the Nova was produced by a body rushing into one of these, so to speak, clouds On entering this cosmical cloud, at once there would be a condition for producing heat, and therefore light, and we have only to imagine the cloud to be of varying thicknesses to account for the peculiar fluctuations which attended the light of the Nova That such a case should take place seems in itself more probable than that of two bodies passing very near one another, and we already know that such streams as suggested do exist Our November shower, for instance, is such a swarm, only on a scale very much smaller than that inferred above

GEOGRAPHICAL NOTES

Until recently the Samoan calendar corresponded with the Australian, but on July 4 last a change was made by order of King Malietoa Tuesday, July 5, was reckoned a second time as Monday, July 4, thereby coming into harmony with the American and European reckoning Samoa, lying to the east of 180°, had retained the old system of time, superseded by the general acceptance of that meridian as the line at which the date is rectified by vessels at sea

Captain Lugard reached London from Uganda on Sunday night It is gratifying to know that his three years' residence in equatorial Africa, and the severe strain of recent events, have not told adversely on his health He will probably communicate the important geographical results obtained by him to a special meeting of the Royal Geographical Society in November

The arrangements for the next session of the Royal Geographical Society present several new features In addition to the ordinary meetings it is proposed to give a special series of Christmas lectures to young people, to be followed by a course of ten weekly educational lectures, specially adapted for teachers, by Mr H J Mackinder The ordinary meetings as provisionally arranged begin on November 14 by a paper on his proposed North Polar expedition by Dr Nansen Mr Joseph Thomson will follow with an account of his expedition to Lake Bangweolo Captain Bower will describe his journey across Tibet, and Captain Lugard will recount his discoveries in equatorial Africa Prof Milne and Mr Savage Landor have promised papers on Yesso, Major Rundell on the Siyin Chins, Mr H O Forbes on the Chatham Islands, and Captain Gallwey on Benin It is hoped that Mr Conway will return to describe his adventures in the Karakoram mountains Apart from the records of travel to which the attention af the Society in its ordinary meetings has usually been mainly devoted, there will be papers dealing with the more general and scientific aspects of Geography The Prince of Monaco will probably describe his experiments on the Atlantic currents, Sir Archibald Geikie will lecture on types of scenery, Prof Bonney on the work of glaciers, Mr J Y Buchanan on the windings of rivers, and Dr Schlichter on his new photographic method of determining longitude

The last number of *Petermann's Mitteilungen* contains an important paper by Dr Alois Bludau giving the co-ordinates for Lambert's equivalent area azimuthal projection of the map of Africa An outline of the continent on this projection, the central point of which is on the equator in 20° E long., shows the remarkable suitability of the map for representing Africa, the distortion being inappreciable

MAGNETIC INDUCTION[1]

The lecturer remarked that it was no less than forty-five years since the magnetic properties of materials had formed the subject of an evening discourse before the British Association At the Oxford meeting in 1847 the lecturer was Michael Faraday, who had only a little while before made his great discovery of diamagnetism and been led to the splendid generalization that all substances are in one way or other, and in greater or less degree, susceptible of magnetic influence And it was an interesting coincidence that in the same year, partly indeed at that same Oxford meeting of the Association, the foundation of the modern mathematical treatment of magnetism had been laid by that infant phenomenon, whom in the vigour of his maturity we were now learning to call Lord Kelvin Discarding the arbitrary hypotheses of earlier theoretical writers, Lord Kelvin, then a stripling at Cambridge, had proceeded to give mathematical expression to the observations and intuitions of Faraday In recent years the science of magnetism had advanced fast, keeping pace with the advance of its industrial applications In common with other branches of electricity it had discovered the advantage of being useful The debt which practice owed to science had been repaid with interest In other departments of science it might be true that there were devotees whose chief pride in their work lay in their reflection that it could never be of any use to anybody this temper of mind was not possible to an electrician The language of electricians had passed with bewildering rapidity into Acts of Parliament and provisional orders of the Board of Trade, and the demands of industry had stimulated discovery and fostered exactness in measurement It was the beneficent reaction of practice on science that had enabled the great work of the Electrical Standards Committee of the British Association to be brought to a successful issue As a fruit of that work electricians were in high hope that this Edinburgh meeting would result in an international agreement with regard to the electrical units, so that whatever the Great Powers might find to differ about they would at least be of one mind as to the magnitude of the volt, the ampere, and the ohm In the co operation of Prof von Helmholtz on the part of Germany, and of M Mascart on the part of France, with Lords Kelvin and Rayleigh and their English colleagues, there were surely the elements of a Triple Alliance which should secure to the electrical world peace, not only with honour, but with precision

The lecture of Faraday in 1847 had dealt with the condition induced by magnetic force in matter which was not ordinarily magnetic Substances were broadly divisible into two classes, those which were strongly susceptible to magnetic influence and those that were only very feebly susceptible The latter was by far the most numerous class, and it was with it that Faraday dealt in his lecture The strongly magnetic substances were iron and its various derivatives, which passed by the general name of steel, also nickel and cobalt A recent discovery by Prof Dewar seemed to require that oxygen, in the liquid state, should be added to this list The lecturer proposed to confine his attention to the phenomena of magnetization which were exhibited by the strongly magnetic metals Let any one of these metals be submitted to the action of a magnetizing force such as would be produced if an electric current were passed through a coil of insulated wire surrounding the metal As the current was gradually increased, the magnetization passed through three stages It began very gradually, at first, while the current was still weak, there was but little magnetism developed Then a stage came on in which the magnetic state was acquired with great rapidity; a small increase in the current now caused an enormous gain of magnetism Finally, the process passed into a third stage, when the magnetism was again acquired slowly, and however much the magnetizing current was increased it was found to be impossible to force the magnetism to exceed a certain limiting value This was the phenomenon of magnetic saturation Recent researches had given definiteness to the rather vague idea which used to be expressed by this phrase, and it was now known not only that a limit existed, but what its values were in the several magnetic metals The lecturer illustrated the three stages in the magnetizing process by means of the lantern, exhibiting curves which showed the connection between mag-

[1] Abstract of an evening lecture delivered before the British Association, at Edinburgh, August 8, 1892, by J A Ewing, M A, F R S, Professor of Mechanism and Applied Mechanics, Cambridge University

netism and magnetizing force, and pointed out that in special cases the three stages became extraordinarily distinct Curves of the same kind were used to show what happened after a magnetizing force had been applied, if it were withdrawn or varied in any way The magnetism in all cases tended to lag behind when the magnetizing force was varied, and hence these curves in any cyclic process became loops enclosing a certain area It had been proved that this area served to measure the energy expended in carrying the substance through a cyclic magnetizing process, the reason why energy had to be spent being the tendency which the magnetism always had to lag behind the force that was operating to change it To this tendency he had given the name "hysteresis," a term which was already of formidable significance in the ears of practical electricians For the existence of hysteresis was the chief reason why the transformers which were used in alternate current systems of electrical distribution absorbed wastefully a considerable amount of power The iron core of a transformer was being carried through a cycle of magnetization from a positive to a negative value and Weber postulated an arbitrary directing force, which tended to hold them in their original direction The lecturer proceeded to show by means of experiments conducted on the projecting table of the lantern, and shown on a large scale on the screen, that no arbitrary directing force was necessary The mutual actions of the molecular magnets on one another supplied all the control that was required It accounted completely for the three stages of the magnetizing process and for all the phenomena of hysteresis It accounted also for the effects which were found to be produced by mechanical vibration and mechanical strain Experiments were made exhibiting the breaking up of molecular groups, bound together by their mutual forces, under the influence of a gradually increased external directing force In these experiments models were used, consisting of a number of small magnets, pivoted like compass needles on fixed centres, and arranged on the horizontal table of a large projecting lantern A pair of coils placed one on either side of the group supplied deflecting force, and as the current in these was gradually increased the three stages of the magnetizing

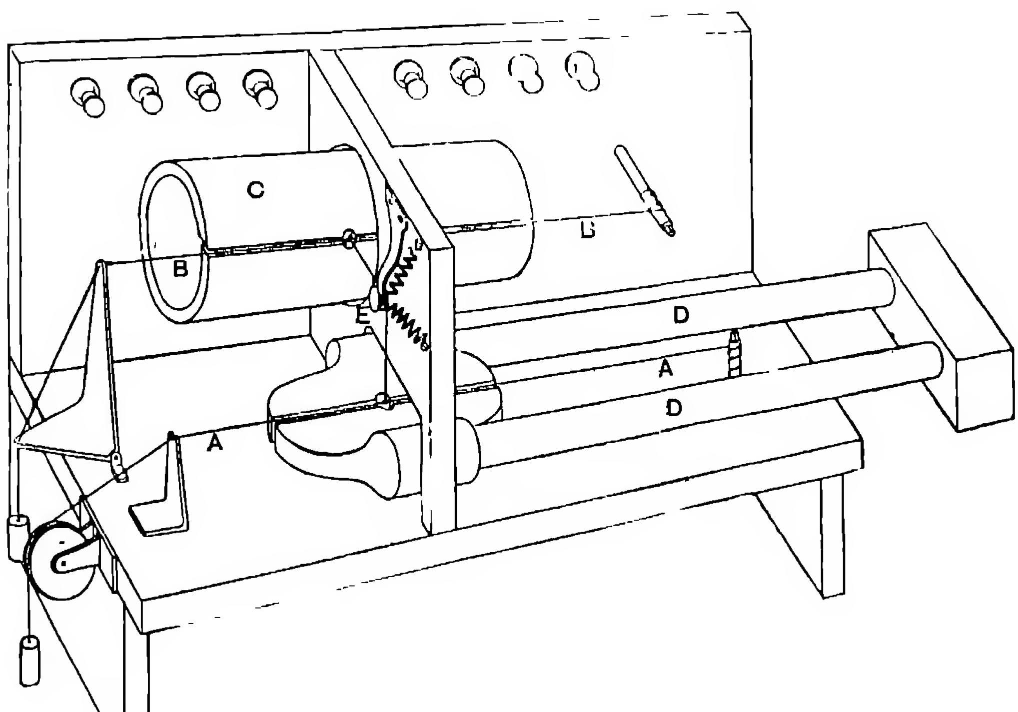


FIG 1 —Prof Ewing's Magnetic Curve Tracer General view of apparatus

back again some 80 or 100 or 120 times a second, and every one of these periodic reversals of magnetism implied a waste of energy, which went on even when no useful current was being drawn off It was a question of considerable practical interest, whether the amount of work wasted on the iron of a transformer was the same per cycle at high speeds of reversal such as were usual in practice, as it was in the slow speed laboratory experiments, by the help of which these cyclic curves had been drawn

The lecturer proceeded to give some account of molecular theories which had been framed to account for the characteristics of the magnetizing process It was suggested, originally by Weber, that the molecules of iron are always little magnets, and that when the iron, as a whole, is not magnetized, it is because as many of the molecular magnets are facing one way as another According to this view the process of magnetization consists in turning the molecular magnets round, so that they face, more or less, one way When a very strong magnetising force is applied, the molecules are forced all to face one way, the piece is then saturated To explain why they did not at once turn round completely when any magnetizing force was applied, process and the phenomena of hysteresis exhibited themselves in the manner in which rearrangement of the elementary magnets composing the group took place In some of the models the magnets turned under water, so that their vibrations were rapidly damped out Slides were also shown which gave some of the results of observations recently made in the lecturer's laboratory by Miss Klaassen, of Newnham College, which demonstrated an extraordinarily close agreement between the phenomena noticed in the magnetization of actual iron and those presented by a model consisting of groups of little pivoted magnets Even the less conspicuous features of the actual process were reproduced in the model with a fidelity which went far to confirm this molecular theory of magnetism It was shown, for instance, that the model reproduces a phenomenon familiar in real iron, namely, the tendency which magnetic changes exhibit to be imperfectly cyclic, under cyclic changes of magnetic force, until these are repeated several times, and also that in the model, just as in real iron, this tendency disappears if a process of demagnetizing by reversals of gradually diminishing magnetic force has been previously gone through

The lecturer proceeded to show in action a novel apparatus he had devised to exhibit the magnetizing process in actual iron, and to test the magnetic qualities of metals This magnetic curve tracer (Fig 1) consists of two wires—AA and BB—tightly stretched in two narrow gaps in the magnets DD and C respectively The magnet C consists of a piece of slotted iron tube, which is kept constantly magnetized Consequently, when a variable current passes along the wire BB that wire sags out or in, giving azimuthal movement to a mirror F The variable current which passes through the wire B serves to magnetize the electromagnet DD, which consists of two bars of the iron to be tested, sunk into fixed pole pieces and united at the back end by a short yoke-piece of soft iron When the magnetism of DD varies it causes the wire AA, which carries a *constant* current, to sag up and down, and this gives movement in altitude to the mirror E The mirror is pivoted on a single needle point, and has freedom to respond to the motion of both the stretched wires AA and BB Since its azimuth movement is proportional to the magnetizing current, and its altitude movement is proportional to the magnetism acquired by DD, the mirror causes a spot of light reflected from it to trace out the ordinary magnetization curve, showing the relation of magnetism to magnetizing force By making the variable current change continuously from a positive to an equal negative value and back again, a complete cycle of magnetization was performed in the bars DD, and in this way the magnetic characteristics of the bars could be completely determined in a few seconds The lecturer proceeded to test in succession a pair of wrought-iron bars, then a pair of hard steel bars, and finally a pair of cast iron bars, causing the cyclic curve for each material to be automatically drawn on the screen, on a very large scale, to exhibit the features of difference The mirror and other moving parts of the apparatus were so dead beat that it was possible to go through a cycle ten or even twenty times a second without experiencing inconvenience from the effects of inertia. In that case, however, the iron must be laminated to avoid sluggishness in the magnetizing process itself Using an instrument with a magnet consisting of a split ring of iron wire, a process of periodic reversal was performed at a speed sufficient to make the curve traced out by the light spot become a continuously luminous line (Fig 2), and the process

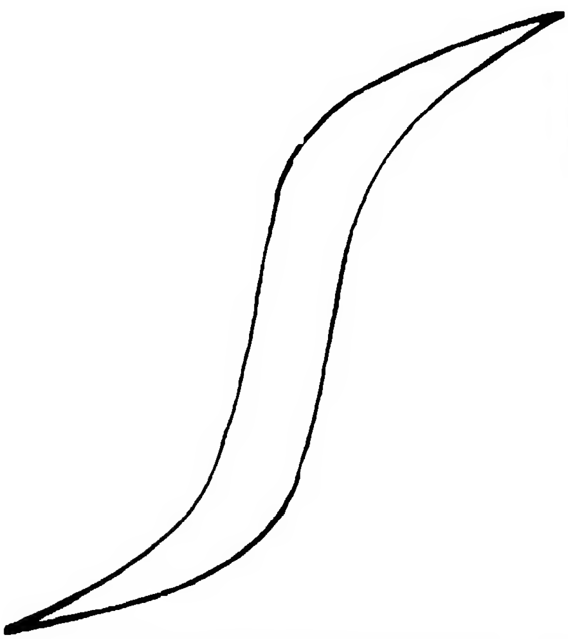


FIG 2—Photograph of Magnetization Curve traced by Prof Ewing's Magnetic Tester

of demagnetizing by reversals was illustrated by making this curve gradually contract itself to zero by slowly reducing the strength of the current while the rapid periodic reversals were continued. The effect was also shown of superposing one periodic alternation upon another, by which loops resembling those of Fig 3 were drawn The lecturer pointed out that these experiments went some way towards answering the question whether the magnetizing process went on in the same way, and involved the same dissipation of energy through hysteresis, at

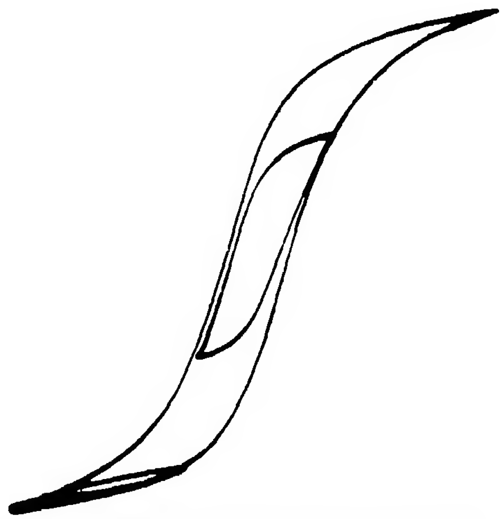


FIG 3 Photograph of Magnetization Curve with Loops

high speeds as at low speeds He concluded by expressing the hope that this apparatus would prove of some service to the builders of dynamos and transformers by giving them a novel means of testing the magnetic properties of their iron with great completeness and in a manner sufficiently simple for workshop use

BOTANICAL PAPERS AT THE BRITISH ASSOCIATION

IN our account of the proceedings of Section D of the British Association (NATURE, August 25, p 403), we promised to refer on a later occasion to some botanical papers which could not then be noticed The following are abstracts of several of the more important of these papers —

"Observations on Secondary Tissues in Monocotyledons," by Dr. Scott and Mr Brebner (1) The secondary tracheides in Dracæna and Yucca develop simply by the enormous growth in length of single cells, the nuclei remaining undivided, and not by cell fusion, as many authors suppose (2) The cambium in the roots of many species of Dracæna does not appear in the pericycle, but in the cortex outside the endodermis The secondary growth starts from the insertion of a rootlet, the cambium being pericyclic near, and cortical at a greater distance from, the rootlet (3) Description of secondary thickening in Iridaceæ

"On the Simplest Form of Moss," by Professor Goebel The author stated that previous researches had led him to the conclusion that mosses and ferns did not stand in direct genetic relationship with each other, but that they are descended from simple alga-like forms, in fact the mosses pass through a developmental stage so alga-like in appearance that it was formerly described as an algal genus *Protonema* If the sexual organs of the moss arose not on the stem but on the protonema, we should have the sexual generation agreeing perfectly with the filamentous algæ The leaves of the moss would then arise originally as protective organs for the antheridia and archegonia. This, up to the present, hypothetical form, actually occurs in Buxbaumia. In this moss the antheridia occur at the end of a protonema-branch, surrounded by a mussel-shaped envelope The female plant is more highly organised, but is still much simpler than in other mosses. These and other observations lead Prof. Goebel to the conclusion that Buxbaumia is a very ancient form which stands in the closest relation to the lower algæ.

"On the cause of Physiological Action at a Distance," by Prof L Errera (Brussels) The author referred to Elfving's observation, that sporangium bearing filaments of *Phycomyces nitens* are attracted by iron, zinc, aluminium, and various organic substances, such attractions not being due to gravitation, light, moisture or contact, but to physiological action at a distance, as Elfving terms it

The author has made numerous experiments which tend to show that the attraction is really hydrotropic, the filaments being attracted by hygroscopic and repelled by non hygroscopic substances, for example —

Any modification of iron which lessens its capacity of rusting at the same time diminishes its attraction on Phycomyces thus, polished steel scarcely attracts, and nickled steel does not do so at all

China clay, which is very hygroscopic, attracts energetically, while china exhibits no attraction These experiments succeed also in a saturated atmosphere, which shows that hydrotropism is not due, as generally supposed, to differences in the hygrometric state of the air

"Notes on the Morphology of the spore bearing members in the Vascular Cryptogams," by Prof F O Bower The author explained by the help of a large series of diagrams his views already laid before the Royal Society, as to the homology of the fertile frond of Ophioglossum with the sporangium of Lycopodium In support of the probability that the former may have been derived from some such type as the latter, by a process of partial sterilization of the sporogenous tissues, he adduced facts relating to Isoetes and Lepidodendron, both of which show a sterilization of parts of the potential sporogenous tissue in the form of trabeculæ in the sporangium

Mr C J Druery sent in a communication, which was read and remarked upon by Prof Bower It related to a new example of apospory found in a young fern seedling, of which the second frond bore upon its margin a number of prothalloid growths The occurrence of aposporous development at so early a stage in the development of the sporophyte had not hitherto been recorded

"On the arrangement of buds in Lemna Minor," by Miss Nina F Layard The object of a series of observations made on budding duckweeds, was to ascertain whether any fixed rule is followed, both in the arrangement and order of production of the buds

Prof F Schmitz read a paper on tubercles on the thallus of *Cystoclonium purpurascens* and other red seaweeds The tubercles are constantly inhabited by bacteria, and appear to arise in consequence of infection by these organisms

"Calamostachys Binneyana, Schimp," by T Hick The object of the paper is to revise and extend our knowledge of the structure of this fossil fruit in the light of a number of preparations which have not been previously described The central part of the axis, formerly described by Carruthers and Williamson as vascular, the author finds to be cellular, thus removing the chief ground for Williamson's reference of the spike to the Lycopodiaceæ Round the cellular pith there are (usually) three primary vascular bundles, which are reduced to the condition of those met with in *Equisetum*, and the young shoots of *Calamites*, *i e* to as many carinal canals with annular and spiral vessels adhering to the margin

As to the affinities, the conclusion arrived at is that the fruit is that of some form of *Calamites*—as Carruthers maintained long ago—and perhaps that of the type known as *Arthropitys*

"Myeloxylon from the Millstone Grit and Coal-Measures," by Mr A C Seward Specimens of Myeloxylon (Brong), [Stenzelia (Gopp), Myelopteris (Ren)] were described from a limestone of Millstone Grit age in North Lancashire, their minute structure being fairly well preserved, and showing collateral bundles, gum canals (?), and the hypodermal tissues characteristic of the genus A much more perfect example from the Binney collection was referred to, of coal-measure age, in which not only the xylem but also the phloem elements had been mineralised in an unusual state of perfection

It was pointed out that in the Binney specimen the position of the Protoxylem on the Phloem side of the bundles was clearly shown both in transverse and longitudinal sections The affinities of Myeloxylon with Cycads and Ferns were briefly discussed, and the conclusion arrived at that this extinct genus, although differing in certain particulars both from Cycads and Ferns, should be placed much nearer the former than the latter

SCIENTIFIC SERIALS

THE *American Meteorological Journal* for September contains the conclusion of "Objections to Faye's Theory of Cyclones," by W C Moore Only a few of the more essential characteristics of cyclonic storms have been considered, but from these the author concludes that it is evident that the generally accepted theory of convectional motion gives a more satisfactory explanation of the various phenomena than the theory advanced by M Faye —"Changes of Plane of the Mississippi River," by Prof T Russell The author analyses a report by Colonel C R Suter, of the Mississippi River Commission relating to the improvement of the river and methods of preventing overflow —"Thunderstorms in New England during the Year 1887," by R de C Ward The difficulty of predicting thunderstorms is shown by the fact that in New England in 1887 the majority of storms occurred in the south eastern quadrant of cyclones, while in the previous year the majority occurred in the southern or south-western quadrant Only 40 per cent of the summer thunderstorms of 1887 occurred in the southern part of cyclonic storms, while in the previous year the number was 70 per cent —"Weather Forecasting at the Signal Office, June 30, 1891," by Prof H A Hazen At this date the weather service was transferred to the Agricultural Department, and the author has given the results of his experience by laying down certain fundamental rules which would be of service to a beginner in the work, as it has sometimes been suggested that it would be almost impossible for a forecaster to impart his knowledge to another —"The Effect of Topography upon Thunderstorms," by R S Tarr The author's observations have led him to believe that topography has a decided effect upon the path of thunderstorms when they are beginning When, however, the storm has assumed more than local proportions, topography has in all probability very little effect upon its motion

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Sept 26 —M Duchartre in the chair —On the white rainbow, by M Mascart A new mathematical treatment of the subject shows that the diameter of drops giving the most perfect achromatism is 29 17μ With drops of 30μ the rainbow will appear the whiter, the more the apparent diameter of the sun hides the excess of blue intermediate between the achromatised points, as well as all the supernumerary arcs, by the superposition of several systems of fringes, so that there is only left an exterior border slightly tinged with red The same will apply to drops slightly different in one sense or the other, but the achromatism persists longer if the diameter diminishes The observation of clouds and fogs has shown that the diameter of the drops varies from 6 to 100μ, the last beginning to fall as rain Thus the circumstances favouring the production of white rainbows are of very frequent occurrence —Places of origin or emergence of the great cholera epidemics, and particularly of the pandemic of 1846–49, by M J D Tholozan From Dr Arnott's communications to the Physico medical Society of Bombay, from the documents of the Medical Committee of Bengal, and from the testimony of Ferrier, who was travelling in Afghanistan at the time, it is evident that the cholera epidemic which invaded Europe and America in 1847, 1848, and 1849 originated in Bokhara, whence it spread to Afghanistan and India, as well as westward Bokhara, Samarkand, Balkh, and Kunduz were attacked at the end of the summer of 1844, Herat and Kabul in October, Jellalabad at the beginning, and Peshawur at the end of November In the following summer the epidemic proceeded steadily eastwards into the "endemic area," reaching Jhelum and Lahore in May, 1845, Meerut in August, and Delhi and Agra in October, at the same time passing down the Indus to Kurrachee, and westwards to Meshhed, whence it proceeded in 1846 to Asterabad, Teheran, Recht, and Baku A similar example of an eastward progress of cholera occurred in 1865, when the great epidemic of Mecca, after having invaded Mesopotamia and Transcaucasia, spread to Teheran, and took the easterly route by Khorassan The writer expresses his firm conviction that the points of emergence of the choleraic epidemics must be considered as their points of origin. The idea that the different pandemic manifestations of cholera which

have depopulated Europe must have invariably come direct from India is no longer tenable For Europe alone, two striking examples, in 1852 and 1869 respectively, have formally demolished the theories which regarded only things coming from the East as bearing any danger of contamination The epidemic of 1852 came from within Poland and Germany That of 1869 73 repeated the same things in Ukraine Nowadays, when these facts have taken their place in science, some minds seek to diminish their importance by pointing out that these epidemics revived some previous epidemics which had their origin in India But that which makes the spreading epidemic or the pandemic is the revival of the choleraic principle or germ with all its original attributes Even in India similar revivals perpetuate the annual endemic, and the epidemics which appear every three, four, or five years. This is the main fact which governs the entire history of cholera, and upon which micro biological research must proceed What difference of morphology, of virulence, or of reproductive faculty is there between the germs of the epidemics which die out at their origin, and those of the epidemics which revive several times, and can invade the whole world without proceeding from India?—Application of a conventional system of rectangular co ordinates to the triangulation of the coasts of Corsica, by M Hatt The trigonometrical network drawn for the hydrographic mapping of the coasts of Corsica describes a closed curve The employment of the conventional system, which transforms into rectangular plane co ordinates the polar co-ordinates reckoned on the sphere round an origin, offers numerous advantages The suppression of the sphericity permits the application of processes of calculation which have been dealt with in a preceding communication on rectangular co ordinates On this account it was interesting to test on a larger scale the methods which had only been utilised for the determination of secondary points The experiment has given satisfactory results, and exhibits the practical advantages of the new system of co ordinates and the methods of calculation K being the length of the geodetic line joining a point to the origin, and Z the angle made by this line with a fixed direction, the conventional co ordinates are $x = K \sin Z$ and $y = K \cos Z$ These assumptions permit the rapid and easy calculation of tables of corrections —On a new hydro carbon, suberene, by M W Markovnikoff —Action of piperidine and pyridine on the haloid salts of cadmium, by M Leopold Hugo

Sydney

Royal Society of New South Wales, June 1 —General Meeting —Prof Warren, President, in the chair —The following papers were read —Oceanic philology, by Sidney H Ray, a determination of the magnetic elements at the Physical Laboratory, University of Sydney, by S Coleridge Farr, on certain geometrical operations, by G Fleuri, analyses of the well, spring, mineral, and Artesian waters of New South Wales, and their probable value for irrigation and other purposes, by John C H Mingaye, remarks on the large sunspots visible at the present time, by H C Russell, F.R S

July 5 —Chemical and Geological Section —Prof Liversidge, F R.S, in the chair —The following papers were read —Microscopic structure of some intrusive rocks in the neighbourhood of Sydney, by Rev J Milne Curran, notes on the occurrence of platinum and its associated metals in the Richmond River sands, also in lode material in the Broken Hill district, by John C H Mingaye

July 6 —General meeting Prof Warren, President, in the chair —Paper read —On the ventilation of sewers and drains, by J M Smail

July 15 —Medical Section —Dr Fiaschi in the chair —Paper read —Recent work on the pathology of cancer, by Dr G. E Rennie

August 3 —General Meeting —Prof Warren, President, in the chair —The following papers were read —Flying machine work, and the 1/4 I H P steam motor weighing 3¼ lb, by L Hargrave. The paper described the experimental work carried out by the author during the past twelve months A compressed-air-driven flying-machine (No 16) had no less than twelve trials, on one of which it flew 343 feet, the speed being a little over ten miles per hour On the first trial it was fitted with a bi-plane, which was found to be a very stable form Some curious experiments with a segment of a hollow cylinder were recorded A description was given of a steam engine and boiler for a flying-machine, the total weight of which is 3¼ lb., including fuel and water the indicated horse power developed was 169 Nine detail drawings were shown, including those of an air pump and small-pressure indicator On the venom of the Australian black snake (*Pseudechis porphyriacus*), by C J Martin, Demonstrator of Physiology in the University of Sydney, and J McGarvie Smith

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Books —Euclid, Books 1 and 2 D Brent (Percival) —Book B or Arithmetical Chemistry, Part 2, new edition C J Woodward (Simpkin) —Tenth Annual Report of the Fishery Board for Scotland Part 3, Scientific Investigations (Edinburgh) Survey of India Department, General Report 1890-91 (Calcutta).—Observations made at the Hong-Kong Observatory in the Year 1891 W Doberck (Hong Kong).—Geological Survey Department, Ottawa, Annual Report new series, vol 4 (Ottawa Dawson) Gemeinverstandliche Vorträge aus dem Gebiete der Physik Dr L Sohncke (Jena Fischer) —The Student's Manual of Deductive Logic K R Bose (Calcutta Lahiri) —Lightning Conductors and Lightning Guards Dr O J Lodge (Whittaker) —Horn Measurements and Weights of the Great Game of the World R Ward (The Author Piccadilly) —The Universal Atlas Part 19 (Cassell) Imperial University of Japan Calendars for Years 1890 91 and 1891 92 (Tokyō, Maruya) —London Inter Sc and Prelim Sc Directory, No 3 July 1892 (London, University Correspondence College) —London Inter Arts Directory No 5 July 1892 (London University Correspondence College) —A Treatise on Analytical Statics, vol ii Dr E J Routh (Cambridge University Press) —Annual Report of the Department of Mines and Agriculture N S W 1891 (Sydney, Porter) —The Birds of Lancashire 2nd edition F S Mitchell (Gurney and Jackson) Odorographia, a Natural History of Raw Materials and Drugs used in the Perfume Industry J Ch Sawer (Gurney and Jackson) —A Text book of Agricultural Entomology 2nd edition E A Ormerod (Simpkin). Beneath Helvellyn's Shade S Barber (E Stock) —Borneo, its Geology and Mineral Resources Dr T Posewitz translated by Dr F H Hatch (Stanford) —How to make Common Things J A Bower (S P C K) —A Short Manual of Inorganic Chemistry Drs A Dupré and H W Hake (Griffin) —A Text book of Coal Mining H W Hughes (Griffin)

Pamphlets —L'Automobile e la Filosofia Naturale e Sperimentale Note ed Osservazioni G Cassola (Napoli, Gargiulo) Epidemic Pneumonia at Scotter and Neighbourhood F H F Emmison (Kimpton) —Contagious Foot Rot in Sheep Prof G T Brown (Murray)

Serials Proceedings of the Liverpool Geological Society Part 4, vol vi (Liverpool) —Natural Science, October (Macmillan) —Traité Encyc de Photographie premier suppl A troisième fascicule C Fabre (Paris, Gauthier Villars) —Journal of the Royal Agricultural Society of England vol iii Part 3 (Murray)

CONTENTS

THURSDAY, OCTOBER 13, 1892

VIVISECTION AT THE CHURCH CONGRESS.

THE attitude of the Church towards science at the present day shows a healthy spirit of tolerance It fully recognizes that research in physical science is the very embodiment of the seeking after truth, and that the proper exercise of faith is consonant with an attitude of expectancy This year, however, has seen an attempt, led by Bishop Barry, to disturb this harmony and to create an exception, namely, in the case of scientific research in Biology, whether of normal structure as physiology, or of abnormal, as pathology At the Church Congress last week the following was referred for open discussion at the instigation of Bishop Barry, who, however, wished, it is stated, to have had a much more sweeping theme presented —

"Do the interests of mankind require experiments on living animals, and, if so, up to what point are they justified?"

There was here presented to the Congress the twofold aspect of the question—utilitarian and moral—the obvious desire of the Subjects Committee being that they should thus have laid before them on these two points the evidence of the usefulness of scientific experiments on living tissues, and the evidence that such research is consonant with morality.

To all scientific men, even if not biologists, there is no need of evidence that experiments on living tissues are necessary to the progress of physiology and pathology As Mr. Horsley showed in his speech, this position is *a priori* established, since the processes of life are chemical and physical in nature, and can only therefore be advanced by experimental observation whether in the laboratory or by the bedside It seems, by the way, to have escaped the notice of all the speakers that every new clinical fact is as much the outcome of "experimental" observation as any note made in a laboratory We would lay stress on this since not only do some dignitaries in the Church but even a few medical men seem to think that clinical discoveries are the result of inspiration, and not the outcome of trying this or that modification of factors and noting the subsequent effects. However, if the Church Congress wanted facts they were supplied in overwhelming degree, and not only facts on the utilitarian side but also many—some unexpected to judge by the excitement produced—on the moral condition of anti-vivisectionists and their beliefs. Putting aside for a moment the utilitarian side of the question, it is doubtful whether the moral responsibility of anti-vivisectionists has ever been more freely exposed to view After Dr. Wilks had revealed the inconsistency of the agitators and their free use of animals (without anæsthetics) for their own ends, Mr. Horsley probed the consciences of the bishops by pointing out that "it has always been a matter of the utmost surprise to the medical profession that educated men in positions of the gravest moral responsibility like bishops should have in this matter descended to receive the information they require from sources of notoriously tainted character, rather than by seeing for themselves in our University laboratories what scientific experiments are in reality"

It is certainly a very fair question to ask of Bishops Barry and Moorhouse—What right had they to lend their help to any cause, however righteous it may appear to them, unless they have made a *bona-fide* effort to hear both sides? Has Bishop Barry visited the Physiological Laboratory at Oxford, or Bishop Moorhouse that and the Pathological Laboratory at Owens College? And if not, why not? Most especially ought such care to have been exercised in the case of anti-vivisectionism, since the leaders of that party have attacked not merely individuals, but the whole medical profession as "murderers," "torturers," &c, and have accused them of the grossest cruelty and self-seeking The bishops referred to have, it is to be feared, forgotten that their office is a very reverend one, not to be lightly used to help any and every alleged reform, and above all not to be used as a means of unfounded denunciation of what Mr Horsley truly calls an honourable, earnest, and hard-working profession

It is difficult to see on what possible ground Bishop Barry can defend his use of the expressions "arrogance," "physiological insolence," when he applies them, as he has done, to the simple statements of fact which have been formulated into the following resolutions, the first passed at the International Medical Congress of 1881, and the second at the recent meeting of the British Medical Association at Nottingham

(1) "That this Congress records its conviction that experiments on living animals have proved of the utmost service to medicine in the past and are indispensable to its future progress That accordingly, while strongly deprecating the infliction of unnecessary pain, it is of opinion, alike in the interests of man and of animals, that it is not desirable to restrict competent persons in the performance of such experiments"

(2) "That this general meeting of the British Medical Association records its opinion that the results of experiments on living animals have been of inestimable service to man and to the lower animals, and that the continuance and extension of such investigations is essential to the progress of knowledge, the relief of suffering, and the saving of life"

We are glad to see that these unanimous resolutions were read to the Church Congress and appreciated by the audience at their proper value and not according to the estimate of Bishop Barry. Similarly, men of science may not only ask whether Bishop Barry was a moment justified in speaking of physiological research as "cruelty" and "demoralization" while ignorant of the real facts, but they certainly have the right to demand that, should he fail to respond to the challenge offered him by Mr. Horsley, and substantiate his grounds for making these assertions, he should withdraw from the agitation (which has, we suspect, only injured his reputation), and make a free and ample apology.

In the same manner also we would call upon Canon Wilberforce to retreat from the unworthy position into which he has been thrown by the force of feeling uncon-

trolled by reason, and not to make the wrong he has done to science greater by continuing to persist in it regardless of the published demonstration of his error

One curious feature of the whole popular view of the anti-vivisectionist campaign is the general belief in the good faith of Miss Cobbe To men of science her methods have been familiar ever since the commencement of the agitation, and more especially since they were clearly displayed in the published trial of Adams v Coleridge By the general public, however, she was regarded as a fanatic, but trustworthy After this latter-day exposure at Folkestone to which she has been subjected we hope that such credulity has at last seen its end, for by the production of Miss Cobbe's latest book, "The Nine Circles," and by comparing it with the originals of the scientific papers from which her statements were alleged by her to be taken, Mr Horsley had no difficulty in convincing the Congress that her statements of facts can no longer be relied upon

It is an old story that a lie dies hard, but die it does at last, and the proceedings of the Church Congress have greatly accelerated the end

Nothing can do this better than for scientific investigators to patiently instruct the public At the Church Congress this heavy task fell on Dr Ruffer, who by way of answer to the vague rhetoric of the Bishops, piled fact upon actual fact until his audience showed how they welcomed the statements of truth as a counterpoise to Episcopal excommunication

The painful position of medical men who can be found willing to sanction such an agitation was well exhibited by the action of Mr Lawson Tait, who having publicly charged Church Congress officials with excluding him from the meeting, was positively proved to have withdrawn himself, the withdrawal being contained in his letter read to the Congress by the chairman of the Subjects Committee, the Bishop of Dover

Lastly, on the broad question of utility, no member of the Church would, we are sure, feel justified in contravening the view that the general regard shared by all Englishmen, and expressed in the above-mentioned resolution of the International Medical Congress, for the proper, that is, humane, use of animals, is ample surety that whether for the sake of food or pursuit of knowledge, the object is obtained at a minimum cost of pain

The most extraordinary illogicality was displayed on this very point by Bishop Moorhouse, of Manchester, for while declaiming against the killing of animals to gain knowledge, he clamoured for liberty to destroy any number to preserve the volume of his voice

But if we were to speak of the illogicality of the anti-vivisectionists there would be no end, seeing that as they do not or will not learn the truth, they live in a circle of contradictions Suffice it to say, that we believe the open discussion of the subject at the Church Congress will do more than anything to show the public that the feeling exhibited by the anti-vivisectionists is one of unmitigated hostility to science, and not one of genuine anxiety for the humane treatment of animals devoted to the service of man

THE NEW VOLUME OF WEISMANN

Essays on Heredity By Dr A Weismann Authorized Translation Vol II Edited by E B Poulton, F.R.S, and A E Shipley (Oxford Clarendon Press, 1892)

IN this second volume of the new edition of Dr Weismann's essays there are brought together four essays which did not appear in the first edition, they are in a convenient form, well translated, and well printed

Nothing is more curious than the public appreciation of Weismann's essays, for in them is no trim, nicely balanced, carefully elaborated statement of his biological theories The successive essays appear as they were published You have the theories in their making, stretching from essay to essay, alive, contradictory, disjointed This historical method of publication is a thing to delight the student of biology, but, one had thought, a torture to the precisian and caviare to the general, yet the public continue to buy, discuss, and no doubt read his works

In "Retrogressive Development in Nature," Dr Weismann describes cases of vestigial organs or rudimentary functions To explain the occurrence of these, the transmission and accumulation of degenerate characters produced by disuse is unnecessary In every organ, as in every animal, variations occur, in every generation unsuitable variations are weeded out, and so the organ or the animal remains adjusted to its environment, or becomes more perfectly adapted to it But when a change of habit or of environment occurs, as when an eyed animal takes to living in dark caves, or when an animal that has been saving its life by swiftness comes into a region devoid of enemies, the less far-seeing or the less swift are not more quickly killed than their better endowed neighbours So far as sight or swiftness are concerned, a condition of panmixia occurs, and the organs of sight and flight slowly degenerate

The argument in "Thoughts on the Musical Sense in Animals and Men" is subtle, ingenious, and less familiar In insects and birds males are the musicians, and sexual selection is a sufficient explanation, but it is not so in man However, in the mammalia the organ of hearing is remarkably developed In the auditory organ of a rabbit there are structural arrangements for nearly two thousand note sensations, while a concert grand piano contains only eighty-seven different notes For the needs of life, the thousand gradations of sound in the woods and the field, of the hunter and the hunted, the mammalian organ is adapted Music itself is an invention, and from the rude melodies of primitive man to the art of Beethoven and Chopin, it has been progressively developed as the intellectual faculties have been developed

The third essay, "Remarks on certain Problems of the Day," is specially valuable, as in answer to certain criticisms by Prof Vines[1] many doubtful points are explained Specially to be noted is the clear re-statement of Weismann's contention that the nuclear substance is the sole bearer of hereditary tendencies, and the new evidence for it contained in the researches of Boveri and O. Hertwig Equally noteworthy is the admission, in

[1] NATURE, October 24, 1889.

reply to Prof Vines' citation of the parthenogenetic fungi, that not only sexual forms may vary into new species

It is to the last essay, that on "Amphimixis, or the essential Meaning of Conjugation and Sexual Reproduction," that most attention will be directed Here there is a full statement, with important additions and alterations of the central part of Dr Weismann's theories However they may bulk in public imagining, questions of acquired characters, of retrogressive metamorphosis, and so forth, are side issues of a search for the morphological expression of the processes of variation

Originally Weismann explained the two successive divisions of the nucleus of an unfertilized egg which form the two polar bodies as, in the case of the first an extrusion of that nuclear plasm which, having served to guide the maturation of the egg, became useless when the egg was mature, and in the case of the second, as a halving of the nuclear substance to make way for the incoming sperm-plasm

In parthenogenetic ova, one division and only one was predicted and found It was suggested that parallel processes occur in spermatogenesis

Subsequent research by O Hertwig and others has brought to light these parallel processes, and Weismann, seeking for a sign, got rather more than he anticipated For the processes in spermatogenesis show first a doubling of the germ-plasma, and then two successive reducing divisions, and it has been shown that exactly this happens in ova also Accordingly, Weismann rejects his original explanation of the first polar body as an extrusion of ovo-genetic nucleoplasm, and the new problem comes to be, what is the cause of that doubling of the nucleoplasm which in primitive sperm and germ cells precedes the two reducing divisions?

Weismann supposes that the ancestral plasms or units of heredity, to which he gives the name "ids," are arranged in "idants," or nuclear rods The doubling process takes place normally by longitudinal division, and simply doubles the number of idants without altering the arrangement of "ids" By this method the number of possible combinations is increased without alteration of the ids The process is a mechanical one to increase the chances of combinations when the idants of sperm and germ cells meet If the idants were coloured rods, to be arranged in pairs—say black, white, red, and yellow for four sperm idants, and orange, green, blue, and crimson for those of the egg-cell—obviously only four pairs are possible The black would have to unite with one of the four others But if before the arrangement in pairs each rod were split in two, there could be two combinations for black, and so on for the others No doubt in many cases the number of idants is far greater than four, and the mechanical arrangement for variations correspondingly greater From the large number of possible combinations there come the relative few individuals of the next generation, and there is thus a basis for the lawless and apparently capricious appearance of varieties Next in importance comes Dr Weismann's belief, based on theoretical considerations, and supported by experiments on *Cypris*, conducted for seven years, that in parthenogenetic reproduction heritable variations may occur But they are far less frequent than in sexual reproduction. But the whole of this essay is full of intricate and curious speculation, speculation which will have to come before every student of biology, and which, whether much or little of it becomes incorporated in the body of accepted knowledge, will at least play a large part in guiding and stimulating present research P C M

ELEMENTARY CHEMISTRY

The Standard Course of Elementary Chemistry By E J Cox, F C S Pp 344 (London Edward Arnold.)

THIS book consists of five parts, which may be obtained separately or bound up in one volume It is based upon the syllabus prescribed by the Education Department for teaching chemistry as a class or specific subject, and professes to lead the beginner from the "familiar" to the "less known" by means of "investigation," the teaching thus afforded being regarded as a branch of mental education as well as of useful knowledge The five parts deal respectively with the properties of the common gases, the atmosphere, water, carbon and non-metallic elements, and with metallic bodies, combination, symbols and formulæ

The general plan of the book and the manner in which the subject is approached have a good deal to recommend them, the detailed treatment contains, however, much which could be improved, and unfortunately much which the learner will have to forget as he progresses in the study of his science In the opening chapter, evidently for the sake of simplicity, the author uses the term heat in place of temperature More confusion on the subject of heat is made later on by the use of equations, such as

"*Chalk* and *Heat* } yield { *Lime* and *Carbonic Acid Gas*"

which appears to attribute to heat a material existence, and even more unsatisfactory are bald statements to the effect that "no heat is produced in the formation of a mixture Heat is produced in the formation of a chemical compound"

Considerable space is occupied in the comparison of the affinities of the elements Because certain metallic oxides, including iron-oxide, are reduced when heated in a stream of hydrogen, the affinities of the metals for oxygen are said to be weaker than that of hydrogen for oxygen In the case of iron and steam the author has to note that the inverse change—the oxidation of the metal by steam—readily occurs, and that the former statement as to the affinities of iron and hydrogen for oxygen, is apparently contradicted This contradiction might have indicated the futility of attempting to compare affinities in a general way and not with reference to the special conditions under which the experiments were performed The inverse change in the case of iron is said to occur when the "temperature" is favourable, but in reality the active masses of the reacting materials determine the direction of the change

Inaccurate statements are numerous Hydrogen is said to form "one-third part of water by volume," "a formula" is stated to "represent a molecule," and a base is given as "a compound of a metal with hydrogen and

oxygen" More objectionable still are occasional instances of bogus reasoning, the most striking example being an erroneous proof of the conservation of mass On three different occasions the indestructibility of matter is stated to be a consequence of the law of definite proportions Almost equally bewildering is an attempt to show that "a molecule occupies two volumes," an attempt which even when correctly carried out might well be excluded from a book which professes to discourage anything akin to cramming No advance is made in familiarizing the learner with accurate conceptions of atom and molecule, indeed the need for the latter conception in chemical philosophy is quite overlooked

Throughout the book the author's mode of expressing himself is frequently not the happiest To say that "air allows all bodies that will to take fire in it," or that "chlorine does not combine with an excess of hydrogen" is harmless enough perhaps On the other hand to talk of the "properties of a mixture" being the "sum of the properties of its constituents," or of the gas being kept dissolved in a bottle of soda water "by the pressure of the cork," or to say that "water has weight and exerts pressure" cannot but be puzzling to the intelligent reader

To prepare a thoroughly good introduction, of the most elementary kind, to the study of chemistry, is a work of considerable difficulty, indeed it is one which few of our leading chemists seem desirous of undertaking Enough we think has been quoted from the book under notice to show that the author has by far underrated the difficulty of this task

J W R

LIFE AND DEATH

Essai sur la Vie et la Mort Par Armand Sabatier (Paris Babé et Cie)

PROF SABATIER'S "Essai sur la Vie et la Mort" forms the fourth volume of the "Bibliothèque Évolutioniste," a series of books published under the direction of M de Varigny, with the view of expounding in a strictly scientific manner the different principles and the diverse applications of the theory of Evolution The series most appropriately begins with a translation of Wallace's "Darwinism," and it is gratifying to our national pride to find that the two other works which have as yet appeared in the series, Ball's "Treatise on Use and Disuse," and Geddes' and Thomson's "Evolution of Sex," as well as the two others announced as in the press, are all by British authors

The present essay, which extends over 280 pp, is the outcome of a series of lectures delivered at the University of Montpellier It is written in a clear, simple style, devoid for the most part of all technicalities which appeal only to the specialist The problems of life and death are dealt with from an exclusively biological point of view, and questions of morality and theology are hardly touched upon It is difficult to do justice to the views expounded in the book in the short space at our disposal, but an attempt may be made to give a short account of its contents. The first part deals with life the properties of living matter are considered in great detail, and Prof Sabatier endeavours to show that the attributes of life are found to some extent, at any rate, in dead matter According to his views "la matière brute est vivante aussi," but the manifestations are slow and dull To the Professor's mind living matter and dead matter are not absolutely distinct between the two states of matter there is only a difference of degree and not of kind "La vie donc est partout, dans la matière dite inanimée comme dans la matière vivante" The various features in which dead matter behaves like living, are considered at great length, but, curiously enough, no mention is made of Butschli's remarkable experiments on artificial amœbæ, recently described in the "Quarterly Journal of Microscopical Science."

This view being accepted, death in the ordinary sense of the word, naturally cannot exist, and the phenomenon which we usually call death becomes but another form of life—"la vie intense" simply passes into the state of "la vie lente" Immortality, according to our author, consists in the indefinite continuity of life ("la vie intense") without arrest or interruption. Like Weismann, he maintains that the negation or the contrary of such immortality involves the presence of a dead body or corpse. Weismann holds that ciliated infusoria are immortal if kept under favourable conditions, these conditions, of course, including frequent opportunities of conjugating Sabatier considers that such infusoria are only potentially immortal, and that the act of conjugation converts this potentiality into a real immortality In his opinion the primitive protoplasm was immortal, and the habit of dying has been acquired by the higher organisms in response to two stimuli, one internal and one outside themselves The internal cause of death is associated with a tendency innate in the living being to improve its position in the world, in response to which it has become more specialized, and developed new organs and powers This specialization has borne with it the seeds of death The external cause is the surrounding world, which constantly stimulates and promotes the organism to new efforts, and in the struggle for the mastery death is brought about

Although we fail to see that Prof Sabatier has thrown any new light upon the problems he attempts to solve, and although the explanations he advances seem to us inadequate, his book is a useful one, inasmuch as he gives us a careful summary of the numerous views advanced by various writers in the last twenty-five years, on the subject of life and death, and criticises with considerable ability the theories of Weismann, Goette, Minot, &c In fact, his destructive powers seem greater than his constructive.

A. E. S.

OUR BOOK SHELF.

Contagious Foot Rot in Sheep By Prof G. T. Brown, C B, 16 pp, 8 illustrations, (John Murray)

THIS pamphlet is a reprint from the second part of the current volume of the Royal Agricultural Society's Journal A few additional remarks on the prevention of foot rot have been added, and if the instructions given were fully carried out, the disease would soon cease to be troublesome The preventive suggestions are (1) separation from the rest of the flock for one month of all animals newly purchased, and (2) isolation of all animals affected.

In discussing the treatment of the disease, Prof. Brown

insists upon the importance of detecting it at an early stage, and in the first part of the pamphlet he explains how to do this with certainty

The pamphlet ought to be read by everyone interested in agriculture and to make it better known the Society has printed as a leaflet a few notes upon the subject. In America the pamphlet would be sent broadcast amongst those interested, and it is to be hoped that Government assistance may soon enable our own Agricultural Society to disseminate knowledge in a similar way

W T

How to Make Common Things By John A Bower (Society for Promoting Christian Knowledge, 1892)

It would be a strange boy who never wanted "to make something" The present little book has been prepared for boys who feel this desire very strongly, but do not quite know how to set about the fulfilment of their wish They will here find ample information on the best way of making a vast number of things, from a hat-rail to a galvanometer, from a pair of stilts to a needle telegraph The author assumes throughout that those whom he addresses are not being taught by a personal instructor in handicrafts, and that they are not the possessors of an elaborate array of tools His directions are clear and practical, and cannot fail to be appreciated by boys who find much to interest them in the exercise of ingenuity and manual skill

The Student's Manual of Deductive Logic, Theory and Practice By K R Bose, (Calcutta S K Lahari and Co, 1892)

THIS book is intended for the use of students at the various Indian colleges, and will be regarded by most teachers of the subject as, upon the whole, a very good text-book The author has read many of the best European writers on logic, and presents clearly a summary of their results He begins with a definition of logic, gives some account of its "branches and parts," and then considers terms, propositions, and inferences What he himself describes as "the distinguishing feature" of the book is a collection of problems and exercises with solutions, or hints towards solution, in close correspondence with the subject-matter of the text

A Text-Book of Agricultural Entomology By Eleanor A Ormerod Second Edition (London Simpkin, Marshall and Co 1892)

THE first edition of this book was published about eight years ago It consisted of lectures which the author had delivered at the Institute of Agriculture of South Kensington There was not much demand for it until last year, when attention was directed to it by the arrangements of the County Councils for the promotion of agricultural education The work was then so widely appreciated that a new edition was soon called for, and there can be no doubt that in its new form it will be more popular than ever, for Miss Ormerod has done everything in her power to make it not only scientifically accurate but practically useful. Students will find it of great service in helping them to a knowledge of insect life and of the best remedies for "infestations"

LETTERS TO THE EDITOR.

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A Functional Hermaphrodite Ascidian.

As of late years a considerable number of structural hermaphrodites have been shown to be protogynous or protandrous, or to have some special modification for the purpose of preventing self-fertilization, it may be of interest to have on record a case of a completely functional hermaphrodite

I had living lately in one of my dishes a large *Ascidia* (probably *A rubicunda* of Hancock) which I observed one morning to be expelling eggs from the atrial aperture The eggs were emitted in batches of from about twelve to twenty at a time, and immediately after each set of eggs came a little white milky jet which hung like a string in the water for a few seconds and then spread out and disappeared On catching some of this string in a pipette and examining it with the microscope it was seen to be a mass of active spermatozoa This alternating passage of ova and spermatozoa continued for fully an hour

The ova at first floated at the surface of the water for a short time and then slowly sank to the bottom On examining some of those on the bottom of the dish after a couple of hours they were found to have commenced development, being in various stages of segmentation so there can be no doubt that self-fertilization had taken place

Very likely this occurs in some other species also, but another common Ascidian (*Corella parallelogramma*), of which I had had several large specimens living a few weeks before, laid eggs in my dishes, and I could not detect any spermatozoa being produced by these individuals. They were functionally female although structurally hermaphrodite

W A HERDMAN

University College, Liverpool, October 3

The Present Comets

ON the 27th ult about 15½h G M T comet Brooks (c, 1892) had a tail 10' long, pointing at a position-angle of 280°

At the latter part of last month Swift's comet (a, 1892) was still a very conspicuous object in a 4¼ inch refractor Observations on several nights showed that it not only still had a very faint tail—at position angle 260 on the 24th at 8½h, when I observed it to be certainly 11' long, and suspected it to 21'—but that also there was an elongation nearly in the opposite direction, while I believe the radius of the head was less towards *n* than towards *s*, but I have not been able to satisfy myself of this

Sunderland, October 5 T W BACKHOUSE

Women and Musical Instruments

IN looking over a very large collection of musical instruments from the aborigines of America, I am surprised to find that there is not one peculiar to women, and that those of the men are never played by the women It is true that the females beat time on various objects and may now and then use the rattle This disappointing fact arrested my attention, and I am curious to know whether savage women, or any other women for that matter, have ever invented a musical instrument, and whether in savagery they even play upon those invented by the men The composition and singing of songs might also be inquired into, though our American savage women do join in certain choruses OTIS T MASON

Washington, U S A, September 26

Determination of *g* by Means of a Tuning Fork

MR C V BOYS informs me that for the converse process of determining the pitch of a tuning fork, the experiment I described recently is no new one, but has been used by him for the last ten years in the instruction of students in South Kensington I observe, however, that he has not made the same use of the trace to eliminate the zero error A. M WORTHINGTON

THE TOTAL ECLIPSE OF THE SUN, 1893

AS I have been asked by some astronomers to give a description of the general appearance and climate of this part of Chile, in which a total eclipse of the sun occurs next year, I have drawn up for publication the following account —

The eclipse takes place on April 16, 1893, at about 8 15 A.M., Chile local time, and will be seen to the greatest advantage in this part of the Province of Atacama.

At the sea coast the central line of total eclipse passes close to Chañaral 29° S L This is not the better known Chañaral, north of Caldera, but a small place equidistant from Coquimbo and Carrizal Bajo The southern limit of total eclipse is 29° 50' S L just north of Coquimbo, and the northern limit 28° 10', just south of Carrizal Bajo

The band of total phase stretches between these two limits in a north-easterly direction, across the country, from the coast towards the rising sun Along the central line of this band the sun will be hidden by the moon for nearly three minutes The eclipse will be total everywhere within the limits given above, but the total phase will be shorter and shorter the nearer those limits are approached, and outside of them the eclipse will be partial

On the accompanying map of the Carrizal and Cerro Blanco and Copiapo Railway systems I have marked the northern and southern limits, and the central line of totality

It will be seen that the port of Carrizal Bajo, 28 4' S L, is just outside the total band, but the railway connecting it with Yerba Buena intersects the central line of total eclipse 70 miles inland, and a branch to Merceditas, 60 miles inland, at an altitude sufficiently high to be above the damp and hazy atmosphere of the coast At the points of intersection the climate is simply perfect for astronomical observations, and is also, during the month of April, delightful to live in

The accompanying form was filled up, in compliance with a request from Amherst College Observatory, to show the cloud conditions in the inland region during the month of April this year as an indication of what might be expected during the same month next year

Cloud Observations at "Mina Bronces," Chile, 1892

Day	Local time 7 45 a m	8 15 a m	8 45 a m	Remarks
April 10	2	2	2	Clouds were light, allowing a slight shadow to the east Bright sun at intervals
,, 11	2	0	0	Clouds were on the horizon, so that the sun rose above them at 8 o'clock
,, 12	0	0	0	Perfectly clear sky
,, 13	0	0	0	Perfectly clear sky Sun rose at 6 22 a m
,, 14	0	0	0	Sun rose at 6 22 a m
,, 15	0	0	0	Fresh wind Sun rose at 6 23 a m
,, 16	0	0	0	Sun rose at 6 24 a m
,, 17	0	0	0	
,, 18	0	0	0	Slight haze at sunrise Sun rose at 6 25 a m
,, 19	2	0	0	Bank of clouds near north east horizon, which the sun rose above at 8 05
,, 20	0	0	0	Sun rose at 6 26 a m
,, 21	0	0	0	,, ,, 6 27 ,,
,, 22	0	0	0	,, ,, 6 28 ,, Strong wind
,, 23	0	0	0	,, ,, 6 29 ,, ,, ,,
,, 24	0	0	0	
,, 25	0	0	0	
,, 26	0	0	0	
,, 27	4	3	3	Haze thick at 8 15 a m, but light at 8 45 a m
,, 28	0	0	0	Sky got cloudy at midday
,, 29	0	0	0	
,, 30	0	0	0	

KEY

0 = "Sun entirely clear from clouds "
1 = "Clouds generally scattered "
2 = "Clouds massed about the sun "
3 = "Sun in haze or fog "
4 = "Sun invisible in thick clouds "

I had two series of observations made, one at Mina Bronces by Mr Martin, chemist to the works (the results of which are hereto appended), the other at Cerro Blanco by Senor Miranda, at his mine Both reports are in every respect alike The 10th and 27th were cloudy, all the other days absolutely clear As the two stations are some twenty five miles apart, these reports show that there is no local weather, and that it is only when a general atmospheric disturbance, originating in the Cordillera de los Andes, occurs that the weather is affected at these high stations

It will be seen that there was only one day—the 27th—out of twenty-one days of observation on which the sun was not visible at eight o'clock in the morning, for on the other cloudy day—the 10th—the sun was bright at intervals

Observatory Stations

I have marked on the map, along the central line of totality, several stations that I think suitable for observatories, the positions are only approximately correct, for I have no means of determining them accurately, but the errors, if any, cannot be great

Undernoted are heights above sea level of some places shown on the map —

Yerba Buena railway terminus	3867 feet
Cerro Blanco, north hill	10,000 ,,
,, south, Peineta	8000 ,,
Carrizo, in the valley, a small farm	5000 ,,
Merceditas railway station	2900 ,,
Cerro del Jote	6000 ,,
Cerro del Cobre	8000 ,,
Lay observatory	4000 ,,

Cerro de Peineta is part of Cerro Blanco, this Cerro Blanco is not part of the Andes, but a detached hill with low ground all round, and a clear view to the north-east It is easily ascended by pack-mules

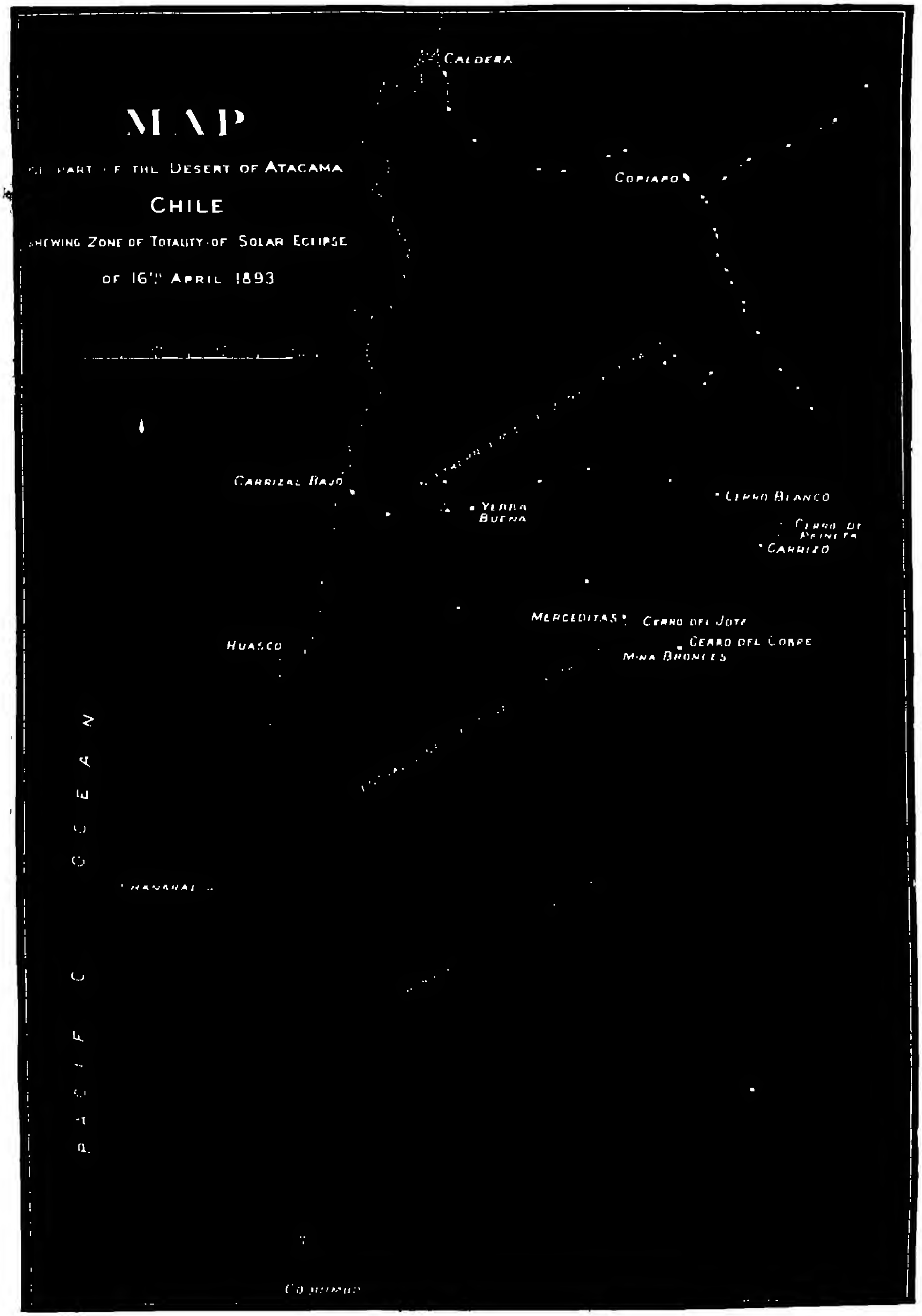
Carrizo is not a hill, but a small farm or large garden, irrigated by a mountain stream The advantages of this station are nearness to the railway, a good road, and plenty of small hills of easy ascent to select from

Cerro del Cobre is a good hill, but probably too far south However, there are hills all the way from Merceditas that might be selected (see Mr Martin's letter)

Serra del Jote, near Merceditas, is accessible to pack-mules half-way up, higher than which it would not be necessary to go Moreover, it is said that the rest of the ascent is difficult The three hills, Cerro de Peineta, Cerro del Cobre, and Cerro del Jote, can all be seen from one another

Lay Observatory On April 15 I went to Merceditas and stayed overnight, as I wished to find near the railway station a hill on which the sun shone at an early hour on the morning of the 16th, through some opening among the surrounding hills, and which would be suitable for ordinary lay observers who had no expensive apparatus, but who wished to see the eclipse well through a smoked or coloured glass To the south of the railway station I found a range of hills eminently suited to the purpose; at a height of 4000 feet above the sea the sun shone over a dent in the Jote at 6 40 a.m The hill is much higher than 4000 feet, but I did not go higher This is an excellent, well-sheltered spot, and would do well as a station for professional astronomers. I went up on horseback in forty minutes, but the ascent, from the railway station, could be easily made on foot in an hour As I could not find any local name for this hill, I called it the Lay Observatory

Climate—At two o'clock in the afternoon of April 15


MAP
of part of the Desert of Atacama
Chile
shewing Zone of Totality of Solar Eclipse
of 16th April 1893
Caldera
Copiapo
Carrizal Bajo
Yerba Buena
Cerro Blanco
Carrizo
Merceditas
Cerro del Jote
Cerro del Cobre
Mina Bronces
Huasco
Pacific Ocean

the temperature at Merceditas was 78° F, this was the hottest time of the day, and it was a warmer day than usual, and at 8 p.m. the temperature was 62° F. Next morning, the 16th, I got up at two o'clock to see the comet then visible, and found the temperature was 58°, at 5 a.m. it was 56°.

Everywhere on the coast of Chile, north of Coquimbo, the sun, in the morning, is almost always obscured by a thick haze which makes the sky of a dull lead colour. This haze is sometimes driven away by the sun during the forenoon, but just as often it remains all day, especially during the months of March, April, and May.

This hazy morning atmosphere extends inland for a distance of about 40 miles and up to an elevation above the sea of about 2500 feet; beyond this distance and height the sky is almost always clear and the air dry. Standing, in the early morning, on a mountain of 3000 to 4000 feet, or higher, you look down on a great white sea of mist covered with whiter ridges like motionless waves, and studded here and there with islands, which are the mountain tops piercing through. This haze is usually gone by nine o'clock, except within about five miles of the sea.

Accommodation on the Hills.—Tents can be quickly and cheaply made with "esteros de totora," that is mats made of reeds. All the more temporary houses of miners and prospectors and of railway track repairers are made of these mats, which are seven feet square, and may be rolled up and carried from place to place. They form an article of commerce, and cost eighteen-pence each, or from eighty to ninety cents of Chile paper currency. During all the month of April and part of May it is quite safe to trust to this kind of tent, but not later than the middle of May, for rain or snow sometimes falls in the end of that month.

There are no venomous reptiles in Chile, nor are there mosquitoes on these hills, and fleas cannot live at an altitude of 4000 feet—no slight advantage.

Rain.—On the Chilian side of the Andes, in the province of Atacama, rain generally falls twice in the year: the first rain is expected in June, the next in July, each rain usually lasting two days, and always accompanied with wind from the north. As soon as the wind changes to its prevailing quarter, the south, there is beautifully clear but cold weather. From two to three inches of rain fall in the year, but sometimes less than one inch. On Cerro Blanco it usually freezes every night from July till the end of August, and some snow lies on the mountain till September. On the hillsides there are plenty of bushes and small trees for firewood, and excellent water is found in all the higher valleys.

I have heard one objection to this district for observing the eclipse, which is, that as the eclipse takes place in the morning, and the sun is not high in the sky, it would be better to go farther east. This objection has no weight, on account of the extreme dryness of the atmosphere. At the mines on Cerro Blanco and the other hills everything gets dried up; Huasco raisins grow hard and rattle on one's plate like nuts; agricultural produce, such as wheat, beans, and barley, brought from Southern Chile as food for man and beast at the mines, loses two per cent. of its weight every month for several months, office ink bottles have to be kept tightly corked or the ink very soon dries up, chairs and tables fall to pieces, veneer peels off, and a piano soon loses its tone. The sky is dark blue, and the sun rises white and dazzling without a trace of any other colour. The hills, the rocks, and the bushes cast dark shadows, and even every pebble the size of a hazel nut casts its shadow, so that in the early morning the gravelly ground seems half wetted with a shower; one side of every pebble is in bright light, the opposite in deep shadow.

Although the eclipse would be the object of greatest interest to visitors, a few weeks might be profitably spent among the copper mines, and if any one wished to become a mine owner, plenty of mines are to be had for the asking. All the mines belong to the State. You have only to take up a mine, pay a nominal licence to the Government annually, and the mine is yours as long as you pay the licence. There are no royalties, no surface rents, and no export duties. The next thing to do is to make the mine pay, and this is sometimes done.

There is no sport in April, but after snow falls on the Cordillera, huanacos and immense flights of turtle-doves come down to feed on the lower slopes. Life, however, is never wanting. The region from Cerro Blanco southward as far as Coquimbo is the home of the fur chinchilla. It feeds on the nut of the carbon tree, *Cordia decandra* (Hook. et Arn.), and on the pea of the algarrobillo, *Balsamocarpon brevifolium* (Clos). This bush, which produces the tannin pod of commerce, thrives best far inland, on sunny, almost rainless slopes, but it must have one shower in June or July, otherwise it bears no fruit. If there be no rain for three or four years—as sometimes happens—the bushes do not die—they just wait. The same thing happens with all the other bushes; sometimes, for several successive years, they are without leaves, and though the soil seems as dry as dust, whenever rain comes they show themselves full of life.

British astronomers—professional and amateur—ought not to lose the opportunity of observing under such favourable circumstances this great eclipse. I doubt if better conditions were ever offered before. The distance to come is long, but the expense is not very great, and can be exactly counted beforehand. An expedition might leave Liverpool in February, by Straits of Magellan steamer, and be home again in June. Or, after the eclipse, go by steamer to San Francisco or Vancouver, and thence by rail to the World's Fair at Chicago, and instead of encountering hardship and danger in some unhealthy climate, have a pleasant trip all the way.

Though horses and mules can be got here, every one should bring a saddle and bridle.

In conclusion I would impress on the members of every expedition that may come out, the importance of selecting, as observing stations, places at a distance of at least 60 or 70 miles from the sea. On the other hand, the advantages of going farther inland are doubtful, and as the railways go no farther, travelling would be more difficult.

JOHN KING,

British Vice-Consul, Carrizal Bajo, and Engineer of the Carrizal and Cerro Blanco Railway.

Carrizal Bajo, Province of Atacama, Chile,
May 1892.

(COPY OF MR. MARTIN'S LETTER.)

Mina Bronces, Jarilla, May 2, 1892.

DEAR SIR,—I have now the pleasure of enclosing the form which you sent to be filled up. As I did not receive your letter till April 9, I could not of course fill in the first nine days, but as you will see by the observations that as the last twenty days have been almost invariably clear, I think the astronomers could safely decide to come here as far as clearness of sky is concerned.

An observatory could very easily be placed on one of the spurs of the Cerro del Cobre, to the south of the latter. It is easily accessible to mules with 250 pounds and affords an uninterrupted view of the sunrise.

Hoping that the filling up of the form will be found to fulfil all requirements. I remain, dear sir,

Yours sincerely,
(Signed) WILLIAM M. MARTIN.

John King, Esq., Carrizal Bajo.

DR MODIGLIANI'S RECENT EXPLORATIONS IN CENTRAL SUMATRA AND ENGANO

LITTLE more than two years ago, writing in this journal on the results of Dr Elio Modigliani's accurate and highly interesting exploration of Nias (NATURE, vol xli p 587), I made the remark that our young traveller had shown that he was made of the stuff of the very best of scientific explorers It is therefore with no small pleasure and pardonable satisfaction that I now have the good fortune to show further proofs that I was not mistaken in thus judging him

Those who have once tasted the sweets of true exploration in little-known lands, and who are animated by the smallest spark of *fuoco sacro*, have felt and know well that thirst for further travels which goads the late traveller to new wanderings It was thus with my friend Modigliani, and he had hardly finished seeing his book on Nias through the press, when he began to long to be away again He first thought of taking off the edge of his peregrinatory desire with a visit and collecting tour to the less-known parts of our new "Eritrea," but an accident, which might have had serious consequences, kept him back on the eve of departure On regaining his health, far from being discouraged, he matured a wider and bolder plan—that of returning to the vast and lovely lands of the Malayans, and penetrating to the heart of Sumatra through the country of the Toba Battaks

Dr Modigliani left Florence in August 1890 Early in October he was at Siboga, then at Padang Sidempuan, in Sumatra, where he interviewed Mr van Hasselt, well known in connection with the big Midden Sumatra exploration ,' however, as the sequel proved, not much information and aid were got from Mr van Hasselt and his Government , besides, war was going on in the Toba region, but this did not deter Modigliani from his object He had secured the services of Abdul Kerim, the Persian collector and taxidermist, who had been with Marquis G Doria from 1862 to 1874, first in Persia, then in Borneo and Tunis, and finally at the Museo Civico at Genoa, which, under Doria's energetic and enlightened direction, has, during the last twenty-five years, been one of the most active and fertile centres of zoological research in the world This was fortunate, for the Javanese hunters and collectors engaged at Buitenzorg were not very efficient

Although he included in his baggage only things that were strictly necessary, he had to engage at Siboga forty-one carriers, mostly Toba Battaks, to convey it to the lake That route, hardly practicable twenty years ago, is now safe, and the only trouble met with was from Dutch convicts engaged in repairing the road It was on this road, at Ayer Kotti, that the American missionaries, Messrs Munson and Lyman, not many years ago, were killed and eaten by the Battaks of the neighbouring village, Huta Sakkak. The country rises continually from the coast until the highlands of the Toba plateau are reached , it is undulated with mountains and broad valleys, such as that of Silindung, but on the highlands the forests have disappeared, and the watered depressions with dense vegetation and the clumps of bamboos surrounding the villages are dotted about At Tarutung, the principal village of Silindung, Modigliani obtained important information on the independent Battaks from Mr Welsink, the Dutch Assistant-Resident, who had long resided in the Battak country, and been some time *Controleur* at Laguboti on Lake Toba, now occupied by the Dutch The Singa Manga Rajah, head chief and religious primate of the Battaks, who had already given so much trouble to the Dutch, was again coming to the front, and this time in connection with the irrepressible Atchinese from the north—an alliance of hereditary foes, for the Battaks have always repulsed the Mohammedan Malays against the invading whites

By the middle of October 1890, Modigliani was at Balige on the shore of Lake Toba, and on the edge of the wild and unexplored Battak country, the land of his dreams He describes the lake as grand and imposing, but more like a northern lake, such as Loch Lomond, because of its bleak bare mountains and early mists, than what might have been expected in the heart of a tropical island Lake Toba is about forty four geographical miles in length , a large mountainous peninsula divides it in two —Tao Silalahe on the north, and Tao Balige on the south At Balige Modigliani had the use of a good house, once occupied by Mr Welsink. He paid an early visit to the *Controleur*, Mr van Dijk, at Laguboti, who placed at his disposal the Government boat with its crew, but requested to be informed of any excursion on the lake beforehand, as some of the lacustrine villages were hostile Modigliani started for a first exploration of Lake Toba on October 27 An old chieftain, Ompu Rajah Doli, went with him, partly as guide, partly as protector He was on his *solu*, the long swift canoe, excavated from a single tree, with which the piratical enterprises on the lake are so deftly performed , this, not one of the largest, was 18 metres long and 1 metre in width , it was manned by eighteen paddlers and one steersman The place of honour is at the prow, which is singularly ornamented. At Ade Ade, one of the further villages, he secured the good will of the powerful chief, Ompu Rajah Hutsa, and with him visited

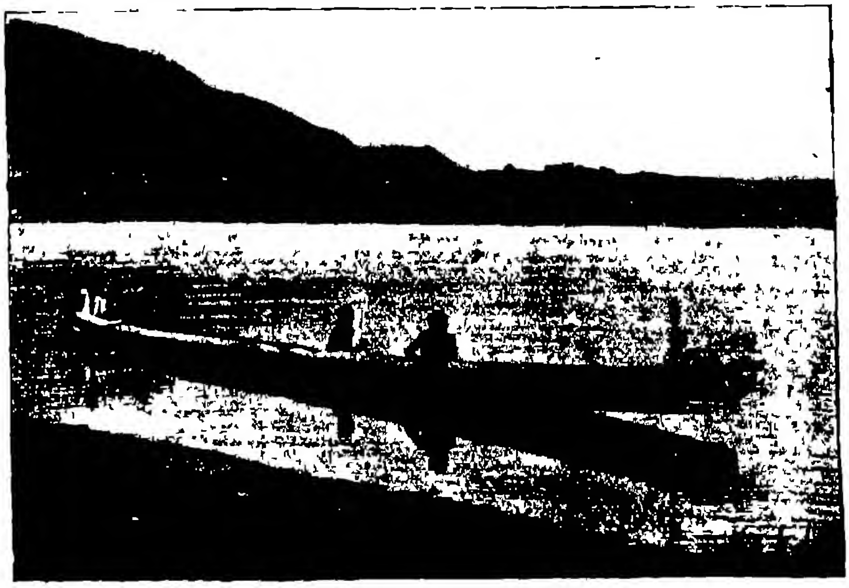


FIG 1—*Solu* (boat) on Lake Toba

the site of Lumban Rajah, the former residence of the Singa Manga Rajah, destroyed by the Dutch. The chiefs and head men of several neighbouring villages had assembled, and many were the questions they put to Modigliani. Amongst others, they asked him who was his Rajah. "The Rajah Roma" said he. This caused a great discussion, after which one of the chiefs said: "How is it that we, having sent to Rajah Rom (not Roma) presents of horses and buffaloes, have never received a return or an answer?" Modigliani was at first rather embarrassed at so direct a question, but replied that the presents had not been received, having perhaps been intercepted. This appeared to convince them, and a Rajah Uti was mentioned as apparently the guilty party. I have mentioned this episode because it turned out to be a most fortunate

Fig. 2.—The *guru* Samalain.

one for our traveller, who got to be known as the envoy of Rajah Rom, and even as that mystic personage himself. It appears that by that name a venerated authority is known to the Battaks, and Modigliani thinks it may be no less a personage than the Hindu god Rama. As the sequel will show, under the patronage of Rajah Rom, Modigliani was able to penetrate into the heart of the independent Battak country, where, in all probability, no other European would have been able to go; and many were the things he had to promise in Rajah Rom's name, and many the presents and great the aid he got as his envoy. The greatest depth found by Modigliani in Lake Toba was 450 metres; the temperature of the water was 24° to 23° C. at the surface, and 23° to 22° C. near the bottom. Only four species of fish, two of molluscs and two of crustaceans, appear to live in the lake.

As a locality better suited for zoological collections, Modigliani went in November to live in the forest of Si Rambe, where, at an elevation of about 1370 metres, he built himself a log hut. Here the maximum day temperature ranged from 28° to 30° C., the minimum night temperature from 12° to 13° C.

It was from his hermitage in Si Rambe that Modigliani, eluding the official impedimenta, started on his adventurous and bold journey across Sumatra, right through the country of the independent and hostile Battaks. Now his supposed connection with the legendary Rajah Rom did him a right good turn; for the yet more or less independent chiefs sought him out, hoping that through his influence Rajah Rom might be induced to redress their wrongs. Amongst these was a *guru*, one of their priests, wise men, and *literati*, named Samalain, a staunch friend of the Singa Manga Rajah, who not only visited Modigliani but undertook to guide and protect him in his exploration of the (by Europeans) untrodden Battak territory. In one of his letters to Marquis Doria, Modigliani gives a vivid description of the savage energy of *guru* Samalain, of his devotion to the Singa Manga Rajah, and of his love of independence. The *guru* sent seven of his devoted followers to act as carriers, and taking one of his Javanese hunters and his interpreter, Si-gu-tala, a Battak, Modigliani left his encampment in the forest of Si Rambe at midnight on December 19, 1890. The utmost caution was necessary to cross the frontier line without being discovered by the colonial authorities. After a forced march of ten hours, the *guru* having joined him on the way, Modigliani reached the village of Lumban Bulu, well within the territory of the independent Battaks. The village chiefs, with armed retainers, and those of some neighbouring villages, all fully armed and equipped, with spears, flint-lock muskets plated with silver and ornamented with ribbons, and their peculiar swords with heavy ivory handles, accompanied and surrounded him. His reception was far from friendly. They would not believe that he was not a Dutch emissary, and spoke of sending him back; even the energetic protestations of the *guru* Samalain were received with signs of doubt. At this juncture our traveller had a happy thought, and drawing from a pocket the flag of Italy, he suddenly displayed it, exclaiming: "This is the flag my Rajah gave me; see, it is different from that of the Dutch; but when it is unfurled Debata (God) is present—you must rise and uncover your heads." The difference was at once noted, and Puttua, the chief who had shown himself most hostile, turned to Modigliani and said, "*Tabi, rajahnami*" ("Hail, my chief"). The others joined, and then two fowls and a pipe were brought to our traveller, and orders given to prepare the *sirih* of welcome and friendship. This is done with special ingredients, the absence of any of which would do away with the sincerity of the offering.

Modigliani was thus allowed to enter the independent Battak country. The next day he resumed his journey towards the east coast. He had to pay for passing a bridge. The Battaks know well the value of money, and use the Spanish dollar divided into 480 *doits* of copper, bearing the date 1804, the British arms, and the inscription "Island of Sumatra" (or the same inscription in Arabic), or else simply a fowl.

Amongst the many interesting things he saw, heard, and learnt, special mention must be made of the magnificent waterfall formed by the emissary of Lake Toba. Modigliani had some difficulty in visiting it, for it is the reputed abode of powerful spirits, or *sombaon*. It is, he says, grand beyond description; all the rivers of the region join the emissary of the lake in the fall, the native name of which is Martua Sapuran Si-arimo: the result is the River Assahan, which flows into the Eastern Sea near Tangion Balei. This is an important geographical discovery, and our friend may well be proud of it. He succeeded in taking a magnificent photographic view of

the principal cascade Two Battak villages, Tanga and Suanan, are on each side of the fall Modigliani managed to visit both, though hostile to each other, as he learnt, on account of cannibal feats recently committed reciprocally, thus cannibalism is not yet extinct amongst the Battaks In this trip Modigliani went as far as Bandar Pulo, near the east coast, but not wishing to get into difficulties with the *Controleur* at Tangiong Balei, he turned back towards Toba, taking this time a new route up the valley of the Qualu or Kuwalu River

The return journey was adventurous, and more than once Modigliani and his small party were in imminent danger A war expedition of the Dutch had recently been this way, and the depredations and looting of the so-called friendly chiefs and their followers had left behind visible traces, and a burning sense of hate and vengeance against the *sordado* of the Cumponi (Dutch), although nothing can be said against the conduct of the Dutch colonial troops It required all the energetic persuasions of *guru* Samalain and all the calm courage of Modigliani to avoid hostilities At the village of Si Buttua, well fortified and in a commanding position, as most are, admittance was gained with difficulty, and matters went worse at the village of Lumban Ballic, where, however, finally Modigliani, as Rajah Rom, was treated with high honours and a dance His last station was at Hite Tano, the native village of his man Si-gu-tala Here, after some delay and hesitation, he was treated with friendliness, and to celebrate the return of Si gu-tala a buffalo was killed, a very grand feast in the Battak country A good tramp of fourteen hours took Modigliani from Hite Tano back to his log hut in the forest of Si Rambe He had been away a little more than a month

Of course, this adventurous trip of Modigliani amongst the independent Battaks got known, the Dutch authorities informed him that he would be expelled if he attempted again to cross into the Battak country, and he found that all his movements were watched and reported by the native police (*opas*) He therefore decided to return to Siboga, where he was on March 14, 1891 He remained there collecting and taking notes until the first days of April, when he proceeded to Bencoolen

The Geographical Society of Batavia had invited him to explore the island of Engano, and a Government steamer was to convey him there Modigliani had accepted with delight; but, after waiting some time in vain at Bencoolen for the promised steamer, he decided to start on his own account, and did so, engaging the *prahu* of a Chinaman.

Engano, the furthermost of the interesting islands which guard the western coast of Sumatra, has up to the present date been all but a *terra incognita*. Crawfurd, in his admirable "Dictionary of the Indian Archipelago," gives scant and partly erroneous information on Engano; whilst Vivien de St. Martin, generally so accurate, in his great "Geographical Dictionary," now being issued, says very little, and tells us that the natives are Negritos! And yet Rosenberg visited and explored the island not many years ago Modigliani, during his stay of over two months, made a thorough exploration of Engano, and of the ways and customs of its natives, and it is indeed fortunate that he went there and gathered such rich ethnological and anthropological materials, for the natives of Engano are rapidly dying out, like those of other savage islands Ten years ago they were about 8000, now, by the last reckoning of the Dutch Agent, they are reduced to 840!

The natives of this island certainly belong to the great

FIG 3—Battak chief and his wife

Malayan family On looking over the photographic portraits taken by Dr Modigliani, I was forcibly reminded of the Nicobarese, and Modigliani agreed with me on examining the fine series of photographs of natives of the Nicobar Islands in my collection, which I owe to the kindness of my friend, Mr E H Man, Deputy Commissioner of the Andaman and Nicobar Islands, and well known for his exhaustive anthropological researches in those two interesting groups.

Modigliani remained in Engano from April 25 to July 13, 1891 His health, which had hitherto resisted many

and various sore trials, was at last injured by the pestilential miasmatic emanations of the mangrove swamps of Engano, and he came away just in time to save his life At the end of July he embarked at Batavia, and by the end of August we had the pleasure of welcoming him back to Florence

He has already given brief accounts of his exploration of the Toba country in letters and in two lectures recently delivered at Rome and Florence He is now busy working out his ethnological materials, those pertaining to zoology have already been partly examined by specialists The principal novelties in zoology are, as was to be expected, from Engano Amongst those already published I recall the following —Birds *Graucalus enganensis*, *Pericrocotus modiglianii*, *Zosterops incerta*, *Geocichla leucolæma*, *Calornis enganensis*, *Gracula enganensis*, *Carpophaga œnothorax*, and *Macropygia cinnamomea*, are new species from Engano, recently described by Count Salvadori, besides, Modigliani has established the hitherto unknown habitat of a lovely Parroquet (*Palæornis modesta*) Reptiles *Draco modiglianii*, *Lycosoma relictum*, and *Coluber enganensis* are new species recently described by Dr Vinciguerra, also from Engano

On the anthropological and ethnological materials collected by Dr Modigliani on this voyage, which are many and of great interest, I intend writing a special report, which will be published elsewhere I will therefore, in concluding this communication, merely draw attention to their scientific value, mentioning the more important series

Amongst the Toba Battaks, Modigliani was not successful in obtaining human skulls, but, with the help of *guru* Samalain, he was able to take with rare ability and perfection a magnificent series of plaster masks of the face from life, both of men and women He has made, besides, a splendid collection of photographs illustrating the people and their habits A most extensive and perfect series of actual specimens and carefully constructed models made on the spot illustrate completely the houses, *sopos*, and boats, with their ornaments, the agricultural implements, house furniture, dress and personal ornaments, food and stimulants, with the utensils pertaining thereto, work-tools, and weapons offensive and defensive, religion and superstitions, witchcraft and literature The carvings on the houses, and the patterns of the textile fabrics of the Toba Battaks, are indeed remarkable as specimens of the finest style of ornamentation Amongst the numerous series illustrating the crude religion and manifold superstitions of this singular people, I may mention the carved wooden figures, with movable arms and a square hole in the chest, in which is the sacred relic (*pangulubalang*) or talisman containing part of the remains of a sacrificed child, these figures, of which Modigliani has collected quite a number, are as rudely made as the *karwars* of North-west New Guinea Of the remarkable magic staffs, called generically *tungal pagñaluan*, but which appear to have individual names, Modigliani has secured seven, they consist of superposed figures, more or less conventionalized, but beautifully carved in a hard dark wood in most cases, in which the human figure and those of the elephant, buffalo, lizard, and serpent are variously entwined Modigliani thinks that each of these staffs symbolizes the history of the village or clan to which it belongs, in which case they might be compared to the genealogical Maori staffs, like the one recording the history of the Ngatirangi tribe, now in the British Museum. As samples of the little-known literature of the Battaks, Modigliani was fortunate enough to secure twenty of their books, now rare They are ancient-looking tomes of various sizes, bound in wooden boards, the leaves are of beaten bark, the writing minute, mystic figures (*hatiha*) being occasionally intercalated These books, written by learned *gurus*, are of a sacred, medicinal, and encyclopædic nature, and much very valuable information on the Battaks will certainly be gained by their translation

At Engano, Modigliani was able to obtain three skulls, and took six excellent plaster casts from the living His series of photographs is also fine, but unfortunately some of the best were spoiled by the heat I have already noted the remarkable resemblance which the natives of Engano show with those of the Nicobar Islands There are amongst them faces which also recall Polynesian and especially Micronesian types Thus the photographs taken by my friend, over a hundred,

Fig. 4.—Battak gentleman

are of great ethnological value The collections illustrating the ethnography of the Engano islanders are, I should say, complete besides beautiful models of the singular houses and canoes, and actual specimens of the ornamented portions, viz doors, cross seats, &c, the mourning and ceremonial dresses and ornaments, house utensils, weapons, &c, are represented by a great number of carefully selected specimens

In conclusion, I can only say that Dr Modigliani has done much excellent work, and that we may look forward with pleasure to the publication of the results of his investigations, both in zoology and in anthropology

Henry H Giglioli

A MODERN REVIVAL OF PROUT'S HYPOTHESIS[1]

It frequently happens in the history of science that the line of thought engendered by one branch of study proves applicable in a totally distinct field In accordance with this principle a great stimulus is occasionally given in some particular line of research by the encroach-

[1] "On the Origin of Elementary Substances and on some New Relations of their Atomic Weights." By Henry Wilde, F R S (London: Kegan Paul, Trench, Trübner, and Co, 1892.)

ment of an investigator who brings the vitalizing ideas derived from his own work to bear upon a new subject It was with some such notions as these that we were predisposed to welcome Mr Wilde's attempt to deal with the greatest of all the problems presented by modern chemistry, but a careful consideration of the author's views has, we regret to say, left us in a state of disappointment for reasons which we will endeavour to explain to the readers of NATURE.

The work under consideration is a quarto pamphlet of eighteen pages and a folding table giving the author's and other arrangements of the chemical elements It consists of a preface dated May 1892, and a paper reprinted with additional notes from the Memoirs of the Manchester Literary and Philosophical Society for 1883 and 1887, the results having been first made known in the Proceedings of the same Society for April, 1878 The preface and paper are followed by translations of the same into French Everything emanating from a recognized authority in a distinct department of science is worthy of consideration by chemists, and there are scattered throughout the work many statements which we cannot but endorse There are, moreover, a few suggestions here and there which might be fruitful, and although the general result is disappointing, it is opportune that the author should have restated his hypothesis at a time when all chemists have more or less assimilated the views of Newlands, Mendeléef, Lothar Meyer, and their followers It may be stated at the outset that Mr Wilde's theory has nothing to do with an electrical origin of the elements as his reputation as an electrician might at first lead us to imagine

In very brief terms the author's theory is that the elements have been evolved from hydrogen by a process of nebular condensation In so far as he regards the elements as polymerides (as we might now express it) of hydrogen, there is nothing new in the idea It is Prout's hypothesis pure and simple We are far from asserting that this hypothesis has been disproved, there is a fascinating simplicity about it—it is so much in harmony with the general course of nature that matter should have been evolved from some primordial stuff that we should like it to be true, but unfortunately the most exact determinations of atomic weights have in later times not always conformed to the requirements of the hypothesis Mr Wilde in effect, if not in words, says *tant pis pour les faits!* These numbers ought to be whole multiples of the atomic weight of hydrogen, and Mr Wilde unhesitatingly makes them so. In some cases the discrepancy between the observed atomic weights and those calculated from the theory is so great—apart from the doubling or other manipulation of some of the old numbers —that this alone will damage his case in the eyes of those who know the scrupulous care taken and the variety of methods resorted to in order to secure purity of material in such determinations We give a few examples —

	Accepted Atomic Weight	Calculated		Accepted Atomic Weight	Calculated
Cu	63 18	62	Cr	52 45	54
Be	9 08	8	W	183 6	186
Sc	43 97	42	Si	28 2	35
Ga	69 9	96	Ni	58 6	56
Y	88 9	123	Co	58 6	56
In	113 6	150	Ir	192 5	196
Ta	182	185	Os	191 12	196

A large number of atomic weights not given above differ by one unit from the experimental results, in fact, more than half the existing determinations are in the light of the present theory erroneous to a most humiliating extent

We are not bigoted in our faith respecting the unassailable accuracy of the determinations of these constants; we all know the enormous difficulties which meet the chemist in his attempts to obtain his compounds in a state of purity. In one part of his paper the author suggests "that slight differences in the determinations may arise from the latent affinity which some elements have for minute quantities of another,' which is a reasonable supposition in its way, although not very happily expressed But later he somewhat inconsistently remarks "that these discrepancies are due to some unknown cause which prevents their [*i e* Cu, Zn, &c] true atomic weights from being ascertained'

From a purely philosophical standpoint the author's proposed emendations of the atomic weights are perfectly legitimate If it can be satisfactorily proved that these constants are the numerical consequences of some general law requiring that the relative combining weights referred to hydrogen should be whole numbers, it is correct to conclude that our determinations are, through experimental error, difficulty of separation, &c, faulty That some such law exists has been surmised again and again, but unfortunately the proof has not yet been found Now the central idea of Mr Wilde's paper is that there is an analogy between Bode's law of the planetary distances and the numerical relationships between the atomic weights, and he even attempts to show that this analogy is the result of a causal connection between the phenomena This is the most important suggestion in the work, as the whole novelty centres in this idea, and the subsequent acceptance of his views will turn upon the strength of his case in demonstrating these two points first, that Bode's "law" is the expression of a physical reality, and, secondly, that the numerical relations between the atomic weights are the physical expressions of a causal connection between the distances of the planets and the condensation of the primordial matter (? hydrogen)

The first point is purely astronomical, and we prefer to let astronomers speak on the subject Prof Simon Newcomb says ("Popular Astronomy") —

It is true that many ingenious people employ themselves from time to time in working out numerical relations between the distances of the planets, their masses, their times of rotation, and so on, and will probably continue to do so, because the number of such relations which can be made to come somewhere near to exact numbers is very great This, however, does not indicate any law of nature If we take forty or fifty numbers of any kind—say the years in which a few persons were born, their ages in years, months, and days at some particular event in their lives, the numbers of the houses in which they lived, and so on—we should find as many curious relations among the numbers as have ever been found among those of the planetary system.

The author thus gets but little support from astronomy and it is to be observed that in the list of planetary distances which he gives he stops short at Uranus, Neptune occupies an awkward position for Bode's "law" The flight which is taken in connecting this "law" with the atomic weights is, however, a bold one and worthy of being given in the author's own words After stating the nebular hypothesis he says —

That this gaseous or primordial substance consisted of a chaotic mixture of the sixty-five elements known to chemists is a notion too absurd to be entertained by any one possessing the faculty of philosophic thinking, as the regular gradation of properties observable in certain series of elements clearly shows that elementary species are not eternal, but have a history, which it is the proper object of physical science to unfold

With this we most cordially agree, and as the same idea has been repeatedly expressed by chemists and physicists, we do not imagine that it is likely to be controverted Then he continues.—

One of the principal facts which, to my mind, establishes the nebular theory of the formation of planetary systems on a firm basis is Bode's empirical law of the distances of the members of the solar system from each other and from the central body, as in this law is comprehended the idea of nebular condensation in definite proportions Now, if elementary species were created from a homogeneous substance possessing a

capacity for change in definite proportions, it is probable that the greater number of elements would be formed during or after the transition of the nebular matter from the annular to the spheroidal form. Moreover, as great cosmic transitions are not made *per saltum*, it might be expected that some modification of the law of nebular condensation into planetary systems, as exhibited in Bode's law, would be found on the further condensation of the primitive matter into elementary species.

There appears to be a flaw in this chain of reasoning which weakens the whole paragraph. It is difficult to see how a law, which the author himself describes as "empirical," can establish a theory on a "firm basis." We admit that an empirical law may be of use—Bode's law is a case in point—but surely it must pass beyond the stage of empiricism before it can establish anything on a firm basis. The astronomical foundation having therefore been shown to be insecure, or, in the opinion of astronomers, even non-existent, it remains next to consider the second point, with respect to which we shall let the author speak for himself:—

One objection raised against the theory which I have propounded on the origin and compound nature of the elements I will remark upon, is an alleged want of causal connection between the series of planetary distances and a series of atomic weights. Now, considering that specific gravities and atomic weights are admittedly correlated properties of the elements, and that specific gravities are fundamentally correlated with the dimensional properties of space, it follows that planetary condensations within interplanetary space are correlated directly with atomic condensations and atomic weights within that space. Hence the law that every increase of atomic weight, in a well-defined odd or even series of elements, is attended by an increase of specific gravity, is a natural consequence of the theory.

This is quoted from the preface; the mechanism of the process is described in the paper as follows:—

In the present hypothesis it is assumed:—(1) That a mass of hydrogen, of a curvilinear form, acquired a motion of rotation about a central point, which caused it to take a spiral or convolute form. (2) As each successive spiral or convulution was formed, the particles of hydrogen combined with themselves, as far as the septenary combination, to constitute the type of each series of elements—the number of types or series being equal to the number of convolutions of the rotating gas. According to this view, the elementary groups may be represented as forms of Hn, H2n, H3n, H4n, H5n, H6n, H7n; the internal convolutions forming the highest type, H7n, and the outer convolution the type Hn. (3) That on a further condensation of the elementary matter a transition from the spiral to the annular form occurred, during or after which the series under each type was generated in concentric zones and in the order of their atomic weights, until the highest member of each species was formed. (4) That as the elementary vapours begin to condense, or assume the liquid form, their regular stratification would be disturbed by eruptions of the imprisoned vapours from the interior of the rotating mass. The disturbance would be further augmented by the subsequent combination of the negative with the positive elements, and also by the various solubilities of their newly-formed compounds; so that the evidence of such stratification of the elementary vapours as I have indicated must necessarily be more fragmentary than that of the geological record.

In support of this last statement the author mentions the well-known association of allied elements in minerals.

The idea of an evolution of matter by a process of nebular condensation as above set forth is to be found under various forms in the writings of Herbert Spencer, of Sterry Hunt, Lockyer, and others. Also, it may be remarked in passing, that the hypothesis of stratification in the order of density was applied to the sun by Johnstone Stoney about the year 1867. In fact the general notion of elementary evolution is so obvious that it cannot fail to present itself again and again to those who think over such problems as are here dealt with. For the sake of chemical philosophy we only wish that this speculation could be placed on a firmer basis of observation or experiment—if for no other reason in order that the minds of chemists might be cleared of this inorganic *Urschleim* in which since the time of Prout they have been compelled to wallow.

Reduced to its ultimate terms it will appear, then, that Mr Wilde's view is a combination of the nebular with Prout's hypothesis, the latter being stated with a precision and boldness which certainly goes beyond any utterance on this subject to be met with in chemical literature since the time of its promulgation. Although the author takes hydrogen as the first stage in his evolutional series he admits, with Prout, that this element "may have been evolved from an ethereal substance of much greater tenuity." Under the seven stages of condensation comprised from Hn to H7n the author arranges all the chemical elements in a tabular form leaving gaps for unknown elements, and correcting the atomic weights where necessary so as to make them accord with the hypothesis. Some of the results of this treatment have already been alluded to. The way in which Bode's method is applied will be understood by taking one example, viz. the first series, Hn:—

0	0		7		Li	−	7
1	23	−	0	=	Na	−	23
2	23	−	7	−	K		39
3	23	−	7	=	Cu	=	62
4	23	−	7	=	Rb	=	85
5	23	−	7	-	Ag	−	108
6	23	−	7	=	Cs	−	131
7	23	−	7	=		=	154
8	23	−	7	−	-	=	177
9	23	−	7	−	Hg		200

The rule of construction is: multiply the atomic weight of the second member (Na = 23 in the above) by the arithmetical series and subtract the atomic weight of the first member (Li = 7 in the above) from the products; the results are the atomic weights of the elements of the series. This method is applied also to the group H2n with tolerable success, *provided the atomic weights are modified to even numbers and that the atomic weight of beryllium is made 8*. Mr Wilde's second group is given below:—

Be, 8; Mg, 24; Ca, 40; Zn, 64; Sr, 88; Cd, 112; Ba, 136; *x*, 160; *x*, 184; Pb, 208.

This is presumably one of the new relations between the atomic weights referred to in the title of the paper. In the third group, however (H3n), very considerable modifications of the atomic weights have to be made, as will be seen from the author's results:—

C, 12; Al, 27; Sc, 42*; Ce, 69*; Ga, 96*; Y, 123*; In, 150*; Er, 177*; Tl, 204; Th, 231.

The six numbers marked with an asterisk stand for 44, 92 or 141, 70, 61·7 or 89·5, 75·6 or 113·4, and 170·6 respectively. A system which necessitates this amount of manipulation of experimental results will certainly fail to commend itself for adoption by chemists. The proposed change of beryllium from 9·2 to 8 is directly opposed by the determination of the vapour density of the chloride by Nilson and Pettersson, and if adopted would cause this element to become still more divergent from the law of Dulong and Petit. The vapour density of indium chloride as determined by Nilson and Pettersson is in accordance with the accepted atomic weight of that element and opposed to that given by Mr Wilde. The elements associated in the first and second groups respectively, may be allowed to pass as natural allies, but the separation of carbon from its analogues, silicon, titanium, &c., and its association in the third group with aluminium, scandium, gallium, &c., is a violation of known relationships. The four halogens according to their atomic weights belong to the author's first (Hn) group. They are regarded as the negative analogues of the alkaline metals and are therefore placed in a separate column.

in such a way as to bring out the relation that there is a constant difference of 4 between each halogen and its positive analogue —

Na, 23 − 4 = 19, F, K, 39 − 4 = 35, Cl, Rb, 85 − 4 = 81 Br, Cs, 131 − 4 = 127, I

In a similar way the oxygen group is made into a negative column having positive analogues in the H2n group and showing a constant difference of 8 —

Mg, 24 − 8 = 16, O; Ca, 40 − 8 = 32 S, Sr, 88 − 8 = 80, Se, Ba, 136 − 8 = 128, Te

Of course chemists have long been familiar with various numerical relationships between groups of allied elements, but this does not appear as sufficient evidence for altering the atomic weights of Br, Cl and Se, unless these relationships can be conclusively shown to be the necessary result of a general law

But apart from such defects as have been pointed out, it will be seen that the proposed grouping breaks down altogether after the third group The author is hardly fair when he says (Preface, p iv) —"While the multiple relations subsisting among the atomic weights of the other series of elements are highly interesting, they do not possess, in the present state of our knowledge, that degree of precision which is the distinguishing feature of the series Hn and H2n An exception might, however, be made in favour of the series H3n, &c"

As a matter of fact it is not a question of "degree of precision" at all, for, as far as we can see, the other groups do not lend themselves to the Bodeian method, at any rate, not in the form applied to the groups Hn, H2n, and H3n We give the author's results as compared with those obtained by the application of his own method —

Group H4n.

x = 16, x = 32, Ti = 48, Ge = 72, Zr = 92, Sn = 116, La = 140, x = 164, D = 188, U = 240

The numbers obtained by the rule (1, 2, 3, 4, &c × 32, and 16 subtracted from each product) are 32, 48, 80, 112, 144, 176, 208, 240, &c, which, after Titanium, do not represent any atomic weights in the group till Uranium is reached

Group H5n

B = 10, P = 30, V = 50, As = 75, Nb = 95, Sb = 120, x = 140, x = 165, Ta = 185, Bi = 210

Calculated (1, 2, 3, 4, &c × 30 and 10 subtracted from each product) the numbers are —30, 50, 80, 110, 140, 170, &c

Group H6n

x = 18, x = 36, Cr = 54, Mo = 96, x = 144, W = 186

Calculated (1, 2, 3, 4, &c × 36 and 18 subtracted from each product) the numbers are —36, 54, 90, 198, &c.

Group H7n

N = 14; Si = 35; [Fe = 56, Mn = 56, Ni = 56, Co = 56], [Pd = 105, Rh = 105; Ru = 105, Da = 105], [Au = 196, Pt = 196, Ir = 196, Os = 196]

Calculated (1, 2, 3, 4, &c., × 35 and 14 subtracted from each product) the results are —35, 56, 91, 126, 161, and 196

The association of nitrogen with silicon and the metals of the iron and platinum groups is, to say the least of it, incomprehensible. We have thought it desirable to give this analysis, for no reason is given in the paper for this particular grouping after the third series, beyond the well-known chemical relationships of the elements which, as we have seen, is sometimes violated in a most unaccountable way. The groups are obviously not constructed by the Bodeian method, the atomic weights are modified in many cases by one or two units, and the result is a classification which differs only from the received classification on points which cannot possibly be conceded by chemists The reason why silicon is separated from its analogues is as follows —

Now, if silicon were the true analogue of titanium, the oxides of these elements should be isomorphous, whereas the crystalline form of quartz is hexagonal, while rutile, anatase, brookite, zirconia, and tinstone (similar oxides of members of the series H4n) are tetragonal, consequently, silicon does not belong to the series H4n

This is a point, and out of justice to the author we give it for what it is worth,[1] but the atomic weight of silicon has been determined by the vapour density of its chloride, and the result is fatal to Mr Wilde's classification His attempt to justify the atomic weight 35 by an appeal to the specific heat is unfortunate, because he takes the old determination by Regnault (0 176) instead of the more recent determination by Weber (0 203 at 230° C) Moreover, he is inconsistent in not allowing the same correction for boron and the other elements which deviate from Dulong and Petit's law

We cannot go much further into the details of this paper Enough has been written to justify the disappointment which we expressed at the outset, and it is only the intrinsic importance of all questions bearing upon the origin of the elements that has warranted such extended treatment It appears that the numerical relations which are brought out by the author's method have either long been known or else—as in his application of the Bodeian method—they do not exist beyond a limited number of groups The results do not take us beyond the point at which chemists were left by Dobereiner, Pettenkofer, Dumas, and numerous other chemists who, for three-quarters of a century, have directed attention to such numerical relationships. In some respects—such, for example, as in the exactness with which the atomic weight of an element is the arithmetical mean of the elements above and below it in the same series—Mr Wilde's numbers express the relationship more closely than those of any other author, but this agreement is simply brought about by forcing the atomic weights into the requirements of the case. The increase in density as the odd and even series are ascended, is nothing more than an imperfect way of stating the well-known relationship between atomic weight and atomic volume, which is so much better shown by Lothar Meyer's curves The table of elements presented by Mr Wilde ignores that fundamental principle of periodicity or recurrence of properties which is the key-note of Mendeléeff's system, and which has led to the general adoption of that system by chemists We do not pretend that Mendeléeff's classification is faultless, the illustrious founder of the Periodic Law would be the first to admit that his system has certain imperfections Mr Wilde has emphasized a few of these in his preface, and he somewhat summarily dismisses the whole scheme in the following words —

From the numerous discrepancies which present themselves in the classification of the elements when arranged in the regular order of their atomic weights, it will be obvious that the idea of recurring properties or periodic functions, in terms of the vertical series of Newlands or the horizontal series of Mendeléeff, has no more relation to chemical science than the law of the increase of population, or the laws of variation and inheritance in organic species.

This paragraph, penned in the present year, will, perhaps better than any other statement that could be reproduced from the paper, enable chemists to form a correct estimate of the value of the work and of the author's qualifications for dealing with the question of the origin of the chemical elements.

R. MELDOLA.

[1] "Stannic and titanic oxides resemble silica both physically and chemically they might be expected to form analogous compounds, and be isomorphous with silica, as Marignac (1859) found actually to be the case" Mendeléeff's "Principles of Chemistry," vol ii p. 95.

NOTES

BY the death of Lord Tennyson not only does England lose one of her noblest sons, but the world loses the Poet who, above all others who have ever lived, combined the love and knowledge of Nature with the unceasing study of the causes of things and of Nature's laws. When from this point of view we compare him with his forerunners, Dante is the only one it is needful to name; but although Dante's knowledge was well abreast of his time, he lacked the fulness of Tennyson, for the reason that in his day science was restricted within narrow limits. It is right and fitting that the highest poetry should be associated with the highest knowledge, and in the study of science, as Tennyson has shown us, we have one of the necessary bases of the fullest poetry—a poetry which appeals at the same time to the deepest emotions and the highest and broadest intellects of mankind. Tennyson, in short, has shown that science and poetry, so far from being antagonistic, must for ever advance side by side. We are glad to know that the Royal Society, of which Lord Tennyson has been for many years a Fellow, was fittingly represented at his funeral by its President and officers.

WE regret to announce the sudden death of Mr. Robert Bullen, the curator of the Glasgow Botanic Gardens. He was well known as a horticulturist, being especially successful in the cultivation of orchids. The post vacated by his death is one of the best of the kind in the country, and we understand that the appointment will rest with the Corporation of Glasgow, who took over the management of the Botanic Gardens in 1891.

THE death of Dr. Léon Poincaré, professor in the Faculty of Medicine at Nancy, is announced. He died on September 15 at the age of sixty four.

AT the meeting of the Linnean Society of New South Wales on August 31, Mr. H. Deane, Vice-President, who occupied the chair, referred to the loss the Society had sustained by the death of Mr. R. D. Fitzgerald, well known for his knowledge, and for his artistic delineations, of Australian orchids.

RUSSIA, which already possesses some of the best equipped chemical laboratories in Europe, is to have another which is to eclipse all others. On September 13/25 the foundation stone of the new chemical laboratory of the University of St. Petersburg was laid with befitting ceremony. The new laboratory, which is designed by Prof. Mentschatkin in collaboration with the architect Krassowsky, is based upon the best existing models in Germany and Austria.

IN the *Times* of the 10th inst. there is an announcement that Surgeon-Major Laurie has proved that the fall of blood-pressure in animals rendered insensible by chloroform is due to the action of the anæsthetic on the brain, and not on the heart. When blood containing chloroform is allowed to reach the brain only all the ordinary phenomena of anæsthesia are observed, but when such blood is conveyed to every other part of the body except the brain, which, by a peculiar arrangement of the experiment, is supplied with pure blood, the anæsthetic effects of chloroform and also its depressing effects on the circulation are not observed. We are glad to see that Dr. Laurie is still continuing his experiments on a subject of such vital interest, and we trust that his energy and the generosity of the Nizam, to which we owe the elaborate work of the Hyderabad Chloroform Commission, will meet an ample reward.

THE British Ornithologists' Union, founded in 1858, consists of upwards of 250 votaries of this branch of natural history, who maintain as their organ the well-known ornithological journal, *The Ibis*, now in its thirty-fourth volume. The more active members of the union have just formed themselves into a club, and will meet together once a month to read and discuss papers and to exhibit specimens. The first meeting of the "British Ornithologists' Club" will be held on October 19. Mr. Howard Saunders, F.Z.S., is the treasurer and secretary.

THE university of Padua is about to hold a festival in honour of Galileo. The seventh of December, 1892, will be the tercentenary of the day upon which Galileo ascended the chair of mathematics at that university. In the words of the letter of invitation which the rector, Prof. Carolus Ferraris, has just issued to some of the learned societies of Europe, "Illo enim die Ann. mdxcii summus acerrimusque investigator legum, quibus caelestium terrestriumque rerum natura continetur, hic cathedram ascendit eamque voce sua immortalitati commendavit." It is to the honour of Padua that it welcomed Galileo to this high position the very next year after he had been publicly hissed and obliged to resign his professorship at Pisa. The festival will extend from the 6th to the 8th of next December.

THE Linnean Society of New South Wales has just issued a second circular with respect to the Macleay Memorial Volume by which it appears that only £170 has been contributed out of £400 which is required for the publication of the Memorial Volume. The circular calls to mind Sir William Macleay's contributions to science, in purchasing and fitting out at his sole expense the ship *Chevert* and exploring the island of New Guinea, and in presenting to the University of Sydney his entire collection valued at £23,000, together with £6000 to provide salary for a curator. Sir William Macleay was also the founder of the Linnean Society of New South Wales, for which he erected a suitable building, and which he endowed with the sum of £20,000. He further founded a chair of bacteriology and four scientific fellowships at the University of Sydney, at a cost altogether of £47,000. The sum of £170 seems hardly adequate as a recognition of these munificent gifts to science, to say nothing of the original researches which Macleay himself conducted.

MR. THOMAS HODGKINS, of Long Island, New York, has sent to the Royal Institution no less than £20,000 for the promotion of scientific research. Not very long ago, as we noted at the time, Mr. Hodgkins presented £40,000 to the Smithsonian Institution at Washington.

THE Severn Valley Field Club has completed the work of the current year. It has paid some attention to the glacial deposits at Gloppa, near Oswestry, which have recently yielded to Mr. A. C. Nicolson a large series of fossils. The members have also visited the Triassic rocks of the area round Warwick. Their work concluded with an investigation of the Uriconian and Longmyndian formations of Western Shropshire under the guidance of the President, Dr. C. Calloway.

DR. J. M. MACFARLANE has been appointed to the chair of Biology in the University of Pennsylvania, Philadelphia. He formerly held the post of senior assistant in the Botanical Department of the University of Edinburgh.

AN influential association has been formed for the promotion of the study of the Hausa language and people, in commemoration of the services of the Rev. J. A. Robinson, who died last year at his work as a missionary in the Niger Territories. Hausa is the *lingua franca* of the Central Sudan, extending from the Sahara to the tribes near the Gulf of Guinea, and from the Egyptian Sudan to the French colony of Senegal. Mr. Robinson convinced himself that no satisfactory work of any kind could be carried on among the races of the Central Sudan without a knowledge of Hausa. The Executive Committee of the new Association have decided to endeavour, with the least practicable delay, to appoint two "Robinson Students," conversant with Arabic or Hebrew, whose preliminary labours would be carried on in the comparatively temperate climate of Tripoli, with a view to their proceeding at a later date to the Central Sudan, where they would make the language and cus-

toms of the Hansas subjects of careful study All scientific observations collected by these students during their residence in Africa will be sent to the Association for distribution to the appropriate societies

THE Association of American Agricultural Colleges and Experiment Stations will hold its sixth annual convention at New Orleans on November 15 The different subjects assigned to station workers for the Columbian Exhibition will be discussed

PROF H MARSHALL WARD, F R S, of the Royal Engineering College, Cooper's Hill, will give a course of ten lectures at University College, London, on "The Morphology and Physiology of Fungi and Schizomycetes" The course will begin on Thursday, October 13, at 3 p m, and be continued at the same time each week till Christmas

A LARGE plant of *Fourcroya* is now in flower in the conservatory of the Royal Botanic Society The secretary of the Society referred to it at the meeting of the Council on Saturday last. The plant is sometimes called the century plant, the idea being that it flowers only once in a hundred years In reality the flower is produced only once in the life of the plant, the duration or term of life varying considerably, according to the treatment the plants individually receive Specimens of the *Agave Americana* have flowered in the Royal Botanic Society's garden, the ages of them being well authenticated as over 80 years; but the plant is known to flower in warmer climes before twenty years of age The present specimen of *Fourcroya* is between twenty and thirty years old It began on August 1 last to produce its flower spike, which, although the plant is slow growing generally, developed at a rapid pace, so that on September 15 the tip had reached the glass roof A square of glass being removed, the flower spike continued its growth, and it is now some 3 feet or 4 feet above the ridge, a total of over 30 feet in height The leaves vary from 6 feet to 7 feet in length

IN his treatise, "On the Propagation of Electric Force," Prof. Hertz mentions some experiments tending to prove that the production of resonance and the period of oscillation in resonators are not influenced by the specific resistance or the magnetic properties of the secondary conductor But if the phenomena be observed electrometrically, the individual properties of the metals soon show themselves This method was employed by Mr V Bjerknes, of the University of Christiania, who gives an account of his results in No 9 of *Wiedemann's Annalen* Experiments made with copper, brass, German silver, platinum, nickel, and iron show that metals have different powers of absorbing the energy of electric waves The rate of absorption increases with the resistance and with magnetization of the metal Iron and nickel were able to follow the oscillations to a certain extent, which means that their magnetization was actually reversed one hundred million times per second.

A method of exhibiting the Hertzian oscillations to a large audience is described in the same number by Mr L Zehnder, of the University of Freiburg The two conducting rods placed in the focal line of the concave mirror are connected with a Geissler tube, within which the ends are placed very closely together, but so that a discharge produces not a spark but a general luminosity inside the tube The secondary Hertz effects are too feeble to be visible except at a very short distance and in a darkened room. In this case they are augmented by a kind of relay. On either side of the terminals of the resonator are two other terminals from a circuit of 600 secondary cells, which can be regulated so that the current is just unable to traverse the distance between the terminals. As soon, however, as the resonator responds to electric oscillations, the relay is brought into action, and a brilliant discharge takes place. In cases where such a large accumulator is not available, it is possible to work with another inductorium, or, still better, to obtain the oscillating current from the primary coil by bringing one end of a wire into its neighbourhood, the other being led to earth. By such means it is possible to exhibit the phenomena in question without even darkening the room

THE weather during the first part of the past week was very boisterous and inclement over the whole of these islands Between Thursday, the 6th inst, and Monday last, two deep depressions closely following each other passed over the country from off the Atlantic, and heavy gales were experienced in all parts of the United Kingdom, accompanied by much rainfall, while thunderstorms and hail occurred in many places The sea also was exceptionally rough, especially on our north-west coasts, and caused much damage on shore Temperature was somewhat low for the time of year, the daily maxima rarely reaching 60° in any part, while the nights were very cold As the depressions passed to the eastward the weather cleared and the temperature decreased considerably, sharp frost occurring on the ground over the inland parts of England Towards the close of the period the type of weather was becoming more settled in character than it had been for some time past, but on Tuesday a depression lay over the Bay of Biscay, which might disturb our conditions The *Weekly Weather Report* of the 8th inst showed that during that week the rainfall exceeded the mean in all districts except the south of Ireland, and that temperature was from 2° to 4° below the mean, the lowest of the minima ranging from 32° to 38° The only district in which bright sunshine exceeded the mean was the Channel Islands, the percentage of the possible duration amounted there to 40, while it was only 8 in the north of Scotland

THE Meteorological Council have published the hourly means obtained from their self-recording instruments at four observatories for the year 1889, for periods of five days, calendar months, and for the year, while means of pressure and temperature and totals of rainfall are also given for every day This is the third year in which the observations have been published in this form, instead of the actual hourly values, as formerly, and an addition has been made by including the monthly and yearly mean values of the daily maximum and minimum temperatures for this and the two previous years in this volume The work contains 112 quarto pages of very clearly drawn up tables

MR H DEVAUX has been making interesting experiments on the sense of taste in ants Among other results he has found that *Lasius flavus*, while fond of sugar, dislikes saccharine The ants swarmed around sugar laid out for them, but turned away from saccharine as soon as they tasted it Even sugar became unpleasant to them when it was mixed with saccharine It seems, therefore, that sweetness is not the only quality which attracts them to sugar

PROF SCOTT has a note in the new volume of "the Transactions and Proceedings" of the New Zealand Institute, on the occurrence of cancer in fish The fish afflicted with this disease were all specimens of the American brook-trout (*Salmo fontinalis*) kept in confinement in one of the ponds at Opoho belonging to the Dunedin Acclimatisation Society Males and females were alike affected, and the diseased fish never recovered. Prof Scott has been able to examine several specimens showing the disease in various stages of advancement, and gives in his paper a short account of the naked-eye and microscopic appearances of the growth. The occurrence of cancer in the lower animals has been frequently observed of late years, and it is by no means so rare among them as it was at one time thought to be. Prof. Scott does not, however, know that it has ever before been noted in fish.

In his report as surgeon-naturalist of the Marine Survey of India, to which we referred last week, Dr A Alcock records some interesting observations on the little estuarine crab *Gelasimus* The most obvious structural peculiarity of *Gelasimus* is the enormous development of one of the chelæ in the male only, the chelæ in the female being minute The species observed by Dr Alcock was *Gelasimus annulipes*, Edw This species lives in vast swarms in "warrens" on the muddy tidal swamps of the Godávari and Kistna, each individual having its own burrow, round which it ranges, and into which it retreats when alarmed In the colder months, at any rate, the males far outnumber the females In a fully adult male the length of the large chela is two-and-a half times the greatest length, and one-and-a half times the greatest breadth, of the whole body, and 40 per cent of the entire weight of the animal, and is coloured a beautiful cherry-red fading to a rose pink, the rest of the animal being of a dingy greenish-brown colour Dr Alcock has been able to observe that, whatever other functions the great chela may serve, it also, in the species under consideration, is (1) a club used in the contests of rival males, and (2) a signal to charm and allure the females This last function is particularly apparent As one walks across the mud one first becomes aware of the presence of these crabs by noticing that the surface of the mud is everywhere alive with twinkling objects of a brilliant pearly-pink colour Carefully watched, these prove to be the enormous chelæ of a crowd of males of *Gelasimus* waving in the air, each little crab standing at the mouth of its burrow and ceaselessly brandishing its big claw. On closer observation, among every ten or so males a small clawless female may be seen feeding in apparent unconcern If the female should approach the burrow of a male, the latter displays the greatest excitement, raising itself on its hindmost legs, dancing and stamping, and frantically waving its beautifully coloured big claw From prolonged watching, Dr Alcock feels convinced that the waving of the claw by the male is a signal of entreaty to the female, and he thinks that no one can doubt that the claw of the male has become conspicuous and beautiful in order to attract and charm the female The second function, as a fighting weapon, becomes apparent when in the general tournament one of the rival males approaches too close to another The great claw is then used as a club, the little creatures making savage back handed sweeps at each other

An excellent paper on fungous diseases and their remedies was read lately by Prof J E Humphrey before the Massachusetts Horticultural Society, and has now been printed One of the principles on which he insists is that the treatment of these diseases, to be efficient, must be preventive rather than remedial. He points out that it is not enough to take care that plants shall have abundant nourishment No practice, he says, is more common among American fruit growers than to leave in the vinery and the orchard, lying on the ground or hanging from the branches, the dead fruits of the season, which have been rendered worthless by fungi Nothing could produce more unhealthful conditions, for these dead fruits commonly furnish to the fungi which attack them precisely the most favourable soil for further and complete development In the next spring the air is full of the spores of these fungi, which find lodgment on the new leaves and fruits of the very plants on which they grew last year, and so the story goes, year after year. "In a word," says Prof Humphrey, "keep your orchards and gardens and greenhouses *clean*. Allow no rubbish to be about on which fungi can breed. Remove and destroy all diseased fruits or plants as scrupulously as you preserve saleable ones, and you will have more saleable ones to preserve. It is surprising how far generous culture and clean culture will go toward preventing fungous diseases, without special treatment."

The Marquis de Nadaillay contributes to *Science* (Sept 23) an interesting account of the various discoveries which have been made in the caves of Baoussé Roussé, between Mentone and Ventimiglia The caves were found in 1872 by M Rivière, who has since vigorously prosecuted his excavations These have yielded many human skeletons, all belonging to the Cro Magnon race. They are robust, and bespeak an athletic constitution and great muscular power The men were remarkably tall, the crania are dolichocephalic, and the tibias platycnemic The bones of all the adults, after the total decomposition of the flesh, were painted red with the help of peroxide of manganese or other substances frequently met with in the caves a custom which the Marquis de Nadaillay believes prevails, or till lately prevailed, among some Indian tribes Much attention has been devoted to the latest discovery, made early in the present year, of three skeletons—a man, a woman, and a "young subject," whose wisdom teeth had not been developed They were found eight metres below the ground, and had been buried on a bed of cinders, broken fragments of charcoal, and remains of all sorts, evidently the hearth on which the family cooked their victuals The boy wore a necklace formed of two rows of the vertebræ of a fish and one row of small shells At different points hung pendants cut out of the canine teeth of stags, decorated with parallel striæ The man had also a necklace of fourteen canines of the stag, also striated With the skeletons were found stone instruments, some of them finely worked, but none of them polished, and some bone implements of very rude fabrication The man was very tall If we judge by the length of his thigh bone, his height must have exceeded six feet six inches The teeth even of the boy were very much worn, those of the man were worn to the roots The bones of many mammals have been found, but none belonging to extinct species, or even to the reindeer On the other hand, no polished stone implement has been discovered The remains, therefore, must be ascribed to the end of the quaternary or the beginning of the neolithic times One cave is still unexcavated The Prince of Monaco, whose property it is, has given orders that the excavations are to begin next spring

Mr C Hedley read before the Linnæan Society of New South Wales, on August 31, a paper in which he presented an interesting study of ancient geography The immediate subject was the range of *Placostylus* He remarked on the essential unity of the *Placostylus* area as a zoological province, embracing the archipelagoes of Solomon, Fiji, Hebrides, Loyalty, New Caledonia, Norfolk Island (?), Lord Howe, and New Zealand, a unity explicable only on the theory that they form portions of a shattered continent, and are connected by shallow banks formerly dry land Deep sea soundings, especially those of the *Challenger* in the Coral Sea, further demonstrate the existence of such a submarine plateau, for which the name of "The Melanesian Plateau" is proposed Further, Mr. Hedley contended that the Melanesian Plateau was never connected with, nor was ever populated from, Australia, that its fauna and flora were originally derived from New Guinea.

In the *Proceedings* of the U S National Museum (vol xv), Lieut Dix Bolles calls attention to an interesting object included in a collection of ethnological specimens given by him to the museum in 1883-85 This is a wooden mask, which has for its eyes two large bronze Chinese coins The grave from which the mask was taken is near the Chilcat village, at the mouth of the Chilcat River, Alaska, where stands a row of six grave-houses on a narrow strip of land close to the river, with a swamp behind them. From this particular grave very little was obtained by the explorers, its contents having nearly all rotted away. Lieut. Bolles was told by the natives that it

was the grave of a medicine man who had flourished more than 200 years before, six successors having filled his office, each one living to a good old age. Careful questioning failed to evoke any other answer. When the coins were shown to the Chilcats, they could not remember having ever seen such objects. Lieut. Bolles concludes that the coins probably were derived from a junk driven on the coast about two centuries ago. "To those," he says, "who doubt the advent of junks on the west coast at this early date, these facts will probably not be satisfactory, but it will be necessary for them to break down by direct evidence such a strong plea."

MESSRS. H. ALABASTER, GATEHOUSE & CO. have now in the press, shortly to be issued, a new work, entitled, "Domestic Electric Lighting, treated from the Consumer's Standpoint." The author is Mr. Ed. C. de Segundo.

"THE ELECTRICIAN" Printing and Publishing Co., Limited, have in preparation for their "Electrician" Series the following volumes:—"Electromagnetic Theory," by Oliver Heaviside; "Electrical Engineering Formulæ, &c.", by W. Geipel and H. Kilgour; "Submarine Cable Laying and Repairing," by H. D. Wilkinson; "Drum Armature Winding and Commutators in Theory and Practice," by F. M. Weymouth; and "Electricity as a Motive Power," by Albion T. Snell, M.I.C.E., M.E.

THE first series of lectures given by the Sunday Lecture Society begins on Sunday afternoon, October 23, in St. George's Hall, Langham Place, at 4 p.m., when Dr. Andrew Wilson will lecture on "The Distribution of Animals and what it teaches." Lectures will subsequently be given by Mr. Willmott Dixon, Prince Kropotkin, Mr. R. Brundenell Carter, Mr. Arthur W. Clayden, Prof. H. Marshall Ward, F.R.S., and Dr. E. E. Klein, F.R.S.

ANOTHER memoir upon persulphuric acid and the persulphates is contributed by M. Berthelot to the *Annales de Chimie et de Physique*. As described in our note of vol. xliv., p. 577, the potassium, ammonium, and barium salts of this interesting acid were obtained last year by Dr. Marshall, of Edinburgh, in tolerably large quantity and in well developed crystals. M. Berthelot, to whom the honour of the first preparation of persulphuric acid and its anhydride is due, now publishes his further work upon the subject, fully confirming Dr. Marshall's results, and adding a few more facts to our knowledge of the acid and its salts. The form of electrolysis apparatus which has been found by M. Berthelot to yield the best results consists of a double cell, the inner vessel of which is constructed of porous porcelain. The liquid contents of both the interior and exterior vessels are cooled by means of glass worms through which a constant current of cold water is maintained. The inner cell of 150 c.c. capacity contains a concentrated solution of potassium or ammonium sulphate, according as potassium or ammonium persulphate is required, in sulphuric acid diluted with six or seven times its volume of water. The nearer the composition of this liquid approaches to that of a solution of bisulphate of potassium or ammonium, the greater is the yield of persulphate. The exterior cell is simply filled with dilute sulphuric acid. The positive pole in the interior cell is most advantageously formed by a stout platinum wire, about one millimetre in diameter, as persulphuric acid is found by M. Berthelot to be rapidly decomposed in contact with a large surface of platinum. Platinum sponge, indeed, instantly decomposes the acid or solutions of its salts. The negative pole in the outer cell may conveniently take the form of a large plate of platinum. The current employed was one of three amperes derived from accumulators. At the expiration of fifteen to twenty hours the internal cell is found to contain large quantities of beautiful crystals of the persulphate. The usual yield of the potassium salt was 20-25 grams, and of the more soluble ammonium salt as much as 40-45 grams, in one operation. M. Berthelot has also obtained potassium persulphate by the direct electrolysis of sulphuric acid and subsequent addition to the product of a concentrated solution of potassium bisulphate, crystals of potassium persulphate, KSO_4, being at once deposited. This mode of preparation is not so advantageous as the method of production by the electrolysis of potassium sulphate as above, but affords interesting proof of the formation of free persulphuric acid by the electrolysis of oil of vitriol. M. Berthelot has further succeeded in preparing persulphuric acid by the gradual addition of anhydrous barium peroxide to concentrated sulphuric acid in a small flask surrounded by ice. So rapid is the action that if the addition of the peroxide is continued until the sulphuric acid is almost exhausted, even although the vessel is maintained in pounded ice, dense vapours are evolved which possess the remarkable odour and other properties of persulphuric anhydride. Another interesting fact observed by M. Berthelot is that a solution of potassium persulphate attacks mercury, even at the ordinary temperature, with production of a yellow basic sulphate which appears to be identical with the salt known since the times of the alchemists as *turpith mineral*.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Miss F. A. Hill; two Racoons (*Procyon lotor*) from North America, presented by Captain Sharp; a grey Ichneumon (*Herpestes griseus*) from India, presented by Mrs. Wyndham Bewes; a Stanleyan Chevrotain (*Tragulus stanleyanus*) from Java, presented by Mr. Chas. J. Noble; a Vulpine Phalanger (*Phalangista vulpina*, ♂) from Australia, presented by Master H. H. Barret; a White Stork (*Ciconia alba*), European, presented by Sir H. Rae-Reid, Bart., F.Z.S.; an Ostrich (*Struthio camelus*, ♂) from Africa, presented by H.M. the Queen; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mrs. Davidson; three Negro Tamarins (*Midas ursulus*) from Guiana; a Canarian Laurel Pigeon (*Columba laurivora*, ♂) from the island of Gomera, Canary Islands; two Nicobar Pigeons (*Colœnas nicobarica*) from the Indian Archipelago, deposited; an Indian Muntjac (*Cervulus muntjac*, ♀) from India; four Ringed Plovers (*Ægialitis hiaticula*) and two Dunlins (*Tringa alpina*), British, purchased.

OUR ASTRONOMICAL COLUMN

LUMINOUS NIGHT CLOUDS.—In an article communicated to *Astronomische Nachrichten*, No. 3120, Herren W. Foerster and O. Jesse invite astronomers and geophysicists both here and abroad to make observations of the very interesting phenomena of luminous night clouds, the appearance of which has, up till now, been observed more or less only at Berlin. Since the year 1885, the authors tell us, these appearances have been most noticeable, and it is because they are now becoming less so that they wish to have as many observations made as possible. The phenomenon appears in the form of cirrus clouds, which stand out bright against the twilight sky. The colour generally noticed is that of a bluish white, and when the horizon is approached, gold and red tints are added. The best time for observation is said to be just before and after sunrise and sunset. From photographs taken at Berlin it has been computed that these clouds are at a height of 82 kilometres. Long after the sun has set they are seen to reflect the sunlight, but as soon as they fall within the reach of the earth's shadow they immediately become invisible. The observations show, so far as may be judged from those already at hand, that the movements of this phenomenon after midnight are directed from the north east ± 40°, and the authors think it highly probable that the resistance of the medium surrounding the earth accounts for these movements. This is to a certain extent affirmed by observations made at Punta Arenas and other places, the phenomena occurring six months after the conclusion of the Berlin observations. The authors suggest that eye observations

(taken every few minutes) should be made in different latitudes, to ascertain the apparent height to which these clouds attain The determinations of azimuth and altitude should also be current to three or four minutes of arc, and the time to two or four minutes Notice should also be taken of the general state of the atmosphere at the time of observation, while photography should be employed to record their place and motion The paper contains one or two more suggestions, among which is the employment of the spectroscope, and concludes with the hope that the importance of this phenomenon in relation to cosmical problems will arouse much interest and enlist many observers, for, in such a case as this, the observations of one institution will not help to solve such a general question as this

NOVA AURIGÆ —From the communications, in *Astronomische Nachrichten*, No 3120, we make the following notes with reference to the magnitude and spectroscopic appearance of the Nova Aurigæ

Dr J Holetschek, of the Vienna Observatory, has examined the star with regard to the former, and finds that, if any, an increase in brightness has taken place since August 24 The following are his figures, N standing for the Nova, and *a* a neighbouring star, the magnitude of which is taken as 9 7 The hours refer to Vienna mean time —

1892	h	N	m
August 24	13¾	0 5*a*	9 65
,, 26	14	2*a*	9 5
,, 27	14	1 5*a*	9 55
,, 28	12¾	2 5*a*	9 45
,, 30	12¼	2*a*	9 5
Sept 2	14	3*a*	9 4

Observations made on Sept 15 12h , Sept 16 11½h , and Sept 17 12½h showed that N was at least four degrees brighter than *a*, and two degrees brighter than the star, 9 5m B D + 30° 924

Using the 30 inch of the Pulkova Observatory, Mr A Belopolsky has made some measurements of the brightest line visible in the spectrum His measures are —

1892	W L	Mean
September 10	501 2$\mu\mu$	
,, 12	501 1	
,, 14	(499 5)	501 0
,, 15	500 9	
,, 16	500 7	

Of the other lines there were seen D or D_3, F, and a dark line about wave length 465$\mu\mu$

MINOR PLANETS —The application of photography to the search of minor planets seems to be rewarded with remarkable success, for no less than four new ones, 1892, E, F, G, and H, have, since September 25, been discovered The first two are due to M Perrotin, while the last two were photographed by M Wolf A fact worth recording is that the plate, on which the latter planets were found, contained also two other images, those of the planets (34) Circe, and (184) Dejopeja , thus the positions of four planets were obtained with one exposure

REPORT OF MR TEBBUTT'S OBSERVATORY —In this small pamphlet we have a condensed account of the present state of the observatory buildings, instrumental equipment, &c , together with the work done during the year 1891 Although the staff is not very great, yet the work carried out shows that all the available time has been made the most of The observations include forty-six occultations of stars by the moon, phenomena of Jupiter's satellites, transit of Mercury, conjunction of Venus and Jupiter, and filar micrometer comparisons of the minor planet Ceres, comprising 106 comparisons and four comparison stars Several comets were observed with the square bar-micrometer, while some interesting double stars and the two variables of Argus and R Carinæ have also been worked at The 9h a.m meteorological observations have been continued with the usual regularity

PHOTOGRAPHIC CHART OF THE HEAVENS —In a paper read on July 1, 1891, before the Royal Society of New South Wales, Mr. H. C. Russell relates many of his experiences, together with some of the results obtained during the preparation of the Sydney Observatory for the photographic chart of the heavens. The first difficulty that turned up had reference to the photographing of the stars of the fourteenth magnitude The two minutes' exposure was found quite long enough for ninth magnitude stars, but the thirty minutes was not sufficient to record those of the fourteenth. A question also arose as to coloured stars, for in many cases stars visible telescopically were not photographed at all Of the many objects photographed with the portrait camera, Mr Russell describes very fully the beautiful nebula 30 Doradus This nebula, as he says, is a great spiral structure, of which we see the greatest diameter, its thickness measured through in the line of sight being comparatively small He has been able also to obtain a very fine photograph of N Argus, a nebula, which, as may be concluded from the negative, "covers a much larger area than that of Orion " The same photograph also confirms the observations made by Mr Russell in 1872 that a conspicuous part of the nebula which Herschel drew and described in 1838 has wholly disappeared, and that its place is now occupied by a dark round spot What this may be is a doubtful question, but as Mr. Russell says "It cannot be a solid body, because the stars are there, but a slight misty body would hide the nebula and not affect the stars very much " The pamphlet concludes with an excellent picture of the κ Crucis cluster.

GEOGRAPHICAL NOTES

COLONEL BAILEY, R E ,lecturer on Forestry in the University of Edinburgh, has been appointed secretary to the Royal Scottish Geographical Society, in room of Mr A Silva White, whose resignation on account of ill-health we noticed some months ago

PROF CHERSKI, whose projected journey in Eastern Siberia was mentioned in Geographical Notes for June 30 (p 212) is reported to have died near Sredne Kolymsk, on his way down the Kolyma river towards Nizhne Kolymsk, where he intended to have passed the winter Cherski has travelled frequently and far in Siberia, and has done much to elucidate the geographical conditions, and in particular the geology of many parts of Northern Asia His great geological map of the Lake Baikal district is the work by which he will be best remembered

THE current number of the *Scottish Geographical Magazine* contains Mrs Bishop's account of her travels in Ladak and the adjacent territories, often called Lesser Tibet As a record of personal adventure and observation of native character the paper ranks worthily with the published records of this traveller's earlier and later journeys

THE *Proceedings* of the Royal Geographical Society for October publishes a short statement of the progress of Indian surveys during the last field season In Bengal the Behar detachment completed the traverse survey of 1610 square miles in districts Muzaffarpur and Champaran In Bombay 2536 square miles of detailed survey were completed on the scale of two inches to one mile, and 2100 square miles were triangulated in the Gujarat and Mahratta country Two parties were at work in Burma In district Sagaing 1842 square miles of cadastral survey and 1142 of traverse survey were completed, while 700 square miles of traverse survey were made in district Shwebo, and a topographical survey, on the scale of one mile to an inch, of 106 square miles of the Chindwin coalfields There were also carried out in districts Amherst, Tavoy, and Mergin 881 square miles of cadastral survey, besides a traverse survey of 510 square miles

THE MICRO-ORGANISMS OF THE SOIL[1]

THE high office with which you have honoured me entails the delivery of an address, which I keenly feel I cannot give in keeping with the standard set by my distinguished predecessors.

Fermentation, though observed since pre-historic times, is perhaps less understood than any chemistry has to deal with. The exciters of fermentation are rendered exceedingly difficult of investigation, because they, like all living things, are subject to physiological—or more specially pathological—functions of life, they are so sensitive that any abnormal influence either changes their whole mode of existence or destroys it altogether; a medium suitable to the life of one special kind is changed by

[1] Address delivered by Prof Alfred Springer as Vice-President of Section C. at the meeting of the American Association for the Advancement of Science.

it into a product which ceases to sustain it, but can nourish a lower class of organisms whereby concomitant fermentations arise, whose united effects are frequently such as to completely modify those produced by each separately, and for this reason have the specific actions of some ferments either totally escaped observation or have been misconstrued. Every succeeding year brings additional proof of the important rôle played by these minute organisms, and to such an extent, especially, has this been the case in connection with the rendition of available nitrogen, that there are good reasons to believe that a clearer comprehension of the action of soil ferments will dissipate all the anxiety chemists now entertain as to a gradual diminution of this so essential nutrient.

To Hellriegel, Wilfarth, Wollny, Engelmann, Winograwdski, Warrington, and Heraus can be attributed the most noteworthy experiments in this special line. In order to appreciate the importance of their discoveries, I will, with your kind indulgence, first give a brief historical *résumé* of the study of fermentation. Owing to the extreme age of the use of alcoholic beverages, ferments entering into their production are best known, and this, added to the fact of their being larger and thus permitting of better examination, has been the determining cause of basing investigations and deductions upon their behaviour.

The very fact that the art of cultivating the vine and making wine is attributed by the Egyptians to Osiris, the Greeks to Bacchus, the Israelites to Noah—the brewing of beer to Gambrinus—shows how old these discoveries must have been. The effects of fermentation are sufficiently striking to have called the attention of primitive man to them. The ancient tribes of Asia and Africa understood how to ferment not only grape juice, but also to obtain alcoholic beverages from substances like starch, not directly fermentable. They used soured dough or beer-yeast as leaven for their bread, and knew how to prepare vinegar. The alchemists were wont to clothe their thoughts in such words as to make it difficult for us to decide what precise ideas they attached to the expressions of "Fermentation and Ferments" which are so frequently found in their writings of the thirteenth to the fifteenth century. They even speak of the philosopher's stone as fermenting unlimited quantities of lead and mercury into gold.

In the fifteenth century Basil Valentine in his "Triumphal Car of Antimony" claims that yeast employed in the preparation of beer communicates to the liquor an internal inflammation, thereby causing a purification and separation of the clear parts from those which are troubled, but considers alcohol as already existing in the decoction of germinated barley. In 1648 Van Helmont declared fermentation the cause of all chemical action and spontaneous generation, going so far as to give directions for the production of mice, frogs, eels, &c. He clearly observed the production of a special gas (gas vinorum) during alcoholic fermentation, and stated that something from the ferment passes into the fermentable substance, developing therein like a seed in the soil, thereby producing fermentation.

Willis, an English physician, in 1659 claimed that all functions of life depended upon fermentation, and that diseases were but abnormal fermentations. Both he and Stahl regarded a ferment as a body endowed with a motion peculiar to itself, which it imparts to the fermentable matter. Stahl in 1697 advanced the following theory: "Under the influence of the internal motion excited by the ferment, the heterogeneous particles are separated from each other, recombining so as to form more stable compounds, including the same principles but in different proportions. Putrefaction is but a particular case of fermentation." This theory remained unchallenged eighty years.

Lavoisier, by applying the new methods of organic analysis he had invented, quantitatively ascertained the relations between the fermented matter and the products.

Guy Lussac considered oxygen the sole cause of fermentation, putrefaction, and decay, by transmitting its motion to the ferment and this imparted its motion to the loosely combined fermentable mass.

The present theories of fermentation originated with Schwann and Pasteur. It took a century and a half before the experiments which led up to Schwann's theory found a scientific explanation by the work of this chemist. Leuwenhoeck had in 1680 already noticed that beer yeast was composed of small spheroid globules. Cagniard de Latour declared yeast a plant and the exciter of fermentation.

Schwann's experiments were made to determine the possibility of spontaneous generation. He found that fermentable fluids, when first heated in closed vessels in the presence of oxygen, to the temperature of boiling water would not ferment. This disproved Guy Lussac's theory that oxygen caused fermentation. He next showed that purified air or oxygen passed into a sterilized fermentable fluid did not induce fermentation, but that this set in with the introduction of ordinary air. He concluded from these experiments that the air was not the exciter, but simply the medium containing it, and that in the floating particles of the atmosphere were organisms capable of developing in the fluid, should these be killed by heat, fermentation would not take place. In his examination of these organisms, although his methods were not absolute, his conclusions that alcoholic ferments are of a vegetable nature were correct.

Instead of general acceptance, Schwann's theory received but little recognition.

Schultze's method of first passing the air entering a sterilized fermentable fluid through oil of vitriol, and that of Schroeder and Dusch of filtering it through cotton can be regarded as modifications of Schwann's experiments. All these experiments conclusively show that the particles in the atmosphere are the exciters of fermentation but do not render them visible.

Pasteur, spurred on by the same motive as Schwann—namely, to determine the question of spontaneous generation—made a simple modification of Schroeder and Dusch's experiment, by substituting gun cotton, and achieved most remarkable results. The gun cotton, containing the particles filtered from the air, was dissolved in ether under the microscope, and now for the first time the organisms could be thoroughly examined.

Tyndall's well-known experiments, with the air tight box coated with glycerine, demonstrated that gravity alone can purify the atmosphere so as to debar fermentation from setting in.

Pasteur's theory is that "The chemical act of fermentation is essentially a correlative phenomenon of a vital act beginning and ending with it, there is never an alcoholic fermentation without there being at the same time organization, development, multiplication of globules, or the continued consecutive life of globules already formed."

The following few examples will serve to show that the slightest changes in nutrients may render them worthless as such to certain ferments and available to others. Organic substances showing optical rotation chiefly exist already formed in the animal or vegetable organisms, or they can be easily obtained from such substances formed during vital processes.

When these substances are made synthetically, they are chemically and physically similar to the natural isomers, but usually do not rotate the plane of polarized light. This leads to the belief that these synthetical products consist of active and inactive molecules in such proportions as to neutralize each other.

Pasteur[1] verified his hypothesis by splitting inactive racemic acid into dextro-tartaric acid. Neutral ammonium racemate in a solution to which the proper inorganic salts had been added was fermented by means of *Penicillium glaucum* and beer yeast. The dextro-tartaric acid was consumed and the lævo left.

Lewkowitch[2] took inactive mandelate of ammonia, employing either *Penicillium glaucum* or *Bacterium termo*, in each case at the end of several weeks all the fluids showed more or less dextro rotation. Natural mandelic acid from amygdalin is lævo rotary, therefore here, as in Pasteur's experiment, with racemic acid it showed that the organisms consumed the naturally produced isomer.

Sac. ellipsoideus and split fungi consume the dextro and leave the lævo. The dextro has the same positive as the lævo negative rotation. The melting points and solubility of the right and left are the same, yet we see that these substances, chemically and physically the same, save in their opposite rotatory powers, can serve in one case as nutrients to certain organisms, and the other are worthless as such.

The Micro-Organisms of the Soil (*Sachse*[3]).

These organisms, according to their actions, can be divided into three groups. Those oxidizing constituents of the soil; those reducing or destroying the same; and lastly those by whose activity the soil is enriched. As regards the first group the oxidation can take place in two ways—they can either oxidize by assimilating the organic substances of the soil and re-

[1] Cr xlvi 615, ib 298.
[2] B. xvi 1505, 1569.
[3] *Chem Cent Bl.*, 1889, vol ii. 169, 225.

ducing them to carbonic acid and water, in order to obtain the necessary heat and energy, or they can oxidize by giving off oxygen. The first may be termed intra cellular, and the second extra cellular acting organisms. Amongst the intra cellular we have primarily, the usual ferments of decay, which assimilate and respire at the expense of the carbon compounds. In some cases the organisms have accommodated themselves to seemingly most remarkable materials for respiration, the combustion of which affords the necessary heat. Thus the Iron Bacteria of Winograwdski[1] require ferrous carbonate for their life and development, oxidizing the same to oxide. This can be physiologically interpreted as a respiration process, the protoxide of the respiration material becoming the oxide of respiration product.

The Sulphur Bacteria are equally remarkable. Their cells are distinguishable by containing from time to time granules of amorphous sulphur. These organisms were formerly regarded as causing the formation of sulphuretted hydrogen in sulphur springs.

Winograwdski[2] claims the reverse to be the case. They do not produce sulphuretted hydrogen but consume it, burning it partially first to sulphur, which deposits in the cell water, then completely to sulphuric acid, which passes out and forms sulphates from the carbonates of the surrounding water. When no more carbonates are present, the combustion of sulphur to sulphuric acid ceases. Physiologically this is also a process of respiration directed towards generating heat and energy; sulphuretted hydrogen is the respiration material and sulphuric acid the respiration product.

(Olivier[3] does not agree with Winograwdski and De Rey Pailhade[4] claims the existence of a substance, philothion, in many plants and animal tissues capable of converting sulphur in the cold to sulphuretted hydrogen.)

Certain nitrification ferments can be regarded as intra-cellular. They may take up ammonia and give it off as nitrates, this process ceasing as in the case of the Sulphur Bacteria, when no more carbonates are present.

We now come to the discussion of two ferments, the concomitant actions of which have heretofore caused much confusion. Schloesing and Muntz were the first to observe nitrifying ferments, but to Warrington and Winograwdski belongs the credit of isolating the nitrous from the nitric ferment; furthermore, the striking discovery of a colourless organism, capable of existing and performing its functions, in a medium totally devoid of organic material, and synthetically producing organic bodies independent of sunlight. The importance of this discovery cannot be over-estimated.

Warrington[5] succeeded in obtaining organisms from meadow soil, cultivated in a solution of ammonium chloride and calcium carbonate, which oxidized ammonia to nitrous acid, but had no effect on nitrates. Assimilating the carbon of the carbon dioxide, they require no organic substance for sustenance. They obtain from the oxidation heat of ammonia the necessary energy to dissociate the carbon-dioxide.

Winograwdski[6] obtained the same ferment employing 1 gr. ammonium sulphate, 1 grm. potassium phosphate dissolved in 1 litre Zurich water, to which he added basic magnesium carbonate. After inoculating the sterilized fluid with the nitrifying agent every trace of ammonia disappeared the fifteenth day. He describes this ferment as being an elongated ellipsoid, the smaller diameter 0.9 - 1 Mkr., the larger 1.1 - 1.8 Mkr. The organisms congregate about a piece of carbonate, cover it with their gelatinous mass, and as the carbonate disappears the cells take the shape thereof.

(Although the two investigators do not quite agree as to the morphological attributes of the ferment, Warrington arrived at the same conclusions as Winograwdski.)

Winograwdski[7] has at last succeeded in isolating the ferment which converts the nitrites into nitrates. He employed gelatinous hydrate of silica, impregnated it with a fluid containing the cultivated nitrous ferment. This medium was next inoculated with strongly nitrifying soil from Quito; shortly afterwards two different organisms formed respective colonies, one of these was the one sought for. It was composed of irregularly shaped rods, dissimilar to the nitrous ferment of the same soil. He has since found this ferment in many other soils; it is capable of converting solutions of nitrites into nitrates.

Strange to say the isolated ferment from Quito does not oxidize ammonia; it produced neither nitrites nor nitrates when sowed in ammoniacal fluids, easily nitrified by the nitrous ferment.

In normal soils the nitrate ferment only produces nitrates even in the presence of a large quantity of ammonia, which does not retard the oxidation of the nitrites immediately after their formation.

Muntz[1] claims the existence of an ammoniacal ferment in the soil which converts organic nitrogen into ammonia, preparatory to nitrification.

Extra-Cellular Oxidation

In order to oxidize outside of the organisms, oxygen must be evolved by an assimilation process. Assimilation as an oxidizing cause, for conditions prevailing in the soil, has heretofore received no significance, since the evolution of oxygen, according to the generally accepted theories, depended upon light and chlorophyll, consequently the produced oxidation could only occur on the extreme outer surface. An exception to this heretofore unrestricted rule has been found by Engelmann as well as one by Heraus. According to Engelmann,[2] Bacterium photometricum sharply discriminates between lights of different intensity and wave lengths. The influence of light upon the bacteria is directly proportionate to the intensity. When the intensity is suddenly decreased, the bacteria shoot backwards with opposite rotation (the author calling this a terror motion), consequently a well defined illuminated spot in an otherwise dark drop serves as a trap for these bacteria. They cannot leave, since the terror motion causes them to move back into the illuminated field as soon as they come to the dark outline.

The mobile forms principally congregate in the ultra red rays, *i.e.* physiologically in darkness, and in them as in the visible parts of the spectrum in places closely corresponding to the absorption bands of bacteriopurpurin. This constant ratio between absorption and photokinetic action clearly indicates that the prime effect of light is equivalent to the carbon dioxide dissociating processes of plants containing chlorophyll.

The bacteriopurpurin is a true chromophyll, inasmuch as it converts the actually absorbed energy of light into potential chemical energy. When lights of different colour were employed, the evolution of oxygen increased with the absorption of light by the Purple bacteria. This shows that the power of developing oxygen is not the specific property of a certain colouring matter, as these organisms contain no chlorophyll.

It is not surprising, therefore, that other organisms, either coloured or uncoloured, be found to possess the property of assimilating carbon in the absence of light and evolving oxygen. Such a discovery has now been made—Hueppe[3] substantiating a communication from Heraus that certain colourless bacteria produce from humus and carbonates, in the absence of light, a body closely resembling cellulose. Oxygen is liberated, but remains unobserved, as it is immediately used to oxidize the ammonia to nitric acid.

The next question is: To which extent do the oxidizing organisms partake in the oxidation phenomena actually taking place in the soil? According to E. Wollny[4] the oxidation of carbon-dioxide is almost completely to be attributed to the activity of small organisms, of which Adametz[5] estimated that there are about 500,000 to 1 gr. soil. As in all such experiments, this conclusion is based upon the fact that no evolution of carbon-dioxide takes place, or is forced to a minimum, in a sterilized soil under otherwise favourable conditions.

Liberation of Combined Nitrogen

This may take place during putrefaction under the greatest possible exclusion of oxygen, or during decay in the presence of oxygen. It does not necessarily occur in all cases, or may not be observed owing to a reverse concomitant process, *i.e.*, the fixation of nitrogen. Nitrogen losses can be expected during decay, on account of the action of the produced nitrous acid upon the amidlike dissociation of humous bodies, as well as in the formation of easily dissociable ammonium nitrites. A peculiar case of the disappearance of available nitrogen exists in the reduction of nitrates, as noticed by Springer,[6] Gayon and Dupetit,[7] and Deherain and Marquenne.[8]

1 *Bot Ztg.*, xlvi. 261.
2 *Bot Ztg.*, xlv 489, 513, 545, 569, 585
3 Cr. cvi. 1744.
4 Cr. cvi. 1683; cvii. 43
5 *Chem. News*, lxiii. 296
6 A. J. P., September 1890.
7 A. J. P., v. 577; Cr. cxiii. 89.

1 Cr. cx. 1206.
2 *Bot. Ztg.*, xlvi 661, 677, 693, 709
3 Nit. Vers., ix
4 LV. St., xxxvi. 197
5 Inaug. Diss., Leipsic, 1886.
6 *Amer. Chem. Jour.*, iv. 452-53.
7 Cr. xcv. 644.
8 Bot., vii. 138

Organisms by whose Activity the Soil is Enriched in Nitrogen

A distinction must be drawn between the higher and lower plants It is a well-known fact that most plants cannot assimilate free nitrogen, whereas there are sound reasons for the belief that the legumes are exceptions to this rule The explanation has been sought in the tubercles These tubercles contain a tissue, consisting of thin walled cells filled with an albuminous substance, consequently they are richer in nitrogen than the roots; they have been regarded by some as pathogenic growths, by others as reserve reservoirs for albumin We may now conscientiously assume that these tubercles arise through exterior infection, and that they are not normal growths

Hellriegel and Wilfarth,[1] in their great work, state —"The legumes deport themselves quite differently from the non leguminous plants respecting the assimilation of nitrogen, whereas the latter are totally dependent for their nitrogen needs upon the nitrogen compounds present in the soil, and their development proportional to such disposable supply The legumes have, besides, the soil nitrogen, a second source, from which they can abundantly cover any deficiency existing in the first This second source is free atmospheric nitrogen The legumes attain this power by the co-operation of active living micro-organisms The mere presence of low organisms in the soil does not suffice to make the free nitrogen serviceable, but it is necessary that certain kinds of organisms enter into a symbiotic relationship with the legumes

Lupines acquire nitrogen like the other legumes They starve in a soil free from nitrogen when the presence of low organisms is excluded, but when this is not the case their growth is normal The experiments were carried on in sand containing a suitable nutritive solution Some of the pots were sterilized, to some infusions from soil were added In all and in only those, to which fresh infusions of lupine soil had been added the lupines developed normally bearing the well-known tubercles on their roots, and contained, when harvested, conspicuously larger amounts of nitrogen than the soil and infusion could have given them Wherever the infusion had not been added, or where it had been sterilized at 100 or even 70, the development remained abnormal, the production scant, tubercles remained absent and the harvested plants contained less nitrogen than had been offered them

According to Ward,[2] Breal,[3] and Pradmowski,[4] tubercles will grow on plants free from them when infected with an infusion from tubercles of other plants

Beyerinck[5] has named the infecting organisms, of which there may be many varieties, Bacterium Radicola With the growth of the tubercles the behaviour of the plant towards nitrogen is changed, and the just mentioned independence begins, this has been proved by an almost superabundance of experiments Still the explanation of the manner in which the nitrogen is acquired is not definitely settled The first inference would be that the root-inhabiting bacteria possess the power of assimilating atmospheric nitrogen, and the higher plants as hosts harbouring these bacteria in their roots, use the nitrogen compounds so produced. Thus there would exist a case of symbiosis between Split Fungi and the higher plants We cannot be too slow in accepting this seemingly simple explanation—still the difficulty of a correct interpretation does not alter the fact that the legumes acquire free nitrogen from the atmosphere, and that the refuse of their roots thus enrich the soil They may be called nitrogen collectors in contradistinction to the graminaceous nitrogen consumers

Berthelot[6] has long contended that the free soil can fixate nitrogen, he considers a sandy and clayey nature of the soil essential, it must admit of free access of air, must not be too moist, be rich in potash and poor in nitrogen Gautier and Drouin[7] claim that the presence of humous substances causes increase of nitrogen.

Soils free from organic substances do not fixate nitrogen, or the gain is slight The presence of ferric oxide so long considered capable of fixing nitrogen, has no effect Berthelot, as well as most investigators in this line, attribute the fixation to the activity of nitrogen fixing chlorophyll free bacteria In most cases the amount is much less than that obtained in soils with legumes. No inorganic soil constituents are known to possess the power of fixing nitrogen, and it is questionable whether humous substances can directly do this

In 1881 Atwater claimed that peas during their growth obtained large quantities of nitrogen from the air Atwater[1] and Woods made another series of eighty-nine experiments, the result will be found in their admirable paper in the American Journal I will quote the following "There was in no case any large gain without root tubercles, but with them there was uniformly more or less gain of nitrogen from the air As a rule, the greater the abundance of root tubercles, the larger and more vigorous were the plants, and the greater was the amount of atmospheric nitrogen acquired The connection between the root tubercles and the acquisition of nitrogen, which was first pointed out by Hellriegel, is abundantly confirmed In a number of these experiments, there was a loss of nitrogen instead of a gain The loss occurred where there were no root tubercles, it was especially large with oat and corn plants, and largest where they had the most nitrogen at their disposal in the form of nitrates This loss may probably be due to the decomposition of the seeds and nitrates through the agency of micro organisms In brief, the acquisition of large quantities of atmospheric nitrogen by leguminous plants, which was first demonstrated by experiments here, and has been since confirmed by others is still further confirmed by the experiments herewith reported These experiments in like manner confirm the observation of the connection between root tubercles and the acquisition of nitrogen There is scarcely room for doubt that the free nitrogen of the air is thus acquired by plants"

Chemists, as a rule, hesitate to accept isolated cell life as modifying and conditioning the action of those more differentiated, yet it seems that all circumstances point to the fact that most reactions taking place between nitrogen and plants are influenced by micro organisms

Let us hope that chemistry will, in the near future, score its greatest agricultural triumph, by unveiling the mysteries which still shroud the specific actions of these organisms, thus making it possible to supply the demands of a constantly increasing population

[1] Z. Rub, xxv I 234.
[2] Cr cvii. 397
[3] *Bot Ztg*, xlvi. 725, 741, 757, 781, 797
[4] N Rd, lv 201
[5] *Bied Cent*, *Bl.*, xvi. 787
[6] Cr cvii. 207, 852, cvi 638, 1049, 1214
[7] Cvi 754, 944, 1098, 1174.

[1] *Amer Chem Jour*, xii 526, xiii 42

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—A course of instruction (Lectures and Laboratory work) in sciences bearing upon Agriculture will be commenced in Cambridge this term, it will extend over two years and will include the following subjects —Agriculture, Chemistry, elementary and agricultural, Botany, elementary and agricultural, some departments of Physiology and Geology, Agricultural Engineering, Surveying, and Mensuration Arrangements will also be made for instruction in Book-keeping, and in Agricultural Law for those who desire it The subjects taken this term will be Elementary Chemistry, by Prof Liveing, and Elementary Botany, by Mr Seward, of St John's College It is hoped that this course will prove useful to gentlemen intending to farm, or to manage their own land, and to those who are likely to become estate agents Further information may be obtained from Mr H Robinson, at the University Chemical Laboratory, Cambridge Prof. Foster announces a new intermediate course in Physiology, with laboratory work, especially for medical students, to be given by Dr L E. Shore, on Wednesdays and Fridays at ten, during the Michaelmas and Lent terms

Dr Donald Macalister, St John's, has been appointed Assessor to the Regius Professor of Physic.

Mr S F. Dufton has been elected to a Fellowship at Trinity College, and Mr. A Hutchinson of Christ's has been elected to a Fellowship at Pembroke College, in each case for distinction in Chemistry Both gentlemen took first classes in each part of the Natural Sciences Tripos

Mr J Y. Buchanan, F.R.S, University Lecturer in Geography will deliver a course of lectures on Oceanography during the present Term in the New Museums, on Tuesdays at 12 o'clock, commencing on Tuesday, October 18

Mr. W C. D. Whetham, B.A., Fellow of Trinity College, has been appointed Assistant Demonstrator of Physics in the Cavendish Laboratory.

Mr W B Hardy, M A., Junior Demonstrator of Physiology, has been elected to a Drosier Fellowship in Gonville and Caius College.

SOCIETIES AND ACADEMIES

Paris.

Academy of Sciences, October 3.—M. de Lacaze-Duthiers in the chair.—Observations of the new planet Borrelly, made at the observatory of Algiers (equatorial coudé), by MM. Rambaud and Sy, communicated by M. Tisserand.—On considerations of homogeneity in physics, and on a relation between the velocity of propagation of a current and the capacity and coefficient of self induction of the line, by M. C. Clavenad.—On the coexistence of dielectric power and electric conductivity. A claim of priority advanced by Mr. E. Cohn over M. Bouty (see *Wiedemann's Annalen*, vol. xxviii. p. 454).—Comparative evaporation of the solutions of sodium chloride, potassium chloride, and of pure water, by M. Pierre Lesage. Within the limits of the experiments, pure water evaporates more rapidly than solutions of either chloride. The solutions of KCl have, with the same degree of concentration, a greater rate of evaporation than those of NaCl.—On a fossil piece of wood containing fluorine, by M. T. L. Phipson. This was found in the cretaceous sandstone of the Isle of Wight, and analysed thirty years ago. It yielded 32.45 per cent. of phosphoric acid and 3.90 per cent. of fluorine. It had a brown colour and a density of 2.71.—Identity of cascarine and rhamnoxanthine, by the same.—On a respiratory globuline contained in the blood of the chitons, by M. A. B. Griffiths. The yellow blood of the chitons contains a respiratory globuline which contains no metal. It is colourless, and possesses the same properties of oxygenation and deoxygenation as hæmoglobine, chlorocruorine, and other respiratory substances. Its empirical formula is

$$C_{621} H_{814} N_{175} SO_{160}$$

It has been named β-achroglobine, to distinguish it from that of the Patella, which has been called acroglobine.—Influence of the electric light on the structure of herbaceous plants, by M. Gaston Bonnier. After his researches on trees carried out at the electric station of the Paris Central Markets, the writer experimented upon herbaceous plants under similar conditions. The plants were placed at distances varying from 1.5 to 4m. from arc lamps, whose light was kept constant for seven months. The excess of ultraviolet radiation was intercepted by glass shades. Under these circumstances, the majority of plants exhibited intense activity of assimilation. 12 gr. of leaves of *Ranunculus bolbosus* developed 1.05 of oxygen in one hour, the corresponding figure for diffused daylight being 0.52, and for full sunlight in midsummer 3.95. A certain proportion of plants died off, even in intermittent light, especially if no shade was used. Some plants showed an exuberant vegetation, the leaves a deeper green, and the petals more striking colours. Of these, however, the larger number soon began to suffer from excessive assimilation. Some were able to adapt themselves completely, such as bulb plants, grasses raised from seeds, arborescent species, and submerged aquatic plants. The latter also showed no difference in structure, whereas the leaves of crocuses, anemones, and ranunculi became almost unrecognisable owing to anatomical modifications. As a general result, if the continuous electric light through glass produces a great development in an herbaceous plant accompanied by an intense green, the structure of the organs is at first highly differentiated; but if the electric light is intense, and prolonged for several months without change, the new organs formed by the plant, which are able to adapt themselves to this kind of illumination, present remarkable modifications of structure in their various tissues, and are less differentiated, although always rich in chlorophyll. Further, the direct electric light is prejudicial to the normal development of the tissues in virtue of its ultra-violet rays, even at a distance of more than 3m.

Gottingen.

Royal Scientific Society, March to June.—The following scientific papers have appeared in the *Nachrichten*:—

March.—Bürger: Preliminary contributions to a systematic account of the Nemertean fauna of the Gulf of Naples.

April.—Wallach and Marmé: New chemical combinations of vegetable origin.—Hecht: Contributions to geometrical crystallography.—Hurwitz: On the theory of Abelian functions, generalising algebraic functions into multiplier-functions and stating the generalised "Roch" theorem.—Schönflies: Certain rectilinear portions of Riemann surfaces.—Fricke: Discontinuous groups whose substitution-coefficients are integral numbers belonging to a quartic "Korper."—Fricke: Modular correspondences.—Fricke: On the *s* function (2, 3, 7).—Ritter: One-valued automorphic forms of deficiency zero.—Lindemann: Solution of equations by transcendental functions. (Second note. See Roy. Soc. of Gottingen, 1884.)

June.—Hallwachs: Velocity of light in dilute solutions.—Klein: *Real* relations in Abelian functions.—Bodlander: Molecular combinations in solutions.—Traube: The crystal forms of optically uniaxial substances.—Drude: The theories of light tested by practical physics.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Books.—Matriculation Chemistry: Temple Orme (Lawrence and Bullen).—Elements of Human Physiology: Dr. E. H. Starling (Churchill).—A Vertebrate Fauna of Argyll and the Inner Hebrides: J. A. Harvie-Brown and T. E. Buckley (Edinburgh, Douglas).—Le Léman Monographie Limnologique, F. A. Forel. Tome Premier (Lausanne, Rouge).—Epidemic Influenza: Dr. F. A. Dixey (Clarendon Press).—Das Photographische Pigment-Verfahren: Dr. H. W. Vogel (Berlin, Oppenheim).

Pamphlets.—Étude sur la Courants et sur la Température des Eaux de la Mer dans l'Océan Atlantique: General H. Mathiesen (Christiania, Larpent).—Jupiter and his System: E. M. Clerke (Stanford).

Serials.—Engineering Magazine, October (N.Y.).—Contributions from the U.S. National Herbarium, vol. i. No. 5 (Washington).—Himmel und Erde, October (Berlin, Paetel).—Veröffentlichungen aus dem Königlichen Museum für Völkerkunde, 2 Band, 1/4 Heft (Berlin, Spemann).

CONTENTS.

THURSDAY, OCTOBER 20, 1892

FRESNEL'S THEORY OF DOUBLE REFRACTION

The Optical Indicatrix and the Transmission of Light in Crystals By L Fletcher (Oxford University Press Warehouse, 1892)

MR FLETCHER has given us a valuable and most interesting book He has attacked some parts of the theory of double refraction in a manner which is free from many of the objections that may be made to the method more usually adopted, and which has the advantage of closely resembling that by which Fresnel himself made his great discovery

In dealing with this discovery we must carefully bear in mind two facts The result of Fresnel's theory—the determination of the actual form of the wave-surface in a biaxal crystal—is undoubtedly true, the mechanical reasoning on which, in his second memoir on double refraction, he bases that result, is as undoubtedly false In recent times the explanation of the properties of the wave-surface has been usually based on the erroneous mechanical reasoning Mr Fletcher, following Fresnel himself, has shown us how all these properties may be deduced from certain experimental results without the introduction of the false mechanics In one sense this is a backward step, but since the advance had been in the wrong direction, it was necessary to retreat, and though Mr Fletcher's book teaches us nothing new of the mechanism of double refraction, it puts the kinematics of the theory and the geometrical results which it entails on a sure foundation, and this is an achievement for which the author deserves our warmest thanks

The history of the discovery of the law of double refraction, as given in Fresnel's own papers, is of the deepest interest The form of the wave surface, in a uniaxal crystal, a sphere and spheroid, had been discovered by Huyghens Up to the time at which Fresnel wrote it was generally supposed that even in a biaxal crystal one ray obeyed the ordinary law of refraction In 1816 Fresnel and Arago proved that in an isotropic medium the direction of the periodic disturbance to which light is due is transverse to the ray, and from that time Fresnel set himself to investigate the laws of double refraction He soon saw that the reasoning which led him to expect that in a uniaxal crystal the velocity of one wave must be constant could not apply to crystals with two optic axes, and that in such, contrary to the usual belief, there could be no ordinary ray This was announced in June 1820. The first memoir on double refraction, presented to the Academy November 19, 1821, but not printed till 1868, gives a detailed account of the experiments by which this result of his theory was verified, and contains the earliest development of the theory itself. According to Fresnel's views at this time the ether displacement in a crystal was at right angles to the ray—it is noteworthy that the latest development of the mechanical theory leads to this same result—and the velocity of propagation depended on the elasticity of the medium in the direction of displacement. Since, then, for any ray there are two possible velocities there must for that ray be two and only two directions of displacement, the light must be polarized in one of two directions Since, also, the velocities are different in different directions, in Fresnel's view the elasticity corresponding to a given direction of vibration must depend on the direction, and a surface of elasticity can be drawn each radius of which shall be proportional to the elasticity in its own direction When once this surface is known, the rest of the problem can be readily solved Now, in the memoir we are referring to ("Premier Mémoire sur la Double Réfraction, Œuvres Complètes d'Augustin Fresnel," T ii No xxxviii) Fresnel proved, for the case in which the double refraction was not strong, for which therefore the distinction between the ray and the wave normal might be neglected, that if for a uniaxal crystal the surface of elasticity were a spheroid of revolution the wave surface and the laws of double refraction would be those discovered by Huyghens It was an easy step from this to generalize and to suppose that in a biaxal crystal the surface of elasticity might be an ellipsoid, and to examine the results This gave him at once, to the same degree of approximation as in the previous case, the form of the wave surface known by his name and the experimental laws of biaxial refraction discovered by Brewster and by Biot As yet the result was only approximate, worked out more completely the theory can be shown to lead to the same form of the wave surface as that developed by Lord Rayleigh (*Phil. Mag*, June, 1871) Huyghens' laws and those of Biot and Brewster are not accurately obeyed.

But Fresnel's mind moved rapidly, and a week later, November 26, 1821 ("Extrait d'un Mémoire sur la Double Réfraction," Œuvres, Vol ii, No xxxix), he corrected his first results and announced his complete theory The modifications required were not great, in his original theory he had supposed the displacement to be at right angles to the ray, in the final form it is supposed to be at right angles to the wave normal, *i.e*, in the wave front, while the elasticity in any given direction, and therefore the corresponding velocity, is given by the reciprocal of the radius vector of a certain ellipsoid instead of by the radius vector itself. With these modifications the wave surface is accurately Fresnel's surface and the experimental laws of double refraction are accurately obeyed To this ellipsoid (of which the inverse is Fresnel's surface of elasticity) Mr Fletcher has given the name of the "Indicatrix" According to Fresnel's theory the two possible velocities of wave propagation in any direction are the reciprocals of the axes of the section of the indicatrix by the wave front This law has been verified to a high degree of accuracy by direct measurement, and is thus made by Mr. Fletcher the basis of his treatment of the problem. These Memoirs of Fresnel's remained unpublished till 1868 The only printed announcement of the results was a notice in the *Moniteur*, December 12, 1821, with a view of claiming priority for the discovery, and the Report of the Referees, Fourier, Ampère, and Arago, who (August 19, 1822) recommended that it should be printed in full in the "Recueil des Savants Etrangers"

Instead, however, the Second Memoir on Double Refraction (Œuvres, tome ii., No. xlvii) was printed

(tome vii of the Recueil) in 1827, the year of his death, and this is the paper which contains Fresnel's latest developments of his theory In it he suppresses entirely his method of generalization and develops that mechanical theory by which, to quote his biographer Verdet, "he endeavoured to rediscover truths which a profound intuition had first revealed to him" The truths remain, and though Fresnel's methods and their historical development are clearly given in his collected works and in M Verdet's most admirable introduction to them, Mr Fletcher has done good service to science in calling fresh attention to these earlier papers and in making a modification of this method of Fresnel's the foundation of his work

In his note to the first memoir, when discussing the inexact reasoning by which Fresnel afterwards supported his mechanical theory, Verdet writes ("Œuvres de Fresnel," ii, p 327) —

> "Il pouvait sembler singulier que le résultat définitif d'un raisonnement incomplet et inexact en deux points fût une des lois de la nature dont l'expérience a le mieux confirmé la vérité On a vu au contraire que cette loi s'était manifestée à Fresnel comme le résultat d'une généralisation toute semblable aux généralisations qui ont amené la plupart des grandes découvertes Lors qu'il a voulu ensuite se rendre compte de la loi par une théorie mécanique il n'est pas étonnant qu'il ait, peutêtre à son insu, conduit cette théorie vers le but qu'il connaissait d'avance et qu'il ait été déterminé dans le choix des hypothèses auxiliaires moins par leur vraisemblance intrinsèque que par leur accord avec ce qu'il était en droit de considérer comme la vérité"

True though this may be, the fact remains that until Lord Kelvin developed his theory of a contractile ether a few years ago, no one of the distinguished men who have followed in Fresnel's steps had discovered a satisfactory mechanical basis for Fresnel's great generalization But to return to the book before us As has been mentioned, Mr Fletcher's method of development differs somewhat from that indicated by Fresnel He finds it more convenient to work with rays than with wave-normals or wave-fronts, and the construction he adopts is the following —Draw a normal at any point of the ellipsoid of elasticity—the indicatrix in Mr Fletcher's language From the centre of the ellipsoid draw a line perpendicular to this normal, and consider a ray travelling in the direction of this perpendicular Then the reciprocal of the intercept on the normal between the surface and the ray measures the velocity of propagation along the ray, and the plane of polarization of the ray touches the indicatrix at the point at which the normal is drawn According to Fresnel's theory the radius vector drawn from the centre to this point is the direction of vibration in the ray, while according to the most recent modification of the theory, the motion takes place along the normal itself From this simple construction the form of the wave-surface and all the known laws of the propagation of light in crystals are deduced in a strict and skilful manner At the same time, while giving Mr Fletcher the fullest credit for his originality, we are at times inclined to wish he had adhered more closely to Fresnel's method He admits of course himself that a single ray cannot be propagated through the ether We may hope that some of those who read his book will go on to study the mechanical theory of double refraction Then they must deal with waves and not with rays, and they would find it an advantage to have had the one idea to guide them throughout. Again, the new method leads to a multiplicity of names for one and the same thing, and this is a disadvantage We have ray-surface used for wave-surface, although the two are identical, nor is it easy at first to recognize the optic bi-normals and the optic bi-radials as the optic axes and the lines of single ray velocity respectively, but these are small points when compared with the main object of the book, which well deserves attention and careful study The last chapter deals with the problem in a more general way, but space forbids us to follow Mr Fletcher into the questions he there raises, it must suffice to call the reader's attention to it, and especially to the fallacy discussed in Section 17

R I G

THE PROGRESS OF HORTICULTURE

Contributions to Horticultural Literature By William Paul, F L S (Waltham Cross, Herts W Paul and Son, 1892)

For about half a century Mr Paul has been labouring at the work of horticulture alike in the garden and at the desk As a business man he has not confined himself simply to commercial routine As an observer and an experimenter he has not been hedged in by the dogmas and prejudices of any particular school of science, and as a writer his aim has always been to record truthfully and instruct faithfully It is a matter of congratulation, therefore, that the author should have gathered together in a convenient form some records of a lifetime's work

Certain portions we should have eliminated as of past or of personal interest only, certain others as of relatively minor importance, but Mr Paul is addressing a mixed audience with varied sympathies and interests, and it may be that the paragraphs we should mark for deletion would be those which others would best care to preserve

Mr Paul groups his writings, as here collected, under the three heads of (1) roses, (2) trees and plants, and (3) fruit culture and miscellanea They would fall equally well under other categories, such as the commercial and practical, the æsthetic and the biological In this notice we must confine ourselves to Mr Paul's writings as a naturalist Such, however, is the interdependence among various branches of inquiry, that it is almost impossible, in this connection to isolate any special subject, even if it were desirable to do so From this point of view Mr Paul's book is, though undesignedly, an apt representation of the present condition of horticulture On the one hand, the relations of that art to the perception of and to the canons of beauty are obvious Equally clear are its bearings on routine practice. On the other hand, its connection with biological science, in spite of the teaching and example of Darwin, is not yet adequately recognized, nor has the statesman as yet grasped the truth that progress in agriculture must follow to a large extent on the lines familiar to horticulturists Of the many remedies proposed to mitigate and clear away the depression under which agriculture is suffering, none is more likely to be serviceable than the adoption, so far as

circumstances permit, of the principles and practice of the progressive gardener This is very obvious to those conversant with the state of commercial horticulture, as contrasted with the condition of the corresponding department of agriculture, and it will be brought home to the thoughtful reader by the perusal of some of Mr Paul's pages It is interesting, too, to see that matters at which some minds would still be inclined to scoff as unpractical, or which they would regard as mere means of affording agreeable recreation, are the very departments in which the greatest practical successes have been achieved in the past, and which are of the best augury for progress in the future

Biologically speaking, Mr Paul has been not only a keen observer but a careful experimenter on a very large scale, and over a very long period It is true his experiments have not been and could not have been made with the exact accuracy which we expect in the laboratory, but they have been made under conditions far more akin to those which occur in nature Moreover, they have been made, although with a definite aim, yet without reference to any particular theory The reader will accordingly find in these pages records of work and inferences from carefully planned experiments directly bearing on many subjects now attracting the attention of naturalists, such as hereditary transmission, variation from seed or from bud, selection, fixation, close fertilization, and the various degrees of cross-impregnation Incidentally these subjects receive illustration in many chapters of Mr Paul's book, but the address on "The Improvement of Plants," which was read in 1869 before the provincial meeting of the Royal Horticultural Society at Manchester, contains a summary of Mr Paul's views on these subjects, which we strongly commend alike to the notice of naturalists and of agriculturists

It is very interesting to compare what he says about selection and variation in plants, such as the Camellia, the Chinese Primrose, or the Hollyhock, which are the offspring of what we regard as pure species, with the corresponding processes in the Rose, the Pelargonium, or the Chrysanthemum, which are veritable mongrels In this connection we may in passing allude to the power which the gardener has, of course within limitations, of creating new forms The orchid cultivator, for example, inferred parentage of certain hybrids met with in a wild state, but he has since proved the correctness of his inference by actually producing in his orchid-house many of the same forms that occur in the forests of the tropics Another very striking case (not specially alluded to by Mr Paul) is the production and development of what are known as tuberous Begonias These have been evolved by the art and patience of the gardener within the last quarter of a century from repeated crossing between certain Andean species of Begonia and their descendants The result is the establishment of a race so totally distinct from anything yet known in nature as would justify a systematic botanist in forming a separate genus for their reception Many an accepted genus is based upon less important points of distinction than those which characterize the tuberous Begonias, and which, indeed, have been gathered together by Fournier under the genus Lemoinea The degree of permanence of this artificially formed genus is, of course, unknown, but we do know already that the peculiarities are reproduced from seed, and that each year the plants are, as the gardeners say, becoming more "fixed" We have alluded to these as illustrations of the kind of work upon which Mr Paul has been engaged for half a century They may be taken as examples of the material he has gathered together in this book, which is not merely presented for the delectation of the ordinary lover of flowers or the profit of trading horticulturists, but is also calculated to increase the productive resources of the country, as well as to forward the progressive development of our knowledge of the natural history of plants

As a further illustration of Mr Paul's method we cite in conclusion a passage which will, we think, justify us for recommending to scientific readers the perusal of a book which they might be disposed, from its title, to think had little in it to interest them "My experience in selecting, hybridizing, and cross-breeding tells me that he who is seeking to improve any class of plants should watch narrowly and seize with alacrity any deviation from the fixed character, and the wider the deviation the greater are the chances of an important issue However unpromising in appearance at the outset, he knows not what issues may lie concealed in a variation, sport, hybrid, or cross-bred, or what the ground newly broken is capable of yielding under careful and assiduous cultivation If we would succeed in this field we must observe, and think, and work Observation and experiment are the only true sources of knowledge in nature and while observing and experimenting we should above all things guard against prejudices"

MAXWELL T MASTERS

LIFE IN MOTION

Life in Motion or, Muscle and Nerve By John Gray McKendrick, M D, F R S (Adam and Charles Black, 1892)

UNDER this title Prof McKendrick gives us the gist of six lectures delivered by him during last Christmas holidays to a juvenile audience at the Royal Institution of Great Britain, and, judging from this little work, it is evident that no pains was spared by him to render these lectures as instructive and interesting as abundant illustrations and experiments could make them. In presenting these lectures to the public in book form he places us under an obligation gratefully to be acknowledged for professional physiologists stand alone amongst their colleagues in other departments of science in their disdain of any attempt at the production of attractive and simple scientific literature In very pleasing sympathetic style the reader is introduced to the world of motion and to the special motions of the living muscle He is shown how the movements of a muscle are recorded by the physiologist, and the apparatus used for its stimulation Artificial tetanus is described, the muscle sound and its elasticity referred to, and a perhaps too short description given of amœboid and ciliary motion The physiology of the nerve is then discussed, and the production of heat in muscle In the fifth lecture is a short account of the sources of muscular energy, a comparison is drawn between a muscle and the steam engine, and a comparatively detailed account of muscle fatigue is given

The sixth and final lecture deals with the electrical phenomena of muscle and with a very curious group of fishes termed "electrical"

The arrangement of the book is excellent, yet we are inclined to think that it shares with many other works on physiology one common fault What we all want to know more about is the life and activity of the organism, and the physiologist very rightly spends much of his time in experimenting in every conceivable way, and generally with isolated parts of the organism His apparatus is often of the most varied and intricate kind, and his experiments yield him definite results Many of these results, however, are at present of little value in shedding light on physiological processes, and should not, we think, obtain the prominent position they now occupy in the text-books To take an example, the experiment to demonstrate the muscle curve, in which the muscle is isolated and stimulated electrically, is one of the stock experiments minutely described in every text book In this experiment the muscle is separated from its antagonistic muscles, stimulated in quite an unnatural way, and the result of the experiment is totally different from what takes place in a contracting limb It is certain that in nearly every text-book the reader will find that from this and similar experiments he is apt to obtain incorrect and misleading ideas He no doubt learns something regarding very interesting electrical machinery, but very little physiology Of recent years far more attention has been bestowed upon the movements of muscles in the limbs, and comparative physiology is at last asserting its influence It is to be hoped that when this knowledge finds a more prominent place in text-book literature, "muscle and nerve physiology," in the proper sense of the term, will be more satisfactorily taught

Returning to what more exclusively concerns Prof McKendrick's book, we may point out a slip on page 81, where it would appear that the muscle sound corresponds in pitch to the fundamental tone of a body vibrating 19 5 times a second, instead of to one vibrating at twice that rate, and that Prof McKendrick does not interpret this sound on the lines followed by Helmholtz and others On page 91 the modern view of a "cell" is represented in a drawing, and the nucleus has inadvertently been omitted On page 31 a long and short circuiting key is represented, while a simple key is described in the accompanying text These, however, are but trivial faults to find in an excellent little work, which is most admirably got up and beautifully illustrated by nearly one hundred excellent figures.

The reader will, we think, obtain a good insight into a department of physiology, and will be stimulated to further research in the literature of this interesting subject.

J. B H

PLUMBING

Principles and Practice of Plumbing By S Stevens Hellyer (London George Bell and Sons, 1891)

THOSE who are acquainted with Mr Hellyer's larger book on domestic Sanitation, "Dulce Domum," will not find much new matter in the present volume, but the subjects are treated less discursively, and are fairly well brought down to date

There is no trade which has been more discussed in recent years than that of plumbing, and if plumbers are not impressed with a sense of their responsibilities, it is certainly not the fault of the architects and engineers who employ them The manual skill necessary to perform the most ordinary operations is in itself so difficult that many workmen fail to acquire it, and, on the other hand, many experts in the details of the craft are never properly educated in the principles of sanitation which are necessary to make their work effectual from a sanitary standpoint It is the combination of both kinds of knowledge in the writer which makes Mr Hellyer's books of exceptional value It matters little whether it is an architect on one hand, or a working plumber on the other, who studies them, because they are of equal value and of equal interest to both The present handbook is specially valuable in these respects because most of the information upon matters of practical workmanship is given concurrently with the reasons which should control the details and the principles which should be in evidence when the work is finished

No one unacquainted with the practical difficulties which frequently crop up in sanitary practice can realise how much knowledge and experience is necessary to overcome them Houses in London often present the most puzzling problems, and an intimate acquaintance not only with the principles and practice of the subject, but also with all the most recent appliances, is required for their successful solution The ventilation of all the different parts of a complicated drainage system, including that which is necessary to prevent the syphonage of traps, sometimes requires an amount of thought and attention which a layman would think was uncalled for in the face of its apparent simplicity It is no wonder that there are frequently failures to meet the highest standard of excellence, especially when incompetent persons are employed to design and superintend the necessary operations On the other hand, there are thousands of houses in London in which no such difficulties occur, and in which the drainage and plumbing arrangements ought not only to be extremely simple in themselves, but intelligible to the ordinary householder When such cases are entrusted to a builder, or an intelligent plumber, the first requisite is the manual skill required to carry out the various details, and this must be acquired by the workman through apprenticeship, or from his having acted as the assistant or "mate" of a journeyman for several years The next requisite is that he should have a clear knowledge of what he is going to do and why he does it This may be acquired to a great extent from his being familiar, in his capacity as a workman, with the designs of an architect or engineer under whose directions he has been employed, and it is to such men that Mr Hellyer's text-book should be specially valuable By studying its pages he will avoid many mistakes He will know what sort of joint to make, what kind of trap to avoid, how to secure the traps from syphonage, and how generally to complete his work so as to pass the latest standards of excellence We can equally recommend it as a text-book for architects

who, although they are unable to acquire any technical skill in carrying out the operations themselves, should have, nevertheless, an intimate knowledge of the principles which they ought to embody.

We think that more space should have been devoted to that portion of the book which deals with drainage proper. While nearly 100 pages are given to lead-laying and the jointing and bending of pipes, only about twenty pages are devoted to house drains, and a great part of this is occupied with illustrations of appliances. Not more than one or two pages are given to the subject of cast-iron drains, although they are strongly recommended, and the subject is a very important one. We trust, however, that the author will remedy these deficiencies in the future editions which will doubtless be required to supply the demand for his excellent text-book.

OUR BOOK SHELF

A Lecture Course of Elementary Chemistry. By H. T. Lilley, M.A. (London: Simpkin, Marshall, Hamilton, Kent and Co., 1892.)

THE abrupt use of chemical terms, and the condensed style adopted by the author in this book, make it evident that it is not specially designed to smooth down the difficulties which confront the unaided learner who approaches chemistry for the first time. It seems rather to be fitted to replace the notes which might be taken on a course of lecture instruction. Regarded in this light it is a useful volume, the knowledge it contains being, in the main, sound and to the point.

It deals with the metals as well as with the non metals, and dovetailed with the ordinary chemical information are many instances that the author has tried to keep pace with current work, and has attempted to give the student all the important points to be noted in a fairly complete course of elementary chemistry.

A short series of exercises chiefly in chemical arithmetic are given at the end of the book, and a table of contents and an index are supplied.

It would be advisable on p. 53 to say that ordinary sulphur crystallises in the rhombic system. To speak of the crystalline form as an octohedron tends to create an impression common among students, that ordinary sulphur belongs to the cubic system. Fluorine was not made by the electrolysis of liquefied hydrofluoric acid, but of a solution of potassium fluoride in the acid; the pure acid is a non-electrolyte.

It is hardly correct to state that calcium sulphate and hydroxide are the only known examples of solids less soluble in hot than in cold water; calcium isobutyrate and one of the thorium sulphates are additional instances. On p. 98 the flame colorations of potassium and sodium are confused, and brass seems to be omitted in treating of the alloys of copper and zinc. J. W. R.

Longmans' School Geography for North America. By George G. Chisholm and C. H. Leete. (New York: Longmans, Green, and Co.)

IF Mr. Chisholm's well-known geographical text-book was to be extensively used in the United States, it was inevitable that it should be altered in a way which would adapt it to the special needs of American schools. The task was undertaken by Mr. Leete, and he has accomplished it with much skill and judgment. The parts he has rewritten are those relating to America in general, North America, and the United States. To these he gives a prominence which was not necessary or desirable for European students of geography, but which is no doubt essential for learners on the other side of the Atlantic. The plan of Mr. Chisholm's book and the spirit of its execution have both been maintained, and the work ought now to be quite as useful in the New World as it has already been in the Old.

Garden Design and Architects' Gardens. By W. Robinson, F.L.S. (London: John Murray, 1892.)

THE author of this book is firmly convinced that to clip and align trees in order that they may "harmonise" with architecture is "barbarous, needless, and inartistic." He is in love with Nature's methods, and would give them in gardens much freer scope than is accorded to them by persons who like best a certain trimness and formality. It is to be regretted, perhaps, that Mr. Robinson deals with the subject in so polemical a temper, but the cause for which he contends is good, and he does excellent service by bringing out prominently what has always been the essential principle of the best and most characteristic kind of English landscape gardening. The value of the essay is greatly increased by a number of well-selected illustrations.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Alleged "Aggressive Mimicry" of *Volucellæ*

IN the course of a review (NATURE, October 6, 1892, p. 535) of a book, "Animal Coloration," by Mr. Beddard, Mr. Poulton takes occasion to refer to a theory professing to elucidate the resemblance of *Volucellæ* to humble bees, &c. This reference is occasioned by the suggestion of a counter-hypothesis by Mr. Beddard. The view adopted by Mr. Poulton ("Colours of Animals," 1890, p. 267) is that proposed by Kirby and Spence, and subsequently alluded to by Kunckel d'Herculais ("Organ. et Devel. des Volucelles," Paris, 1875) and others; but as Mr. Poulton makes no reference to these authorities he may be assumed to accept the full responsibility. In the place named he says:—"The boldness of these enemies sometimes depends on the perfection of their disguise. Thus the larvæ of flies of the genus *Volucella* live upon the larvæ of bees and wasps. *Volucella bombylans* occurs in two varieties, which prey upon the humble bees *Bombus muscorum* and *B. lapidarius*, and are respectively like these Hymenoptera. The resemblance is very perfect, and the flies enter the nests to lay their eggs." Mr. Beddard (*l. c.*, p. 225) criticizes the view that the fly resembles the bee that it may with impunity enter the nest, and proposes to look on the presence of the fly's larvæ in the bees' nests as akin to the presence of supposed "pets" in the nests of ants. As Poulton points out, this suggestion leaves the original difficulty of the likeness of the fly to the bee untouched.

Having little interest in either of these speculations, which seem fantastic and premature, it is with reluctance that I take part in the discussion. The case, however, of *V. bombylans* is not only interesting as a striking, and to us in England a most accessible instance of the phenomenon of Mimicry, but as an example of Variation it is almost unique among animals, while among plants perhaps it is paralleled only by Darwin's famous case of the peach and the nectarine. It is besides a case well suited for experiment and close observation. The nests of surface building bees may towards evening be lifted bodily, bees, *Volucellæ*, and all, with a spit of earth, and transferred to a box. This may be taken home and set next morning on a window sill, when on opening the box the bees will go on with their work for the rest of the summer. If any one seeks an opportunity of honestly trying to get to the bottom of a case of Mimicry, instead of speculating about it at large, he can scarcely find a better case than this. The need for such observations is great, for the account confidently given by Poulton, though according well with his hypotheses, accords with the truth less well.

In these circumstances it may not be out of place to give a brief statement of the facts as they were established by entomologists long ago. The *Volucellæ* are a small group of flies, con-

taining four British species (Verrall, "Cat Brit Dipt," 1888), of these most if not all resemble various Hymenoptera The commonest and most remarkable is *V bombylans*, which may be seen in any English hedgerow on a sunny day in early summer This fly exhibits the rare condition of existing in two distinct forms in both sexes The one form is black with a red-tail, in no small degree resembling a small worker of a red-tailed humble-bee such as *B lapidarius* L or *B Derhamellus* Kirb The other form has a yellow border to the thorax, yellow hairs on the antero-lateral parts of the abdomen, and a grey tail, to an equal degree resembling a small worker of one of the several yellow banded humble bees, *e g B hortorum* L, *B terrestris* L, or *B Scrimshiranus* Kirb Both varieties occur in both sexes and are about equally common The problem of the evolution of these distinct forms is thus one of the most complex Some may ask, If the varieties are thus distinct, how are they known to be one species? The evidence of this is (1) that no point of structure can be found to differentiate them, (2) that males of the one variety have been seen coupled with females of the other and *vice versa* (Macquart, "Suites à Buff," p 479, Zeller, *Stet ent Ztg*, 1842, p 66), and lastly (3) that intermediate forms have been found as rarities (Erichson, *Stet ent Ztg*, 1842, p 115) This evidence may not satisfy all, but as regards Mr Poulton the identity of the two as one species is not in dispute, for he admits this

But though the likeness of *V bombylans* L and its var *mystacea* L. (= *plumata* de Geer) to the red tailed humble bees and to the yellow banded humble-bees respectively, is really close, neither these forms nor the less common var *haemorrhoidalis* Zt present any special likeness to *B muscorum* L, which has a bright brown thorax and a grey abdomen It is true that Kunckel has spoken of a resemblance between the var *mystacea* and *B muscorum*, but it is hard to see upon what ground, for indeed it is much as if one were to liken a tabby cat to a fox As Kunckel himself says, the great resemblance of the fly is to the yellow banded *B hortorum*

To return to Mr Poulton's statement, he says that the two varieties prey upon "*Bombus muscorum* and *B lapidarius*, and are respectively like these Hymenoptera" These words contain an ambiguity which I cannot believe intentional But supposing for a moment that one of the varieties *were* like *B muscorum* (which it is not), the sentence must be taken to mean that each variety preys upon the species of bee which it most resembles, the red-tailed variety on the red tailed bee and the yellow variety on the other This is indeed demanded by the hypothesis of "Aggressive Mimicry" In this form the statement is often made, though I never met it elsewhere in print I invite Mr Poulton to produce observations in support of that statement If he will establish it he will do a useful work When this statement was written I must believe that Mr Poulton had not read the several authorities on the subject, many of whom relate how both varieties have been reared from the nests of each type of bee, both from the red tailed and from the yellow-banded (Kunckel, p 58, Drewsen, *Stet ent Ztg*, 1847, p 211, F Boie, Kroyer's "Naturh. Tids," 1838, p 237) It is still possible that both varieties are born of one mother, and it is possible, too, that each female does her best to choose the nest of a bee like herself, but in support of this hypothesis I know no evidence, and indeed Kunckel (p 58), after considering this possibility, gives it as his opinion that probably the varieties of *V bombylans* lay indifferently in the nests of all *Bombi* From the omission of these facts, which to an appreciation of the evidence are vital, we should infer that Mr Poulton was not acquainted with Kunckel's work, were it not that he repeats Kunckel's selection of *B. muscorum* as a form resembled by one of the two varieties

But though Mr Poulton is wrong in saying that either variety specially resembles *B muscorum*, he is right in saying that *V. bombylans* preys on this bee's nests, for *both* varieties have been bred from them, even from the same nest (Kunckel, p. 58) In my rooms at this moment are several nests of *B muscorum*, each containing many larvæ of *V bombylans*, resting for the winter, to emerge in summer, as I hope

There is then evidence that the two varieties, though they may breed together, yet remain substantially distinct, and that though they respectively resemble different species of bees, they are both found together, not only in nests of bees which they resemble, but also, and in my own experience, more abundantly, in the nests of another bee which they do not resemble.

Mr Poulton further omits to mention that *V pellucens*, though in nowise resembling the common wasp, yet lives in its nests, together with *V inanis* which does resemble a wasp, and *V zonaria* which is like a hornet (Kunckel, pp 54 and 55) This fact also I commend to Mr Poulton's ingenuity

The publication of statements like this of Mr Poulton's, omitting most salient facts—facts, besides, which, though adverse to his speculations, add a ten fold interest to the subject—is surely unfortunate It may be replied that Mr Poulton's book is of a popular character and does not aim at the completeness of scientific work, but in making choice of evidence, even for popular exposition, it is well to remember that the value of facts is not to be measured by the ease with which they may be momentarily fitted to the sustenance of a facile hypothesis WILLIAM BATESON

St John's College, Cambridge, October 9

Induction and Deduction

MISS JONES agitates a question that ought not to settle down without having caused that discussion which its propounding is fit to awaken

This discussion does not, however, relate to the mutual relations of Induction and Deduction—at least, not as the main topic thereof It relates to the fragmentary condition of that which is usually referred to and accepted as logic We are so apt to take it for granted that our so called logic is tolerably competent and complete as an account of human reasoning in general, that it is of great utility when some one—as Miss Jones does now—raises a question that is adapted to direct our reflections towards some one of the several, perhaps many, gaps that exist in that most important, but too often not understood and misunderstood, branch of science It is with this specially in view that I have ventured to write this

In geometry nothing is more usual than to draw a universal conclusion from a case that, to all ordinary ways of apprehension, seems to be a single instance Indeed, this is one of the cardinal features of geometrical reasoning Perhaps we might well say that it is the most characteristic feature It is this feature that the question that Miss Jones agitates ought to call into prominent notice

She selects for her purpose the case of the isosceles triangle, and asks, How, from premising that the angles at the base of an (one) isosceles triangle are equal to each other, are we logically warranted in concluding that that same equality is true of all isosceles triangles?

That we do thus conclude is known to all, as is also the truth that such a conclusion is a typical one in geometry Nor have we, nor can we have, the least misgiving as to the rigorous validity of such conclusions

It would be a digression for me to point out here the essential characteristics of that form of reasoning which, properly speaking, is induction It is sufficient for my present purpose to remark that true induction is utterly unable to yield us any conclusion that is more than *probable and approximate*

From these characteristics alone we may know that our geometrical conclusions in view are *not*, as Miss Jones takes them to be, inductive conclusions

But since our geometrical conclusions are natural and valid, the question still remains, What sort of conclusions are they?

If we propose to call them deductive conclusions, then, when we revert to the array of syllogisms, categorical, hypothetical, disjunctive, dilemmatic, &c, we find none of them, nor any combination of them, that can by any means be made applicable We have to get not merely from an apparently particular but from an apparently absolutely singular proposition to a universal one To do this deductively, the body of doctrines and canons, that is usually called logic, confesses itself wholly unable It lays down as one of its cardinal rules, one that it declares is "founded upon the Laws of Thought," that if any premise is particular, then only a particular conclusion can be drawn

Nevertheless, I am going to submit that the reasoning under discussion is a true instance, not of induction, but of deduction. I submit that the reasoning that we do actually follow is that which may be formulated thus:—

This isosceles triangle is ANY *isosceles triangle*

The angles at the base of this isosceles triangle are equal to

each other Therefore, the angles at the base of any (or every or all) isosceles triangle are equal to each other

In order to make the nature of this reasoning plainer, I will put the same in symbols

Put X = the isosceles triangle in general,
Z = this particular isosceles triangle,
a = angles at the base,
e = equal to each other

Then our reasoning will appear thus —

Z is X,
a of Z is e
a of X is e

This looks very much as though we had in hand a case of the logic of relatives

We will all recollect the challenge of De Morgan —"If any one will by ordinary syllogism prove that because every man is an animal, therefore every head of a man is a head of an animal, I shall be ready——to set him another question" This would be in symbols—

All M is A,
h of M is h of A

Our case, according to this sort of formulation, would appear—

Z is any X,
a of Z is a of X,
a of Z is e,
a of X is e

The distinguishing characteristic of our case as compared with the case put by De Morgan resides in the different natures of the two propositions—

All M is A,
and Z is any X

The former is the usual universal categorical affirmative proposition of ordinary logic The latter is a sort of universal categorical affirmative proposition that certainly exists and is important, but which has not yet been recognized, unless it may be by the quantifiers of the predicate in their proposition—

All A is all B

It implies rigorously that not only

Z is any X,
but that Z is every X,
Z is all X,
any (or every or all) X is Z
„ („ „) not X is not Z
„ („ „) „ Z „ X
any X is every Z
every X is any Z
every not X is any not Z
any „ „ „
&c, &c

In truth, to a superficial notice, it may easily seem to confuse the most important logical distinctions But this is only because we are so used to identifying logic in general with the logic of extension It is the logic of extension, or in other words, metric logic, that has been persistently tendered to us as the only logic worthy of study, if not indeed as the only logic practicable or perhaps possible Yet we can now, I think, see that geometry at least makes great use of a logic that is not the logic of extension, and that the existence of geometry is an earnest that that other logic may be developed and formulated, if not completely at least to some very useful extent

The proposition,

Z is any X,

is, as I conceive, a proposition of the logic of intension It applies not to things, or to concepts in connection with things, but to pure abstract concepts like geometrical figures, whose marks are exhaustively specified, or, if any are not specified, the same depend upon and are implied by those that are specified

One point more remains to be explained

We must not from the recognition that Z is any X, and the rigorously following proposition that whatever is true of either X or Z is true of the other, conclude that these propositions should if valid hold for marks that are accidental to Z, or to any single instance of X. If we fail to keep clearly in mind the intensive scope of our propositions, we may discredit them, or one of them, by observing that although we have laid down that whatever is true of Z is true of any X, yet nevertheless it does not follow that Z is any X, as regards say the size of Z or any single instance of X Size may not be any necessary mark of either, and if so it is for all logical purposes impertinent to the propositions in question, and must be altogether ignored

I will conclude by saying that the inference actually made in the case put by Miss Jones is a deduction, because it necessarily follows from the premises laid down Logic has no connection with the truth of premises, it only says what certain propositions entail If in an intensive sense this isosceles triangle is any isosceles triangle, then any isosceles triangle is this isosceles triangle, and every isosceles triangle is this isosceles triangle, and all isosceles triangles are this isosceles triangle, and if the angles at the base of this isosceles triangle are equal to each other, it follows necessarily that the angles at the base of all isosceles triangles are equal to each other

Chicago, August 16 FRANCIS C RUSSELL

BY the courtesy of the Editor of NATURE I have been allowed to read Mr Francis C Russell's very interesting remarks with reference to my note on "Induction and Deduction" in NATURE of July 28 (p 293)

I agree with Mr Russell as to the validity and certainty of an inference from equality of angles in *one* isosceles triangle to equality of angles in *all* isosceles triangles But while I regard this inference as a "true induction" because it is an inference to a general proposition on the strength of a particular instance, Mr Russell denies that it is an induction because he holds that induction can give only approximate and probable conclusions, and considers that the certainty which he allows to belong to the geometrical conclusion in question is due to the fact that the inference is *not* from a particular instance, but is really and truly *from* universal *to* universal—the one isosceles triangle from which the argument starts being a kind of "pure abstract concept," so that we can say—

This one isosceles triangle is *any* isosceles triangle, therefore *every* iso celes triangle is *this* isosceles triangle, &c

This appears to me to be entirely inadmissible How can *this* triangle *BE that* and *the other* triangle? To say that it is, is to lose sight of the distinction between *identity of individuality*, and *similarity of characteristics* And that the assertion (*this* triangle is *every* triangle) is untenable appears also from Mr Russell's own admission further on, when he says that "we must not, from the recognition that Z is any X, and the rigorously following proposition, that *whatever* is true of X or Z is true of the other, conclude that these propositions should, if valid, hold for marks that are accidental to Z or to any single instance of X" If Z *is* any X, how can any X have marks which Z has not, or Z have marks which any X has not? We cannot get out of the difficulty by reference to extension and intension, for this reason, that every categorical proposition, to be significant, must be read both in "intension" and in "extension"—that is, affirmatives must be understood as asserting identity of extension (application) in diversity of intension (signification), while negatives *deny* identity "This isosceles triangle is *any* isosceles triangle" can have a useful signification only if it is interpreted to mean—

This triangle [not *is* but] *is similar* (in so far as isosceles) *to* any isosceles triangle—that is, all are *similar* in respect of the characteristics which are inseparable from equality of sides Hence (as I said in my letter, July 28) "in all cases equality of angles at the base is inseparable from equality of sides"

I am not clear what precise meaning can be attached to the expression "pure abstract concept," still less how a geometrical *figure* can be an abstract concept I am, moreover, disappointed that Mr Russell makes no examination whatever of my own attempt to formulate the process from Particular to General

With reference to Mr Russell's symbolical argument—

Z is X,
a of Z is e,
a of X is e,

I think that it may be logically described as a process either (1) of Substitution (Jevons)—a kind of Immediate Inference dependent on identity of application—thus —

Z is X;
∴ X may be substituted for Z

In a of Z is e
substitute X for Z,
and we have a of X is e

Or (2) a combination of what Jevons calls Immediate Inference by Complex Conception (which I should like to class with some other Immediate Inferences as Extraversion, which is largely used in mathematics) and Mediate Inference, thus—

Z is X (a)
∴ a of Z is a of X ∴ (b)
But a of Z is e (c)
∴ a of X is e (d)

(b) is Inference by Complex Conception from (a), (b) and (c) are the premisses which give (d) as their (syllogistic) conclusion.

Cambridge, October 11. E. E. CONSTANCE JONES.

The Temperature of the Human Body

MR. CUMMING'S second or "physical" query will, I think, require no answer if his first or "physiological" question is replied to. If an isolated muscle from which evaporation was prevented could go on working in a heat enclosure, and always remain at a lower temperature than the enclosure (which it could only do by transferring heat from itself to its surroundings), we should have to ask in good earnest how this was consistent with the Second Law of Thermodynamics. We are quite certain, however, that the temperature of the working muscle would always, when a steady state of things had been reached, be above that of the enclosure.

The temperature of an isolated muscle during activity (assuming that it could be kept alive and evaporation prevented) would, of course, not only be very much higher "at the equator" than "at the pole," but also somewhat above that of the surrounding bodies in either latitude. The intact homoiothermal animal, even when the temperature of the air is greater than that of its blood, is on the whole, within the limits which can be borne, always losing more heat to its surroundings than it receives from them. For heat is still becoming latent at the evaporating surfaces of the body, the skin and the respiratory mucous membrane, even when the balance of gain and loss by radiation, &c., is telling the other way, and, indeed, in general more evaporation than usual is going on when this is the case. The temperature of these surfaces is always kept below that of the blood which comes to them. The blood, therefore, always loses heat here, and gains it from the muscles, which accordingly transfer heat to a medium colder than themselves, even when the external temperature is higher than that of either.

If, of two similar and similarly situated men, A and B (I ask pardon for degrading an austere geometrical phrase to such loose and vulgar application), exposed to the same high temperature (above that of the blood, say), A sweats little and B much, while the blood-temperature of both remains constant, A must either produce less heat than B or lose more in other ways than evaporation of sweat. He may produce less either because he works less than B, or because even at rest his metabolism is not so active. Or an extra loss of water-vapour from the lungs may make up for the diminished loss from the skin. For example, in the dog, which has but few sweat-glands, nearly the whole of the evaporation takes place in the respiratory tract. Of course much water is evaporated from the skin which never appears as visible sweat, and it is possible that some persons give off a greater proportion of the total perspiration in this way than others do, the quiet steady sweater, if one may be allowed the expression, getting through as much work on the whole as the steaming paroxysmal kind of fellow who breaks out into dewdrops on the smallest provocation. But it should be clearly recognized that an air temperature equal to or above that of the blood is occasional, and not permanent in any latitude, and that men, and even animals, adopt expedients to avoid such extremes and to tide them over.

Any good recent text-book of physiology will give the information asked for as to what is known of the mechanism by which the temperature of warm-blooded animals is kept approximately constant. It is too wide a subject to be entered into here. In man the regulation of the heat loss seems to be far more important than any regulation of the production of heat. The former is, of course, largely voluntary, but the quantity of blood going through the skin, an important factor in more than one way, is greatly influenced by reflex nervous impulses. It is doubtful whether the very considerable heat capacity of the bodies of large animals has been sufficiently taken into account in its bearing on the steadiness of the blood temperature. This in itself prevents any *sudden* change. In some animals, and apparently more especially in small animals—*e.g.*, the rabbit and guinea pig—the production of heat, as well as the loss, is very distinctly under the control of the nervous system, and is increased when the external temperature is lowered, and diminished when it is raised.

Of course, as your correspondent is doubtless aware, we do not really know what kind of a machine a muscle is, except that it is a machine by means of which the potential energy of the food is partly transformed into mechanical work and to a much greater extent into heat. Up to a certain limit the work and the heat *increase together*, although less heat is given off by an active muscle which is allowed on the whole to do external work than by the same muscle when it constantly undoes its own work.

G. N. STEWART.

New Museums, Cambridge, October 11.

THE following brief account of the working of the heat mechanism of the human body will, I hope, help to make clear to Mr. Cumming the problems of which he seeks the explanation.

The temperature of a man at the equator is within a degree Centigrade the same as that in the arctic regions. This is because, in the first place, in the arctic regions the loss of heat from the body is very slight, and in the tropics it is very great, for (a) in the tropics more perspiration is secreted by the skin, and this, in consequence of the high temperature of the air, evaporates very quickly, and hence the body is kept cool. It is true, as Mr. Cumming says, that in the tropics people may not be observed to perspire freely, but that is simply because as fast as the perspiration is secreted it is evaporated. It is what is called insensible perspiration. (b) More water is secreted by the bronchial mucous membranes in the tropics, and in consequence of the higher temperature of the air it, like the perspiration, evaporates very quickly. The excessive secretion of moisture by the body when the temperature of the air is high, is shown in a Turkish bath, and leads, in a bath of about two hours' duration, to a loss of weight amounting with some persons to three pounds, and to a great diminution in the quantity of urine secreted. (c) In the tropics the vessels of the skin are more widely dilated than in the arctic regions, hence there is more blood in it, and therefore heat is more readily radiated and conducted from the skin to the external atmosphere. (d) The specific heat of the body is very high, and so it cools very slowly in the arctic regions. Judging from some experiments I have made on animals, it is, at the usual temperature of the human body, well over 1·0. (e) The above facts are certain, but in addition, for all we know to the contrary, the skin may, under different conditions, have different radiating powers quite apart from the quantity of blood in it.

In the second place, although it has not been calorimetrically proved, *it is very highly probable that in the arctic regions the quantity of heat produced by the body is much greater than in the tropics*.

With regard to the second query of Mr. Cumming, no doubt, as he says, the human body in the tropics must often be the coolest of surrounding objects; in this case it cannot lose anything by radiation or conduction, but it is kept cool by the rapid evaporation of perspiration (usually insensible) and fluid secreted by the bronchial mucous membrane. Whether or not a man in the tropics produces any heat under such circumstances has not been *demonstrated*, but *probably, although the production of heat falls very low, it does not entirely cease*.

65 Harley-street, W. W. HALE WHITE.

Photographic Dry Plates

I HAVE found great difficulty in obtaining fresh photographic dry plates of whatever maker, from dealers, who frequently pass off upon the purchasers packets of plates which have been in stock for a long time, and consequently unfit for use. It has therefore occurred to me that this trouble might be avoided by the makers dating every packet as issued by them, thus following the custom of the Platinotype Company with their tins of paper. By such a system the purchaser would be able to protect himself,

and many makers' plates would be found much more satisfactory

I shall esteem it a favour if you will allow this letter to appear in your journal Enclosing my card, I subscribe myself,

October 17 PREVENTION

INVITATION TO OBSERVE THE LUMINOUS NIGHT CLOUDS[1]

SINCE the year 1885 a very remarkable phenomenon has been noticed in the sky in our latitudes, which well deserves to excite the interest of astronomers and geophysicists The following is the substance of what has so far become known regarding the so-called luminous night-clouds

In the latitude of Berlin the phenomenon shows itself only during a comparatively short period of the year from May 23 to August 11 While in the first years it was seen pretty frequently even before midnight, it has, during the last four years, rarely appeared except after midnight The phenomenon appears in the form of cirrus clouds, which come out bright on the twilight sky This especially distinguishes them from the ordinary cirrus-clouds, which, with the depths of the sun in which the luminous clouds are seen at present, come out dark on the light twilight sky The colour of the phenomenon is generally a bluish white, which becomes yellowish and reddish in close proximity to the horizon

Often repeated photographs which have been taken simultaneously at various points in the neighbourhood of Berlin, show that the altitude of the luminous clouds is constant and exceedingly great—82 kilometres In consequence of this great altitude, they receive light from the sun standing *below* the horizon, which makes them appear light on the twilight sky They are visible only so long as the sun shines on them, as soon as the shadow of the earth passes over them they become invisible As a rule they begin in the morning, shortly before twilight, and they disappear as soon as the sun stands higher than 8° to 10° below the horizon

Of late years these clouds have been seldom seen Within the period above stated, they occurred this year only about ten times, while in the first years they were very frequent Their appearance is subject to great changes, while they frequently exist only in a few little luminous stripes or patches, at times they appear in greater accumulations and with a more intense light Especially in the last days of the period, from August 2 until 6, their light seems to be considerable in our latitudes Generally they are observed in the proximity of the horizon—over that part of it under which the sun is

Frequent observations of the movements of the phenomena, which, after midnight, are always from the direction of N.E ± 40°, render it probable *that the movements are caused principally through the resisting medium of the mundane space* In accordance with this is the fact that in the half-year after its appearance in this country, the phenomenon has been observed repeatedly in the southern latitudes of 53° by the meteorological observer, Mr. Stubenrauch, in Punta Arenas, as well as several times by ship-captains

Other observations confirm the assumption of an annual wandering of this kind For instance, in Graham's-town under 33° S lat the phenomenon was observed on October 27, 1890,[2] and in Haverford under 40° N lat, according to written information it was observed on May 17, 1892 These dates, taken in association with the time of the appearance in this country, directly indicate a wandering of the phenomenon from N to S and back.

The luminous night-clouds decrease year after year in respect to the frequency of their appearance as well as to their extent and to their intensity of light The phenomenon therefore will entirely disappear within a few years It seems, however, that during the next two years observations will still be possible, which may give us information regarding several questions of extraordinary importance

Measurements of the apparent altitude of the upper limits of the luminous clouds, mainly in the time in which the upper limit of the twilight-segment has the comparatively small altitude of, say, 1° to 10°, would be of great value Such measurements will serve to decide the question whether the altitude of the clouds varies under different geographical latitudes, providing that the measurements always refer to such points as lie within the upper limits of the clouds, produced by the shadow of the earth

During the last few years the whole twilight-segment has been comparatively seldom filled out by the luminous night-clouds, and it may therefore frequently remain doubtful whether the highest point of the phenomenon really lies in the limit of the earth shadow In order to make sure that the measurements are adapted to their purpose, they must be repeated as often as possible in intervals of a few minutes In the evening this limit is generally recognized by the fact that within it parts of the phenomenon disappear from above, while towards morning new parts always become visible within the limit upwards The distance of the zenith of the upper limit of the luminous clouds in the vertical of the sun for the latitude of Berlin, presuming that the phenomenon stretches over the whole of the twilight-segment, may be seen from the following statement —

Depth of the sun below the horizon °	Zenith distance of the upper most limit °
12 0	80
12 5	83
13 0	85
13 5	86
14 0	87

Moreover, as by means of a telescope the upper limit of the phenomenon is generally seen a little higher than with the naked eye, it is desirable that the telescope should always be adjusted to the limit-line seen with the naked eye A comparison of the appearance seen with the naked eye with the one seen through the telescope, will enable the observer to discover easily the line corresponding to the one seen with the naked eye The exactitude of these measurements must be about 3′ to 6′, with respect to the azimuth and to the altitude, while the time should be exact within two to four seconds

The employment of photographic apparatus is of advantage for the indication of the place, as well as of the movements, of the phenomenon But only those kinds of apparatus are suitable in which the proportion of the diameter of the opening to the focal distance is at least 1 4 or greater If the proportion is smaller, the duration of lighting will last too long, and consequently, on account of the quick changings of the phenomenon, the details will get lost With an apparatus of which the proportion of the aperture-diameter to the focal distance is 1 . 3, the duration of lighting for the various depths of the sun below the horizon, on condition that the phenomenon is light in some degree, is as follows —

Depth of the Sun below the Horizon	Duration of Lighting s
9	16
10	21
11	27
12	35
13	48
14	72
15	122

[1] Scientific Journals are requested to reproduce this article
[2] Compare *Astr Nachr*, No 3008

Generally at the same time stars become visible on the photographic plate, through which, in association with the time of photographing, the direction of adjustment of the apparatus is ascertained (that is to say, the position of the axle of the apparatus is ascertained)

With regard to equatorial regions, it is of great importance that the exact time in which luminous night-clouds pass through them should be determined According to the observations hitherto made, the passing through the equator may take place in the time between the beginning of September and the end of October, and the return between the beginning of March and the end of April Under 20° S lat, the time of passing through will, in that case, be from the middle of September until the middle of November, and from the middle of February until the middle of April, and under 20° N lat from about the middle of March until the middle of May, and from the middle of August until the middle of October In consequence of the daily rotation of the earth round its axis together with the distinct movements of the earth, atmosphere, it may be that the passing through the equator does not take place in the simple manner here described It does not seem to be unlikely that the periods are not limited as exactly as stated

Moreover, it is probable that the luminous night-clouds consist of a gas which is condensed in consequence of the lower temperature prevailing in the altitude of 82 kilometres On the question relating to the nature of this gas depend several other cosmical questions for instance, with respect to the temperature of the air of the mundane space and the temperature of the atmosphere at the altitude of 82 kilometres, which will be answered through comparing experiments in the laboratory For this reason, spectrographs of the sunlight at low altitudes of the sun, in the season in which the phenomenon of the luminous night clouds is seen, are of great value Such spectrographs should be taken in the evening shortly before sunset, and in the morning shortly after sunrise

It appears that in the northern regions of the earth, in about 70° latitude, in the period from the middle of June until the middle of July, an especially great accumulation of clouds takes place, which, however, on account of the sun standing constantly *above* the horizon during this period, will be hardly visible It will, therefore, be of special advantage for these regions to take spectrographs of the sunlight at low positions of the sun

These short remarks regarding the importance of the phenomenon with reference to cosmical problems may serve to show that the observations necessary for the exploration of the subject are well within the sphere of astronomers and geophysicists There can be no doubt that the observations necessary for the solving of these questions are far beyond the capacity of a single institution. Those who take interest in the furtherance of the questions we have indicated are therefore requested to assist through one or other of the kinds of observation above noted in the investigation of the luminous night-clouds [1]

W FOERSTER
O JESSE.

Berlin Royal Observatory, September 1892

SOME OPTICAL ILLUSIONS [2]

A STRIKING illusion, first described by Zollner some thirty years ago, and usually called by his name, appears in Fig 1 Of the four main lines each adjoining pair seems to converge at one end, and to diverge at the other, whereas in reality the lines are all parallel The first step in an explanation of the illusion would be the determination of its essential factors, of its various forms, and of some general principle embracing under one formula its several varieties The next step would be to correlate this formulation with some recognized psychological principle The generalization is found

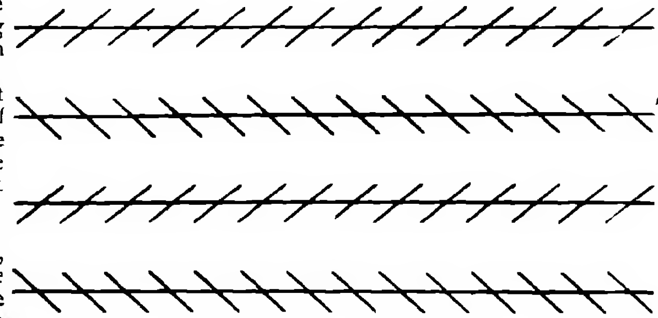


FIG 1

in the statement, that *the direction of the sides of an angle are deviated toward the direction of the angle*, and may be illustrated by reference to Fig 2 In this figure the continuation of the left horizontal line seems to fall below the right horizontal line, and the continuation of the latter above the former, in reality the two are continuous Similarly, if the continuations of the oblique lines be added, they will not seem continuous, but divergent slightly to one side or the other If now we call the direction of an angle the direction of the line that bisects it, then the deviation is what would result from a drawing up of the sides of the angle towards this central bisecting line, the left end of the left horizontal line would be drawn up, and the right end of the right horizontal line would be drawn down, and thus the two seem discontinuous The same would happen, though to a less degree, if either oblique line were omitted. There are many other ways of illustrating this fact. Instead of drawing the right line horizontal, we may incline its right end downwards slightly, and then it will seem continuous with the left horizontal line. We may apparently incline both lines so that they would converge towards a point between and below them, as in Fig 3 and the like. Two further points or corollaries should be noted (1) that the

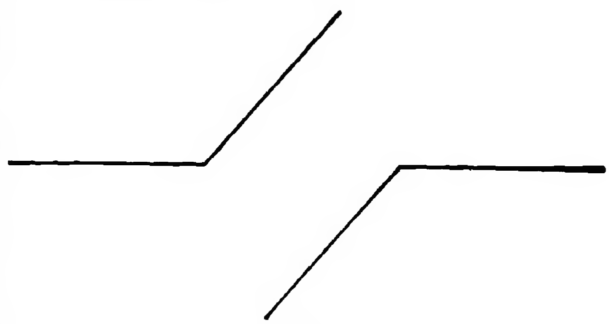


FIG 2

FIG 3.

[1] A publication, "Die leuchtenden Nachtwolken," by O Jesse, which may be expected within the next months, will contain details regarding the entire present position of these questions.

[2] Abstract of a paper on "A Study of Zöllner's Figures and other Related Illusions," by Joseph Jastrow, Ph D. (with the assistance of Helen West), being a part of "Studies from the Laboratory of Experimental Psychology of the University of Wisconsin" — *American Journal of Psychology*, vol iv. No. 3.

larger the angle the greater the deviation. Similar figures with acute angles substituted for the obtuse ones would show a scarcely perceptible illusion. (2) When obtuse

FIG. 4.

angles are combined with acute angles, the deviating effects of the former outweigh those of the latter. In Fig. 4 the effect of the angle ACD would be to make the

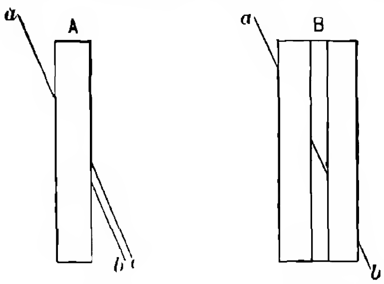


FIG. 5. FIG. 6.

line AB if continued fall *below* FG, while the effect of BCD would be to make AB fall *above* FG; the former outweighs the latter, and the illusion appears as directed

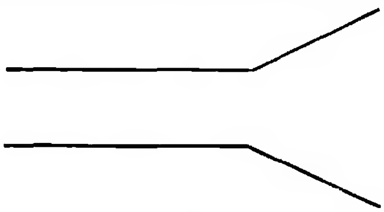


FIG. 7.

by the angle ACD. The angle BCE reinforces ACD, while ACE reinforces BCD. Angles greater than 180° do not come into consideration. When all the angles about a

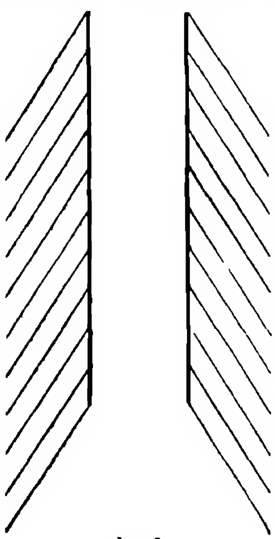


FIG. 8.

point are equal, *i.e.*, are right angles, the illusion disappears. Figs. 5 and 6 furnish other illustrations of the same principles. In Fig. 5 the line *a* seems continuous with *c* while it is so with *b*, and this because the obtuse angles formed by lines *a* and *c* with the vertical lines respectively, deviate the lines *a* and *c* towards the direction of the angles sufficiently to bring them in line with one another. Fig. 6 adds the further complication—explicable upon the same principles—that the line is deviated once in one direction and then in the reverse direction.

We have next to show that the illusion of deviation from

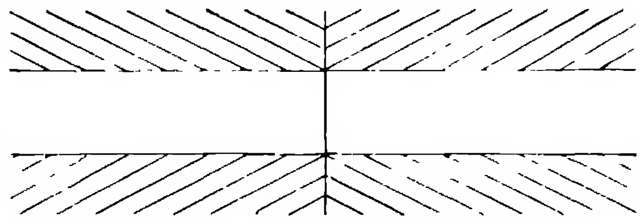


FIG. 9.

parallelism is similar to that from continuity. If the right-hand portion of Fig. 3 be rotated through 180° and placed below the left-hand portion, we have Fig. 7, in which we observe a tendency for the two horizontal lines to diverge on the left and converge on the right; this is just what our dictum demands. To strengthen this illusion we add more oblique lines, and thus more angles, the obtuse

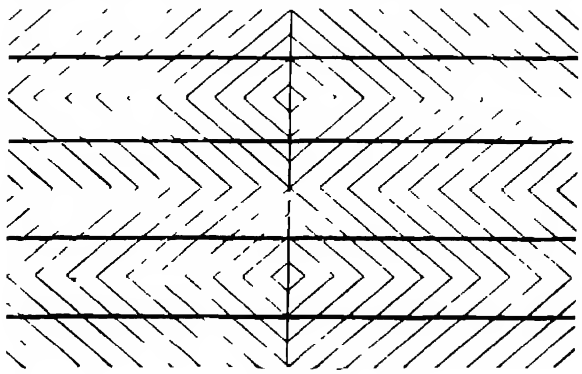


FIG. 10.

angles in all cases outweighing the acute ones—Fig. 8. We have now only to draw two figures like Fig. 8, side by side, and draw the oblique lines across the vertical ones (thus keeping the figure compact) to obtain Fig. 1, with which we set out. The possibilities of illusion do not stop here: by drawing the oblique lines in one direction on

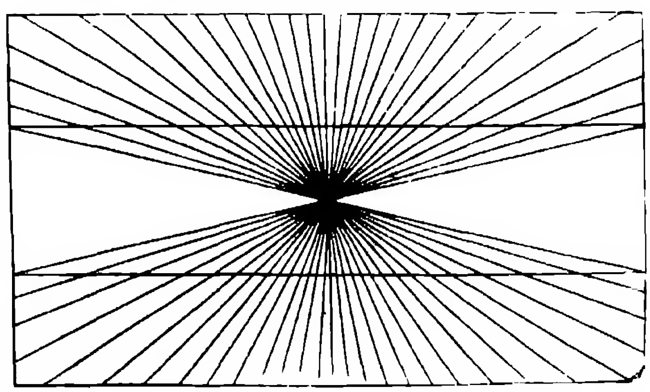


FIG. 11.

one side, and in the other direction on the other side, we can deviate the two halves of the same pair of parallel lines in opposite directions, as is done in Fig. 9; while most striking of all is the elaborate design of Fig. 10, in which it is difficult to realize that the four main lines are all straight and parallel. If the page be viewed with one

eye, and held horizontal nearly on a level with the eye, the true relations will appear Fig. 11 is valuable for its conclusive demonstration that the deviation is proportional to the angle, the increasing angles gradually bend the straight lines away from one another, and give them the gradual change of direction of curves These and other forms of illusion are all included in the generalization that the sides of an angle are deviated towards the direction of that angle[1]

The psychological principle with which this generalization may be correlated is the law of relativity This law emphasizes the fact that a sense-impression is not the same when presented alone and when in connection with other related sense-impressions We cannot judge the direction of lines independently of that of the angles whose sides they form As a further illustration of this principle it may be shown that angles will affect the apparent *lengths* of lines as well as their apparent *directions* If in Fig 12 we compare the horizontal portion of the uppermost figure with that of the lowest, it is almost impossible to believe that they are of equal length. The intermediate horizontal lines seem intermediate in length, and thus illustrate the fact that the apparent length of the horizontal lines is directly proportional to the size of the angles at their extremities The illusion would persist if we converted these figures into truncated pyramids by adding a line parallel to the horizontal line, and would then illustrate the fact that equal lines may be made to appear unequal by the effect of the areas whose contours they help to form A converse effect is illustrated in Fig 13 Here the upper figure seems larger than the lower, because its larger parallel side is brought into juxtaposition with the smaller parallel side of the lower figure This illusion and others show especially well when cut out of paper and held against suitable backgrounds As the figures are moved about one another the upper constantly becomes the larger More than two figures may be used, and a variety of such contrasts may be formed

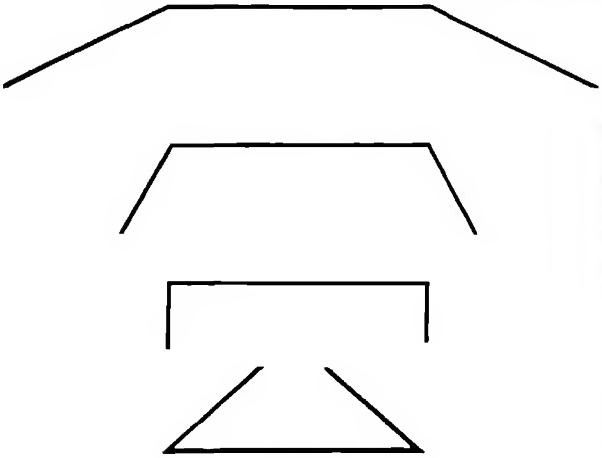


FIG 12

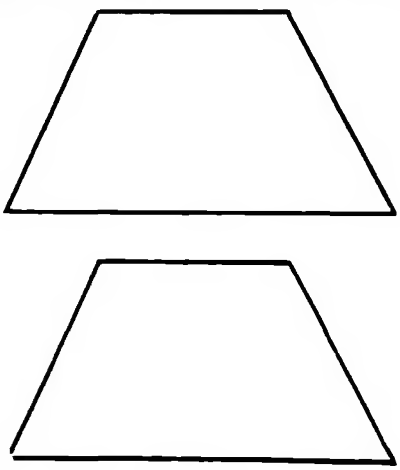


FIG 13.

The subject is by no means fully considered in these illustrations nor is the explanation offered as final or adequate If it seems to direct investigation into fruitful paths its chief purpose will be accomplished

[1] The reader is referred to the original paper for further illustration of this dictum, as well as for explanations of apparent exceptions and a discussion of the conditions affecting it.

THE NEW SATELLITE OF JUPITER

THE new number of the *Astronomical Journal* contains Mr Barnard's account of his discovery of this additional member of our system We make the following extracts - "Nothing of special importance was encountered until the night of September 9, when, in carefully examining the immediate region of the planet Jupiter, I detected an exceedingly small star close to the planet, and near the third satellite I at once suspected this to be a new satellite I at once measured the distance and position-angle of the object with reference to satellite three I then tried to get measures referred to Jupiter, but found that one of the wires had got broken out and the other loosened Before anything further could be done the object disappeared in the glare about Jupiter Though I was positive the object was a new satellite, I had only the one set of measures, which was hardly proof enough for announcement I replaced the wires the next morning The next night with the great telescope being Prof Schaeberle's, he very kindly gave the instrument up to me, and I had the pleasure of verifying the discovery and secured a good set of measures at elongation In these observations, and those of the succeeding night, only distances from the following limb of Jupiter could be measured These were observed with the wires set perpendicular to the belts The planet was thrown outside the field the satellite bisected, and then the limb brought in and bisected also This method would not permit any measures from the poles of the planet for latitude On the 12th I inserted a strip of mica, carefully smoked, in front of the field-lens, for occulting the planet This served admirably, permitting the satellite and planet to be both seen at once, and measures from the polar limbs could be made with great ease The observations of the satellite from the 12th were all thus made

"To avoid any personal equation I have on each night measured the diameters of the planet, for use in reducing the observations to the centre of Jupiter Since the 12th, these have been measured through the smoked mica, so as to avoid introducing any error from the reduced brightness of the planet The diameters were measured by the method of double distances Just what the magnitude of the satellite is, it is at present quite impossible to tell Taking into consideration its position, however, in the glare of Jupiter, it would, perhaps, not be fainter than the thirteenth magnitude It will only be possible to settle this question with any certainty by waiting until some small star of the same magnitude is seen close to Jupiter, and then after determining its magnitude when away from the planet In general the satellite has been faint—much more difficult than the satellites of Mars On the 13th inst, however, when the air was very clear, it was quite easy.

"It is scarcely probable that this satellite will be seen

with anything less than twenty-six inches, and only with that under first class conditions I give here the observations that I have so far obtained, and defer any suggestions as to a name until a later paper It certainly should not disturb the present harmony existing in the Roman numerals already applied to the satellites

"It is so wholly different from any of the other moons in physical aspect, that it ought, in a sense, to be considered independent of them, and simply be called, say, the fifth satellite, with a suitable mythological name

"It will be seen that on three of the dates of observation the east elongation is well covered in the measures"

Plotting the observations at elongation, the following values of the distance were obtained —

				From Jupiter's centre Miles
September 10 (apparent)	61″ 04	log R =	7 08267	112250
,, 12 ,,	61″ 55	,,	7 08452	112750
,, 14 ,,	61″ 60	,,	7 08324	112400

From these the following periods result, using the well-known formula -

$$P = p\sqrt{\frac{m}{M}\,\frac{R^3}{r^3}}$$

	h	m
September 10 period	11	47 6
,, 12 ,,	11	52 3
,, 14 ,,	11	49 0
Mean	11	49 63

The observations, all made in standard Pacific time (eight hours slow of Greenwich) are given at length in the *Journal*

The latitude measures show that the satellite's orbit lies in the plane of Jupiter's equator, and Mr Barnard holds that it is consequently a very old member of Jupiter's family, "since it would doubtless take ages for the orbit to be so adjusted" W L

NOTES

The ordinary general meeting of the Institution of Mechanical Engineers will be held on Wednesday evening, October 26, and Thursday evening, October 27, at 25, Great George Street, Westminster The chair will be taken at half-past seven p m on each evening by the President, Dr William Anderson, F R S The ballot lists for the election of new members, associates, and graduates having been previously opened by the Council, the names of those elected will be announced to the meeting The nomination of officers for election at the next annual general meeting will take place The following papers will be read and discussed, as far as time permits —Second Report of the Research Committee on the value of the steam-jacket, by Mr Henry Davey, Chairman (Wednesday), and experiments on the arrangement of the surface of a screw propeller, by Mr William George Walker, of Bristol (Thursday)

We are asked to intimate that the late Prof Adams has left a number of separate copies of certain of his mathematical and astronomical papers, and that Mrs Adams will be happy to distribute them to scientific friends who make application for them by letter addressed to her at 4, Brookside, Cambridge

The Harveian oration was delivered on Tuesday afternoon by Dr J H Bridges He presented an able and most interesting sketch of the scientific influences amid which Harvey's work was done, and the relation of his great discovery to later research

The controversy as to vivisection is still going on in the *Times* For the present, therefore, it may be enough for us to reproduce the letter which was signed by Sir Andrew Clark, Sir James Paget, Dr Samuel Wilks, and Sir George Humphry, and printed in the *Times* on Saturday last It is as follows —

"Having already expressed our views, personally or by letter, to the Church Congress, we decline to enter into any further public discussion on the question of so called 'vivisection,' for the following reasons, the statement of which we make solely because we think it is due to your readers —Firstly, after full consideration, we are satisfied that the scientific aspect of this question cannot receive adequate and just treatment in the columns of a newspaper Secondly, because it is hardly possible for us to name any progress of importance in medicine, surgery, or midwifery which has not been due to, or promoted by, this method of inquiry"

Prof Virchow was invested, on Saturday last, with the insignia of office as Rector of the University of Berlin. He chose "Learning and Research" as the subject of his address He acknowledged that study had contributed greatly to create a mutual basis of understanding and a common educational foundation for the peoples of Europe, strengthening at the same time the idea of consanguinity That state of things, however, was, he thought, entirely changed, and he contended that the turning-point in the supremacy of the classical languages had been reached "A grammatical education is not the means for progressive development demanded by our youth Mathematics, philosophy, and the natural sciences give young minds so firm an intellectual preparation that they can easily make themselves at home in any department of learning"

Prof Berg has succeeded the late Dr Burmeister as director of the National Museum in Buenos Ayres

Dr G v Lagerheim, at present director of the Botanic Garden at Quito, Ecuador, has been appointed curator of the museum at Tromso, Norway

Mr W G Ridewood, B Sc, of the Royal College of Science, South Kensington, Assistant to the Director of the Natural History Museum, has been appointed Lecturer in Biology to the St Mary's Hospital Medical School

The October number of the *Kew Bulletin* opens with a section giving some interesting information as to Lao tea Some time ago a singular method of using the leaves of what has since been proved to be the Assam tea plant of commerce (*Camellia thea/era*) was brought before the Society of Arts by Mr Ernest Mason Satow Amongst the Laos, a people inhabiting a district of Siam, in the neighbourhood of Chiengmai, the tea leaves are not used for making an infusion as in other countries, but are prepared wholly for the purpose of chewing The leaves are first steamed and then tied up in bundles and buried in the ground for a period of about fifteen days Leaves thus prepared, called locally "mieng," are said to keep for two years or more The habit of chewing "mieng" is almost universal among the Laos, and to men engaged in hard work, such as poling or rowing, it is said to be almost indispensable The *Bulletin* prints a correspondence in which the result of an inquiry made by Kew in regard to the plant yielding "mieng" and the method of preparation is detailed.

The other sections in the October number of the *Kew Bulletin* deal with Chinese silkworm gut, mangrove bark and extract, Burmese black rice; Mauritius tea, potato disease in Poona, British North Borneo, and Allouya tubers There are also some miscellaneous notes

We learn from the *Journal of Botany* that Dr H Trimen, F R S, the Director of the Botanic Gardens at Paradeniya Ceylon, has received the sanction of the Government to proceed with the publication of the flora of that island The work will be published in parts by Messrs Dulau and Co., and will form two vols. octavo, together with a quarto atlas of 100 coloured plates,

drawn by the native Cingalese artists attached to the gardens The first part is now in the press The book is more especially designed for use in the colony, and will enter into more local detail than has been hitherto the practice in the Colonial floras published by the Government

MR G HOGBEN delivered an excellent address lately before the Canterbury College Science Society, New Zealand, on earthquakes In the course of his remarks he described the system which, for the last three years, has been in force in New Zealand for the observation of earthquake phenomena and the telegraphing of the results to a central station This system has been adopted in Victoria, New South Wales, South Australia, and Tasmania, and will probably be shortly adopted in Queensland The various colonies exchange reports with New Zealand, and it is proposed that the system shall be further extended, so that the colonies may be brought into communication with the islands of the Pacific and America and Japan

A REUTER telegram despatched from Vienna on October 14 announced that reports had reached that city of the occurrence of violent earthquake shocks in Eastern Europe The vibrations were strongest in Roumania, being felt at Bucharest, where they lasted 15 seconds, and at Galatz during 30 seconds At Oltenizza the shock lasted fully 90 seconds, and did considerable damage in the town A shock was felt at Sofia on October 14, at seven o'clock A M , and also at Philippopolis, Varna, and Rustchuk The seismic wave passed from south to north, the vibration lasting several seconds, and being accompanied by subterranean rumbling

THE depression over the Bay of Biscay referred to in our last issue took a very unusual route, the track being almost circular, moving first in an easterly and north easterly direction towards the north of France, and then recurving by the south west of England back to the Bay of Biscay, when it again travelled to the eastward The disturbance caused to the weather in this country was very great and the rains were very heavy, with serious floods, especially in Wales and the midland and northern counties In Yorkshire it rained almost incessantly from Thursday to Saturday, a fall of 1½ inch being measured in one day The weather was still further disturbed by an area of low pressure lying over the north of Germany between Sunday and Monday, which caused disastrous gales and further heavy rains in the eastern part of the country. The temperature has been very low for the season, the daily maxima scarcely reaching 55 in any part of the kingdom, owing to the persistent northerly and north easterly winds Towards the close of the period temperature fell several degrees lower, with sharp day frosts in Ireland, under the influence of an anti-cyclone, which spread over the country from the Atlantic, while hail and sleet showers fell in places The *Weekly Weather Report* of the 15th inst showed that the temperature of the past week was everywhere below the mean, being as much as 4° in the south-west of England and 5° in the south of Ireland The rainfall greatly exceeded the average over the north and east of England

AN anemometer by M Timchenco of a novel construction is described by Prof Klossovsky, of the Odessa Observatory, by which both the wind direction and velocity are marked on a cylinder by one symbol The recording apparatus is moved by clockwork and the indications are made by electrical contacts The duration of the contact depends upon the velocity of the wind, a light wind producing a contact of longer duration than a strong one The indications are by means of arrows printed on the paper covering the cylinder, which show the direction of the wind, and the number of arrows marked on a length of paper corresponding to one hour furnishes data for finding the velocity by an empirical scale determined by comparison with a Robinson's anemometer The apparatus only requires to be adjusted twice a month, or in some instruments only once a month, and calls for no attention in the meantime A battery cell is sufficient to produce the contact, for most of the work is done by means of weights

THE *Annuaire* of the Municipal Observatory of Montsouris for the years 1892 93 contains, in addition to the usual tables showing *inter alia* the extremes of temperature at Paris since 1699 and the monthly rainfall values since 1690, much useful information with reference to the climate and the microscopic examination of the quality of the air Although it does not fall within the province of the observatory to issue weather forecasts, applications for such information are sometimes received and answered, in the interest of agriculture The opinion is expressed that by basing the calculations on the general methods adopted by Laplace in his memoir entitled "Probabilité des causes d'après les événements," it is not impossible to give a long forecast which may be at times of much use Some interesting remarks are also made as to the possibility of foreseeing the character of the summer from the weather experienced in the early spring, based chiefly on the time of the appearance of the north east winds, and the differences in their usual strength and physical qualities, in connection with the transparency of the air The results of the analysis of the air show that the minimum amount of carbonic acid occurs between May and September, and that the amount at night is greater than during the day

THE new University of Chicago has decided that its work shall go on all the year through, including the summer months According to the New York *Nation*, the calendar year is divided into four quarters of twelve weeks each, beginning respectively on the first days of October, January, April, and July , and at the end of each quarter there is to be a recess of one week Each quarter consists of two terms of six weeks No student is to be held to an attendance of more than three quarters, or six terms, in each year, so that the normal academic year is no longer than at other colleges Each student is to begin his academic year whenever he is ready, and to take his quarter's vacation whenever it suits his convenience He may even take his two terms of vacation in different quarters

AN investigation of the phenomena exhibited at the negative poles of vacuum tubes appears in vol xl of the *Sitzungsberichte* of the Prussian Academy Professor E Goldstein considers that the term "stratification" as applied to the light at the cathode is a misnomer, since two at least of the strata can be shown to pervade the entire region of luminosity The light nearest the cathode is yellowish, and about 1 cm thick Next comes Crookes' "dark space," which in reality shines with a faint blue light. Then follows the third and most highly luminous layer, whose colour changes from a blue to a violet as the exhaustion is carried further The first layer was shown to be a separate phenomenon on a previous occasion The so called second layer shows the peculiarity of rectilinear propagation It is emitted from the electrode normally to its surface, or very slightly divergent, whereas that of the third layer spreads throughout the bulb and even passes round corners. The second layer is best shown by concave poles, which concentrate the light at the centre of curvature If observed through a blue glass, which cuts off the third layer, it is seen to diverge from the focus and impinge upon the wall of the bulb. The phosphorescence observed in the glass where it is struck by the "radiant matter" is due to this part of the light only, and not to the third layer It is this also which produces the well-known phenomena of shadows. A glass rod laid in its path casts a shadow through the blue space, which is, however, relieved by the purple luminosity of the third layer The former is also the only light deflected by a second cathode It is to be concluded that the light at the negative pole of a vacuum tube consists of three different species, each pervading the others, but having distinct and characteristic properties of its own

IN the current number of the "Annals of Scottish Natural History," Mr E P Knubley discusses the question whether legislative protection is required for wild birds' eggs. He suggests that the most practicable plan might be for Parliament to grant powers to the County Councils from time to time, and as necessity arose, to place certain portions of a district, such as mountains, commons, waste places, lakes and meres, or portions of cliffs or foreshores, under an Act for specified months in the year—say, from April 1 to June 30 What, however, is most urgently wanted, as Mr Knubley says, is that landlords and occupiers shall, as far as possible, protect birds breeding on their property or "occupation"

MR ERNEST ANDERSON recently read before the Field Naturalists' Club of Victoria an interesting paper on some Victorian Lepidoptera He said that a great charm accompanied the rearing out of the Victorian species, because the results were very frequently of a most unlooked for character The Victorian forms followed the same rule as many plants and animals in having characteristics and habits purely Australian, and not only so, but they helped to bridge over the sharply defined divisions known in Europe, and merged the various groups so imperceptibly into each other that it was hard to say where one ended and another began. Speaking of the processional caterpillars (*Teara melanosticta*), Mr Anderson described how a female laid some ova in a small box and covered them very thickly with yellow down Very shortly afterwards a thread like structure was visible, which close examination revealed to be composed of newly-hatched caterpillars in Indian file, each having its head close up to the tail of its forerunner, and the whole line moving simultaneously with mathematical precision

THE use of gas engines does not seem to be nearly so common in the United States as in Great Britain According to the *Railroad and Engineering Journal*, they are generally regarded in America as of service for light work only, and it is with some surprise that our contemporary has noted the advertisement of an English firm, which keeps all sizes up to forty horse power in stock, and offers to furnish single engines of any size up to two-hundred and-fifty-horse power This much exceeds the capacity of any gas engine built until very recently

THE U S Department of Agriculture has published a valuable account, by Harvey W Wiley, of experiments with sugar-beets in 1891 The experiments were divided into three classes, (1) culture of the sugar beet conducted by farmers in different parts of the country, (2) culture of the sugar-beet conducted by the agricultural experiment station of Wisconsin and numerous farmers in Wisconsin, under the direction of the agricultural experiment station of that State, by authority of the Secretary of Agriculture, (3) experiments conducted at the beet sugar experiment station of the Department at Schuyler, Nebraska

WE learn from the *American Naturalist* for October that the vertebrate fossils collected by Prof Marsh, to which we lately referred, are not likely, after all, to be soon exhibited in the National Museum at Washington Our contemporary says "One side of a small room is the only space at present occupied by the material in question, and it is safe to say that no other space has been yet provided As the National Museum committed the error at its establishment of attempting an exhibit of modern human industries, as we pointed out at the time, the space for scientific exhibits is necessarily greatly curtailed. The necessities of this department require the erection of a new building, and until that is done it is safe to say that the vertebrate collections of the U S. Geological Survey will not be exhibited."

SLEEP is one of the least understood of physiological phenomena A new theory of it (we learn from the *Revue Scientifique*) has been offered by Herr Rosenbaum He supposes the essential fact in the fatigue of the nervous system leading to sleep to be a hydratation of the nerve-cells, an increase of their water-content The greater the hydratation, the less the irritability This hydratation arises through chemical change of the nervous substance during activity A small part of the water escapes by day through the lungs, but the greater part is eliminated during sleep Its passage into the blood takes place by virtue of the laws of diffusion, and depends on the quantity and density of the blood, its amount of fixed principles, its speed of flow, &c Elimination of the expired air takes place according to the laws of diffusion of gases The assimilable substances of the body take the place of the water eliminated in sleep The repair of the physical and mental forces through sleep is due to this elimination and replacement Intelligence is in inverse ratio of the proportion of water in the brain, and may be measured by this proportion, at least in the child It may be doubted whether this theory explains the sleep of hibernating animals, or that caused by opium and anæsthetics

D J MADISON TAYLOR has been elaborately investigating the various problems relating to physical exercise in health and as a remedy, and some of the results are set forth in the *Journal of the Franklin Institute* for September and October One conclusion is, he says, uniformly prominent in the instances of damage from boat and other racing Always the training has been "either insufficient or bad, or both"

IN one of the papers contributed to the third number of the Trinidad Field Club's Journal, Mr J Edward Tanner describes some interesting observations of the habits of the Parasol or Leaf Cutting Ants Two nests of these ants were on his table at the time when his paper was being prepared He begins by noting that all in Trinidad who are interested in such subjects know the hurried manner in which a parasol ant returns to her nest (all leaf cutting workers are females), bearing erect in her mandibles the portion of leaf she has herself just cut off, and apparently running home with it in triumph These foragers, for they are the ones who supply the household, carry their portion of a leaf well into the nest, drop it, and return for another piece, nor do they cease doing so till the supply is more than those in the nest require Mr Tanner could not induce the ants in one of his nests to carry any leaf whatsoever into the nest, till one day he coaxed a small worker to do so As she entered she was caressed by those in the nest, who stroked and patted her with their antennæ The small piece of leaf she had brought was at once taken by one of the larger workers, to go through its various processes, while she returned for more, and she continued to bring in pieces till late in the evening Strange to say, none of the others followed her example Even four weeks later only two or three carried in any portions of leaf Mr Tanner suggests that this may have been due to the fact that the queen was accidentally killed while the nest was being taken. The other nest had a queen, and with it there was no trouble, for the ants kept themselves well supplied from whatever was offered to them on their feeding ground, whether rose leaves, plumbago, or quis-qualis. "Each forager," says Mr. Tanner, "drops her portion of leaf in the nest, which is taken up as required by the small workers, and carried to a clear space in the nest to be cleaned. This is done with their mandibles, and if considered too large it is cut into smaller pieces. It is then taken in hand by the larger workers, who lick it with their tongues. Then comes the most important part, which almost always is done by the larger workers, who manipulate it between their mandibles, mostly standing on three legs. The portion of leaf is turned round and round between the mandibles, the ant using her palpi, tongue, her three legs, and her antennæ while doing so It

now becomes a small, almost black ball, varying in size from a mustard seed to the finest dust shot, according to the size of the piece of leaf that had been manipulated. The size of the piece of leaf is from an ¼ by ⅛ of an inch, by ¼ by ¼ of an inch I do not wish it to be understood that only one class of workers manipulate the leaf, for all seem to take to it very kindly on emergency Even the smallest workers will bring their tiny ball to where the fungus bed is being prepared These balls, really pulp, are built on to an edge of the fungus bed by the larger workers, and are slightly smoothed down as the work proceeds The new surface is then planted by the smaller workers, by slips of the fungus brought from the older parts of the nest Each plant is planted separately and they know exactly how far apart the plants should be. It sometimes looks as if the plants had been put in too scantily in places, yet in about forty hours, if the humidity has been properly regulated, it is all evenly covered with a mantle, as if of very fine snow It is this fungus they eat, and with small portions of it the workers feed the larvæ"

MR. O P HAY records in the latest volume of the Proceedings of the U S National Museum a curious habit of horned toads. Some years ago two boys from Texas, whose family had moved into his neighbourhood, showed him a few lizards belonging to the genus Phrynosoma, and popularly called horned toads The boys declared that these little animals, when teased, would sometimes squirt blood out of their eyes Mr. Hay did not think much about the matter at the time, but was lately vividly reminded of it in the department of reptiles in the National Museum Near his desk there was a specimen of *Phrynosoma coronatum*, which had been sent from California by a member of Dr Merriam's exploring party About August 1 it was shedding its outer skin, and the process appeared to be a difficult one, since the skin was dried and adhered closely One day it occurred to Mr Hay that it might facilitate matters if he gave the animal a wetting, so, taking it up, he carried it to a wash-basin of water near by and suddenly tossed the lizard into the water. "The first surprise," says Mr Hay, "was probably experienced by the Phrynosoma, but the next surprise was my own, for on one side of the basin there suddenly appeared a number of spots of red fluid, which resembled blood" He immediately recalled what the boys had told him of the ability of horned toads to squirt blood, and he concluded that this was a good time to settle the question whether this fluid was blood or not A microscope was soon procured and an examination was made, which immediately showed that the matter ejected was really blood A day or two afterwards Mr Hay was holding the lizard between his thumb and middle finger, and stroking its horns with his forefinger All at once a quantity of blood was thrown out against his fingers, and a portion of it ran down on the animal's ne and this blood came directly out of the right eye Mr Hay has since found that the phenomenon has been noticed by other observers, and, while he was preparing his paper, his attention was called to the fact that more than twenty years ago Mr A R Wallace read before the Zoological Society of London letters from a correspondent in California, who described this creature as squirting from one of its eyes "a jet of bright red liquid very much like blood"

MESSRS. PERCIVAL AND CO announce the following works:— "Geometrical Drawing," by A. J Pressland, "Lessons on Air," by A. E. Hawkins, "The School Euclid," an edition of Euclid, Books I–vi, with Notes and Exercises, by Daniel Brent; and a series of elementary text-books entitled "The Beginner's Text-books of Science," of which Mr G. Stallard is the general editor.

MESSRS. GEORGE BELL AND SONS have published a second edition of Mr. A. J Jukes-Browne's "Student's Handbook of Physical Geology" The author explains that in preparing this edition he has spared no pains to make it a trustworthy handbook for those branches of the science to which it relates

MESSRS. WHITTAKER AND CO have issued for the benefit of amateur coil-makers a practical manual on "Induction Coils," by G E Bonney The author's object has been to place in the hands of his readers "a cheap and handy volume giving a general insight into the construction of ordinary spark coils, medical coils, and batteries for working them" There are more than a hundred illustrations

MESSRS LONGMANS, GREEN, AND CO have issued a new edition, revised and largely re-written, of the well-known "Outlines of Psychology," by Prof James Sully

MESSRS. CHAPMAN AND HALL will shortly publish a work by Rev H N Hutchinson, entitled "Extinct Monsters" It will be illustrated by Mr J Smit, who has made twenty-four restorations of antediluvian animals The book is not intended for geologists only, but for all who are interested in the study of animal life Dr Henry Woodward, F R S, keeper of geology, Natural History Museum, contributes a preface

THE new number of *Records of the Australian Museum* (Vol III, No 2) opens with a paper, by Mr J Douglas Ogilby, on some undescribed reptiles and fishes from Australia To the same number Mr C Hedley contributes a paper on the structure and affinities of *Panda Atomata*, Gray Mr. A North has a note on *Manucodia comrii*, Sclater

THE University College of North Wales has published its calendar for the year 1892 93

GLYCOL aldehyde, $CH_2OH\ CHO$, the hitherto almost unknown first aldehyde derived from glycol, forms the subject of a communication to the current number of the *Berichte* by Prof Emil Fischer and Dr Landsteiner. This substance acquires additional interest when the ordinary sugars are defined as aldehyde- or ketone-alcohols, for it then becomes the first member of the series. Prof Fischer now shows how glycol aldehyde may readily be obtained, discusses its properties, and points out that by its polymerisation a new sugar is obtained, tetrose, the first synthetical sugar containing four atoms of carbon The only evidence hitherto published of the existence of glycol aldehyde is that afforded by the work of Abeljanz and Pinner The former chemist considered that he had obtained it by heating di-chlor ether with water, and by the action of sulphuric acid upon mono chlor-hydroxy-ether. But upon repeating the work of Abeljanz, Prof Fischer finds that the substance considered, upon very slight evidence, to be glycol aldehyde is another compound altogether. Pinner afterwards attempted to obtain it by decomposition of a substance discovered by him, glycol acetal, with acids, but Prof. Fischer finds that this reaction only occurs under conditions such that the glycol aldehyde is itself also decomposed. In view of the formation of glyceryl aldehyde by the action of baryta upon acrolein dibromide, a reaction now of historical importance as being the one which led Prof Fischer to the first synthesis of grape sugar, it was thought probable that glycol aldehyde might be similarly obtained by the action of baryta upon the mono-bromine derivative of aldehyde, $CH_2Br\ CHO$. Mono-brom-aldehyde, however, had never been hitherto obtained, so Prof. Fischer and Dr Landsteiner first sought a method for its preparation. They eventually obtained it, as a viscid colourless liquid of powerful tear-exciting odour, by heating mono-brom-acetal, $CH_2Br\ CH\begin{cases}OC_2H_5\\OC_2H_5\end{cases}$, with anhydrous oxalic acid. When the mono-brom-aldehyde thus

obtained was mixed with water containing barium hydrate partly in solution and partly in suspension, and the whole maintained for half an hour at 0°, the odour of the brom aldehyde disappeared almost completely Upon removal of the baryta by sulphuric acid and the hydrobromic and sulphuric acids by lead carbonate, the filtered liquid was found to contain glycol aldehyde, which could be concentrated by evaporation over oil of vitriol *in vacuo* The solution of glycol aldehyde reduces Fehling's solution with great energy at the ordinary temperature When warmed with a solution of phenylhydrazine in acetic acid crystals of an osazone are deposited, just as happens in the case of other members of the series of sugars Glycol aldehyde is readily oxidized by bromine water to glycollic acid, $CH_2OH.COOH$. When treated with a dilute solution of sodium hydrate polymerization occurs, a sugar of the composition $C_4H_8O_4$, the first synthetical tetrose, being formed, which is readily isolated in the form of its osazone (phenyl hydrazine compound) This osazone appears to be identical with one obtained by Prof Fischer from one of the oxidation products of natural erythrite The preparation of glycol aldehyde completes the synthesis of the whole of the members of the series of sugars, from the first member up to the sugars containing nine atoms of carbon, with the exception of pentose This latter sugar Prof Fischer hopes shortly to obtain from the tetrose above described

THE additions to the Zoological Society's Gardens during the past week include a Grivet Monkey (*Cercopithecus griseo viridis* ♀) from Zanzibar, a Bengal Fox (*Canis bengalensis*) from Pondicherry, presented by the Rev J W Scarlett, a —— Monkey (*Cercopithecus sp inc*) from the Zambesi, presented by Mr Joseph A Moloney, a Bonnet Monkey (*Macacus sinicus*) from India, a White Stork (*Ciconia alba*), European, presented by the Rev Sidney Vatcher, a Mona Monkey (*Cercopithecus mona*) from West Africa, presented by Miss Synge, a Hairy Armadillo (*Dasypus villosus*) from South America, presented by Mr J H Hamilton Benn, a Common Badger (*Meles taxus*), British, presented by Mr. W Butler, a —— Galago (*Galago sp inc*) from East Africa, presented by Mr Thomas E C Remington, , an —— Ichneumon (– ——), a Purple crested Touracou (*Corythaix porphyreolophus*), two Black Gallinules (*Limnocorax niger*), a Tambourine Pigeon (*Tympanistria bicolor*), an Emerald Dove (*Chalcopelia afer*), four Half collared Doves (*Turtur semitorquatus*), a —— Fruit Pigeon (*Treron sp inc*), four —— Tree Frogs (*Hylambates maculatus*), seven Smooth clawed Frogs (*Xenopus lævis*) from East Africa, presented by General Mathews, three Mitred Guinea Fowls (*Numida mitrata*), a —— Snake (*Philothamnus semivariegatus*) from East Africa, presented by Mr. W Hall Buxton MacDonald, M D, a —— Pratincole (*Glareola sp inc*), a Half-collared Dove (*Turtur semitorquatus*), a Nilotic Crocodile (*Crocodilus niloticus*) from East Africa, presented by Mr R MacAllister, two —— Francolins (*Francolinus* ——), a - Coucal (*Centropus* -——), five Half collared Doves (*Turtur semitorquatus*) from East Africa, a Black tailed Hawfinch *Coccothraustes melanurus*) from Japan, presented by Mr F Pordage, a Flap necked Chameleon (*Chamæleon dilepis*), two Square marked Toads (*Bufo regularis*) from East Africa, presented by Mr E Millar, a Galeated Pentonyx (*Pelomedusa galeata*), two —— Skinks (*Gerrhosaurus major*), five —— Geckos (*Hemidactylus mabouia*), three —— Lizards (*Mabuia striata*) from East Africa, presented by Mr Frank Finn, F Z S, a Common Quail (*Coturnix communis*), captured at sea, presented by Mr A Torrie, a Honey Buzzard (*Buteo apivorus*) from France, presented by M S A Pichot C.M.Z S, a Burrowing Owl (*Speotyto cunicularia*) from South America, presented by Mr R. B Shipway, two Common Boas (*Boa constrictor*) from Trinidad, presented by Messrs Mole and Urich; a Black-headed Lemur (*Lemur brunneus*) from Madagascar, a Yellow tailed Rat Snake (*Spilotes corais*) from Trinidad, deposited, an African Wild Ass (*Equus tæniopus*), born in the Gardens

OUR ASTRONOMICAL COLUMN

A NEW COMET —A telegram from Kiel announces the discovery of a new comet by Prof Barnard on October 12 last, at 17h 12 2m mean Lick time The position, as therein stated, was R A 293° 29′, and Declination + 12° 33′ As this new comet is termed "very dim," as seen with the large Lick refractor, it is needless to say that few instruments can at present observe it

OUR SUN'S HISTORY —The question of "How our Sun commenced to grow hot," is the subject of an article by Lord Kelvin in the October number of *L'Astronomie* In these few pages he deals with various questions, among which may be mentioned What is the temperature of the Sun? Is it increasing or diminishing? What was the state of the matter constituting our Sun before it was united into a single mass and began to grow hot? The answer to the last question leads him into the method of construction of our solar system In considering the question of the encounter between two bodies as the origin, he finds that the probability of such an encounter between two neighbouring stars belonging to a large number of bodies, attracting one another mutually, and scattered in space, is much greater if they are at rest than if they are moving, even if their velocities are greater than those acquired in falling from rest As an explanation of this Lord Kelvin takes the case of two solid and cold bodies of diameters equal to half that of the sun, and of mean densities equal to that of the earth, and supposes them at rest, the mean distance between each other being that of the earth from the sun The collision caused by mutual attraction will transform the bodies into a fluid, incandescent mass, and he describes how this mass will arrange itself round this surface of collision The next case he takes is similar to the one above, only the bodies have originally considerable velocities Further on, as a special instance, he assumes the presence of 29 millions of solid cold globes, each having a mass equal to that of our moon, and the total masses of which are equivalent to that of our sun These bodies, absolutely at rest, are supposed to be disseminated uniformly on the surface of a sphere (radius = terrestrial orbit), and allowed to fall towards the centre of the sphere by attraction The result, to state briefly, is a mass of highly heated vapour, which afterwards expands and contracts consecutively, forming a gaseous nebula, measuring forty times the radius of the terrestrial orbit By supposing that, instead of absolute rest at the commencement, these moons have a certain movement, the total sum of which represents a moment of rotation round a certain axis, equal to the moment of rotation of the solar system, this nebula would be a more or less facsimile of our solar system in its earlier stage, as figured out by La Place for his nebular theory Thus this theory, "founded by La Place on the history of the sidereal universe such as Herschel observed, and completed in its details by his profound dynamical judgment and imaginative genius, appears to-day a truth demonstrated by thermodynamics" For the theory of the sun, Lord Kelvin says in conclusion that the antecedents immediately before incandescence cannot be definitely stated, since the latter may have been caused by large and few bodies, or by agglomerations of such bodies as meteorites

SILVERING GLASS MIRRORS — Mr. Common, in the *Observatory* for October, gives a brief account of various processes and methods for producing good reflecting surfaces. In the short historical sketch we find that the modern process is due to an observation of Baron Liebig, who, in 1835, found that on heating aldehyde with an ammoniacal solution of silver in a glass vessel a brilliant deposit of metallic silver was deposited on the surface of the glass. In all the methods used up till quite recently the surface to be silvered had to be suspended over the bath, owing to the formation of mud which settles down and prevents the proper deposition of silver, thus really large surfaces could not be dealt with This was the case with Mr Common's 3 foot, a pneumatic arrangement being made to hold the mirror by the back In dealing with the 5 foot, this method could not be so easily applied, and experiments were made to find some means by which this "mud" could be entirely eliminated. This was successfully

done by omitting the potash from the bath. One curious fact of observation is that the mirrors experimented on never seemed to take the first application of the silvering solution, but on being recleaned with nitric acid the second was always successful. Why this should be so does not seem to be easily explained, for Mr. Common only commits himself to the statement that "the nature of the liquid other than distilled water last in contact with the surface of the mirror seems to be the determining thing."

Himmel und Erde.—In this magazine for October there is a most interesting set of articles, of which we mention the following:—"Meteorology as the Physics of the Atmosphere," by Herr Wilhelm von Bezold. This comprises a general summary of the proceedings of the German Meteorological Society, which met in Braunschweig on June 7 last.—"Astronomy of the Invisible," by Herr Dr. Scheiner. This is the first of a series of articles, and deals, as far as it goes, with the discovery of Neptune by Adams and Le Verrier; it contains also a translation of the letter which Le Verrier wrote to Dr. Galle, who was then an assistant at the Berlin Observatory, telling him the results he had obtained, and asking him to make a search for the unknown planet. As a matter of interest we will give the elements of Neptune as obtained by Le Verrier and Adams, together with the true ones afterwards determined, for the results of such a piece of work will always be looked upon with interest.

	Le Verrier	Adams	True elements
Half major axis	36·15	37·25	30·05
Eccentricity	0·1076	0·1206	0·0090
Longitude of Perihelion	285°	299°	46°
Mass (Sun = 1)	0·0001	0·00015	0·00005
Inclination	0°	0°	1° 8

In the notes two excellent illustrations of parts of the moon are inserted, one being a reproduction of a photograph taken at the Lick Observatory on August 31, 1890, and the other displaying the region to the north of Hyginus, showing these curious river-like appearances as first remarked by Prof. Weinek of Prague. Other notes deal with the astronomical reasons of the Ice Age, observations of Mars during the period 1883–88, polariscope observation of the surface of Venus, &c.

GEOGRAPHICAL NOTES

Mount Orizaba, or Citlaltepetl, in Mexico, has been measured trigonometrically by Mr. J. T. Scovell, with the result that its height is fixed as 18,314 feet. Popocatepetl is about 700 feet lower, and unless Mount St. Elias is found to considerably exceed Russel's estimate of 18,100 feet, Orizaba must be considered the highest summit in North America.

The pumping of brine from the North German salt mines and the consequent subsidence of the land, is the cause of a somewhat interesting change in the small lakes near Mansfeld. The Salzigen See, as observed by Dr. Ule, of Halle, had a maximum depth of thirty metres on June 18, and of no less than forty two metres on June 28, the subsidence of the bottom having taken place at the average rate of more than one metre a day.

Following the death of Dr. Theodor Menke (see p. 302) we have to notice the loss of his fellow-worker, Dr. Karl Spruner von Merz, at the age of eighty-nine. He died on August 24, 1892. After a military career of some distinction, he retired from the army in 1886. His attention was early attracted to historical geography, and his famous "Historical Atlas" (1837–1852) has made his memory imperishable. It was in preparing the third edition of this atlas that he was first associated with Menke.

The camels which were introduced into German South-West Africa last year, have, according to the *Deutsches Kolonialblatt*, proved a great success. They are employed in keeping up communication between Walfisch Bay and Windhoek, and for journeys into the interior. Their power of travelling for a week at a time without food or water has frequently been put to the test on the borders of the Kalahari desert. The climate does not seem to affect them unfavourably, and they have proved exempt from the many fatal diseases which attack horses and even oxen in Namaqualand.

A lecture on "Regions and Races" was delivered on Monday evening in the Regent's Square Hall by Dr. H. R. Mill. The object of the lecture was to demonstrate the continuity of geography with the physical sciences which account for the growth of the surface features of the globe, and with the natural sciences which explain the forms of plant and animal life on its surface. The interactions between man and his environment were discussed as the true basis of the higher geography.

M. J. Thoulet has this summer been engaged in an oceanographical study of the Basin of Arcachon, and publishes in the last number of the *Comptes Rendus* an interesting epitome of his preliminary results. This lagoon forms a valuable oyster preserve, and the researches into the action of the tides on the enclosed water has practical as well as scientific bearings. The investigation will be continued, so as to include the other lagoons along the coast enclosed by sand dunes, and more or less cut off from the sea.

THE COMPARATIVE PHYSIOLOGY OF RESPIRATION[1]

Among the very first of the physiological acts observed were those of respiration. The regular movements of breathing, from the first feeble efforts of the new-born babe until the sigh in the last breath of the dying—after which is silence, cold, and dissolution—have commanded the attention and claimed the interest of every one, the thoughtful and the thoughtless alike. And one comes to feel that in some mysterious way "the breath is the life." But in what way does breathing subserve life or render it possible? Aristotle and the naturalists of the olden time supposed that it was to cool the blood that the air was taken into the lungs, and, as they supposed, also into the arteries. With the limited knowledge of anatomy in those early days, and the fact that after death the arteries are wholly or almost wholly devoid of blood, while the veins are filled with it, what could be more natural than to suppose that the arteries were vessels for the cooling air? If one supposes that he has entirely outgrown this view of Aristotle, let him think for a moment how he would express the fact that an individual is descended from the Puritans, for example. In expressing it even the physiologist could hardly bring himself to say other than "he has the blood of the Puritans in his veins." Would he say "he has the blood of the Puritans in his arteries"?

As observation increased the cold-blooded animals were more carefully studied and found to possess also a respiration; they certainly do not need it to cool the blood. Then there are the insects and the other myriads of living forms that teem in the oceans, lakes, rivers, and even in the wayside pools. Do these, too, have a breath? And the plants on the land and in the water, is the air vital to them? Aristotle and the older naturalists could not answer these questions. To them, on the respiratory side at least, all life was not in any sense the same. It was not till chemistry and physics were considerably developed, not until the air-pump, the balance, and the burette were perfected that it was possible to give more than a tentative answer. It was not, until the microscope could increase the range of the eye into the fields of the infinitely little, possible to form even an approximately correct conception. The first glimmerings of the real significance of respiration for all living things was in the observation that the air which would not support a flame, although it might be breathed, could not support life. That is, there must be something in the transparent air that feeds the flame and becomes the breath of life, the real *pabulum vitæ*, the merely mechanical action of the air not being sufficient.

Since the experiments on insects and other animals by Boyle (1670) with the air pump, by Bernouilli, on subjecting fishes to water out of which all the air had been boiled, and those of Mayow (1674), it became more and more evident that respiration was not confined to the higher forms, but was a universal fact in the organic world. Then came the most fruitful discoveries of all, made by the immortal Priestley (1775–6), viz., that the air is not an element, but composed of two constituents—nitrogen, which is inert in respiration, and oxygen, which is the real vital substance of the air, the substance which supports the flame of the burning candle and the life of the animal as well.

What would seem more simple at this stage of knowledge

[1] Address delivered, in August, 1892, at the meeting of the American Association for the Advancement of Science, by Prof. Simon Henry Gage, of Cornell University, Ithaca, N.Y., Vice-President of the Biological Section.

than that the parallel between the burning candle and the living organism should be thought to represent truly the real conditions? That as the candle consumes the oxygen, burns, and gives out carbon dioxide, so the living thing breathes in oxygen, and gives out in place of that consumed carbon dioxide And as in each case heat is produced, what would be more natural than to look upon respiration as a simple combustion? This was the generalization of Lavoisier (1780-89) As he saw it, the oxygen entered the lungs, reached the blood, and burned the carbonaceous waste there found, and was immediately given out in connection with the carbon with which it had united, and as the gas given off in a burning candle makes clear lime water turbid, so the breath produces a like turbidity

But here, as in many of the processes of nature, the end products or acts were alone apparent, and while the fundamental idea is probably true that respiration is, in its essential process, a kind of combustion or oxidation, yet the seat of this action is not the lungs or blood If the myriads of microscopic forms are considered, these have no lungs, no blood, and many of them even no organs, they are, as has been well said, organless organisms, and yet every investigation since the time of Vinci and Von Helmont, Boyle and Mayow, has rendered it more and more certain that every living thing must in some way be supplied with the vital air or oxygen, and that this is in some way deteriorated by use, and the nearer investigation approaches to the real life stuff or protoplasm, it alone is found to be the true breather, the true respirer, as was shown long ago by Spallanzani (1803-7) If one of the higher animals, as a frog, is decapitated and some of its muscle or other tissue exposed in a moist place, it will continue to take up oxygen and give out carbon dioxide, thus apparently showing that the tissues of the highly organized frog, may, under favourable conditions, absorb oxygen directly from the surrounding medium, and return to it directly the waste carbon dioxide This shows conclusively that it is the living substance that breathes, and the elaborate machinery of lungs, heart, and blood-vessels, are only to make sure that the living matter, far removed from the external air, shall not be suffocated Still more strange, it has been found that if some of the living tissue is placed in an atmosphere of hydrogen or nitrogen entirely devoid of oxygen, it will perform its vital functions for a while, and although no oxygen can be obtained, it will give off carbon dioxide as in the ordinary air If it is asked, "how can these things be?" the answer is apparently plain and direct Not as the oxygen unites directly with the carbon in the burning candle does it act in the living substance The oxidations are not direct in living matter, as in the candle, but the living matter first takes the oxygen and makes it an integral part of itself, as it does the carbon and nitrogen and other elements, and, finally, when energy is to be liberated, the oxidation occurs, and the carbon dioxide appears as a waste product

The oxygen that is breathed to day, like the carbon or the nitrogen that is eaten, may be stored away and represent only so much potential energy to be used at some future time in mental or physical action

So far only living animal substance has been discussed If plants are considered, what can be said of their relations to the air? The answer was given in part by Priestley (1771), who found that air which had been vitiated by animal respiration became pure and respirable again by the action of green plants He thus discovered the harmonizing and mutual action of animals and plants upon the atmosphere, and there is no more beautiful harmony in nature Animals use the oxygen of the air and give to it carbon dioxide, which soon renders it unfit for respiration, but the green plants take the carbon dioxide, retain the carbon as food and return the oxygen to the air as a waste product This is as thoroughly established as any fact in plant physiology, and yet, in his experiments, Priestley had some of what he called "bad experiments", for instead of the plants giving out oxygen and thus purifying the air, they sometimes gave off carbon dioxide, and thus rendered it more impure, after the manner of an animal What investigator cannot sympathize with Priestley when he calls these "bad experiments"; they appeared so rudely to put discord into his discovered harmony of Nature But Nature is infinitely greater than man dreams The "bad experiments" were among the most fruitful in the history of scientific discovery. Ingenhausz (1787) followed them up, carefully observing all the conditions, and found that it was only in daylight that green plants gave out oxygen, in darkness or insufficient light they conducted themselves like animals, taking up oxygen and giving out carbon dioxide Finally it was proved by Saussure (1804) and others that for green plants, and those without green, like the mushroom, oxygen is as necessary for life as for animals It thus became evident that this use of oxygen and excretion of carbon dioxide was a property of living matter, and that the very energy that set free the oxygen of the carbon dioxide was derived from oxidations in the green plant comparable with those giving rise to energy in animals Further that the purification of the air by green plants in light is a separate function—a chlorophyll function as it has been happily termed by Bernard—and resembles somewhat digestion in animals, the oxygen being discarded as a waste product Indeed so powerful is the effort made to obtain oxygen for the life processes by some of the lowest plants—the so called organized ferments—that some of the most useful and some of the most deleterious products are due to their respiratory activity In alcoholic fermentation, as clearly pointed out by Pasteur and Bernard, the living ferment is removed from all sources of free oxygen, and in the effort for respiration the molecules of the sugar are decomposed or rearranged and a certain amount of oxygen set free

It has been found that the motile power of some bacteria like *Bacterium termo* depends on the presence of free oxygen in the liquid containing them When this is absent, they become quiescent This fact has been utilized by Engelmann and others in the study of the evolution of oxygen by green and other coloured water plants The bacteria serving as the most delicate imaginable oxygen test, so that when the minutest green plant is illuminated by sufficient daylight, the previously quiescent bacteria move with great vigour and surround it in swarms Out of the range of the plant, the bacteria are still, or move very slowly, as if to conserve the minute energy developing substance they have in store until it can be used to the best advantage

May we not now approach the problem directly, and answer for the whole organic living world the question, "What is respiration?" by saying it is the taking up of oxygen and the giving out of carbon dioxide by living matter? This is the universal and essential fact with all living things, whether they are animals or plants, whether they live in the water or on land But the ways by which this fundamental life process is made possible, the mechanisms employed to bring the oxygen in contact with the living matter, and to remove the carbon dioxide from it, are almost as varied as the groups of animals, each group seeming to have worked out the problem in accordance with its special needs It is possible, however, in tracing out these complex and varied methods and mechanisms, to discover two great methods—the Direct and the Indirect

In the first, there is the direct assumption of oxygen from the surrounding medium, and the excretion of carbon dioxide directly into it The best examples of this are presented by unicellular forms like the amœba, where the living substance is small in amount, and everywhere laved by the respiratory medium But as higher and higher forms are destined to appear, evidently the minute, organless amœba could not in itself realize the great aim toward which Nature was moving There must be an aggregation of amœbas, some of them serving for one purpose and some for another Like human society, as civilization advances, each individual does fewer things, becomes in some ways less independent, but in a narrow sphere acquires a marvellous proficiency Or, to use the technical language of science, in order to advance there must be aggregation of mass, differentiation of structure, and specialization of function Evidently, however, if there is an aggregation of mass, some of the mass is liable to be so far removed from the supply of oxygen, and the space into which carbon dioxide can be eliminated, that it is liable to be starved for the one and poisoned by the other Nature adopted two simple ways to obviate this—first to form its aggregated masses in the form of a network or sponge, with intervening channels through which a constant stream of fresh water may be made to circulate, so that each individual cell of the mass could take its oxygen and eliminate its carbon dioxide with the same directness as its simple prototype, the amœba

But in the course of evolution forms appeared with aerial respiration, and the insects, among these, solved the mechanical difficulty of respiration by a most marvellous system of air-tubes, or tracheæ, extending from the free surface, and therefore from the surrounding air, to every organ and tissue By means of this intricate network, air is carried and supplied almost directly to every particle of living matter The respiration is not quite

direct with the insects, however, for the oxygen and carbon dioxide must pass through the membranous wall of the air tube before reaching or leaving the living substance.

In the next and final step, the step taken by the highest forms, the living material is massed, giving rise not only to animals of moderate size, but to the huge creatures that swarm in the seas or walk the earth, like the elephant. With all of these the step in the differentiation of the respiratory mechanism consists in the great perfection of lungs or gills, and in the addition of a complicated circulatory system with a respiratory blood, one of the main purposes being, as the name indicates, to subserve in respiration by carrying to each individual cell in the most remote and hidden part of the body the vital air, and in the same journey removing the poisonous carbon dioxide.

This has been called Indirect Respiration, because the living matter of the body does not take its oxygen directly either from air or water, but is supplied by a middleman, so to speak.

The complicated movements by which water is forced over the gills, or by which the lungs are filled and emptied, and the great currents of blood are maintained – that is, the striking and easily observed phenomena of respiration are thus seen to be only superficial and accessory, only serve as agents by which the real and the essential processes, that go on in silence and obscurity, are made possible.

So far I have attempted to give a brief *résumé* of the views on respiration that have been slowly and laboriously evolved by many generations of physiologists, each adding some new fact or correcting some misconception, and I trust that this brief sketch has recalled to your minds the salient facts in our knowledge of respiration, and that it will give a just perspective, and enable me, if I may be permitted, to briefly describe what I believe to be my own contribution to the ever accumulating knowledge of this subject.

In 1876–77, Prof. Wilder, who may be said to have inherited his interest in the ganoid fishes directly from his friend and teacher, Agassiz, who first recognized and named the group, was investigating the respiration of the forms Amia and Lepidosteus, common in the great lakes and the western rivers. As his assistant it was my privilege to aid in the researches, and to acquire the spirit and methods, as in no other way is it so readily possible, by following out, from the beginning to its close, of an investigation carried on by a master. The results of that investigation were reported to this section in 1877, and formed a part of the proceedings for that year. From that time till the present the problems of respiration in the living world have had an ever increasing fascination for me, and no opportunity has been lost to investigate the subject. The interest was greatly increased by the discovery that a reptile—the soft-shelled turtle—did not conform to the generalizations in all the treatises and compendiums of zoology, which state with the greatest definiteness that all reptiles, without exception, are purely air-breathing, and throughout their whole life obtain their oxygen from the air and never from the water. The American soft shelled turtles, at least, do not conform to this generalization, but on the contrary, naturally and regularly breathe water like a fish, as well as air like an ordinary reptile, bird, or mammal.

In carrying on the investigation of the respiration of the turtle, there appeared for solution the general problem, which, briefly stated, is as follows. In case an animal breathes both air and water, or more accurately, has both an aerial and an aquatic respiration, like the ganoid fishes, Amia and Lepidosteus, like the soft shelled turtles, the tadpoles, and many other forms, what part of the respiratory process is subserved by the aqueous and what by the aerial part of the respiration? So far as I am aware this problem had not been previously considered. It was apparently assumed that there were in these fortunate animals two independent mechanisms, both doing precisely the same kind of work—that is, each serving to supply the blood with oxygen and to relieve it of carbon dioxide, as though the other was absent. That was a natural inference, for with many forms the respiration is wholly aquatic, all the oxygen employed being taken from the water, and all the carbon dioxide excreted into it. On the other hand, in the exclusively air-breathing animals, as birds and mammals, the respiration is exclusively aerial.

This natural supposition was followed in the first investigations on the *respiration of the soft shelled turtles*, and while it was proved with incontestable certainty that they take oxygen from the water like an ordinary fish—that is, have a true aquatic respiration, in addition to their aerial respiration—there was altogether too much carbon dioxide in the water to be accounted for by the oxygen taken from it. Furthermore, upon analyzing the air from the lungs of a turtle that had been submerged some time the oxygen had nearly all disappeared, and but very little carbon dioxide was found in its place, while, as compared with human respiration, for example, a quantity of carbon dioxide nearly as great as that of the oxygen which had disappeared should have been returned to the lungs. Likewise in Professor Wilder's experiments with Amia, to use his own words: "Rather more than one per cent. of carbon dioxide is found in the normal breath of the Amia, but much more of the oxygen has disappeared than can be accounted for by the amount of carbon dioxide." Everything thus appeared anomalous in this mixed respiration, and instead of a clear, consistent, and intelligible understanding of it, there seemed only confusion and ambiguity. Truly these seemed like "bad experiments."

It became perfectly evident that the first step necessary in clearing the obscurity was to separate completely the two respiratory processes, to see exactly the contribution of each mechanism to the total respiration. But this was no easy thing to do. In the first place, the animal must be confined in a somewhat narrow space in order that air and water, which are known to have been affected by its respiration, may be tested to show the changes produced in it by the respiratory process; in the second place, the water has so great a dissolving power upon carbon dioxide that even if it were breathed out into the air it would be liable to be absorbed by the water. Then some means must be devised to prevent the escape of the gases from the water as their tension becomes changed; and, finally, the animal in the water must be able to reach the air. A diaphragm must be devised which would prevent the passage of gases between the air and the water, and at the same time offer no hindrance to the animal in projecting its head above the water. As a liquid diaphragm must be used, it occurred to me that some oil would serve the purpose, but the oil must be of peculiar nature. It must not allow any gases to pass from air to water, or the reverse; it must not be in the least harmful or irritating to the animal under experimentation, and, finally, it must itself add nothing to either air or water. Olive oil was thought of, and later the liquid paraffins. The latter were found practically impervious to oxygen and fulfilled all the other requirements, but unfortunately they absorb a considerable quantity of carbon dioxide. Pure olive oil was finally settled upon as furnishing the nearest approximation to the perfect diaphragm sought.[1]

The composition of the air being known, and a careful determination of the dissolved gases in the water having been made, the animal was introduced into the jar and the water covered with a layer of olive oil from ten to fifteen millimetres thick. The top of the jar was then vaselined, and a piece of plate glass pressed down upon it, thus sealing it hermetically. Two tubes penetrate this plate glass cover, one connecting with the overlying air-chamber and the other extending into the water nearly to the bottom of the jar. As the water and air are limited in quantity, the shorter the time in which the animal remained in the jar the more nearly normal would be the respiratory changes; the experiment was continued only so long—one or two hours—as was found necessary to produce sufficient change in the air and the dissolved gases of the water to render the analyses unmistakable.

Proceeding with the method just described, the results given in the following table were obtained:—

Table of Mixed Respiration, showing the number of cubic centimetres of oxygen removed from air and water, and the amount of carbon dioxide added to the air and the water.

	Oxygen from air	Oxygen from water	Carbon Dioxide to air	Carbon Dioxide to water
Ganoid Fish (*Amia calva*)	65	10	22	53
Tadpoles (*Larval Batrachia*)	70	5	24	51
Soft shelled Turtle (*Amyda mutica*)	31	8	10	29
Bull Frog (*Rana catesbiana*)	183	4	110	77

NOTE.—The oxygen from both the water and the air, and the carbon dioxide in the air, were determined with exactness in all the experiments; but owing to the failure of some steps in the titration for the carbon dioxide in the water, the figures given for the Amia and the soft-shelled turtle are the calculated results, assuming that the respiratory quotient is one, as that is the relation found by analysis in the other cases.

[1] See Wm. Thörner on the use of olive oil for the prevention of the absorption of carbon dioxide. Repertorium der analytischen Chemie, 1885, pp. 15 17.

It requires but a glance at the figures in this table to see that the aerial differs markedly from the aquatic part of the respiration Even in the frog, in which the skin forms the only aquatic respiratory organ, the tendency is marked The law appears to be unmistakably this, viz that in combined aquatic and aerial respiration, the aerial part is mainly for the supply of oxygen and the aquatic part largely for the excretion of carbon dioxide This law, which I stated in 1886, has been confirmed by the repetition of old experiments and by many new ones made during the present summer It is also confirmed by the experiments made on Lepidosteus in a different way by Dr E L Mark, and published in 1890. I therefore feel that this is the expression of a general law in nature

From the standpoint of evolution we must suppose that all forms originated from aquatic ancestors, ancestors whose only source of oxygen was that dissolved in the water As the water is everywhere covered with the limitless supply of oxygen in the air, there being 209 parts of oxygen in 1000 parts of air as contrasted with the 6 parts of oxygen dissolved in 1000 parts of water, it is not difficult to conceive that in the infinite years the animals found by necessity and experience that the needed oxygen was more abundant in the overlying air, and that some at least would try more and more to make use of it And as any thin membrane with a plentiful blood supply may serve as a respiratory organ to supply the blood with oxygen, it is not impossible to suppose that such a membrane, as in the throat, could modify itself little by little with ever increasing efficiency, and that a part might become especially folded to form a gill and another might become sacular or lung-like to contain air While I am no believer in the purely mechanical physiology which sees no need of more than physics and chemistry to render possible and explain all the phenomena of life, yet it is patent to every one that, although vital energy is something above and beyond the energies of physics and chemistry, still it makes use of these, and certainly dead matter forms the material from which living is built. So given a living thing, it, in most cases, moves along lines of least, rather than of greatest, resistance, therefore if practically a limitless supply of oxygen may be obtained from the air and only a limited amount from the water, if anything that might serve as a lung is present, most naturally it (the animal) will take the oxygen from the air where it is in greatest abundance and most easily obtained On the other hand, carbon dioxide is so soluble in water that practically a limitless amount may be excreted into it, and as it is apparently somewhat easier, other things being equal, for it to pass from the liquid blood to the water than to the air, it seems likewise natural that the gills should serve largely for the excretion of the carbon dioxide into the water This is the actual condition before us in these, and I believe in all other cases, of mixed or of combined aerial and aquatic respiration And I believe, as stated above, that it may be laid down as a fundamental law in respiration that wherever both water and air are used with corresponding organs—gills for one and lungs for the other—that the aerial part of the respiration is mainly for the supply of oxygen, and the aquatic part largely for the getting rid of carbon dioxide

It is not difficult to see in an actual case like that of the Ganoid Fishes (Amia and Lepidosteus) the logical steps in its evolution, by which this most favourable condition has been reached A condition rendering these fishes capable of living in waters of almost all degrees of purity, and thus giving them a great advantage in the struggle for existence But what can be said of the soft-shelled turtles, animals belonging to a group in which purely aerial respiration is almost exclusively the rule? Standing alone, this might be exceedingly difficult or impossible of explanation The Batrachia (frogs, toads, salamanders, &c) all have gills in their early or larval stage, and most of them develop in the water, and are in the beginning purely aquatic animals. The adults must therefore, in most cases, repair to the water at the spawning season and frequently in laying the eggs they must remain under the water for considerable intervals Being under the water, and the need of oxygen becoming pressing, there seems to be, by a sort of organic memory, a revival of the knowledge of the way in which respiration was accomplished, when, as larvæ, their natural element was water, and they take water into the mouth and throat This may be done by as highly a specialized and purely aerial form as the little brown tree-frog (*Hyla pickeringii*) or the yellow spotted salamander (*Amblystoma punctatum*) Another very interesting form, the vermilion-spotted newt (*Diemyctylus*), after two or three years of purely aerial existence goes to the water on reaching maturity and remains there the rest of its life, regularly breathing both by its lungs and by taking water into its mouth and throat A still more striking example is given by Prof Cope The young siren almost entirely loses its gills, and later regains them, becoming again almost completely aquatic in its habits as in the larval stage

With these examples, which may be seen by any one each recurring year, is it impossible or difficult to conceive that in the struggle for existence the soft shelled turtles found the scarcity of food, the dangers and hardships on the land greater than those in the water? Or, remaining constantly in the water, and advantageously submerged for most of the time, it gradually reacquired the power of making use of its pharyngeal membrane for obtaining oxygen from the water and excreting carbon dioxide into it as had its remote ancestors And further, is it not intelligible that with capacious lungs, which it can fill at intervals with air containing so large a supply of oxygen that it, like the other double or mixed breathers, should use its lungs to supply most of the oxygen and its throat to get rid of much of the carbon dioxide?

Indeed it seems to me that if the evolution doctrine is a true expression of the mode of creation, then development may be in any direction that proves advantageous to an organism, even if the development is a reacquirement of long discarded structures and functions

In closing may I be permitted to say to the older biologists—to those familiar with the encouragements and inspirations that come with original investigation, that I trust they will pardon what to them is unnecessary personality or excess of detail in this address, for the sake of the younger ones among us, to whom the uphill road of research is less familiar Judging from my own experience in listening to similar addresses by my honoured predecessors, it is helpful to know, when one is beginning, something of the "dead work," the difficulties and discouragements, as well as the triumphs, in the advancement of science

MINES AND MINING AT THE CHICAGO EXHIBITION

THE exhibition of objects relating to mines and mining at the "World's Fair" promises to be one of exceptional interest and importance The following details about it were given by Mr George F Kunz in a paper read before the recent meeting of the American Association for the Advancement of Science —

The building of mines and mining, which is entirely completed, is 700 feet long and 350 feet wide, at an elevation of 25 feet above the main floor On both sides is a gallery 60 feet wide, running the entire length of the building Up to the present time there have applied for space in this building 26 foreign Governments and 36 States, these exhibits to be supplemented by other State and Government exhibits, such as that of Sweden in the Swedish building, the East Indian in the East Indian court, Illinois in their State building, &c

There will be a scientific collection of all the known elements, and with them a complete collection of all the known alloys of gold, silver, copper, zinc, tin, &c , such as electrum, German silver, Babbits metal, fusible metal, and the thousand and one other, common and rare, used in the arts and industries In the name of the Lake Superior copper mines, Prof Alex Agassiz has promised a complete exposition of ores, rocks, and processes, illustrating the occurrence mining, metallurgy of copper There is now in preparation a coal collection to contain all varieties of coal, from every known occurrence in the United States Petroleum will be shown as it never has been at any exhibition The subject of abrasives of all kinds will form a special exhibit under the charge of Mr T Dunkin Paret, who has devoted his entire life to this subject, and is now making a special European trip to enlist the co operation of foreign manufacturers and investigators to supplement the American exhibit

The De Beers Mining Company of South Africa, who own and control more than 95 per cent of the entire diamond output, will make first a full and comprehensive exposition of diamond mining and the original blue stuff, a decomposed peridotite, enclosing carbonaceous shale, the matrix of the diamond, in great quantities They will show it passing through

the various washing machines, and every process separating the diamond from the matrix, in which exists a percentage of 1 carat 205 milligrams in a load of 1600 pounds There will be a case containing over 10,000 carats of diamonds of all colours and of the various qualities, with a full series of the associated minerals and rocks Every stage of the cutting and polishing of the diamond will be represented

Nearly every mineral dealer in the United States has applied for space, and from the foreign trips and other preparations it is very evident that in the line of cabinet specimens and educational minerals the assembled collections will exceed those of any other exposition in importance

One of the large gallery halls will contain a reference library for the use of visitors This it is hoped will be a very comprehensive exposition of the literature of the subject of mines, mining, geology, and mineralogy This is to be supplemented by historical portraits, documents, and other allied material

An early history of mining and mining processes will be shown, starting with stone hammers and other aboriginal implements found in the copper mines of Lake Superior and the turquoise mines of New Mexico, the old Mexican Pateo, to the most improved modern methods, and the remarkable sectional and glass models of mines, prepared by eminent mining engineers, used in the great mining lawsuits to prove their arguments

One of the large corridor rooms in the gallery has been offered to the American Institute of Mining Engineers for their own use as a headquarters during the Exposition They in turn may extend the courtesy to mechanical and civil engineers, as well as the English, German, French, and other foreign engineers whose hospitality they enjoyed in 1889 There is every reason to believe that at least from 800 to 1000 foreign engineers will visit the Exposition

If only three fourths of the promised exhibits are received, and there is every assurance that there will be many more coming, it may be safely said, even now, that the mining, metallurgical, geological, and mineralogical exhibits of the Columbian World's Fair will exceed in scientific importance and in extent the combined exhibits of the Centennial, the 1878, 1889, the Paris and the Vienna Expositions, at least two fold

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE —Lord Walsingham, the High Steward of the University, has expressed his wish to give annually for three years a gold medal for the best monograph or essay giving evidence of original research in any subject coming under the cognizance of the Special Board for Biology and Geology The offer having been accepted and the regulations for the medal having been approved, the Special Board for Biology and Geology give notice that the medal is offered for competition for the second time during the ensuing academical year The essays are to be sent to the chairman of the Special Board (Prof Newton, Magdalene College) not later than October 1, 1893

The regulations for the medal are published in the *Cambridge University Reporter*, No 908 (November 17, 1891), p 186

Sir R S Ball, Lowndean Professor, will give his inaugural lecture in the Anatomical Theatre on Friday, October 21, at noon

Dr Cayley, Sadlerian Professor of Mathematics, resigns his place on the Council of the Senate on October 25

The Council of the Senate recommend that the University of the Cape of Good Hope should be affiliated to Cambridge, on the same terms as those granted to New Zealand

LONDON —Four lectures upon "The Sun in its Relation to the Universe of Stars" will be delivered in Gresham College, at six p m on the evenings of October 25, 26, 27, and 28, 1892, by the Rev Edmund Ledger

SCIENTIFIC SERIALS

The Journal of the Royal Agricultural Society of England, 3rd Series, Vol iii, pt 3 —Allotments and Small Holdings, by Sir J B Lawes and Dr Gilbert The authors have collected statistics relating to Allotments and Small Holdings in Great Britain They point out that "within the present century there has been a great reduction in the number both of owners and of occupiers of farms not exceeding 50 acres in area, such as it seems to be the object of the promoters of the Small Holdings Act of 1892 greatly to increase" After noticing the Rothamstead Allotments they proceed to discuss the conditions essential to the success of small holdings, and they conclude that ordinary rotation farming is much less suitable for small holdings than dairy farming, the production of poultry and eggs, and market gardening when favourable conditions exist, the authors do not believe, however, that the system of small holdings will materially check the influx of agricultural labourers into the towns This number of the *Journal* also contains a short article by W H Hall on Small Holdings in France Mr Hall is "convinced that small holders (in England) have a great future before them as soon as they can be educated up to producing such articles as require to be consumed fresh, and will not bear long carriage" This last clause contains the key of the whole matter —On the Vermin of the Farm, pt. ii, by J E Harting In this paper the author has much to say in defence of the mole (*talpa europæa*), and of the weasel (*mustela vulgaris*), there is little but condemnation, however, for the hedgehog, the stoat, and the polecat, the last mentioned animal is now hardly known to most people, though the domesticated variety (the ferret) is common -The Warwick Meeting of 1892, by Dr Fream, Official Reporter This report shows the meeting to have been a good average one, except in the attendance of visitors on the last two days Judge's reports show that in many cases the quality of the exhibits of live stock was far above the average.—Miscellaneous Implements Exhibited at Warwick, by T H Thursfield —The Farm Prize Competition of 1892, by J B Ellis —Among the shorter articles is one deserving of careful attention, entitled New Modes of Disposing of Fruit and Vegetables, by Chas Whitehead, in which are discussed the "evaporating" and the "canning" of fruit, methods already in use in Queensland are described and discussed with reference to their adoption in this country when prices for fresh fruit are low —Dr J W Leather contributes a short article upon his method of detecting and estimating "castor-oil seeds in cattle foods" A weighed quantity of the suspected food is digested with hot dilute sulphuric acid (or HCl, about 2 p c.) for half an hour, washed free from acid, re-digested with a hot dilute solution of caustic soda, washed, and then finally treated with a quantity of bleaching powder The husks of all seeds other than castor oil seeds are bleached by this treatment, and any unbleached husks can be picked out and weighed

Wiedeman's Annalen der Physik und Chemie, No 9 —The principle of least effect in electrodynamics, by H von Helmholtz —On the differences of potential of chains with dry solid electrolytes, by W Negbaur —On the reciprocity of electric osmose and flow currents, by U Saxen —Resonance phenomena and absorptive capacities of metals for the energy of electric waves, by V Bjerknes —Objective presentation of the Hertzian experiments with rays of electric force, by L Zehnder —Dispersion and absorption of light according to the electrical theory of light, by D A Goldhammer —On the measurement of high temperatures, by L Holborn and W Wien The apparatus was a modification of Le Chatelier's thermo-element, consisting of a combination of platinum and a platinum-rhodium alloy This was calibrated by placing it inside the porcelain vessel of an air-thermometer and comparing the readings, different thermo couples were compared by exposing together in short porcelain tubes, two branches being welded together The following fusing temperatures were deduced gold 1072°, silver 968°, copper 1082° —On the expansion of gases at low pressures, by G Melander Working with pressures ranging from 770 to 4mm, and temperatures from 0° to 100°, the gases being kept at constant volume, the supposed law of constant decrease of coefficient of expansion with decreasing pressure was found not to hold good. That of air decreases down to 232mm, where it is 0 003659, and then increases. That of carbon dioxide decreases down to 76mm, after which it increases, whilst that of hydrogen increases steadily —Specific gravity and heat of fusion of ice, by J v Zakrzevski The apparatus was a very delicate form of Bunsen's ice calorimeter The specific gravity of ice at −0 701° C was found to be 0 916710 The cubical coefficient of expansion at that temperature was 0 000077, which gives for the sp gr of ice at 0° C the value 0 916660 —On the theoretical conceptions of Georg Simon Ohm, by K. Von der Mühll —Variation of the specific volume of sulphur with the temperature, by M Toepler.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 16.—"Thermal Radiation in Absolute Measure." By Dr. J. T. Bottomley, M.A., F.R.S.

The paper contains an account of an experimental investigation by the author in continuation of researches on the same subject which have been already published (Roy. Soc. Proc., 1884, and Phil. Trans., 1887). In the earlier experiments metallic wires heated by an electric current were used. The loss of heat from a heated body, however, depends to some extent on the form and dimensions of the body; and it seemed important to experiment on the loss of heat from bodies differing in form from the wires already used, and larger in dimensions.

Accordingly, two copper globes used by Mr. D. Macfarlane in 1872 (Roy. Soc. Proc., 1872, p. 93) were employed for a new series of experiments.

After preliminary experiments (using the same enclosure which Macfarlane employed and with the surfaces of Macfarlane's globes prepared in four different ways) new apparatus was constructed. The object was to experiment both with full air pressure and with different amounts of exhaustion of the air, and Macfarlane's enclosure is unsuitable for this purpose.

In the arrangement adopted, the heated globes were hung at the centre of a hollow metallic sphere, which was connected with the Sprengel pump and surrounded with cold water, and were allowed to cool. The temperature of the cooling globe was read off at equal intervals of time by means of a thermo-electric junction; and from these readings the absolute loss of heat per unit of cooling surface, per unit difference of temperatures of surface and surroundings, per unit of time, is calculated.

The details of the apparatus and method of experimenting are given in the paper. It is enough to say here that the globes were used with their surfaces in two different conditions:—(1) Thinly coated with lamp-black, and (2) silvered and brightly polished; and in both conditions the absolute loss of heat, both in air and in vacuum more or less complete, was determined. The tables and curves attached to the paper give the details of the results.

To quote one or two examples:—With the sooted surface a total loss of heat by convection and radiation of 3.42×10^{-4} c.g.s. units per square centimetre, per second, per 1° C. of difference of temperatures of globe and surroundings, was observed with a difference of temperatures of 100° C., and with the surroundings at about 14° C. Under similar circumstances the radiation in vacuum of $\frac{1}{2}$M (half-a millionth of atmospheric pressure of non-collapsible gas) was about 1.40×10^{-4}.

Taking a silvered and brightly-polished surface under the same circumstances, the loss in full air was 2.30×10^{-4} c.g.s., and with the highest vacuum and brightest polish obtained, it was reduced 1.80×10^{-5}, with in this case a difference of temperatures of 180° C. The loss with 100° C. difference would be considerably less, but is not known experimentally at present.

The author returns thanks to Mr. James H. Gray, M.A., B.Sc., for excellent assistance given; and expresses himself most deeply indebted, both for assistance in experimenting and calculating of the results, and for most valuable and ingenious aid of various kinds during the course of this work, to his friend Mr. A. Tanakadate, now Professor in Tokio, Japan.

Entomological Society, October 5.—Henry John Elwes, vice-president, in the chair.—Mr. C. O. Waterhouse exhibited a specimen of *Latridius nodifer* feeding on a fungus, *Trichosporium roseum*.—Mr. McLachlan, F.R.S., exhibited a male specimen of *Elenchus tenuicornis*, Kirby, taken by the Rev. A. E. Eaton, on August 22 last, at Stoney Stoke, near Shepton Montague, Somerset, and described by him in the *Entomologist's Monthly Magazine*, October 1892, pp. 250-253. Mr. McLachlan stated that another specimen of this species had been caught about the same date in Claygate Lane, near Surbiton, by Mr. Edward Saunders, who discovered that it was parasitic on a homopterous insect of the genus *Liburnia*, and had also described it in the *Entomologist's Monthly Magazine*.—Mr. J. M. Adye exhibited, for Mr. McRae, a large collection of *Colias edusa*, *C. edusa* var. *helice*, and *C. hyale*, all taken in the course of five days' collecting in the neighbourhood of Bournemouth and Christchurch, Hants. There were twenty-six specimens of *helice*, some of which were remarkable both in size and colour. He stated that Mr. McRae estimated the proportion of the variety *helice* to the type of the females as one in fifty. Mr. Adye also exhibited two specimens of *Deiopeia pulchella*, recently taken near Christchurch. Mr. Hanbury, Mr. Jenner Weir, and Mr. Merrifield commented on the interesting nature of the exhibition and on the recent extraordinary abundance of *C. edusa* and the var. *helice*, which was probably not exceeded in 1877.—Mr. Dallas Beeching exhibited four specimens of *Plusia moneta*, lately taken in the neighbourhood of Tunbridge Wells.—Mr. H. Goss exhibited, for Mr. Gervase F. Mathew, two *Plusia moneta* and their cocoons, which were found at Frinsted, Kent, on September 3 last. It was stated that Mr. Mathew had found seven cocoons on the under side of the leaves of monkshood, but that the imagos had emerged from five of them.—Mr. Rye exhibited a specimen of *Zygæna filipendulæ* var. *chrysanthemi*, and two varieties of *Arctia villica*, taken at Lancing, Sussex; also varieties of *Coccinella ocellata* and *C. oblongoguttata* from Oxshott.—Mr. A. H. Jones exhibited specimens of *Argynnis pales* var. *isis*, and var. *arsilache*, the females of which showed a tendency to melanism, recently taken in the Upper Engadine; also melanic forms of *Erebia melampus*, and a specimen of *Erebia nerine*.—Mr. Elwes exhibited specimens of typical *Erebia melas*, taken by himself in the Western Tyrol, on July 25 last, at an elevation of 7000 feet; also specimens of the same species from Hungary, Greece, and the Eastern and Central Pyrenees. He stated that the absence of this species from the Alps, which had seemed to be such a curious fact in geographical distribution, had been first disproved by Mrs. Nicholl, who discovered it at Campiglio two years ago. He also exhibited fresh specimens of *Erebia nerine*, taken at Riva, on the lake of Garda, at an elevation of about 500 feet; also specimens of the same species, taken at the same time, at an elevation of about 5000 feet, in cool forest glades; and remarked that the great difference of elevation and climate did not appear to have produced any appreciable variation in this species.—Mr. G. T. Porritt exhibited two varieties of *Abraxas grossulariata*, bred during the past summer from York larvæ. Also a curious Noctua taken on the sandhills at St. Anne's on Sea on August 20 last, and concerning which a difference of opinion existed as to whether it was a melanic form of *Agrotis cursoria* or of *Caradrina cubicularis*. Also a small dark form of *Orgyia antiqua*, which had occurred in some numbers at Longridge, near Preston.—Mr. A. Eland Shaw exhibited a specimen of *Mecostethus grossus*, Linn., taken lately at Irstead, in the Norfolk-broad district. He stated that this was the first recorded capture of this species in Britain since 1884.—Mr. C. G. Barrett exhibited a specimen of *Syrichthus alveus*, caught in Norfolk about the year 1860; a beautiful variety of *Argynnis euphrosyne*, caught this year near Godalming; and a series of varieties of *Ennomos angularia*, bred from a female taken at Nunhead.—Mr. P. Crowley exhibited a specimen of *Zygæna filipendulæ* var. *chrysanthemi*, taken last August at Riddlesdown, near Croydon.—Lord Walsingham, F.R.S., sent for exhibition several specimens of larvæ of *Sphinx pinastri*, preserved by himself, which were intended for presentation to the British Museum. The larvæ had been sent to him by Lord Rendlesham, who obtained them from ova laid by a female captured in Suffolk last August.—M. de Nicéville communicated a paper entitled "On the variation of some Indian Euplœas of the subgenus *Stictoplœa*" and Captain E. Y. Watson exhibited, on behalf of M. de Nicéville, the specimens referred to in this paper. Colonel Swinhoe, Mr. Hampson, Mr. E. B. Poulton, F.R.S., and the chairman took part in the discussion which ensued.—Mr. W. Bateson read a paper entitled "On the Variation in the Colours of Cocoons and Pupæ of Lepidoptera; further Experiments."—Mr. Poulton read a paper entitled "Further Experiments upon the Colour relation between certain Lepidoptera and their Surroundings."—Miss Lilian J. Gould read a paper entitled "Experiments on the Colour-relation between certain Lepidopterous larvæ and their surroundings, together with observations on Lepidopterous larvæ." A long discussion ensued, in which Mr. Jenner Weir, Dr. Sharp, F.R.S., Mr. Merrifield, Mr. Poulton, and the chairman took part.

PARIS

Academy of Sciences, October 10.—M. Duchartre in the chair.—M. Emile Picard presented to the Academy the second volume of his "Traité d'analyse."—The University of Padua invited representatives of the Academy at the forthcoming tercentenary celebration of Galileo's accession to his chair at that University.—A decisive blow to the theory of centripetal and ascending motion in cyclones, by M. H. Faye.—The move-

ments of the heart, studied by chronophotography, by M Marey The heart of a tortoise was removed and mounted so that a funnel led into an auricle, and a bent tube out of the ventricle and upwards to the mouth of the funnel The funnel was filled with defibrinated blood, which passed into the auricle and thence into the ventricle When the latter was full, an automatic systole projected the blood upwards through the tube and back into the funnel This process was repeated for several hours after death. It was more minutely studied by taking a series of instantaneous photographs in rapid succession (reproduced), which show the details of the process with great accuracy For actinic purposes, the heart was painted white with water colour The hypothesis of an active diastole of the ventricle was proved to be unfounded —The inhibitory phenomena of the nervous shock, by M H Roger —On the transformation of the equations of Lagrange, by M Paul Painlevé —On a class of curves and surfaces, by M A Pellet On the motion of a thread in space, by M G Floquet —On internal reflection in crystals, by M Bernard Brunhes —A new method of preparation and photometry of the phosphorescent sulphide of zinc, by M Charles Henry It is possible to obtain several pounds at a time of a fine phosphorescent zinc sulphide by the following process Add ammonia to a perfectly neutral solution of pure zinc chloride, redissolve the precipitate in an excess of ammonia, precipitate completely, but without the slightest excess, the ammoniacal oxide of zinc by sulphuretted hydrogen, heat to a white heat in a crucible of refractory earth placed inside a graphite crucible, after having well washed and dried the amorphous sulphide to the exclusion of all impurities. By Mascart's photometer, the intensity of light emitted by a sample of the sulphide in candle metres after saturation was 0·000215 But this value is probably too small —On the antimonites of pyrogallol, by MM H Causse and C Bayard —On the tartaric ethers, by M P Freundler —Volumetric determination of the alkaloids, by M L Barthe —On a new method of brick manufacture, used in certain parts of Central Asia, by M Edouard Blanc This mode of manufacture is practised by the tribes in Western Mongolia, on the frontier of Siberia The extremes of temperature render a brick of great durability a necessity of life This is attained by the use of steam The oven is cylindrical and surmounted by a hemispherical cap, which is kept open for the first three days The bricks, about 7000 at a time, are baked by means of a fire fed by about 7000 kgr of an annual ligneous plant, the *Alhagi Camelorum* On the third day, the opening is closed with felt, which is kept constantly wetted, so that the bricks are enclosed in a steam bath, while kept at a red heat Under these circumstances, some novel chemical reactions appear to take place The bricks, red after the first period, appear dark grey after the second part of the process Their structure appears porous, they become sonorous and acquire a great hardness They show a striking resemblance to certain trachytes Made from the same clay as our bricks, they resist weathering very much better, and have an extraordinary hardness and cohesion —A process for testing the purity of coprah oils and palm oils, by M Ernest Milliau —On the part played by spermine in intra-organic oxidations, by M Alexandre Poehl —On the respiration, transpiration, and dry weight of leaves developed in sunlight and in the shade, by M L. Geneau de Lamarlière —On the structure of the assimilating tissue of the branches in Mediterranean plants, by M William Russell —Experimental study of the action of the humidity of the soil on the structure of branches and leaves, by M Auguste Oger —Contributions to the stratigraphy of the Pyrenees, by MM Roussel and De Grossouvre —On some bombs of Etna, from the eruptions of 1886 and 1892, by MM L Duparc and L. Mrazec.—Meteoric iron recently fallen at Hassi Iekna, in Algiers, by M Stanislas Meunier —Oceanographic observations relating to the basin of Arcachon (Gironde), by M J Thoulet —Vegetation of the lakes of the Jura mountains, by M G Rambault Ant Magnin —M Bischoffsheim, on behalf of Prof Weineck, Director of the Prague Observatory, presented a photograph of the lunar crater Vendelinus

DIARY OF SOCIETIES.

LONDON.

SUNDAY, OCTOBER 23

SUNDAY LECTURE SOCIETY, at 4.—The Distribution of Animals and what it Teaches (with Oxy hydrogen Lantern Illustrations) Dr Andrew Wilson.

TUESDAY, OCTOBER 25

MINERALOGICAL SOCIETY —Anniversary Meeting —Council Report —On Crystallized Zirconia (Baddeleyite), a New Mineral Species from Ceylon L Fletcher, F R S —Preliminary Note on Xanthoconite and Rittingerite H A Miers and G T Prior —A Locality of Cerium Minerals in Cornwall, H A Miers —On Gypsum from Herne Bay F Rutley

FRIDAY, OCTOBER 28

PHYSICAL SOCIETY, at 5 Discussion of Mr Williams's Paper on the Dimensions of Physical Quantities —Dicussion of Mr Sutherland's Paper on the Laws of Molecular Force, to include Papers by Dr Young and Mr Thomas on the Determination of Critical Density, Critical Volume, and Boiling Points

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS —The Framework of Chemistry, Part 1, W M Williams (Bell).—A German Science Reader F Jones (Percival) —Chemical Lecture Experiments G S Newth (Longmans) —Outlines of Psychology, new edition Dr J Sully (Longmans).—Animals' Rights H S Salt (Bell)—University College of North Wales Calendar for the Year 1892–93 (Manchester, Cornish) —The Climate of Rome and the Roman Malaria Prof Tommasi Crudeli, translated (Churchill) —The Fauna of Liverpool Bay, Report 3 (Liverpool Dobb) —Atomic Consciousness (Whimple, Harris).—Geographische und Naturwissenschaftliche Abhandlungen I Dr J Rein (Leipzig, Engelmann) —Metal Colouring and Bronzing A H Hiorns (Macmillan) —The Telephotographic Lens T R Dallmeyer (Dallmeyer) —The Geological and Natural History Survey of Minnesota N H Winchell (Minnesota) —Brachiopoden der Alpinen Trias, Nachtrag I A Bittner (Wien) —Atlas der Völkerkunde Dr G Gerland (Gotha, J Perthes) —British Fungus Flora, vol 1 G Massee (Bell)

PAMPHLETS —Rutherfurd Photographic Measures of the Stars about β Cygni H Jacoby (New York).—Ueber die Einseitigkeit der Herrschenden Krafttheorie Dr N von Seeland (Leipzig, Pfeffer) —Weitere Untersuchungen über die Tägliche Oscillation des Barometers J Hann (Wien)

SERIALS —Internationales Archiv für Ethnographie Band 5 Heft 4 (Kegan Paul) —Annals of Scottish Natural History, October (Edinburgh, Douglas) —Palestine Exploration Fund Quarterly Statement, October (Watt) —Transactions of the Leeds Naturalists' Club &c., 1890, vol 1 (Leeds) —Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1891 92, vol 5, No 2 (Manchester).—Notes from the Leyden Museum vol xiv Nos 1 and 2 (Leyden, Brill).—Morphologisches Jahrbuch, 18 Band, 4 Heft (Williams and Norgate) —Botanische Jahrbucher für Systematik, Pflanzengeschichte und Pflanzengeographie Sechzehnter Band, 2 Heft, Fünfzehnter Band, 4 Heft (Williams and Norgate).—Journal of the Royal Statistical Society, September (Stanford) —Mind, October (Williams and Norgate) —The Asclepiad, No 35, vol 9 (Longmans).—Medical Magazine, October (Southwood) —Jahrbuch der k k geologischen Reichsanstalt, Jahrg 1892 xlii Band, 1 Heft (Wien) —Bulletin of the New York Mathematical Society, vol 2 No 1 (New York)

CONTENTS.

THURSDAY, OCTOBER 27, 1892

POLAND'S "FUR-BEARING ANIMALS"

Fur-bearing Animals in Nature and Commerce By Henry Poland, F Z S , 1 vol , 8vo (London Gurney and Jackson, 1892)

ALTHOUGH, as civilization spreads with ever-quickening progress over all parts of the world's surface, wild animals necessarily diminish in numbers year by year, few people have any idea of the enormous quantities of furs and pelts still annually imported into the United Kingdom, and of the extent of the commerce in such commodities still carried on Mr Poland's useful treatise on Fur-bearing Animals will afford us much information on this subject In the introduction to his volume full statistics about the past and present condition of the fur-trade are given, and it is stated that at the great fur sales now held at the College Hill sale-rooms in London the annual value of all classes of fur-skins sold is little short of £1,000,000

But it is with the main portion of the present work that naturalists will be most interested, as, so far as we know, this is the first occasion on which a large amount of practical knowledge of the subject has been combined with a certain amount of scientific information Mr Poland takes the fur-bearing animals systematically, mostly, it appears, according to the order and nomenclature employed in the list of animals in the Zoological Society's Gardens, and gives us under each head particulars as to their localities, distribution, coloration, and varieties, together with information as to the quantities of skins imported and the uses to which they are devoted

Beginning with the Quadrumana, we find that the skins of about twenty five Monkeys and Lemurs are used in commerce Of these the most abundant is the "Black Monkey" of Western Africa (*Colobus vellerosus* and other allied species), of which some 90,000 are imported every year Another species of Colobus, the Guereza of Abyssinia and Eastern Africa, also furnishes a "rare and much esteemed skin," of which the value is from 10*s* to 15*s* We may remark that the Tcheli Monkey (*Macacus tcheliensis*) is not from Cochin China, as stated by Mr Poland, but from Mantchuria, north of Pekin, where it ranges further north than any other Monkey now existing There is a fine example of this species at present living in the Zoological Society's Gardens The "China Grey Monkey," described as having a "long white tail," is evidently of quite a different species, the Tcheli Monkey having only a very short caudal appendage

The Carnivora, which next follow, take up the greater part of Mr Poland's volume, nearly 150 species of this extensive group supplying pelts which are more or less useful to mankind Commencing with the larger Cats, our author calls attention to the great difference between the Bengal Tiger and the Mongolian or Chinese variety of the same animal, in which the fur is very thick, often from 1½ to 2 inches in length, and makes a long fringe round the face Skins of the Chinese Tiger are much esteemed on this account, and fetch from £10 to £40 each, according to quality ; whereas a good Bengal Tiger skin may be purchased at about £4 or £5 The Lynx is another of the true Cat-tribe which furnishes a rather important article of trade, the quantity of Lynx-skins imported by the Hudson's Bay Company ranging up to 40,000, and in exceptional years reaching even to 70,000 Coming to the Musteline Carnivora or Weasels, we find the Mink (*Mustela vison*) an animal of still greater importance in trade In 1890 upwards of 360,000 skins of the Mink from North America were sold in London, and converted mostly into muffs On the other hand, an allied species of the same genus, the Ermine (*M erminea*), formerly so much esteemed, and regarded as a princely fur to be devoted exclusively to royalty, is going quite out of fashion "It has become very much neglected and a few years ago was practically unsaleable "

The fur of the Skunk, *Mephitis mephitica*, many persons will be surprised to hear, in spite of its "powerful scent," which "cannot be entirely got rid of," is largely used In 1891 nearly 700,000 skins of it were imported, and worked up into muffs and capes But the prince of furs of this division of the Carnivora is that of the Sea-otter, *Enhydra lutris*, of the north-west coast of America, an animal generally supposed to be almost extinct in consequence of long ages of persecution But 2369 Sea-otter skins were imported by the Alaska Commercial Company and other traders in 1891, and sold at an average price of £57 apiece "The fur is principally consumed in Russia, where it is used for collars of noblemen's coats "

From the Sea-otter we pass by an easy transition to the Fur-seals—a group still of sufficient importance to have brought three of the greatest nations of the world nearly to loggerheads, but in bygone years much more abundant than now From South Georgia in the Antarctic Seas one million two hundred thousand Fur-seal-skins are said to have been taken soon after its discovery, and nearly an equal quantity from Kerguelen Island, but the natural consequence has followed that the animal has become practically extinct in the Antarctic seas. The only species of Otaria that still yields its skin year by year to supply the ladies of Europe and America with "sealskin jackets" is the Alaska Fur seal, *Otaria ursina*, which, owing to the stringent regulations enforced for its preservation, is still abundant in certain parts of the North Pacific According to the best authorities about 4,500,000 of this Fur-seal resort to the Pribylov Islands every breeding season, and until 1890, when the number to be slaughtered was reduced, 100,000 were killed every year. Smaller quantities are obtained from other parts of the North Pacific We need not here go into further details upon this animal which has lately been the subject of so much discussion, except to say that unless even more severe regulations are made for its preservation than those now existing, the Alaska Fur-seal will indubitably share the fate of its Antarctic brethren, and cease to furnish an article of commerce

Of the order Insectivora, which follows the Carnivora, Mr. Poland only mentions two species as supplying fur for the use of mankind These are the Common Mole (*Talpa europæa*) and the Russian Musk-rat or Desman (*Myogale moschata*) The skin of the Mole is so small as to be of little value, but several thousands are collected annually and converted into those most comfortable of garments, moleskin waistcoats The fur of the

Russian Desman (*Myogale moschata*) is sometimes used in this country for mantle-trimmings, but is more appreciated in America. The Desman of the Pyrenees (*M pyrenaica*), which Mr Poland confounds with that of Russia, is a much smaller and quite different animal

We now come to the great group of Rodents, many of which supply their skins in enormous quantities for the benefit of mankind Mr Poland's list contains thirty-three species of this Order The Beaver, formerly of such pre-eminent importance, is now much reduced in numbers, but 63,419 Beaver-skins were sold by the Hudson's Bay Company in 1891 Another Canadian Rodent, the Musquash (*Fiber zibethicus*), still ranges over the "north-west" in enormous armies, from three to four millions of their skins being obtained every year In 1891 the Hudson's Bay Company alone sold 554,104 of them Another much appreciated little animal of the Rodent order is the Chinchilla from the highlands of Chili and Bolivia Its fur, which is remarkably soft and delicate, is principally used in England, France, and America Several allied species of the peculiar South American family *Chinchillidæ* are also called by the general name of "Chinchilla"

Of the Leporidæ or Hare family, which concludes the Rodents, the Polar Hare and the Common Rabbit supply the largest numbers of useful skins Of the Russian or Polar Hare (*Lepus glacialis*)—one of the best-known denizens of Arctic latitudes—from 2,000,000 to 5,000,000 skins are said to be collected annually, mostly in their thick white winter coats But Rabbit-skins are employed in much more enormous quantities Since the great increase of this Rodent in Australia and New Zealand, where, as is well known, the Rabbit has become an awful pest, the number of its skins sent to London for sale from those colonies has increased year by year, until, according to Mr Poland's calculations, from fifteen to twenty millions are now imported Very large numbers of Rabbit skins are also brought to England from France, Germany, and other countries, mostly taken from domestic varieties

The American "Buffalo" (more correctly "Bison") is extinct as regards trade purposes, so that we need not go into the quantities of "Buffalo-robes" formerly imported, which in Catlin's time reached 200,000 in the year; nor will the other species of the order Ungulata, of which Mr Poland gives forty-six in his list as affording skins more or less used in commerce, detain us long The most important of them are the different varieties of the domestic Sheep and Goat, which are spread all over the world and supply mankind with every variety of clothing-materials The extent of this commerce is enormous Of tanned Goatskins alone 7,259,212 were imported into this country in 1891, and 5,613,996 skins of "East Indian Sheep" were sold in London

The Edentates, Marsupials, and Monotremes, with which Mr Poland concludes his volume, are of small importance after the preceding orders "Australian Opossum," however, under which common name are included skins of several different species and varieties of the genus *Phalangista*, forms an exception, as the annual supply of this article exceeds two million skins, which are much appreciated for their "cheapness, light weight, pretty colour, and general usefulness" Of Kangaroos of all sorts over 120,000 skins were imported in 1891, so that, what with these and the Phalangers and its twenty million Rabbit-skins, Australia has a fair share of this lucrative commerce But altogether, no doubt, the Dominion of Canada and adjoining district of Alaska still get the lion's share of the traffic in "furs and pelts"

In concluding our somewhat lengthy notice of Mr Poland's volume we may say that it is replete with information that a zoologist cannot obtain elsewhere in a convenient form, but at the same time contains many errors in the identification of the species, some of which we have pointed out In a second edition, which will doubtless be called for, the author should obtain the assistance of a scientific expert He would also do well to cut out of his list some of the less important species (such as the Dingo, Great Anteater, and Echidna), which are not really used for trade purposes, and to bring up his statistical information under every head to the most recent date

SPINAL NERVE-IMPULSES AND ELECTROMOTIVE CHANGES

The Structure and Functions of the Brain and Spinal Cord By Victor Horsley, B S, F R C S, F R S (Griffin and Co, 1892)

AS stated in the preface, the present volume (being the Fullerian Lectures for 1891) discusses the spinal cord and ganglia alone, and is to be followed by two others, dealing respectively with the brain and with physiological psychology

Most books of this character have to be considered in their relation to two classes of readers—those who are experts in its subject-matter and those who are not—a distinction that applies with special force to the outcome of Royal Institution lectures We shall therefore take two readings of the volume before us

The table of contents and a cursory glance at the text very soon bear out the author's modest remark that these lectures have no pretensions to form a monograph upon the subject of which they treat Nor are they an elementary review of it (in the ordinary sense of these words), but rather a series of vignettes—historical, zoological, and speculative—relating to the nervous system The historical lecture is interesting, the curious and hideous figure on p 13, from a twelfth century manuscript in the Bodleian Library, very aptly fulfils its purpose, viz, to demonstrate that no advance is there apparent upon the ideas of Aristotle Prof Horsley avoids plainly asserting that Sir Charles Bell discovered the sensory and motor functions of the nerve-roots, the statement is implied, not made, at first reading we think it is made, on second reading we recognize that it is not made, on third reading that it is positively implied It is evident that Prof Horsley has read Bell's original pamphlet, "Idea of a New Anatomy of the Brain" (1811);[1] he does not, however, go

[1] Not an easy matter—we only know of one copy in London, that at the British Museum misdated 1802—nor a superfluous matter, as any one knows who has compared the "reprints" of 1824 and of 1830 with the original paper in the Phil Trans. of 1821 on the nerves of the face. Correct reprints of Bell's first paper have been published in "Documents and Dates of Modern Discoveries in the Nervous System," (? by A Walker), London, 1839, and in the "Journal of Anatomy and Physiology" for 1869, by A Shaw

on to say that Bell's two roots (before 1824) were an anterior "cerebral" root, subserving motion and sensation, and a posterior "cerebellar" root serving to govern vital actions. The *principle* of localization in nerve-roots, far more clearly stated by Walker in 1809 and the facts demonstrated by Majendie in 1822, are not alluded to. In the second lecture Kleinenberg's cells are figured and described, and on the next page admitted to be mythical; thus Prof. Horsley is enabled legitimately enough to utilize this time-honoured if anatomically incorrect illustration to enforce the essentially correct principle of differentiation. Lecture III. treats of jelly-fish, star-fish, and cray-fish, with reference to rhythm, "localization" and co-ordination of movements. "Localization" is used as a term to denote a physiological property or function (pp. 48-49), *i.e.*, as used by psychologists to denote an act of the subject, rather than as used by physiologists to indicate observed relations between parts and functions. This use of the word is perfectly legitimate, but it is rather apt to create confusion of thought. "Localization" is sometimes used in a similar sense in relation to brain-function, and with a similar inconvenience. "localization" *by* the brain in a psychological sense is properly localization by the subject, localization *in* the brain is an object of physiological experiment. No doubt it may be said that psychological localization rests upon physiological differentiation and localization; none the less the use of the term to denote a physiological property or function is not advisable without very careful definition. Lecture IV. deals with vertebrates: nerve-fibres, gullet theory of canalis centralis, spinal cord, and nerve-roots. Lecture V. with ganglia. Here we must criticise. Looking to the class of readers addressed, Fig. 26 may be misleading as regards the anatomy of anterior and posterior roots. Fig. 28 (altered from Hirschfeld and Leveillé) is very confusing, and the anatomy of the brachial and lumbar plexuses is strange. A reader who should gather his notions of the functions of spinal ganglia from pp. 110-113 would have a very wrong idea of the state of our physiological knowledge; nor does the odd expression, "the immense discovery by Claude Bernard, of the so-called vaso-motor system of nerves," possess much justification as regards historical accuracy.[1]

The four last lectures contain—necessarily mingled with familiar elementary considerations—a statement of the results arrived at by Professors Gotch and Horsley from their electrical investigation of nerve-impulses in afferent and efferent nerve-channels, and to the expert form the most important part of the book. We begin, therefore, to read more closely, still bearing in mind, as indeed is suggested by the style, the requirements of non-expert readers. Nothing arrests attention on the first two pages. On p. 129 we pause at this sentence:—"It is very interesting to see that the protoplasm of a nerve conductor has a distinctly longitudinal arrangement, which, it is not going too far to suggest may, by virtue of this fact, be more adapted for the polarization of its molecules for the better transmission of nerve-impulses." Having dissected out the possible meaning of this sentence we proceed. Two pages further we are stopped for a moment by a confusion between the local excitability of nerve and its conductivity. On the next page (p. 132) we demur to the assertion that "secondary tetanus depends upon the electrotonic state of the first preparation." On page 138 we find no reason to accept the distinction that "no doubt may reasonably exist that active nerve yields products of oxidation, which doubt certainly exists as to the acidification of nerve." Both facts are possible but unproven; no proof whatever has been attempted of the first; the second has been investigated with positive and with negative results. Page 146 includes a figure in which the current is *not* shown as an action current, but the reverse; moreover, with the instrument figured (capillary electrometer), *no current* is under observation.

But these twenty pages are enough, and we shall have but little space to discuss what forms the main positive differentia between Prof. Horsley's book and other books of the same class, *i.e.*, the conclusions derived from electrical data.

The conditions of criticism in this connection are altogether different, and we need not stop to examine into the accuracy of elementary points. Prof. Horsley is now addressing himself to an expert audience; his reasoning and his data have yet to pass through the refining fires of doubt and of objection, with, it is to be hoped, ultimate confirmation. The principle of the method of investigation is a well-established one; we know that electrical variations are indicators of functional variations; in the spinal cord, as elsewhere, functional activity may therefore be roughly gauged by galvanometer or by electrometer. Gotch and Horsley did this as regards efferent channels and afferent channels; as regards the first they found by the electrometer that the character of discharge in the pyramidal tract does not differ from its character in motor nerves; as regards the afferent tract they find that impulses pass up the cord chiefly in the posterior column of the same side. These conclusions may be admitted without imprudence. But the conclusions that may not safely be admitted without further experimental elaboration, are those relating to the functional discharges (inferred from electrical discharges) up and down the anterior and posterior roots, and to the quantitative distribution of centripetal impulses in the various columns of the cord. As regards this second point the physical conditions are not sufficiently analyzed (either in this volume or in the original paper) for us to admit, *e.g.*, that average galvanometric swings of 60 and 20 indicate a passage of afferent impulses in the proportions 60 and 20 per cent. in the posterior and in the lateral columns respectively. That the deflection was proportional to the number of fibres excited, is an assumption requiring proof (p. 212, *cf.* also pp. 145, 159, 160).

As regards the first point, it was found that electrical discharges pass easily *down* as well as *up* the posterior

[1] In point of time Brown-Séquard is the true discoverer of vaso-motor nerves. Bernard's experiments were made subsequently, and interpreted otherwise.

"D'après ces expériences, il n'est donc pas possible d'expliquer le réchauffement des parties par une prétendue paralysie des artères, qui, à raison d'un élargissement passif, laisseraient circuler une plus grande quantité de sang.

"Si alors [*i.e.* en galvanisant] les artères, comme les veines, se resserrent et reviennent sur elles-mêmes, cela tient à ce qu'il n'y a plus de sang pour les distendre, mais ce n'est pas du tout l'effet d'un resserrement actif des vaisseaux.

"... il ne peut venir à l'idée de personne de penser à rapporter [le phénomène circulatoire qui succède à la section du nerf sympathique] à une paralysie pure et simple des artères." (Bernard, *Annales des Sciences Naturelles*, 1854, p. 198.)

root, but are "blocked" *up* the anterior root, and diminished *down* that root But in the inferences *qua* functional impulses derived from these data, two considerations appear to have been insufficiently borne in mind—(1) The rapid death of interrupting grey matter as compared with the endurance of white matter, and (2) the disproportionate magnitude of negative variations by *electrical* excitation as compared with negative variations by *functional* excitation The contrast between interrupted and non-interrupted tracts, as regards the transmission, gauged electrically, may have been in part due to the first cause, and an adequate recognition of the second fact would have withheld Prof Horsley from expressing astonishment "a revelation to us" is his phrase—at finding the electrical variation in a nerve eight or ten times as great by direct electrical excitation as by discharge of a nerve centre Du Bois-Reymond's analogous deflections obtained on strychninized frogs were 1° to 4° *versus* 40° by direct electrical excitation A functional discharge *down* posterior roots, if proved to occur, is a new and surprising phenomenon, but its existence is not *at present* proved by the existence of an electrical discharge, electrical effects by electrical excitation are tainted evidence, electrical effects down the posterior roots by functional excitations above, although incidentally touched upon, were not exhaustively examined, and considering the recognized dangers of experimental fallacy, we may not admit as proved that nervous impulses are discharged down afferent channels Prof Horsley infers unreservedly that functional discharge occurs *down* the posterior roots, and that centripetal impulses *up* the anterior roots are blocked at the cord This he regards as striking evidence of the truth of the kinæsthetic doctrine (*i e*, that nerve action starts from the afferent or sensory side of the nerve centre, p 170), but the connection between this presumed functional downflow in afferent channels and kinæsthesis is not made apparent, up-flow in afferent channels is matter of common knowledge; up flow by efferent channels has (so far as we know) been contended for by no one since Lewes But as regards these last points, they may be expected to receive fuller and more precise analysis in the promised volumes on the brain and on physiological psychology

A D W

ELECTROTECHNICAL TRAINING

Electrical Engineering as a Profession and How to Enter It. By A D Southam. (London Whittaker and Co, 1892)

THIS book consists of a collection of extracts from the notices of various firms regarding apprentices and articled pupils, and from the prospectuses of colleges which give an education in electrical engineering It reminds us of the gorgeous but depressing volumes one has met so often in one's summer outing, containing particulars of hotels in Aden, hotels in Algiers, hotels in Andermatt, &c, each hotel possessing, at least so it is said in the gilt-edged page advertisement, every possible attraction—a magnificent view, a first-rate cuisine, electric light, ascenseur, and all the other dreariness of a bandboxy barrack.

First we thought that the length of description which the author had given to a particular technical educational establishment was a measure of its goodness, but that idea we dismissed when we found that only three pages of description were given to that technical college in South Kensington, regarding which the author says "This institution deservedly stands at the head of all the technical institutions in this country" Next it occurred to us that the author might have acted on the "good wine needs no bush" principle, but that hypothesis had to follow the other, for we feel sure that the Walker Engineering Laboratory at Liverpool is not bad, and yet it requires fifteen pages of talking about Then we wondered whether each professor had been asked to write as much as he liked, so that the length of the description of a particular set of laboratories was in proportion to the leisure of the writer, and lastly, we have been speculating whether the likeness to the "Hotels of the World" book might not be quite complete, and the length of the description was a measure of the length of the purse of the advertiser

However, be the plan of the compilation what it may, the book contains a good deal of information, also some salutary advice with which we quite agree —"Undoubtedly the best training for a young man entering the electrical profession is to go through the course at one of the technical schools or colleges, and then when thoroughly grounded in the theory and having a general idea of the practice of his profession, to be articled for some months to a good firm of electrical engineers, where he will be able to acquaint himself with the practical part of his business as actually carried out on commercial principles," and again, "if he then goes to both a Technical College and is also articled, it is advisable that the former should precede the latter, for the reason that when he is placed in the workshop his previous technical training will enable him to appreciate and see the importance of much which he would otherwise have overlooked"

For the fathers who desire to place their sons directly in a works on leaving school, there is given a long list of engineering firms who are willing to receive £300 and the lad, some are willing to take only one hundred and twenty guineas a year, from year to year, or even as little as £100 a year—and the lad In many cases a month's trial is allowed, but judging from the ignorance of elementary mathematics and science displayed by many articled pupils in works, we presume that either these subjects are not required, or a month is not a long enough time for this astonishing ignorance to be discovered Naturally enough these firms do not bind themselves to provide work for these articled pupils when their term is finished, indeed we know of a firm with over 100 articled pupils which is applying elsewhere for an assistant

When will the parental idea die out that a lad who is pitchforked into a works must turn out an engineer? No doubt many of our successful engineers never received any education in a technical college; so many of our battles were won by men armed only with bows and arrows, but that is no reason for confining the equipment of a modern regiment to these primitive weapons. Either the teaching given at a technical college materially helps the lad in his subsequent practice in the works, or it is a fraud and ought to be stamped out If it affords real help

to the lad, then why, we ask, do not the firms insist on their pupils obtaining it before they enter the works?

Mere evening instruction for a lad who has been hammering, say, from 6 a m to 6 p m is well-nigh useless, and at the best ought to be regarded only as a makeshift for those who are compelled to spend the day earning their living To place a lad at a technical college for two years, and then for two years at a works would cost, as far as fees and premium are concerned, about £250 To article him for three years at the works about £300 When will parents see that the cheaper course is far the better, and when will firms refuse to take an articled pupil unless he has already acquired that theoretical knowledge which is necessary to enable him to benefit by a works training? The father who articles his son to an engineering firm immediately the lad leaves school and expects him to pick up his technical education at odd moments, may be more liberal in his money, but certainly is no more liberal in his ideas than the parents who sent their sons to receive their practical training at Dotheboy's Hall "Now, then, where's the first boy?" "Please, sir, he's cleaning the back parlour window" "So he is, to be sure," rejoined Squeers "We go upon the practical mode of teaching, Nickleby C-l-e-a-n, clean, verb active, to make bright, to scour W-i-n, win, d-e-r, der, winder, a casement When a boy knows this out of a book he goes and does it"

P D

HYGIENE AND PUBLIC HEALTH

A Treatise on Hygiene and Public Health Edited by T Stevenson, M D, F R C P (Official Analyst to the Home Office), and Shirley Murphy (Medical Officer of Health of the Administrative County of London) Vol I

THIS is a treatise consisting of various contributions from different writers In the selection of authors it has been wisely decided not to limit the choice to members of the medical profession, and the wisdom of this decision has been exemplified in the acquisition of two of the very best articles which the book contains, *i e* that by P Gordon Smith, F R I B A, and Keith D Young, F R I B A, entitled "The Dwelling," and that by W N Shaw, F R S, headed "Warming and Ventilation"

There are at present several excellent small works upon hygiene and public health, but these of necessity treat of the subject in far too cursory a manner—indeed, they are designed more to meet the repuirements of candidates for the Public Health Diplomas now granted by many examining Boards This work is evidently intended as a book of reference, and there is no doubt that it will be of great value to those from whom a special knowledge of public health work is demanded While, then, the last year or two have been remarkably fruitful in the production of works upon the subject here treated of, the volume before us will not be one jot the less appreciated on this account, for it meets a want which must long have been felt among those who desire a better and more inclusive knowledge of public health matters than was hitherto accessible in a collective form

It is needless to insist that the work is all well done, and that any shortcomings must, of necessity, be faults of omission rather than of commission, for the list of contributors includes those who occupy some of the foremost positions as authorities upon the subjects of which they treat It is not an easy task—and one is conscious of running great risk of appearing arrogant—to single out those sections especially deserving of praise If this is permissible in such a work, we should point to the two articles already mentioned as occupying a foremost place —indeed, the article upon "Warming and Ventilation" is a little too exhaustive and technical in its physical aspect, and deals too briefly and sparingly with the commoner provisions now used for both the purposes of warming and ventilation,—a shortcoming which has the effect of somewhat sacrificing the practical utility of the article to its bulk, when viewed from the health officer's standpoint It would not be easy to speak in terms too high of the all-round excellence of the article upon "Disposal of Refuse," by Prof W H Corfield, M A, M D, and Louis C Parkes, M D, D P H, and the work of compiling this section could not have been entrusted to more capable hands "Water," by T Stevenson, M D, is a capital article, but one would like to have seen in it more about the methods of collecting water and distributing it, and of the risks which the water runs of pollution in and around dwellings

In the preface we read that "it has been the desire of the editors that the several papers which these volumes contain should present a fair account of the knowledge, so far as obtainable, of the subjects of which they treat", and this is invariably achieved, for where the account is not an excellent one, it is always more than a "fair one

The contribution upon "Air," by Prof J Lane Notter, M A, M D, is too short, and does not nearly include all the material given in his edition of Edmund Parke's work, and the same fault may be found with the articles upon "Hospital Hygiene," by H G Howse, M S, and "The Inspection of Meat," by E W Hope, M D, D Sc

"Systematic Physical Education"—a subject which has been all too little studied in this country—is well and spiritedly treated of by F Treves, F R C S

The articles upon "Baths," by H Hale White, M D, "Clothing," by G V Poore, M D, "Food," by Sidney Martin, M D, "Soil," by S M Copeman, M A, M D, D P H, "Meteorology," by G J Symons, F R S, "The Influence of Climate upon Health," by C T Williams, M A, M D, "Offensive and Noxious Businesses," by T W Hime, B A, M D, and "Slaughter Houses and their Administration," by E W Hope, M D, D Sc, are all good, though some of them might have been fuller The article upon "The Influence of Climate upon Health" might with advantage have considered much more fully the reasons why the various climatic conditions influence the health of man in the way they do The contribution upon "Meteorology," which is capitally illustrated, and one of the most useful in the book, might also have considered the physical causes which affect the readings of the various instruments, and dealt more fully with the principles upon which these are constructed. The article upon "Food" is excellent in some respects, but an attempt to convey to the reader, in an abstract form, the methods of food analysis fails—as

it always does when such a subject is treated of in brief space—to be of great assistance to the reader

The index is good, and the book is a valuable addition to Public Health literature.

OUR BOOK SHELF

Lehrbuch der Botanik nach dem gegenwärtigen Stand der Wissenschaft Bearbeitet von Dr A B Frank Erster Band Zellenlehre, Anatomie und Physiologie 8vo 670 Seiten, mit 227 Abbildungen in Holzschnitt (Leipzig Wilhelm Engelmann, 1892)

THIS is essentially a fifth edition of Sachs's renowned "Lehrbuch der Botanik," the fourth and last German edition of which appeared as long ago as 1874 An English edition, emended and augmented by the translator, Dr S H Vines, was published in 1882 Now, ten years later, Dr Frank has written a completely new work As the author tells us in his preface, he was requested in 1890 to prepare a new edition of Sachs's book, but he has adopted the wiser course of making himself responsible for the whole Nevertheless, free use has been made of Sachs's excellent illustrations, upwards of ninety out of the two hundred and twenty-seven having been taken from that source, "because the author could not replace them by better ones" About sixty are borrowed from other authors, and about seventy of them are original, or at least Dr Frank's own, for some of them have appeared elsewhere A number of them are reduced from Frank and Tschirch's "Wandtafeln" Certainly the book is admirably illustrated In the limitation and arrangement of the material the author has followed Sachs in a general way, though he has separated the physiology and anatomy from morphology and classification The two latter branches are to be dealt with in a second volume, promised early next year So far as the present volume is concerned, we can strongly recommend it to the student familiar with the German language It is written in a clear, succinct style, and, so far as we have been able to test it, it is well up to date Dr Frank is well known as a writer and teacher of botany, and especially for his researches and experiments relating to the nutrition of plants The sources of the nitrogen of plants and symbiosis are two subjects to which the author has devoted much attention, and they are discussed in some detail from his own standpoint We are glad to see that copious and complete references are given to the books and articles of the principal writers on the various subjects, whose views are discussed or adopted Unfortunately there is no index, and it is not easy to find one's way through the table of contents True, a "carefully prepared" index is promised with the second volume, but a separate one to each volume would be far more convenient and time-saving It is not as though the second volume was a continuation of the first, and it is to be hoped that the author and publisher will even yet see their way to provide this facility for using the work

Arithmetical Chemistry Part II Book B By C J Woodward, B Sc (London Simpkin, Marshall, Hamilton, Kent, and Co Birmingham Cornish Bros, 1892)

THE student will find in the present edition of this work what is practically a new book, as the author has enlarged and entirely rewritten the original publication The opening lessons treat of analyses, the formulæ of minerals, Dalton's law of partial pressures, gas analysis, &c, and are on the whole satisfactory The introductory portions of the lessons, which embody the principles involved in the exercises, and contain typical examples fully worked out, are clear, as a rule, and the exercises themselves are both suggestive and useful. The same may be said of the concluding part of the book, wherein are briefly discussed atomic weight determinations, and the various means of controlling atomic weights, calorific power and intensity, heats of formation, dissociation, and gaseous phenomena, comprising the kinetic theory, diffusion, and absorption by water

The intermediate lessons on molecular weights are, however, not up to the standard of the others It is not made plain when discussing Avogadro's law that a vapour density observation, when possible, is the decisive mode of fixing the molecular weight of a compound The vague description of the apparatus used in measuring osmotic pressure can only confuse the reader, and loose statements such as "*solutions* behave as gases," p 51, must have the same effect The relationships established in connection with the vapour pressures of solutions only hold if the dissolved substance is practically non-volatile, this point is omitted, and the definition given of equimolecular solutions is not the one in common use. Indeed, the entire treatment of the properties of solutions as applied to molecular weight observations, although it may perhaps enable the student to solve problems, is much too fragmentary and loosely put together to give him an adequate idea of what is known on the subject It may also be pointed out as somewhat late in the day to give a few of Kopp's conclusions as an account of specific volume

Among minor corrections it may be noted that on p 6, in the first erratum, solvent should be solution, vapour-tension might often be replaced by vapour-pressure, xylol should be xylene, and amyl benzoat should be amyl benzoate, on p 48 "Ostwald's Solutions" might be included in the list of English works to which the student is referred

The book contains an index, a list of answers, and a collection of the questions in arithmetical chemistry set at the Honours examinations of the Science and Art Department, and at the B Sc examinations of London University A portion of the author's A B C Five figure logarithms is presented with this edition J W R

Lessons in Heat and Light By D E Jones, B Sc (London Macmillan and Co, 1892)

THE success of a previous work on "Heat, Light, and Sound," has led Prof Jones to extend the two former parts, and publish them separately for the use of schools and junior classes in colleges As an introduction to the study of experimental physics, the book cannot fail to be of great value The principles of the subjects are very clearly stated, and the experiments from which they have been deduced are fully described Most of the experiments may be easily performed by students, the instructions being sufficiently clear to guarantee success Numerous arithmetical examples, partly selected from the author's "Examples in Physics," are added at the ends of the various chapters The physiographic bearings of the subject of heat have been brought well to the front, thus the origin of the Gulf Stream, trade winds, and the formation of rain and snow are explained. Many of the diagrams have been carefully drawn to scale, in order to give the student an idea of the dimensions of the apparatus which may be conveniently employed in performing the experiments

Elements of Magnetism and Electricity By John Angell, F C S, F I C (London. Collins, Sons, and Co., 1892.)

THIS is a new edition of one of the best known text-books for use in connection with the classes under the control of the Science and Art Department The book calls for no special remark, but the fact that a hundred thousand copies have already been disposed of seems to demonstrate its usefulness Experiments and illustrations are its special features

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Further Notes on a recent Volcanic Island in the Pacific

THE volcanic island—Falcon Island—in the Tonga group in the Pacific, of the recent appearance of which an account is given in NATURE, Vol. xli., p. 276, has recently been passed by a French vessel of war, the *Duchaffault*, which reports that the island is not now more than 25 feet high.

In October, 1889, when examined by Commander Oldham, it was 153 feet high, and a little over a mile long. Nearly entirely composed of ashes, it was rapidly washing away, and by the account above, it would seem that more than one half the island must now have disappeared. W. J. L. WHARTON.

October 20.

Earth-fractures and Mars "Canals."

ON seeing the figure of the so-called "canals" of Mars, published in NATURE of a few weeks back, I was at once reminded of the pattern assumed by the cracks of glass broken by torsion, as in Daubrée's well-known geological experiment.

I enclose a photograph of part of a large slab of glass broken in this way in a class experiment of my own, and although other slabs, which have unfortunately not been preserved, exhibited, if I remember rightly, still more Martial-looking networks, I think that the general resemblance is obvious enough in this case.

It may perhaps be well to explain to non-geological readers of NATURE that Daubrée's glass-breaking[1] is regarded by many as reproducing in miniature the kind of fractures which are found to occur in those portions of the earth's crust with which we are acquainted, and that by torsion only has it proved possible to imitate the peculiar pattern assumed by such fractures, whether

they be joints or dislocations. It is further held by many that such lines of fracture in such patterns are a necessary result of the shrinking of the outer coat of a planet in course of cooling.

Mere fractures, such as we meet with in our own planet, could, of course, not be seen from any considerable distance, and if the circumstances of denudation were the same in Mars as with us, the "canals" could certainly not be the representatives of our usually hidden and featureless earth-cracks. There seems, however, to exist, in the extraordinarily rapid melting of gigantic ice-fields described by Prof. Norman Lockyer, some evidence of denuding power in Mars on a scale enormously larger than is the case with us. Earth-fractures—and for the matter of that Mars fractures too—must many of them be lines of weakness along which denudation acts more freely than elsewhere, and if this denudation be phenomenal and cataclysmic, as appears to be likely in Mars, wide valleys or channels capable of being distinguished at great distances would soon be scoured out along them.

I would wish especially to draw attention to the three following points observable in the photograph, viz., the two marked directions in which the crack lines run, one set crossing the others often at, or very nearly at, right angles; their occasional doubling and rough parallelism for some distance; and their frequent sudden stoppage—three of the features most noticeable in the Mars lines. G. A. LEBOUR.

Durham Coll. Science, Newcastle, October 13.

[1] Not "ice-breaking" as a mistranslation of the word "glace" has caused it to be described in some English text-books.

A Wave of Wasp-Life.

MR. HUDSON'S charming work on "The Naturalist in La Plata" reminds me of a very interesting wave of wasp life which appeared in Wisconsin in the summer of 1886. We were living at the time in our summer house at Pine Lake, and were making observations on the habits of the different animals in the neighbourhood.

In the latter part of July we suddenly found ourselves surrounded by large numbers of yellow jackets and hornets. Everywhere through the woods and fields a veritable plague of wasps seemed to have descended upon the earth. During all the month of August we heard the same report from summer residents within a radius of twelve or fifteen miles of Pine Lake. In our immediate neighbourhood we knew of forty-seven nests. Allowing 1500 wasps to a nest—a very low estimate for that season of the year—this gave us over 70,000 wasps. Plates of meat and bones that were set outside for the cats were immediately covered with them, and in spite of screens in doors and windows they even entered the house, alighting on the food at the dinner-table, or darting about and catching flies.

The cause of this sudden increase in the number of wasps was evidently a general one, since it acted in the same way upon three species—*Vespa vidua*, *V. maculata* and *V. germanica*. An examination of the Signal Service statistics does not show anything unusual in the preceding winter and spring, but either the weather must have been especially favourable, lessening the ordinary death-rate of the queens, or there must have been a marked decrease in the parasites or other enemies which ordinarily keep these species in check.

The duration of the favourable conditions proved brief enough. It is probable that every one of our forty-seven nests furnished, at the very lowest estimate, one hundred developed and fertilized queens to start forty-seven hundred new nests in the following year; yet the increase in the checks to the too great ascendency of these species more than counter-balanced the abnormal increase. The winter of 1886-87 was not especially severe, but in the following summer the most careful search on our part, and on the part of others, whose efforts were stimulated by the offer of rewards, only gave us four nests in our neighbourhood, and on all sides we were met by the inquiry: "What has become of the wasps?" G. W. PECKHAM.

Milwaukee, Wisconsin, October 12.

Note on the Occurrence of a Freshwater Nemertine in England.

A FEW days after reading M. de Guerne's "History of Freshwater Nemerteans," published in the August number of the *Annals*, I happened upon a specimen of the group amongst the roots of some water plants, which I collected in the river Cherwell, close to Oxford. I was, at the time, searching for the cocoons of a new Rhinodrilid worm, of which a description will shortly appear. The gathered roots, with the cocoons, were placed in a bottle of water, in order that the worms might hatch out. On examining the bottle two days later, namely, on September 5, I noticed a small bright orange animal, about half an inch long when extended, creeping amongst the cocoons. Further observation with the microscope showed that it was a species of *Tetrastemma*. Unfortunately the animal was crushed before I had done more than sketch the general appearance and make some few observations, and I have not yet succeeded in finding more specimens; so that I am unable to state how far it agrees with or differs from the previously known freshwater forms enumerated by M. de Guerne, most of which are included by Silliman and later authors under the title *Tetrastemma aquarum dulcium*.

In one or two points, however, my sketches show certain differences from those of Silliman:—

(*a*) The colour (orange) is due to pigment in the skin, and not to the red colour of the nervous system. I may mention that Dugès' species, "*Prostoma clepsinoides*," was yellow ochre, and "*Pr. lumbricoideum*" was yellow marbled with red; whilst Leidy's "*Emea rubra*" was yellowish flesh-coloured (probably due to the hæmoglobin in the nervous system).

(*b*) The anterior pair of eye-spots is further from the prostomium than in Silliman's drawing. I found no third pair of eye spots, which, however, it is stated, is absent in the young.

(*c*) The ciliated pits are further forward, being midway between the brain and the anterior end of the body.

(*d*) The proboscis and its retractor muscle are much more undulating, when withdrawn into the body, than Silliman shows.

The proboscidial spine, with its groups of accessory spines, agrees very closely with the figures given by Silliman.

I can say nothing about the generative organs. For the present, then, I must leave undecided the specific name of this British *Tetrastemma*. W. BLAXLAND BENHAM.

Anatomical Department, Museum, Oxford, Oct. 12.

Protective Mimicry

MR. BATESON'S letter on "Aggressive Mimicry" (NATURE, October 20) recalls to my mind a curious case of protective mimicry which came under my notice last August on Dartmoor. Large patches of the heath had been burnt, a common practice on the moorlands to ensure a fresh young growth for the sheep. The whole ground was alive with a common species of orthoptera (Locustina), the small green grasshopper with short antennæ. They leapt aside at every step in the short grass and scrubby heath; upon the burnt patches they were equally numerous, but with this difference—all, without exception, were coal black on abdomen, thorax, and head, whilst the wings were of an ashen hue. So much did the colour adaptation resemble the blackened turf and heath they hopped amongst it was almost impossible to follow them with the eye; we made many amusing attempts, but were nearly always defeated. I measured one of these burnt patches, and found it to be from thirty to forty yards square. A yard or two from this, on the untouched herbage all the Locustina were bright green. I found one specimen on the borderland in a transition state, not dull all over as I had expected, but in spots and patches of bright green and black. One enemy at least of these insects abounded on the moor, namely, the common lizard (*Zootoca vivipara*), for I have observed there is no food lizards will eat more greedily than grasshoppers. I have seen some that I have in captivity swallow twenty or thirty in two or three minutes, even after their usual meal of worms. They always became greatly excited, if one may apply so warm an expression to such cold blooded animals, and rushed about the case when a collection of live grasshoppers were thrown to them. Certainly I was much struck by the rapid action of the power possessed by these Locustina on Dartmoor of assimilation to environment, and did not doubt but that this colour adaptation was for the purpose of protection, the eye producing by reflex action the change in the pigment cells. ROSE HAIG THOMAS.

STELLAR PARALLAX[1]

THE Delegates of the University Press have recently published the results of Prof. Pritchard's systematic investigations into the parallax of those stars of the second magnitude whose North declination permits the inquiry to be made with facility and advantage in these latitudes. Our first feeling on glancing over the contents of this *brochure* must be one of hearty congratulation to the distinguished professor that he has been permitted to see the full outcome of a protracted inquiry, conducted at a period in his life when a less energetic astronomer would have felt himself justified in withdrawing from active participation in scientific research.

[1] "Researches in Stellar Parallax by the aid of Photography." By Charles Pritchard, D.D., F.R.S., Savilian Professor of Astronomy in Oxford.

Prof. Pritchard might well have been content to rest on the laurels he had won, and to have staked his reputation upon that career of acknowledged utility which has marked his direction of the Oxford University Observatory.

Immediately on the completion of the photometrical examination of Argelander's Uranometria, and with a zeal that admitted of no delay, Professor Pritchard busied himself with this inquiry into the parallax of stars of the second magnitude. But if the inquiry was undertaken with eagerness, and pursued with ardour and resolution, it was not characterized by hurry, or its success imperilled by incompleteness. Confident himself that photographic methods possessed the requisite accuracy to make the research successful and trustworthy, the Savilian Professor set to work to establish the reliable character of measurements made on sensitized films, and not till that confidence was demonstrated did he embark upon the larger work now under notice. These preliminary inquiries have been published in a series of papers in the proceedings of the Royal and Royal Astronomical Societies, and the confidence gradually acquired by enlarged experience induced him to proceed with the determination of the parallax of 61 Cygni, the results of which are published in detail in the third fasciculus of the Annals of the University Observatory. In this case he selected four stars in the immediate neighbourhood of the principal star, and sought the difference of parallax between each of the components and of the four stars of comparison. This long research may be regarded by some as a work of supererogation, inasmuch as the labours of Bessel and that of many later astronomers have satisfactorily settled the parallax of this star within very approximate limits. But if we properly understand the motives of Prof. Pritchard, his intention was not so much to seek anew the parallax of that system, as to discover with what degree of accuracy the method of photography, hitherto unapplied in this direction, represented the work of others made directly in the field of the telescope. Nor was this his only view. By selecting four stars in the immediate neighbourhood of 61 Cygni and seeking the difference of parallax between these stars of comparison and each of the components of the system, he instituted a very severe inquiry as to the trustworthiness of that method, which he had imagined as capable of dealing with the delicate question of stellar parallax. The severity of the test consists in deducing the same value of the parallax (eight in all) from each set of measures, and as a matter of fact the accordance, *inter se* between these several determinations is as close as could have been anticipated, and likewise in satisfactory unison with the work of other astronomers.

The completeness of this inquiry and the publication of it in detail have had two happy results. In the first place, Prof. Pritchard has, in the present instance, been able to confine the printing within very narrow limits, so narrow, indeed, as possibly not to have done himself justice. The details of his process, the mutual agreement of his measures, and his method of discussion having all been fully set out in his previous work, he has not felt himself obliged to enter into these minute particulars, but has contented himself with presenting the results. This method of arrangement, no doubt suggested in the first place by economical motives, has afforded opportunity for adding a very interesting history of the processes and results that have hitherto been followed with more or less success by others, and also the exhibition in a concise form of the different values of the more trustworthy determinations, derived by previous observers. The second advantage, immediately arising from the earlier investigations, is, that an examination of those results has shown that no increase of accuracy (commensurate with the increased labour at

least) was obtained by continuing the observations of the stars throughout the whole of the year, that is, to secure observations in all positions of the parallactic ellipse. If the measures were confined to those epochs when the parallactic displacements were greatest, and a sufficient number of observations secured at those critical times, a determination of parallax could be relied upon to within about one thirtieth of a second of arc. This is approximately the limit of accuracy that Professor Pritchard hoped to reach, and in this selection he appears to have been guided by the conviction, that in the present condition of cosmical inquiries, to which stellar parallax bears the closest relation, it is of more importance to know within very narrow limits the parallaxes of many stars than seek with the utmost accuracy the parallax of a very few. And in this respect there can be no doubt but that Prof. Pritchard's judgment is correct. The former is the view of a philosopher, the latter that of a conscientious and painstaking observer. Guided by the broader view, the result of his work has been to enrich the data at the command of students of cosmical science by assigning the approximate distance to some thirty stars, a number which bears no inconsiderable proportion to the total number of separate determinations made by all other astronomers combined.

Prof. Pritchard's view of the history of stellar parallax is that of a scientific struggle, a continual and severe wrestle on the part of the astronomer with the inevitable inaccuracy of observation and imperfect instruments, in which sometimes one opponent, sometimes the other, has the mastery. He passes in his historic survey rapidly over those days when from various obvious causes the detection of stellar parallax was scarcely possible, moved however to admiration by, and induced to linger over, the success that attended the early observations of Molyneux in the case of γ Draconis when discussed, a century later, by Auwers, a success that later observers have struggled to repeat ineffectually. He brings before us, but touches with a light and kindly hand, the dispute that embittered the lives of Brinkley and of Pond, but it is not difficult in reading a little between the lines to see with whom his sympathies rest. Later on in the history of the research, Henderson meets with his deserts, as a clear-sighted astronomer of distinguished ability, cautious and persevering, and one who in the struggle after accuracy obtained an undoubted measure of success. This historical introduction will we think be read with pleasure by many who may have no particular interest in this special subject of inquiry. The comments of one who has encountered and overcome many similar difficulties, and has kindly sympathy with all who have travelled along the same path, cannot but be of interest and of value, and we could have wished that this portion of the book had been considerably extended. How many astronomers are now acquainted, with any degree of adequacy, with the serious difficulties that attended the early application of the heliometer in this department of research, and with the dispute that raged long and dubiously around the names of Wichmann and of Schluter? All are willing to admit that in the hands of many competent observers—it would be invidious to mention any without naming all—the heliometer is doing splendid work, but the difficulties with which the early masters had to cope are now all but forgotten, and it is certainly wise to treasure a sympathetic remembrance for the earlier exponents of the improved and successful methods now in vogue.

The last portion of Prof. Pritchard's history is occupied with the bearing of stellar parallax on the problem of the construction of the stellar universe. He seems to have had before his mind two questions, which, long hovering in an unexpressed form, were first formally enunciated by Dr. Gill. The first question is, What are the average parallaxes of stars of the first, second, third, and fourth magnitude respectively compared with those of fainter magnitude? To this question the Savilian Professor replies very cautiously. The researches of Dr. Elkin on stars of the first magnitude point to an average parallax of 0″·089 for stars of that class, and just as certainly Prof. Pritchard's researches point to an average parallax of 0″·056 for stars of the second magnitude. But he pertinently asks what can be understood by an average of distances (as indicated by parallaxes) in cases where the separate elements vary from actual zero to half a second, and where moreover many of the brighter members are the furthest removed from us? Notwithstanding these exceptional cases, which challenge attention, the fact remains and it is apparently the only conclusion which can be drawn with any certainty, that the stars of the first magnitude are on the whole nearer to us than those of the second, and that these again are as a whole nearer to us than the faint stars with which they have been compared. With conclusions of this sort it would seem that astronomers will have to content themselves for some time to come.

The second question which Dr. Gill suggested or formulated was—What connection does there exist between the parallax of a star and the amount and direction of its proper motion?—or can it be proved that there is no such connection or relation? The answer given to this second query is even less satisfactory than to the former. Prof. Pritchard contents himself by exhibiting in a tabular form the parallax and the proper motion of all stars that have been successfully handled, and the only conclusion drawn or warranted, is a suggestion that there is at least quite as close a connection between the apparent proper motion of a star and its distance from us, as there is between its distance and its magnitude.

If we examine or attempt to trace any connection between the mass, the brilliancy and the distance of a star, we are baffled by the same kind of uncertainty, arising in some measure from the paucity of instances in which it is possible to make the inquiry, and we are reluctantly forced to admit that such investigations are premature. At least that would be the conclusion of an ordinary mind, but here it is that Prof. Pritchard sees his opportunity for future efforts and renewed vigour. With an energy that must be the admiration of his friends, he selects for further investigation two subjects, either of which might fully occupy the time and the hands of a younger man. He proposes in the first place to determine the parallaxes of several stars of the Pleiades, a few of the brighter as well as a few of the fainter, with the view of discovering whether the faint and the bright are indiscriminately mixed at that distance. The second subject of his proposed inquiry is not less interesting. It consists in the investigation of the distances of some of the binary systems from our sun, and from a more complete knowledge of the masses, the mutual distances, and the parallaxes of these systems, Prof. Pritchard thinks it not unlikely that many interesting and possibly unexpected associations may reasonably be anticipated, thereby affording us some further insight into the constitution and the mechanism of the Stellar Universe. We can only hope that Prof. Pritchard's health and strength may be spared to witness the completion of this programme, but in that case we are assured he would immediately sketch out for himself some new field of inquiry, and court even longer and more protracted labour.

CONTRIBUTIONS TO THE STUDY OF DISINFECTION[1]

PROFESSOR J. MASCHEK, whose name is already familiar to us through his investigations on water bacteria, has brought together in pamphlet-form a large

[1] "Beiträge zur Theorie und Praxis der Desinfection, von Prof. J. Maschek." Im Selbstverlage des Verfassers, Leitmeritz.

number of experiments on the relative value of various disinfectants and disinfectant processes Since the introduction of Koch's methods, the study of the subject of disinfection has been immensely assisted, and it is now possible to take a more accurate measure of the extent to which micro-organisms are affected by different treatment, whether chemical or mechanical The stimulus which it has thus received has not unnaturally drawn a large number of workers into this particular field of inquiry, and the literature is already very unwieldy

One of the principal difficulties which surround the study of micro organisms is their individuality, their apparent idiosyncrasies, and this is not confined to closely allied varieties, but is found amongst members of one and the same species Thus, the previous history of a micro-organism, the nature of the culture material used, the temperature at which the cultivation has been kept, the age of the growth, &c, are all points which have to be taken into consideration as likely to influence the behaviour of the particular specimen under observation This sensitiveness of bacteria may possibly to some extent account for the discrepant results which have been obtained by different investigators, although working in similar directions, which has rendered the accurate appreciation of the value of these results a by no means easy task Again, what succeeds in a laboratory is not necessarily equally successful when carried out on a large scale, and it is this difficulty which has so frequently led to such disappointing results in actual practice

Prof Maschek has endeavoured by a series of most arduous and painstaking experiments to throw a little more light on some of the problems of disinfection, and in gathering up his work has wisely abstained from attempting an exhaustive survey of the general literature, restricting himself to a brief introduction and particular reference to those investigations with which he has been more closely concerned In the majority of the experiments the author employed Koch's well-known method of sterilized silk threads, each of which was subsequently impregnated with pure cultivations of a number of different pathogenic micro-organisms These were distributed in various parts of a room about 19-ft long, 13-ft wide, and 15½-ft high, on the ceiling, walls, corners, floor, &c, whilst in some cases they were wrapped up in different materials, such as filter-paper, muslin, linen, in order to imitate as nearly as possible the actual conditions under which the organisms might be supposed to be present in an infected room In each case, after the application of the disinfectants under observation, these silk threads were submitted to plate-cultivation, and in some instances their pathogenic properties were also tested by inoculation into animals

The first elaborate series of experiments was made with the vapour of corrosive sublimate, which some authorities have recommended as an effective germicidal agent, but quite apart from the difficulty of getting rid of the poisonous crystals of corrosive sublimate which remained attached to various parts of the room, Prof Maschek was not able to obtain satisfactory results, although every precaution was taken to ensure success In this respect his experiments differ from those of Konig, who confidently recommended its use for disinfection purposes The effect of chlorine gas was next tested and applied both in the dry and damp state The results were, however, far from encouraging, for even when employed in the damp state the spores were not destroyed In connection with these experiments a very instructive instance is given of the signal failure which accompanied the use of chlorine in the Alexander Hospital in St Petersburg, which was designed for receiving different infectious illnesses. Suspicion as to its efficacy was first aroused after its use in the disinfection of a ward in which diphtheria patients had been treated This ward was afterwards used for scarlet fever cases, and subsequently complications with diphtheria made their appearance, in consequence of which the ward was closed and disinfected with chlorine (A ward of 900 cubic metres capacity being subjected to the chlorine gas evolved in treating 50 kilos of chloride of lime with 65 kilos of hydrochloric acid) After the disinfection was completed, the ward was thoroughly cleansed and ventilated, and allowed to remain empty for seven months On its being re-opened for the reception of measles cases complications with diphtheria again arose, although the patients when taken into the ward were wholly free from diphtheria The measles patients were therefore removed, and the ward was again disinfected with chlorine, only this time a much larger quantity was employed (135 kilos of chloride of lime with 148 5 kilos of hydrochloric acid) after which it stood empty for another seven months Later on cases of smallpox were received into this ward, but diphtheria again appeared, the physician, two nurses, and an attendant being amongst those attacked, whilst complications with diphtheria again occurred amongst the patients In consequence of this the unfortunate ward was once more closed and thoroughly disinfected with chlorine, and was reopened for typhoid fever patients, but all children's cases were rigorously excluded, in consequence of their particular susceptibility to diphtheria After the adoption of this special precaution no further attacks of diphtheria were met with It might, however, be urged that as regards the infection of patients suffering from measles with diphtheria, the disease was possibly introduced from outside, and did not necessarily arise in the ward itself, were it not for the fact that there were three other wards in the hospital in which cases of measles were being treated at the same time, and no single attack of diphtheria occurred Krupin, who is the authority for these facts, confirming the valuelessness of chlorine for disinfecting purposes, found that the spores of anthrax were not destroyed in a hospital ward after being exposed to the action of this gas for more than 40 hours

A large number of experiments were made with a view to determining the number of micro-organisms present on the walls of a room For this purpose a small sterilized bit of sponge cut in the shape of a cube (of about half-inch side) was used to rub down a measured portion (about 4 square inches) of the wall The sponge was afterwards placed in a tube containing sterile melted gelatine and rotated gently, so as to disengage all the organisms on its surface The gelatine was then allowed to congeal on the sides of the tube, and after suitable incubation the colonies made their appearance, and were estimated in due course It was found that the numbers present on the walls and ceiling respectively varied considerably Near the floor the number was much greater than on the middle of the wall, whilst here again they were more abundant than on the ceiling For example, on one of the walls, at a distance of rather more than an inch from the ground, as many as 2,871 microbes were found, whilst on the ceiling over a similar area only 85 were discovered It was also noticed that those portions of the wall or ceiling which were exposed to currents of air from either the window or door exhibited generally a smaller number of bacteria than did places which were shielded from such draughts Prof Maschek further found that one rubbing was wholly insufficient to remove all the organisms from a given surface, and it was only after the process had been repeated five times that all bacterial life could be banished with certainty Although the figures thus obtained are of interest by way of comparison, yet it is difficult to believe that they represent the *actual* numbers present. The accuracy of this method, originally devised by Esmarch, rests on the assumption that on placing the sponge in the tube of melted gelatine and rotating it gently (for if this were done

violently the gelatine would froth, and the surface become covered with small bubbles, which would greatly interfere later with the counting of the colonies) all the organisms attached to the surface of the sponge would be removed. Now the sponge being left in the tube must necessarily obscure part of the gelatine surface; moreover, the interstices becoming soaked with gelatine, colonies would certainly develop within the sponge itself and escape detection, whilst it is quite inconceivable that gentle rotation would suffice to detach even all those organisms which are adherent even to the surface of the sponge.

Wall surfaces deprived of micro-organisms in the manner described above were subsequently sprayed with distilled water infected with different pathogenic bacteria, and after sufficient time had elapsed for these surfaces to dry, the effect of various disinfectants was tried. Numerous investigations are also recorded of the use of creolin, carbolic acid, and mixtures of the latter with solutions of corrosive sublimate. The effect of exposure to high temperatures, in apparatus specially constructed for the purpose, has also been tried, whilst the disinfection of sewage matters with lime is also carefully considered, and a large number of experiments recorded with the typhoid and cholera organisms.

The following interesting account is given as an illustration of the success which can be achieved in disinfection on a large scale. An epidemic of diphtheria broke out in a small village in Germany and proved particularly fatal amongst the children, indeed so alarming was its progress, that the Burgomaster was led to suggest the disinfection of the whole village. A public meeting was held and the inhabitants were instructed as to the nature of the epidemic, and the possibility of checking it by the combined action of every household. Public funds were devoted to the purchase and distribution of the requisite disinfectants, and during three days the whole place is described as smelling of carbolic, whilst in all directions windows and doors were to be seen wide open, a very unusual sight in the country, and more especially in the month of February when this occurred. The work of disinfection was carried on most systematically, every article which could not be either washed or baked was treated with a 5 per cent. solution of carbolic acid. In short, no efforts were spared to thoroughly disinfect everything, and the result was that although the epidemic before the commencement of this disinfecting crusade was steadily gaining ground, it suddenly stopped. This must be considered as a tribute to the sagacity and energy of the inhabitants; for, as Prof. Maschek points out, experience teaches us to expect a gradual decline, due to the possible weakening of the virus, so that towards the end of an epidemic the number of bad cases is lessened and recoveries are more frequent.

In conclusion the words of M. Duclaux may be appropriately quoted: "Les études sur les antiseptiques n'ont gagné que de s'encombrer de résultats qui se contredisent les uns les autres, et entre lesquels on ne peut faire un choix, précisément parcequ'ils ont été souvent obtenus en dehors des conditions d'une étude précise. Il faut donc abandonner cette méthode, scruter avec de plus en plus de soin la phénomène, faire de la science, en un mot." This "*faire de la science*" is precisely the spirit in which Prof. Maschek has carried out his experiments; the immense care with which they have been conducted, the ungrudging labour bestowed upon them should render his results a most valuable contribution to the subject of disinfection. It is only to be regretted that they are not published in a form in which they would be more likely to become known and appreciated.

GRACE C. FRANKLAND.

AN ETHNOGRAPHICAL SURVEY OF THE UNITED KINGDOM.

A CIRCULAR letter, which we have been asked to print, has just been issued on behalf of the Committee appointed by the British Association to organize an ethnographical survey of the United Kingdom. The Committee consists of Francis Galton, F.R.S., J. G. Garson, M.D. and E. W. Brabrook, F.S.A., representing the Anthropological Institute; Edward Clodd, G. L. Gomme, F.S.A., and Joseph Jacobs, M.A. representing the Folk-lore Society; H. S. Milman Director S.A., George Payne, F.S.A., and General Pitt Rivers, F.R.S., representing the Society of Antiquaries of London; Joseph Anderson, LL.D., Secretary of the Society of Antiquaries of Scotland; and A. C. Haddon, M.A., Professor of Zoology at the Royal College of Science of Dublin. The following is the circular letter:—

SIR,—The above-named Committee, in pursuance of the object for which they have been delegated by the Society of Antiquaries of London, the Folk-lore Society, and the Anthropological Institute, and appointed by the British Association, propose to record for certain typical villages and the neighbouring districts—

(1) Physical Types of the Inhabitants.
(2) Current Traditions and Beliefs.
(3) Peculiarities of Dialect.
(4) Monuments and other Remains of Ancient Culture; and
(5) Historical Evidence as to Continuity of Race.

As a first step, the Committee desire to form a list of such villages in the United Kingdom as appear especially to deserve ethnographic study, out of which a selection might afterwards be made for the Survey. The villages suitable for entry on the list are such as contain not less than a hundred adults, the large majority of whose forefathers have lived there so far back as can be traced, and of whom the desired physical measurements, with photographs, might be obtained.

It is believed by the Committee that such villages may exist in the districts with which you are acquainted, and, as you are eminently capable of affording help in this preliminary search, we have to request that you will do so by kindly furnishing the names of any that may occur to you, with a brief account of their several characteristics; mentioning at the same time the addresses of such of their residents as would be likely to support the Committee in pursuing their inquiry.

They would also be glad to be favoured with the names of any persons known to you in other districts to whom this circular letter might with propriety be addressed.

We are, Sir,
Yours faithfully,
FRANCIS GALTON, *Chairman*.
E. W. BRABROOK, *Secretary*.

All communications should be addressed to "The Secretary of the Ethnographic Survey, British Association, Burlington House, London, W."

NOTES.

THE Board of Trinity College, Dublin, on October 22 elected Dr. Arthur A. Rambaut, M.A., Royal Astronomer of Ireland, on the foundation of Dr. Francis Andrews. The election was made under the provisions of Letter Patent 32 George III., dated in 1792. The new Professor of Astronomy in the University of Dublin, graduated in 1881 as a Senior Moderator and Gold Medallist in Mathematics, since which period he has acted until now as Assistant at the Observatory at Dunsink

He is the author of several astronomical papers published in the Transactions of the Royal Irish Academy and of the Royal Dublin Society

IT is proposed that a portrait medal of M Hermite, the eminent mathematician, shall be struck in commemoration of his approaching seventieth birthday The circular asking for subscriptions is signed by a number of well known mathematicians

THE following nominations have been made for the Council of the London Mathematical Society for the session 1892-3. The ballot will be taken on November 10 For President, A B Kempe, F R S, Vice Presidents, A B Basset, F R S, E B Elliott, F R S, Prof Greenhill, F R S, Treasurer, Dr J Larmor, Hon Secs, Messrs M Jenkins and R Tucker, other members, Mr H F Baker, Dr Forsyth, F R S, Dr Glaisher, F R S, Mr J Hammond, Prof M J M Hill, Dr Hobson, Mr A E H Love, Major Macmahon, F R S, and Mr J J Walker, F R S After the election of the Council Prof Greenhill will read his Presidential Address

IN consequence of the alterations in the rooms of the Chemical Society, the first ordinary meeting of the Society will be held on Thursday, November 17, at 8 p m

THE late Dr C A Dohrn left his magnificent entomological collections, with the library connected with them, in trust to his son, Dr H Dohrn, who was directed to use them as the nucleus for the formation of a natural history museum in Stettin Dr H Dohrn has now not only carried out his father's wishes, but has presented to his native town his own conchological collections and library

THE Geologists' Association will hold a conversazione on Friday, November 4, in the Library of University College, Gower Street Among the exhibits will be a series of photographs of the recent eruption of Mount Etna. These will be shown by Mr F W Rudler

MR M C POTTER has been appointed to the Chair of Botany at the College of Science, Newcastle on-Tyne

THE annual meeting and conversazione of the Postal Microscopical Society took place at the Holborn Restaurant on the 20th inst There was a good attendance, and many microscopical specimens were displayed An address on polarized light was delivered by Mr G H Bryan, the president

THE following lectures will be given at the Royal Victoria Hall on Tuesday evenings during the coming month —Nov 1, Prof A H Green, "Coal, what it is and how it was made," Nov 8, W D Halliburton, M D., F R S., "The history of some famous epidemics," Nov 15, Hermann H Hoffert, D Sc., "Electric sparks and lightning flashes," Nov 22, Prof Hall Griffin, "Among the hills of Asolo an illustrated account of the poem 'Pippa Passes'"

NATURALISTS who visit the Zoological Society's Gardens should not fail to go to the Insect House and see the Pratincole, which has lately been received, and is kept in a cage in this building So far as we know, it is the first example of this curious form of plover that has ever been seen in captivity The specimen in question does not, however, belong to the Pratincole of the south of Europe (*Glareola torquata*), which has sometimes occurred in this country, but to an allied African species—the Madagascar Pratincole (*Glareola ocularis*). The bird was obtained near Mombasa, in Eastern Africa, and presented to the society by Mr. R. MacAllister. It was carefully brought home, along with many other interesting specimens, from Zanzibar and the adjoining mainland by Mr Frank Finn, F.Z.S., on his return from his recent expedition to that country

A CORRESPONDENT from Tangier writes that during the recent mission to Fez of Sir Euan Smith, Mr. Walter H Harris and Mr. Carleton, the interpreter, were informed by a cherif from Tafilelt, cousin of the Sultan, and Governor over an extensive district, that there is no question as to the existence of dwarf tribes down the Dra, where they are very numerous Sir Euan Smith was told of this statement, and probably had a talk with him Mr Harris intended to have taken a trip down the Dra to Akka, but was convinced from what he heard that such a trip would be an act of suicide He however believes that he can get full information as to the dwarfs, and perhaps photographs, without going so far, and he has just left for a trip to the interior for two months Herr E G Donnenberg, who has been for some years engaged in pushing German trade in Marocco, and every year visits the principal cities, says that a year ago he saw in Marocco city from half a dozen to a dozen dwarfs, one of whom was accompanied by a dwarf wife They were about 4 ft high, and robust and well made, and were certainly not Moors who had been dwarfed by rickets, as they differed from the ordinary population of Marocco in appearance Herr Donnenberg's address is Tangier, and he states that he is ready to answer any queries that may be sent to him, but that he cannot add anything to what is here stated, as he did not ask any questions as to the dwarfs, not knowing that they were of interest He goes to Marocco city before long, and will make it a point to find out all he can respecting them

DURING the latter part of last week a depression lay over the North Sea, which spread both in size and intensity, causing strong northerly winds all over this country, with heavy gales and snowfall in Scotland and the east of England, while in the southern districts the weather was fine and bright The temperature was unusually low for the time of year, the mean temperature having in fact been considerably below the average on each day since the beginning of the month The daily maxima have varied from 40° in the north to 52° in the south, with sharp frosts at night On Sunday night the grass thermometer in London fell to 20°, while 25° in the shade were registered the next night in the north and west During the early part of the present week, the area of high pressure in the west gave place to a depression, which arrived from off the Atlantic, causing cold easterly winds in the south with very heavy rains in the south-west of England, the weather over Scotland improved, although some snow showers continued to fall on the east coast The *Weekly Weather Report*, issued on the 22nd instant, showed that the temperature of that week was much below the mean, the deficit ranging from 5° to 7° Rainfall exceeded the mean in the east and north-east of England, but in all other districts there was a deficit In the south west of England there was still a deficit of about eight inches since the beginning of the year.

WE recently drew attention to a new meteorological journal published in Paris, we now note the appearance of a similar publication at Vilafranca del Panadés, in Spain It is published on the 15th of each month, and contains a series of short elementary articles and notes, occupying only twelve small octavo pages We hardly expect it to find many readers in this country, but hope it may awaken more interest in the subject in Spain, where practical meteorology is not at present on the same level as in other European countries.

THE Director of the Lyons Observatory, M C. André, has published, under the title, "Relations des Phénomènes Météorologiques déduites de leurs Variations Diurnes et Annuelles," the results of the meteorological observations taken there for ten years ending 1890 The text and plates together occupy one hundred and sixty-eight large octavo pages, and, this volume will be found to be full of interest and instruction, to any one wishing either to take observations or to work up

the results. The title is well chosen, for the work treats of the relations which connect the different phenomena; it also gives all necessary precautions for ensuring the accuracy of the observations. Particular attention is paid to the important subject of diurnal and annual variations of the different elements, and to the various points to be noted, while the different theories of atmospherical electricity are explained at considerable length.

A BEAUTIFUL and instructive lecture experiment, illustrative of the conditions of the heated atmosphere which give rise to the mirage, is described by MM. J. Macé de Lepinay and A. Perot, in their "Etude du Mirage," which appears in the *Annales de Chimie et de Physique*. Water is poured into a long rectangular trough with glass slides, and covered with a layer of alcohol about 2 cm. thick, containing a trace of fluorescene. After a few hours, during which the alcohol diffuses slowly through the water, a flat beam of light is sent through the mixture at a very slight inclination to the horizon. Under these conditions a kind of garland of light is seen to traverse the liquid, due to a series of curvilinear deflections or "mirages" in the less highly refractive water below and total reflections at the upper surface of the alcohol.

PROF. W. CROOKES and Prof. W. Odling, in their report on the London Water Supply for the month of September, are able to give an excellent account of the 182 samples which they analyzed. All were found to be perfectly clear, bright, and well filtered. In respect to the smallness of the proportion of organic matter present, the character of the water furnished by the seven companies continued to be entirely satisfactory, the mean amount of organic carbon in the Thames derived supply, for example, being ·118 part, and the maximum amount in any single sample examined being but ·145 part, in 100,000 parts of the water—numbers practically identical with those of the previous month, or ·115 part for the mean, and ·152 part for the maximum, amount. The average of the past six months, in the case of the Thames derived supply, has amounted only to ·116 part of organic carbon in 100,000 parts of the water, with a maximum, twice met with, of ·152 part in any individual sample. The authors of the report do not expect that with the coming on of autumn and winter this low average will be much longer sustained. They note that the water supply to London is habitually at its best during the hot season, when a high quality of the supply is more especially called for.

AN interesting report on the Congress of the Library Association of Great Britain, held at Paris last month, was read on Tuesday before the Salford Royal Museum and Free Libraries' Committee. It was prepared by Mr. Alderman W. H. Bailey, who had naturally a good deal to say about the Paris Free Libraries. The governing bodies of almost all these institutions consider that there are many reasons why the libraries should be closed in the daytime when respectable artizans are engaged in earning their living. Books are therefore given out for two hours every evening of week days, generally from eight to ten o'clock, and also for two hours every Sunday morning. Mr. Bailey and the other members of the Congress were delighted with the Paris Libraries of Industrial Art, to which they devoted much attention. These Libraries—which, like the Free Libraries, are under municipal control—are in the artizan districts of Paris. Books, patterns, prints, drawings, and photographs are lent out. "Not only do house decorators," says Mr. Bailey, "find designs and books relating to work, but fan painters, porcelain modellers, designers of iron and bronze gates, medieval metal workers, cabinet makers, builders, and all workers in the constructive as well as the decorative arts may here find stimulus and draw inspiration from the wealth of examples on the shelves and walls." Free lectures are delivered in the winter on industrial art and science, and on the designs, books, and models in the Libraries.

VARIOUS experiments which are being made in France with a view to the improvement of the potato have attracted a good deal of attention in Australia. According to a statement recorded in the *Agricultural Gazette of New South Wales*, no fewer than 110 growers have obtained from a variety known as "Richter's Imperator," from twelve to twenty tons per acre, while the average is over fourteen tons to the acre. The Minister of Agriculture in New South Wales has approved of one hundredweight each of this and any other three sorts highly reputed in France being imported for experimental purposes.

AT a recent meeting of a society of French agriculturists, it was stated by Baron Bertrand-Geslin, that ten or twelve years ago a disease appeared among the chestnut trees in central and north western France, and destroyed them in great numbers. The wood, moreover, could not be utilized for heating purposes. At this juncture an enterprising person appeared, who bought up large quantities of this dead wood and sent it by canal to Nantes, where he had works established for utilizing it in the tanning of leather. Chestnut wood contains, in fact, 5 to 6 per cent. of tannic principles, whereas oak contains only 3 or 4. By the means adopted in these works the principles are concentrated in a sirupy liquid of great strength. This establishment has become very important; it absorbs annually thirty to thirty-five million kilogrammes of wood of these dead chestnuts from three departments traversed by the canal from Nantes to Brest, and expends about 120,000 francs per annum, a considerable reduction of the loss sustained by the landowners. It was mentioned, however, by M. Paul Becquerel, in reply to a question as to competition of the new extracts with bark, that those extracts, which are products allied to tan, do not give the same results, or leather of such good quality, and many tanners who have used them have returned to the old methods of tanning.

DR. R. MUNRO contributed to the *Times* of Monday a long and most interesting account of the recent discovery of an ancient lake-village in Somersetshire. The site is about a mile north of Glastonbury. Before excavations were begun, there were sixty or seventy low mounds, rising from one to two feet above the surrounding soil and measuring from twenty to thirty feet across. That the mounds were of archæological interest was first suspected by Mr. Arthur Bulleid, who began to excavate some of them during the present summer, and was soon rewarded by making striking discoveries. Woodwork corresponding to that of the crannogs of Scotland and Ireland has been exposed, and among the objects which have been recovered are some of bronze, a few of iron, and various specimens of pottery. Mr. Bulleid has also dug out "a splendid canoe neatly formed out of the trunk of a tree." This was found about a quarter of a mile from the settlement. It would seem that the inhabitants, after a period of long occupancy, indicated by a succession of superimposed hearths, were flooded out of their homes, for an accumulation of flood soil now covers the whole meadow to the extent of 12 inches to 18 inches in depth. The surrounding district is richly cultivated, but, in looking over an old map of the date of 1668, Dr. Munro found that it contained a lake called the "Meare Poole," into which three streams debouched, and from which the site of the present discovery could not be far distant. He suggests that this lake had larger dimensions in earlier times, and that when the settlement was founded the locality was a shallow lake or marsh. The old map represents the district lying immediately on the north-west borders of the "Meare Poole" as inhabited by the Belgæ. Dr. Munro is strongly inclined to think that the settlement belongs to the so-called Late Celtic period. This he would simply call the Celtic period, for there is no evidence, he believes, of earlier Celtic remains in Britain

than those known as Late Celtic. "The style of art," he says, "which controlled the manufacture of Late Celtic objects involves such an enormous advance in metallurgical skill over that of the Bronze Age, that it is impossible to suppose the two are connected by any evolutionary stages in this country. From the standpoint of archæological research this interval, or rather *hiatus*, can only be bridged over by the supposition that the people who owned Late Celtic remains were newcomers and conquerors in Britain." Much light will no doubt be thrown on the question by the further exploration of these remarkable mounds.

A LIVELY correspondence on the subject of birds *versus* insects has been going on in the Malta papers. According to the *Mediterranean Naturalist*, the enormous increase of insectiferous pests during the last few years has caused the agricultural industries to decline to an alarming extent, and it is urged that the evil has now increased so much as to call for legislation. In the Maltese Islands there are no laws for the protection of birds, and, the lower classes of the Maltese being keen sportsmen, no opportunities are allowed to either the migratory or the indigenous species of increasing.

IT was observed by Prof. Voit that when dogs were fed exclusively on bread they daily lost albumen, though not weight, the body becoming more watery and the hæmoglobin of the blood diminishing. This matter has been recently further investigated in his laboratory by Herr Tsuboi. Of three rabbits, one was fed with milk, rolls, and some hay, another with much hay, the third with potatoes. The last had more water in muscles and blood, and less hæmoglobin than the first. In another experiment (with like results) one of two cats was fed with meal and fat, another with bread and some meat extract. Again, three rabbits were fed with potatoes, the first with iron added, the second with serum, the third with blood. The last was found to have most solid matters in muscles and blood, and most hæmoglobin. It is not (the author points out) the amount of food by itself alone that determines the result, otherwise, in the fasting state, the hæmoglobin would be least, whereas it is the same as with good feeding. It is rather the insufficient composition of the food, the too small amount of albumen, with excess of starch-flour that has the injurious effect.

THE phosphoroscope of Becquerel is a well-known instrument, enabling one to observe the phosphorescence of some substance when the exciting light is gone. It is designed to be used with sunlight. M. Lenard has devised an instrument (*La Nature*) for use with the electric spark. To the armature of a Foucault interrupter in an induction coil, is attached a light wooden rod, having at its end a piece of blackened pasteboard, which is thus driven up and down before a spark-interval between two brass knobs connected with the coil and a condenser (added to intensify the spark). The body to be examined is placed close behind the interval, so that it is uncovered very quickly after the spark passes. Some curious phenomena are observed. The short duration of the spark makes the screen seem at rest, and some thousandths of a second after one sees a luminous body behind where it was, so that at first sight one might think the screen opaque to the spark, but transparent for the phosphorescent light, an illusion due to the persistence of luminous impressions. Some bodies, such as various carbonates of lime, behave very much alike in this apparatus and in Becquerel's; some are favoured in the latter, and on the other hand, crystals of arragonite, which are invisible after solar illumination, give a faint reddish light after the spark. Various experiments are described. The most curious results are furnished by the remarkable substance, asaron. In a Crookes tube this gives a bright light, it gives also a distinct glow in the ultraviolet spectrum of the spark, but in the phosphoroscope it is absolutely dark. The vibratory movement ceases immediately with the excitation.

THE new number of the *Internationales Archiv für Ethnographie* (Band v., Heft 4) consists mainly of the first part of what promises to be an elaborate paper (in German) on the inhabitants of the Nicobar Islands, by Dr. W. Svoboda. In October, 1886, while the German corvette, *Aurora*, lay in the harbour of Nangcauri, Dr. Svoboda had many opportunities of seeing the natives, and Mr. F. H. Man gave him facilities for the thorough study of a splendid collection of ethnographical objects from various parts of the group. Afterwards he extended his knowledge of the subject by reading books which dealt with it, and by visiting the ethnographical museums of Berlin and Vienna. The results he is now bringing together, and those of them embodied in the present contribution show that he is not only a good observer but that he knows how to state facts clearly and concisely. The paper is illustrated with coloured plates and woodcuts.

THE British Institute of Public Health has now an official quarterly journal, called *The Journal of State Medicine*. It is published by Charles Griffin and Co. The second number has appeared, and contains original papers on the following subjects—lead in articles of food, by Prof. William R. Smith; points in the ætiology of typhoid fever, by Edmond J. McWeeney; chemical bacteriology of sewage, by W. E. Adeney; and new method of sewage purification, by W. Kaye Parry.

A NEW and revised edition of the late Prof. Moseley's well-known "Notes by a Naturalist on H.M.S. *Challenger*," has been issued by Mr. John Murray. It includes an excellent portrait, which vividly reminds us of the great loss inflicted on science by his premature death.

MESSRS. WHITTAKER AND CO. have published the first part of a work entitled "Dissections Illustrated: A Graphic Handbook for Students of Human Anatomy," by C. Gordon Brodie. The plates are drawn and lithographed by Percy Highley. The work will be completed in four parts. The present part deals with the upper limb, and includes seventeen coloured plates.

A SECOND edition of "A Short Manual of Inorganic Chemistry," by Dr. A. Dupré and Dr. H. W. Hake (Charles Griffin and Co.), has been issued. The authors have endeavoured to bring the statement of facts up to date without increasing the bulk of the work, and to remove those errors to which their attention has been drawn.

A RE-DETERMINATION of the mechanical equivalent of heat has been made by M. C. Miculescu at the Sorbonne. An account of the method appears in the *Annales de Chimie et de Physique* for October. The method was that of water friction at constant temperature. The liquid was enclosed in a cylindrical vessel with three envelopes. Water was kept circulating round the innermost one at such a rate that the difference of temperature of the water at entrance and exit was constant as measured by a thermopile. The heat thus derived from the water inside could be estimated by the quantity of water passed through. The water inside was stirred by vanes mounted on an axial shaft kept rotating by a gramme machine of 1 horse power running at 1200 revolutions per minute. The expenditure of work was measured by making the whole apparatus its own dynamometer. It was suspended so as to turn round the common axis of the stirrer and the motor. The resistance met with by the former tended to turn the apparatus in the direction of revolution of the latter. It was kept stationary by a weight attached to an arm exerting a measurable couple. The mean of 31 values ranging from 425·21 to 427·12 was 426·70 in kilogram-metres

per calorie, or 4 1857 × 10^7 ergs For the normal scale of the hydrogen thermometer this would be 426 84

A NEW and very convenient method of preparing acetylene gas is described by M Maquenne in the current number of the *Comptes Rendus* A short time ago the same chemist succeeded in preparing a comparatively stable compound of carbon with the metal barium, BaC_2, by heating powdered retort-charcoal with barium amalgam in a current of hydrogen Upon bringing this compound in contact with water a violent action was found to occur with evolution of almost pure acetylene gas On account, however, of the troublesome nature of the operations of procuring barium amalgam and preparing from it the new compound, together with the very small quantities of the latter eventually obtained, this mode of preparing acetylene was only of theoretical interest, and not suitable as a laboratory method of preparation M Maquenne now describes a new process for preparing barium carbide, by means of which large quantities may very readily be procured in a few minutes, and from which correspondingly large volumes of acetylene may be derived The principle of the method consists in reducing barium carbonate by metallic magnesium in presence of carbon An intimate mixture is first made of barium carbonate prepared by precipitation, powdered metallic magnesium, and calcined retort-carbon Convenient amounts are twenty six grams of barium carbonate, ten and a half grams of magnesium, and four grams of charcoal This mixture is then introduced into an iron bottle of about seven hundred cubic centimetres capacity, furnished with a tube, also of iron, thirty centimetres long and two centimetres internal diameter The iron bottle is then heated in a gas furnace which has previously been raised to a red heat At the expiration of about four minutes an energetic reaction occurs, accompanied by the projection of brilliant sparks from the mouth of the tube The apparatus should then at once be removed from the furnace, the end of the tube stopped, and the bottle and contents rapidly cooled by the external application of cold water The product may then be extracted, when it is found to consist of a mixture of magnesia with 38 per cent of carbide of barium, a little excess of carbon, and a trace of cyanide formed at the expense of the atmospheric nitrogen The reaction accords very closely with the equation —

$$BaCO_3 + 3Mg + C = BaC_2 + 3MgO$$

Carbide of barium may be preserved for an indefinite time in a dry atmosphere. It is a grey, porous, and very friable substance When heated to redness in the air it burns with a vivid incandescence It is also capable of combustion in chlorine, hydrochloric acid gas, and vapour of sulphur In order to prepare acetylene from it the powder is most conveniently placed in a small flask fitted with a doubly-bored caoutchouc stopper, carrying a dropping funnel containing water, and a delivery tube. The moment water is allowed to drop the equivalent quantity of acetylene gas is evolved in accordance with the equation —

$$BaC_2 + 2H_2O = Ba(OH)_2 + C_2H_2.$$

The delivery of the acetylene may be regulated with great nicety by suitable adjustment of the stopcock of the dropping funnel The acetylene thus prepared possesses the further advantage of being remarkably pure, containing 98 per cent of C_2H_2. It is interesting to learn that by allowing a stream of this pure acetylene to pass through a long heated glass tube for a few hours several grams of synthetical benzene have been accumulated by M Maquenne.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr W. F Faulding, a Buffon's Touracou (*Corythaix buffoni*) from West Africa, presented by Mr A. L. Jones; two Double banded Sand Grouse (*Pterocles bicinctus* ♂ ♀) from Senegal, presented by Mr H H. Sharland, F Z S, a Gannet (*Sula bassana*), British, presented by Dr Davis, a Roseate Cockatoo (*Cacatua roseicapilla*), a King Parrakeet (*Aprosmictus scapulatus* ♀) from Australia, presented by Mrs Addiscott, four Alligators (*Alligator mississippiensis*) from the Mississippi, presented by Mr John Terry, two Thick billed Seed-eaters (*Oryzoborus crassirostris*), a Tropical Seed Finch (*Oryzoborus torridus*), a Saffron Finch (*Sycalis flaveola*), a Bluish Finch (*Spermophila cærulescens*) from South America, a Puff Adder (*Vipera arietans*) from West Africa, deposited

OUR ASTRONOMICAL COLUMN

COMET BARNARD (OCTOBER 12) —An *Astronomische Nachrichten* circular note gives the following elements and ephemeris, computed from observations made on the 16th, 17th, and 18th of this month —

Elements

T = 1892 Nov 12 745 Berlin M T

ω = 168 49

☊ = 220 50

i = 21 39

log q = 0 03669

Ephemeris Berlin Midnight

1892	R A h m	Decl ° ′	Log Δ	Br
Oct 25	20 6 6	+7 47		
27	13 5	6 51	9 6825	1 46
29	21 5	5 52		
31	29 8	4 51	9 6609	1 66
Nov 2	38 7	3 47		
4	48 2	2 40	9 6377	1 87
6	20 58 3	1 29		

As the brightness at the time of discovery is taken as unity, it will be noticed that the comet is quickly gaining in intensity, the value for November 8 being 2 08 Br Its position on the 31st lies in the southernmost part of the constellation of the Dolphin, forming very nearly an equilateral triangle with α Aquilæ and β Delphini

DISCOVERY OF THREE NEW PLANETS BY PHOTOGRAPHY — M Perrotin has communicated to the French Academy an account of the discovery of three small planets by M Charlois, of the Nice Observatory, by the aid of photography The apparatus employed consisted of an Hermagis portrait lens of 15 cm aperture and 80 cm focal length, mounted provisionally on M Loewy's *equatorial coudé* The instrument was being employed for the photography of the region of the ecliptic With exposures ranging from two hours and a half to three hours, the eight negatives obtained since September 12 cover a region 80° long and 10° broad, and show all the stars visible through the 38 cm refractor A careful examination of the plates reveals the presence of three unknown and eight known planets The former, now known under the names 1892, D, E, and F, are all of about the twelfth magnitude.

RUTHERFURD MEASURES OF STARS ABOUT β CYGNI — Mr Harold Jacoby, in No 4 of the *Contributions from the Observatory of Columbia College, New York*, presents us with the reduced results of the measures of the plates containing the group of stars surrounding β Cygni The method of measurement was exactly the same as that employed in the case of the Pleiades plates, but that of reduction has received some slight modification For instance, the measures of the eastern and western impressions have not been separately dealt with, but their mean has been taken, and the reduction continued, using this mean as a single observation. As the accuracy of these measurements depend on the exactitude of the scale value determinations to a very considerable extent, it is satisfactory to hear that this value has remained materially the same for a very long period The largest and smallest values recorded in the Pleiades plates were 28″ 0167 and 28″ 0066, the mean value amounting to 28″ 0124, and it is

his last-mentioned value that has been used in the above reductions The probable error of these determinations is then ±0″ 00071, which corresponds to ±0″ 025 per 1000″ But Mr Jacoby does not think that the average uncertainty of the final places exceeds 0″ 15 on account of scale value While comparing the Rutherfurd stars with those of Argelander, he found that four stars from the latter were lacking, while they were recorded on the original negatives of the former Observations made this year showed that three wer visible, while the fourth (No 28), which was quite close to No 27 on the Rutherfurd negatives, was this year "only a sort of elongation of No 27" On the other hand, the following of Argelander's stars were absent from the plates —

B D	+ 27 3395	Mag	8 8
	+ 27 3414	,,	9 0
	+ 27 3417	,,	9 0
and perhaps			
	+ 27 3435	,,	8 5
	+ 28 3343	,,	9 0

A NEW VARIABLE STAR —In *Astronomische Nachrichten*, No. 3124, Prof Pickering announces the discovery of a new variable star in Aries by Prof Schaeberle The fact of this star being a variable was first noted when, on an examination of two plates taken December 18 and January 24, 1891, it was found that on the former it appeared of the 9 5 magnitude, while on the latter it was absent altogether Recent visual observations have shown, however, a star of the eleventh magnitude in the exact position of the suspected variable, and this has been confirmed by means of photographs From photographs of the same region, taken since October 31, 1890, the magnitudes recorded have been 9 6, 10 2, 11 0, less than 11 7, 10 1, 10 0, 10 4, 10 3, and 10 9 The star s position for 1900 is given as

R A 3h 5 5m Decl + 14°24′

JUPITER'S FIFTH SATELLITE —It hardly ever happens that, after a discovery of any importance has been made, there are not a few "claimants" who wish to annex it as their own This is the case with Prof Barnard's discovery of the fifth moon to Jupiter, but the advantage he possesses over these said "claimants" is, we might say, infinite, for it is only with such an instrument as that at the Lick Observatory that this "mite" of a satellite can be observed with success One of the despatches in which one "claimant's" views were put forth, had the audacity to insinuate that Prof Barnard was directly inspired to this discovery by information contained in a letter sent to the Observatory We are glad to see that Prof Barnard deals with these "claimants" as they deserve, and we hope it may be a lesson to others who wish to assert their priority without good and sufficient reasons for doing so

As an illustration of the difficulty of observing this satellite, we may mention that Prof Young, in a letter to Prof Barnard, says that although he has used a 23 inch Clark, which is an instrument as nearly perfect as can be made, he was not rewarded with success.

THE SPECTRUM OF NOVA AURIGÆ —Herr E von Gothard, of the Observatory at Herény, has taken a very successful photograph of the Nova spectrum, the results of which he communicates to *Astronomische Nachrichten*, No 3122 The instrument used was a 10½-inch reflector with a 10-inch objective prism, and the exposure given amounted to 45 minutes The spectrum shows six lines, and a comparison with the spectrum of the ring nebula and the Wolf-Rayet stars presented a remarkable concordance, the first failing only in the second Nova line, and the second differing only with regard to the intensity of the individual lines The following table shows this somewhat more clearly —

	I	II	III	IV	V	VI	VII
Nova	6	1	10	5	3	4	—
G. C 4964	8	2	10	6	6	8	—
Ring nebula	8	—	5	2	7	6	10

The wave lengths of the lines are, we are sorry to say, not inserted.

"JUPITER AND HIS SYSTEM" is the title of a small book recently published by Mr Stanford, and written by Miss E M Clarke. The authoress has brought this book out at a time when this planet is receiving most attention, for was it not in opposition, shining with exceeding brightness, on the 12th of this month? One great point about this little monograph is that facts throughout have been strictly adhered to, so that the reader is presented with the true state of the planet as we know it The information is well up to date, as for example the mention of the new satellite, and the book is written in a popular yet accurate style One thing that calls for attention is the price (one shilling), which could doubtless have been halved

GEOGRAPHICAL NOTES

MR J Y BUCHANAN, F R S, is this term delivering a course of lectures on Oceanography in Cambridge University It is satisfactory to know that the lectures are better attended than has been the case since the foundation of the Geography lectureship, and that the greater number of those present this term are undergraduates

MR JOSEPH THOMSON has submitted to the British South Africa Company the report of his journey to the Lake Bangweolo region, made last year, which ill health has prevented him from preparing sooner He speaks of Northern Zimbesia generally as a region of great possibilities It is a plateau rarely less than 3500 feet high, with a climate in which Europeans should find no difficulty in living for several years at a time It is well suited for cattle rearing and for planting, and there is an appearance of mineral wealth Like the rest of tropical Africa, the land must be occupied and cultivated, and the natives must be trained to industry before commercial results of any importance can be obtained

THE special meeting of the Royal Geographical Society to hear Captain Lugard s paper on Uganda will be held on Thursday, Nov 3, at 8 30 p m On account of the great popular interest at present being manifested in the region of the Equatorial lakes, no extra tickets can be issued by the Society, as the attendance of Fellows and their friends will probably more than fill the hall

THE new number of *Petermann's Mitteilungen* contains some articles of considerable interest Dr W Ruge, son of the well-known geographer, Dr Sophus Ruge, contributes a short but learned treatise on the geography of Asia Minor, which combines literary research with personal exploration Dr Ernst H L Krause produces an interesting map of North Germany, showing the distribution of forests and the most common species of trees during the Middle Ages This work is accomplished mainly by the consultation of old records, and the examination of the remains of old forests and very ancient trees The study of history is greatly helped by such a map, and the influence of increasing density of population and extending cultivation of farm crops is brought out strikingly by comparison with a map of the vegetation at the present day. Dr Karl Sapper's description of Lake Yzabal in Guatemala is also worthy of note

GEIKIELITE AND BADDELEYITE, TWO NEW MINERAL SPECIES

VARIOUS pebbles were lately brought to this country by Mr. Joseph Baddeley, who has been acting as manager of a Gem and Mining Company in Ceylon They had been picked up by him in the neighbourhood of Rakwana (Rackwanné) at various times, and had then attracted his special attention by reason of their high specific gravity Their real nature not being evident on inspection, Mr Baddeley, when invalided, brought them home to England for identification

One kind of pebble, kindly analyzed for him by Mr Claudet, was found to be essentially a tantalate of yttrium

Pebbles of another kind were taken to the Museum of Practical Geology in Jermyn Street for examination The external characters being found by Mr. Pringle insufficient for the determination of the species, the pebbles were handed over to Mr Allan Dick for chemical investigation Quantitative analysis proved the mineral to be essentially magnesium titanate ($MgTiO_3$) and chemically analogous to Perofskite, calcium titanate ($CaTiO_3$) To this interesting new species Mr Dick, in a paper read before the Mineralogical Society in June, gave the name Geikielite, in honour of Sir Archibald Geikie, F R.S, Director General of the Geological Survey, in whose laboratory the analysis had been made.

As described by Mr Dick, Geikielite has a specific gravity

3 98 its hardness (6 5) is between that of quartz and felspar It has a perfect cleavage, with a splendent metallic lustre, and an imperfect cleavage nearly at right angles to the former The pebbles themselves show no remains of crystal-faces, are bluish-black in colour, and opaque, but thin cleavage-flakes, when seen in the microscope, have a peculiar purplish red tint, and in convergent polarized light show a uniaxal figure, of which the axis is just outside the field of vision When digested with hot strong hydrochloric acid the finely powdered mineral is slowly decomposed, and the titanic acid separates out In strong hydrofluoric acid complete solution takes place in a few hours The mineral is infusible with the blowpipe fused with microcosmic salt it gives the characteristic reaction of titanic acid, notwithstanding the presence of a small proportion of oxide of iron

Shortly after Mr Dick's paper had been read, Mr Baddeley courteously offered to allow me to select a single pebble for the British Museum Collection out of his small store of the mineral, the remaining ones being required by him for sending as samples to be used by searchers in Ceylon But this store, small though it was, consisted of more than one kind of pebble, the close similarity of aspect being due to friction against a bit of graphite which was with them On this heterogeneity being pointed out, Mr Baddeley allowed me to take not only the promised pebble of Geikielite, but also those three pebbles which, not being Geikielite, were useless as samples of that mineral One of the three fragments proved to be garnet a second was ilmenite—both of them common minerals—but the third, a fragment of a crystal still retaining some of its faces, presented characters which give it unusual interest

The fragment, which weighs just over three grains, is black and opaque, and has the general aspect of columbite, its extremely high specific gravity (6 02) and its hardness (6 5) are also suggestive of that mineral In microscopic fragments it transmits light and is dichroic, changing from a greenish yellow to brown with the plane of polarization of the light, the fragments, when examined in convergent polarized light, show a biaxal figure, the apparent axial angle being large (near 70), the character of the double refraction is negative There is only one well developed zone of crystal faces remaining on the fragment, it consists of two rectangular pairs of parallel faces (pinakoids) and of four prism faces (*m*), the faces of one pinakoid (*a*) being much larger than those of the other (*b*), the angle *am*, as determined by means of reflection, is about 44°, but the images of the signal are multiple and wanting in definition, the dispersion of the optic axes indicates that the system of crystallization is mono symmetric Two other faces form a re-entrant edge parallel to the larger pinakoid, and inclined to the edges of the well developed zone, but whether this is really due to twinning or not is far from evident

The above set of external characters suggested that the fragment does not belong to any of the known species, and it became necessary to determine its chemical behaviour, but on account of the necessity of preserving the natural faces of what might possibly be an unique fragment, this was a process demanding great caution, fortunately, the behaviour was such that it was practicable to determine the precise chemical nature of the mineral without interference with the crystal faces, or, indeed, any appreciable destruction of material It will be sufficient to state here the result, namely, that the material is no other than crystallized zirconia, the technical details relative to both this mineral and Geikielite will be given in the next number of the *Mineralogical Magazine* It is remarkable that, notwithstanding the wide prevalence of zircon itself (silicate of zirconium), the natural occurrence of the oxide of zirconium has not previously been noticed For this new species I beg to suggest the name Baddeleyite, in recognition of the services of Mr Baddeley to mineralogical science, but for his close scrutiny of the mineral products of Rakwana, the existence of the above remarkable species would doubtless have long remained unknown

L. FLETCHER

NEW BRITISH EARTHWORMS

THE additions which I have been able to make to our list of indigenous Annelids during the past two years fall naturally into two groups. There are, first, two species which are new to science, and are therefore at present known only as British species. In addition to these there are several species which, while they have been recorded for various Continental stations, have never been found in England till I discovered them among the gleanings which I have passed under review from nearly every part of the country I shall first of all give a description of the new species

1 *Lumbricus rubescens*, sp nov

This is a genuine Lumbricus in the strictest sense of the word, as it is understood by all those who adopt Eisen's analysis of this group of worms published in 1873 The lip forms a perfect "mortise and tenon," with the first ring or peristomium, and the girdle consists of six segments, four of which bear the *tubercula pubertatis* I first discovered it in Yorkshire in 1891, and have since then taken it myself at Hornsey in Middlesex, Tunbridge Wells, and Dallington in Sussex, while more recently I have received it from Avonmouth in Gloucestershire

In general appearance it resembles the common earthworm (*L terrestris*, L), as recently defined and differentiated It is slightly smaller in size, but frequents similar haunts, and might in most respects easily be mistaken for the type It has the male pores on segment 15 on raised, pale papillæ, but the girdle invariably commences on segment 34, and extends to the 39th, while the band which forms the *tubercula pubertatis* extends over 35 to 38 Its general form and appearance will

FIG 1—*Lumbricus rubescens*, Friend Natural size

be best understoood by the study of the woodcut (Fig 1) Internally it does not differ from the other Lumbrici, but the dorsal pores commence between [illegible] This makes the fourth true Lumbricus found in the British Isles, and it may be a convenience to collectors if I append a tabular statement of the features by which each is distinguished from the other

Chart of the Genus Lumbricus

Lumbricus	Segments occupied by the Girdle	Tubercula	First dorsal pore	Papillæ	Spermatophores	Average length	No. of segments
Terrestris, Linn	32—37	33—36	[illegible]	15, 26	[illegible]	5 inches	150—200
Rubescens, Friend	34—39	35—38	[illegible]	15 28	32/33	4 inches	120—150
Rubellus, Hoffm.	27—32	28—31	[illegible]	none	[illegible]	3 inches	110—140
Purpurous, Eisen	28—33	29—32	[illegible]	10 (11)	[illegible]	2 inches	100—120

It will be seen that there is now a regular series in relation to the first dorsal pore, [illegible], as well as in the matter of length from 2 to 5 inches and upwards, and number of segments from 100 to 200 or thereabouts These points are worthy of note in the study of the evolution of worms.

2 *Allolobophora cambrica*, sp nov

This species, which I have since found in several parts of England, first came to my notice as a new species from Wales Hence the specific name I had previously assigned it to one or other of the related species, but eventually found on dissection that it was quite distinct from every other worm of which I have been able to obtain any description

At first sight *A cambrica* has all the appearance of the mucous worm (*A mucosa* Eisen) Its average length in spirits is about 2 inches, but when living, and moderately extended, it measures three inches It is of a fleshy colour, with a somewhat transparent skin, so that the blood vessels can be well observed between the girdle and the head The dorsal pores are conspicuous in specimens which have been placed in methylated spirits, the first occurring between segments 4 and 5 The

[1] Vejdovsky and others mention the occurrence of Spermatophores on these species, but do not state the position The point is one which should not be ignored

setæ are in four couples, the individuals of which are near each other The girdle covers segments 29 to 37, while 31 33 35 bear each a pair of tubercules (Fig 2) as in the green worm

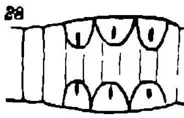


FIG 2—Diagram of girdle of *A cambrica*, Friend, showing tubercula on ventral surface

(*A chlorotica*) There are two pairs of spermathecæ in segments 10 and 11, opening anteriorly, the male pore on segment 15 is borne on prominent papillæ, which cause the adjoining segments to appear swollen (Fig 3) It is a very clean worm,

FIG 3—*Allolobophora cambrica*, Friend Natural size

exudes but little mucus as compared with the green worm, the tail is much longer than in that species, which, in the matter of girdle and tubercules, it most nearly resembles It will be well to tabulate the points in which this worm resembles and differs from its nearest allies

Allolobophora cambrica resembles

Allo. chlorotica	*Allo mucosa*
in position and appearance of male pore, girdle, and *tubercula pubertatis*	in colour, shape, size, activity, position of first dorsal pore, and appearance of male pore

It differs

in mucus, transparency, length and shape of tail, and number of spermathecæ	in position and shape of girdle, position of *tubercula pubertatis*, and general outline

Tabular View

Allolobophora	Segments occupied by the Girdle	Tubercula	First dorsal pore	Spermathecæ	General observations.
Chlorotica	29—36	31 33 35	[illegible]	9 10 11	Dirty green, opaque, sluggish, and grub like, exudes much mucus
Mucosa	26—32	29 30 31	[illegible]	10 11	Flesh coloured active, with transparent epidermis little mucus
Cambrica	29—37	31 33 35	[illegible]	10 11	Closely resembling *A mucosa* in general features

When our knowledge of the hybridity of worms is more perfect, it is possible that some new light will be thrown upon such coincidences as these I have received the worm from, or collected it in, Nottinghamshire, Hertfordshire, Yorkshire, and Montgomeryshire I believe I have also found it in Westmorland and elsewhere, but entered it either under one or the other of the two species which it so closely resembles

Next, we have to note the worms which are new to Britain, though not new to science These all fall under the genus Allolobophora, and several of them are so well marked that I have, in some recent articles on this subject, revived Eisen's subgeneric term Dendrobæna, and placed under it about half a-dozen species of tree-worms which are more or less widely distributed in this country

The tree-worms are small, hardy, and active, the lip is usually very delicate, and appears to be used, not only as a sucker and boring agent, but also as a tissue dissolver, probably by the use of a special saliva. The setæ are usually in eight almost equidistant rows, and the lip cuts more or less deeply into the first ring The type of this group is *Dendrobæna Boeckii*, Eisen, which has been the subject of endless confusion The true species, following the diagnosis of Eisen, is very rare in England, and I have found it nowhere but in Airedale and Wharfdale, Yorkshire I believe all the other records which have been given by other writers should be assigned to the much more common and widely distributed species known as *Allolobophora subrubicunda*, Eisen This worm belongs to the same group, but lives among vegetable *débris* as well as beneath the bark of decaying trees Another species (*A arborea*, Eisen) is found only in dead timber I have specimens from Cumberland, Gloucestershire, Yorks, and Sussex It is one of the prettiest and neatest worms indigenous to this country Nearly related to this is another (*A celtica*, Rosa), which, while it prefers trees, will thrive among decaying vegetable matter. I first found it at Langholm, N B, some two years ago, but since then I have taken it plentifully in Carlisle, Morecambe, and Tunbridge Wells, besides receiving it from Sussex, Devonshire, Gloucestershire, Northants, and elsewhere It bears spermatophores during the spring months

When I was in the south of England in the early months of this year, I discovered a couple of specimens of a new British tree worm (*A constricta*, Rosa) This species seems to me to belong to the south, just as *D Boeckii* belongs to the north I am making notes on the distribution of these species in order if possible to ascertain their limits A very anomalous worm (*Lumbricus Eiseni*, Levinsen) belongs to this group, though it has certain Lumbricus affinities It is far from being a true Lumbricus, since it possesses neither *tubercula pubertatis* nor spermatheca Its girdle, too, is abnormal, for, whereas in the genuine Lumbricus the girdle invariably covers six segments, in this worm it extends over eight or nine At present it does not fit in to any known genus, and should probably be made the type of a new genus I have found it in Carlisle, Gloucestershire, and Sussex Rosa has obtained it in Italy, and Levinsen in Copenhagen, so that it appears to be very widely distributed On the Continent one or two further species belonging to this group are on record On account of their habits, size, and affinities I place them in the subgenus Dendrobæna, which may be presented in tabular form as follows —

Tabular View of Subgenus Dendrobæna

Dendrobæna	Segments occupied by the Girdle	Tubercula	First dorsal pore	Setæ	Prostomium	Colour
Boeckii, Eisen	29—33	31 32 33	—	8 equidistant	Cuts ⅔ peristomium	Dark brown
Subrubicunda, Eis	26—31	28 29 30	[illegible]	4 wide pairs	Cuts one half	Rose red, fleshy
Arborea, Eisen	27—31	29 30	[illegible]	4 wide pairs	Cuts one half	Red brown, iridescent
Eiseni Levinsen	24—32	0	[illegible]	4 close pairs	Cuts the whole	Violaceous iridescent
Constricta, Rosa	26—31	0	[illegible]	4 pairs	Cuts one half	Rose red, fleshy
Celtica, Rosa	30—36	33 34	—	4 wide pairs	Cuts one half	Violaceous, ruddy

Another group of worms belonging to the genus Allolobophora, with features more or less similar to those of the typical earthworm, has recently been enlarged by the addition of two or three species The first (*A profuga*, Rosa) seems to be generally distributed throughout England, as I have received it from several localities Its synonymy, however, is at present somewhat uncertain The long worm (*A longa*, Ude) is the most ubiquitous of all our native species, and has for years past been confused with the common earthworm. The other species must for the present be entered as *A. complanata* (Dugès) The Continental authorities differ in their judgment respecting the identity and synonymy of this worm, and I have hitherto been unable to disentangle the complications Certain it is that we have a species which corresponds in part with the worm described imperfectly by Dugès, and I hope in a little time to be able to determine its exact relationships

I append a list of all those species of British earthworms which I have personally collected, examined, and identified, in

each instance referring to the original memoir, and collating the worm with the author's description

A List of Known British Earthworms

	Author	Date	Memoir
LUMBRICUS			
1 Terrestris	Linnæus	1758	"Syst Nat," ed x, tom i, 647
2 Rubellus	Hoffmeister	1845	"Familie der Regenwürmer"
3 Purpureus	Eisen	1870	*Öfversigt af K Vet Akad*
4 Rubescens	Friend	1891	Linnean Society 1892
ALLOLOBOPHORA			
§ 1 Lumbricoidea			
5 Longa	Ude	1886	*Zeitschrift f Wiss Zool*
6 Profuga	Rosa	1884	"I Lumbricidi del Piemonte
7 Complanata	Dugès	1837	*Ann des Sc Nat* 2nd ser, viii
§ 2 Mucida			
8 Chlorotica	Savigny	1826	Cuv "Hist des Prog Sc Nat, ii
9. Trapezoidea	Dugès	1837	*Ann des Sc Nat*, 2nd ser viii
10 Turgida	Eisen	1873	*Öfversigt af K Vet Akad*
11 Fœtida	Savigny	1826	Cuv, Hist Pr Sc Nat tom iv
12 Mucosa	Eisen	1873	*Öfversigt af K Vet Akad*
13 Cambrica	Friend	1892	NATURE, current issue
§ 3 Dendrobæna			
14 Boeckii	Eisen	1873	*Öfversigt af K Vet Akad*
15 Subrubicunda	Eisen	1871	" "
16 Arborea	Eisen	1873	" "
17 Eiseni	Levinsen	1883	"Syst Geogr Overs" over de Nord An
18 Constricta	Rosa	1884	I Lumbricidi del Piemonte
19 Celtica	Rosa	1886	*Bolletino dei Musei di Zoo ed Anat*
ALLURUS			
20 Tetraedrus	Savigny	1826	Cuvier "Hist des Prog," tom iv, p 17
21 Luteus	Eisen	1870	*Öfversigt af K Vet Akad*

When Darwin wrote his work on "Vegetable Mould," he assumed the existence of eight or ten species of earthworm in Great Britain We now find a score of well defined species, to which I have no doubt we shall be able to add a few others when the montane and out-of-the way habitats have been explored I shall be happy to receive consignments of living worms from any part of the kingdom, packed in tin boxes lightly filled with soft moss, and addressed The Grove, Idle, Bradford

HILDERIC FRIEND

THE PROBLEM OF MARINE BIOLOGY[1]

IN common with the other branches of biological science, the study of marine life has made wonderful advances in the past half century, and we now begin to get a proper conception of the vastness and importance of this realm of nature

The study of marine life has been compassed by serious difficulties, on shipboard it is impossible to examine in the living condition the enormous quantity and endless variety of forms brought up at a single haul of the net or dredge, and the old method of merely dropping the specimens into vials of alcohol resulted in vials of wrath to the naturalist who later studied the creatures in hopes of gaining from the distorted relics some knowledge of the normal appearance and anatomy Now all this is changed, and by aid of certain chemical reagents most animals can be killed and preserved in a manner very satisfactory for study of their gross and microscopical anatomy, and hence the material collected can be examined at leisure in permanent laboratories with results corresponding to the better facilities There has, too, been a great lack of suitable and accurate collecting apparatus The early method was to scoop up a quantity of sea water and then tediously examine it in small quantities under the microscope In 1845 Johannes Muller, the great pioneer of marine biology, conceived the idea of condensing into a small volume of water the forms which would be found in a very great area. This resulted in the invention of the "Muller Net," a small gauze net which is drawn through the water, entangling in its meshes the very minute and delicate organisms For a long time Muller and his students pursued the study of marine forms, and at length came the discovery that the marine fauna and flora was directly comparable to the terrestrial

Yet little is known of the laws of the distribution of marine life The laws of the distribution of the terrestrial fauna and flora have been formulated for animals in the classical works of Wallace and for plants by Griesbach The famous *Challenger* expedition (1873 1876), under the direction of Sir Wyville Thompson and Dr John Murray, has given us the largest conception of the wealth of marine life, and has laid the foundations for the study of the marine forms both at the surface and in the depths of the ocean Dr Murray in his preliminary report called particular attention to the enormous wealth of organic life not only at the surface, but also many hundred fathoms below He says that when living forms were scarce on the surface the tow net usually disclosed very numerous forms below, even to a depth of 1000 fathoms or more In the North Pacific Ocean, the discovery was made that zones of definite depth are characterized by animals and plants peculiar to them The tow nets sunk to 500, 1000, or 2000 fathoms brought up forms never found within 100 fathoms of the surface The animals characteristic of these different depths are, for the most part, of the class of Radiolarians, those microscopic organisms whose silicous skeletons form much of the soft ooze which carpets the bottom of the deep sea Prof Haeckel, by study of this material, was led, in his monumental work on the Radiolaria, which forms a part of the "Report of the Challenger," to the recognition of three groups, (*a*) pelagic, swimming at the surface of the calm sea, (*b*) zonary, swimming in definite zones of depth (to a depth of more than 20,000 feet), (*c*) profound (or abyssal) animals swimming immediately over the bottom of the deep sea In general the different characteristic forms correspond to the different zones (up to 27,000 feet)

The existence of this intermediate pelagic fauna was called in question by Alexander Agassiz, on the ground of the liability of error in using the ordinary open net instead of one which could be closed at a definite depth and then drawn up, and more particularly upon the ground of his own experiments made in 1878 on the *Blake* expedition He believes that the great bulk of the ocean contains no organic life at all, that the surface fauna of the sea is limited to a relatively thin layer, and that there is no intermediate layer, so to speak, of animal life between the fauna of the bottom of the deep sea and of the surface

Agassiz's results are contradicted by those of Chierchia on the Italian corvette *Vettor Pisani* With the closable net invented by Palumbo he brought up an astonishing quantity and variety of forms of life from different depths, even up to 4000 metres Prof Carl Chun, with an improved closable net, studied the marine fauna and flora of the Gulf of Naples He formulates his results as follows (1) That part of the Mediterranean investigated shows a rich pelagic life even to a depth of 1400 metres, as well as at the surface (2) Pelagic animals, which during the winter and spring appear at the surface, at the beginning of summer seek the depths (3) At greater depths pelagic animals occur, which hitherto have seldom or not at all been observed at the surface (4) A number of pelagic animals during the summer remain at the surface and never go into the depths From his observations upon the vertical distribution of marine life he was led to remark that the surface fauna was apparently only the advance guard of the vast army below His conclusions were confirmed by observations made during a trip to the Canary Islands, and agree with those made by Prof Haeckel twenty years before

Prof Hensen, of Kiel, has for several years past been studying the phenomena of pelagic life with a view of ascertaining its relations to the fisheries question He has proposed the term Plankton (from πλάνομαι, to wander) to designate this world of marine life Prof Haeckel agrees with this and adds Planktology, that branch of biology which deals with the study of the Plankton Prof Hensen hopes to gain valuable information upon the phenomena of marine life by a careful mathematical estimation of the number of individuals in a given bulk of water Presumably from this and other data some knowledge may be gained of the quantity of life which any definite area of the sea is capable of sustaining

Prof Ernst Haeckel, of Jena, has lately published an admirable *résumé* of our knowledge of pelagic life, and has made a very distinct advance by formulating some of the laws which govern its distribution He has probably done more than any

[1] Reprinted from the *American Naturalist* for October, 1892

one man to advance our knowledge on this line. Ever since 1854, when, as he tells us, he accompanied the great Johannes Müller to Heligoland and was there introduced by his master to the marine wonderland, he has almost continuously pursued the study of the Plankton. He believes that aquatic life in its broadest features shows conditions of distribution similar to those of terrestrial life, and that we may for the former as well as for the latter distinguish five great geographical provinces, each represented by characteristic forms of animals and plants: (1) the Arctic Ocean; (2) the Atlantic; (3) the Indian; (4) the Pacific; (5) the Antarctic.

All aquatic organic forms fall into two great divisions: (1) Those which live free in the water, either swimming actively or passively floating at the mercy of currents and winds. These compose the Plankton. The Plankton thus includes the widest range of organic size and form, from the minutest microscopic organisms to the gigantic cetaceans. (2) Those forms which live upon the sea bottom, either fixed or creeping about. To these the term Benthos (τὸ βένθος, the bottom of the ocean) is applied. The variety of forms living near the shore is known to vary with the depth, while the forms characteristic of the comparatively shallow waters of the coasts are widely different from those which inhabit the bottom of the deep sea.

The number and the kind of forms composing the Plankton are found to differ with the quality of the water, *i.e.* fresh or salt. In the ocean there is a marked difference which is conditioned by the distance from the shores, either of continents or islands. There are many species of animals, particularly certain cœlenterates, echinoderms, and worms, which pass only part of their life as free swimming animals; for the remainder, they are bottom dwellers. Such species are not usually found far from the coast, and hence the true oceanic Plankton is made up of forms which pass their entire life as free swimming organisms. By the presence or absence of these bottom dwelling species the Planktologist can determine approximately the region where the forms were captured.

A mere list of the genera, not to mention the species, of plants and animals up to the present found to take part in the constitution of the Plankton would be very formidable. The range in size is enormous; from the exceedingly minute unicellular algæ $\frac{1}{2500}$ of an inch in diameter to the huge bulk of many fishes and cetaceans. The microscopic forms constitute the fundamental food supply in the cycle of marine life. They are capable of exceedingly rapid multiplication, and furnish nourishment for the myriads of large animals, which in time are preyed upon by the still higher forms. The inconceivable number of individuals of the smaller species is demonstrated by Prof. Hensen's determination of the number of individuals in about two cubic yards of Baltic Sea water. This was found to contain 5,700,000 distinct organisms, of these only about 150,000 were visible to the unaided eye. But very often microscopic forms become so numerous as to form a slime upon the surface of the water for a considerable area. Ships frequently sail for miles through water coloured by these microscopic organisms, *e.g.*, the so called "black water" of the Arctic and Antarctic Seas, is a slime of diatoms, which serve as food for the shoals of minute crustacea and mollusca (Pteropods, sea butterflies, and Cephalopods, squid, cuttlefish) upon which the walrus and whales feed. In the warm regions the inconceivably enormous quantity of diatoms are replaced by another kind of alga, the Oscillatoriæ, which often for an area many miles in extent colour the sea a dark red or yellowish brown. The Red Sea received its name from the abundance of one of these algæ, *Trichodesmium erythræum*, which, according to Ehrenberg, coloured the water along the shore a blood-red. In the warm region also are found the huge floating banks of Sargassum, or gulfweed, forming the so called Sargasso Seas of the Atlantic and Pacific Oceans. These areas are found to have a marine fauna and flora peculiar to themselves, but approximating in character to that of the coast waters.

The simplest forms of animal life of the Plankton belong to the groups of Infusoria and Rhizopods; to the latter belong those minute animals, the Foraminifera and Radiolarians, which occur in such enormous quantities that their calcareous and siliceous shells form the "deep sea ooze" which carpets the bottom of the deep sea. It is the shells of these animals, too, which have built the vast chalk beds in various parts of the world. Among the multicellular animals which take a prominent part in this marine world are many species of medusæ (jelly fish) and the closely related Siphonophores, of which the beautiful Portuguese man-o'-war is the most familiar representative. The class of worms is represented by many free-swimming species; but in the number of individuals it is far surpassed by the molluscs, chiefly represented by the squids, the pearly and paper nautilus, and the huge cuttlefish, and by the minute and delicately beautiful sea butterflies (Pteropods), which occur in vast schools in the polar seas. Often, too, in very considerable number are found the free-swimming larvæ of Echinoderms, as also many worm larvæ, which, like the former, pass their adult life upon the bottom. Every haul of the gauze net is certain to contain some representatives of the great class of Crustacea, often great numbers of species, as well as of individuals. In distribution these seem to be subject to pretty definite laws, and a careful study of the phenomena would be of great interest. There are found also certain Tunicates, a group interesting because many investigators believe that here we find the transition from the invertebrate ancestor to the higher plane of life of which man is at present the highest representative.

The vertebrates of the Plankton embrace the great group of fishes, and in addition the marine birds, the seals and walrus, and finally the cetaceans. In this connection, too, the enormous number of fish eggs floating at the surface of the ocean, as well as the transparent, newly-hatched fry must be mentioned. Prof. Hensen hopes to get an idea of the approximate number of fish of a given species in a certain area, computing the number of eggs and fry of that species within that area.

The phenomenon of marine phosphorescence is very widely known with admiration and wonder. Its cause is chiefly or solely bound up with organic life. The majority of pelagic animals display the phosphorescent light in different degrees. In some the entire living animal is brightly luminous; in other the light is limited to special organs. But much of the phosphorescence of the ocean appears to be caused by the fragments of dead organisms, and is connected with the presence of bacteria.

Since many chlorophyll bearing organisms are found at depths unpenetrated by sunlight, it has been suggested that the light necessary for their growth is furnished by the phosphorescent organisms.

The composition of the Plankton is exceedingly irregular, both in qualitative and in quantitative relations; its distribution in the ocean is also very irregular, both in time and in place. The variations occur near the shore as well as far out at sea. Very often the greater part of the mass of Plankton is made up of organisms belonging to a single group. Sometimes unicellular algæ make up nearly the whole bulk, at another medusæ, siphonophores or ctenophores; indeed, almost any group of marine organisms may occur in such quantities as to compose more than one half of the total bulk of the Plankton, at that time and place. The fundamental causes of variation in the quantity and quality of the Plankton appears to be conditioned by time, climate, and currents.

Temporal Differences.—For a satisfactory determination of these more complete observations are needed. Reliable data can be furnished by the observations at the numerous marine laboratories and zoological stations now springing up in different parts of the world. The causes which underlie these yearly, monthly, daily, and hourly variations are manifold; in part meteorological, in part biological. They are comparable to the corresponding oscillations of the terrestrial fauna and flora, and depend on the one side upon climatic and meteorological conditions, and on the other upon the varying mode of life, particularly upon conditions of reproduction and development. Just as the annual development of most land plants is bound up with a definite time of year, as the time of budding and leafing, of blooming and fruiting, have in the "struggle for existence" become adapted to the meteorological conditions, the time of year, and other conditions of existence, so too the annual development of most marine animals is conditioned by definite habits, which have become fixed by heredity. The yearly variations may be compared to the good and bad fruit years. This yearly variation has been noted by many observers in case of many marine animals. Our attention is often called to an example of it in the unusual abundance or scarcity of the catch of certain food fishes.

Many marine animals, particularly certain medusæ, siphonophores, ctenophores, molluscs, and tunicates, are found at the

surface only periodically, in one or a few months of the year This is probably dependent upon conditions of reproduction and development, as well as upon the temperature of the season The daily variations are conditioned by the weather, and particularly by the wind and rain A shower will very quickly reduce the specific gravity of the surface water and thus drive the surface-dwelling animals below Many animals rise to the surface only at a definite time of day, some in the morning, others at noon, and yet others only towards evening

Climatic Difference —Prof Haeckel thinks that the quantity of the Plankton is very little dependent upon the climatic difference of the zones, but that the quality is greatly so, and indeed in this way, that the number of component species diminishes from the equator to the poles These conditions, he believes, are directly referable to the influence of the sun, "the omnipotent creator," whose more direct rays bring about an acceleration in the processes which make up the cycle of life As this is true of the terrestrial fauna and flora so it is true of the marine

Currentic Differences —Conspicuous differences are also brought about by the numberless currents, great and small, by the little known deep sea oceanic currents as well as by the better known great surface currents, the Gulf Stream, the Falkland Stream, the Guinea Stream and others These currents play a great *rôle* in the distribution of many forms of life More local influences are exerted by the small currents whose causes are found in the climatic and geographical conditions of the adjacent coast The relations of Plankton life to currents is little known, and needs investigation, but first a better knowledge of the currents themselves is necessary

Almost every one who has seen the surface of the ocean in a calm has noticed the glassy areas of irregular shape These are found on the high seas as well as in sheltered bays and harbours, and are of very special interest to the student of marine life So far as made out they are extremely irregular in time and place of appearance, and the conditions governing them have not been carefully studied They are in a measure influenced by winds and currents, by the ebb and flow of the tide Here, into a limited space, are crowded great numbers of organic forms, this space is readily distinguished from the surrounding water in which there is comparatively little life These phenomena have been noticed by seafaring men and have many different names in different countries

A word in conclusion as to the bearing and importance of the Plankton in human economy in the near future When Malthus promulgated his famous doctrine he failed to consider the final element which enters into the problem of human population, the human mind The ingenuity of the human mind has brought about a decreased efficiency in the natural checks to undue increase, and thus an artificial increase in the food supply is rendered necessary for the crowding population This food supply is now mainly derived from the cultivation of the land A still further increase of population will necessitate a levy upon marine life As soon as man to any great degree becomes a factor in the Plankton conditions by drawing from it large quantities of food, particularly in the form of mature animals, the equilibrium of oceanic life will be disturbed, and must be adjusted by artificial means But further, a study of the phenomena of marine life shows that the water as well as the land, through cultivation, is capable of producing a greatly increased food supply for man The necessity of cultivating the marine resources is even now apparent, and many governments have already begun to cope with the question by the establishment of commissions of fisheries Of these commissions that of the United States stands in the front rank by virtue of its positive results But in the near future individual attention must be turned to supplementing the terrestrial resources, the wheat fields, the cattle and sheep ranches, by an increasing utilization and development of the possibilities of marine farming, by fish propagation, by plantations of oysters, clams, quahaugs and scallops, by raising herds of lobsters and crabs Improved breed of fish, of lobsters will result The possibilities are well-nigh limitless, and by cultivation of the sea and sea bottom, as well as of the land, man will postpone indefinitely the fulfilment of the Malthusian prophecy.

But conditioning all advance in the possibilities of marine cultivation is the knowledge of the Plankton, of its distribution, and of the fundamental basis of marine life the microscopic marine organisms in the ocean.

GEORGE W. FIELD

OPTICAL PROJECTION[1]

THE intention of this lecture is to give a general survey of the subject of Optical Projection, which now takes its position in science, and to present examples of what may be done by this method It would be difficult to determine which subject claims a first place Some scientists say the microscope should have the preference, while others take a different view For my own part, I think the microscope and polariscope stand foremost, on account of the facility with which these branches of science may be pursued for the benefit of a large number, without multiplying expensive apparatus, also because of the convenience in saving the eyes from undue strain Indeed, to many persons, looking at objects in the table microscope is little short of a painful operation, and consequently the study of small objects becomes to them impossible The projection method immediately brings the required relief

For general instruction, projection methods are invaluable, such as, for instance, showing diagrams, photographs, and other slides, upon the screen, as well as for spectrum analysis In fact, the subjects which can be illustrated by means of optical projection are innumerable, but time will allow me to present only a few examples, and I trust that, when I approach the end of my lecture, my view of the importance of this subject will be held in equal estimation by you

Probably the only people in the world that benefit by the experience of their predecessors are those who pursue the study of science They are free from the accusation of robbing the brains of other men, when they take up methods or apparatus already known and improve upon them or employ them for their own work In such cases, however, it is always understood that honour should be given where honour is due, and accordingly I have no wish to represent to you any piece of apparatus as of my own devising, when in reality it belongs to another

Few men have had a larger experience, and attained greater success in optical projection, than has Mr Lewis Wright, who has embodied in his most recent forms of apparatus all that was good in designs existing until his time I have, therefore, started from his models making such modifications as I thought to be desirable Mr Wright does not appear—if I may say so—to have had much experience with the electric arc light as a radiant, and I found, at a very early stage, that great difficulties had to be encountered when this light was used, chiefly because the radiant approaches more nearly to what theory requires That which was easy with the lime-light became almost impossible with the arc lamp, and these difficulties had to be conquered

Many scientific men are dissatisfied with the projection microscope, on the ground that very high magnification does not give that resolution and that sharpness which is found in the usual methods of observation This want I fully admit At the same time it is scarcely right to condemn a particular method because you try to apply it to an unsuitable purpose Hundreds of thousands of subjects may be shown with the projection microscope with far greater profit to the student than was possible in the old way The very fact that the professor can place his pointer upon any part of the picture on the screen is invaluable to the students I shall, therefore, attempt to show you only a series of microscopical subjects suitable for projection, and shall not employ very high magnification

In regard to some substances very high powers may be used with advantage, but much time would be lost in getting them into the field and focussing them upon the screen These, consequently, I omit, so that a large number of subjects may be illustrated

It is fair to state that most of the apparatus used to-night has been constructed by Messrs Newton, of Fleet street, and the luminous pointer by Messrs Steward, of the Strand The arc lamp is a Brockie's projector Messrs Baker, Watson, and others have also come to my assistance

I will first show, on the screen, a picture of the lantern carrying its various apparatus, and then a few systems of lenses, which may be employed for the projection microscope, as well as a diagram of the microscope itself

Sub-stage condensers and objectives are, as a rule, made to suit the table microscope When projecting, by means of an objective alone, in consequence of the screen distance being very

[1] Friday evening discourse delivered by Sir David Salomons at the Royal Institution, on February 26.

great—or, in other words, the microscope tube being exceedingly long as compared with the table instrument—the objective has to be approached very close to the slide, in fact, with the higher powers, closer than the cover-glass will allow. This close working distance renders necessary special sub-stage condensers, and in many cases a special one is required for every screen distance with each objective. This requisite would seem to be a complete stumbling block to microscope projection work. With the lime light the difficulty does not enter in the same degree as with the arc light, and as we are now dealing with the latter, further reference need not be made to the oxy-hydrogen light. There are two ways of surmounting the difficulty, one by the use of plano concave lenses, introduced in such a way as to be equivalent to greatly lengthening the focus of the objective on the screen side, while it enables, as a consequence, the objective to be slightly further removed from the slide, *i.e.*, giving what is termed a greater working distance. The objection to this method is that, even when these plano-concave lenses are corrected, the result, though greatly improved, is not perfect. The second way, which is a perfect one, is that of introducing an eye-piece. In both these methods, that the best results may be obtained, the objective is made to occupy a position not very different from that which it would do if employed on the table microscope.

In the eye-piece method almost the exact conditions can be complied with for which the objective was made. I propose, therefore, to show the subjects by the eye-piece method. The only objectives which will be used are (1) Zeiss's 35 millimetre projection objective, with a sub stage condenser, 4 inches focal length placed a considerable distance from the slide, (2) Newton's 1 inch projection objective, the sub-stage condenser as in the first case, and (3) Zeiss's $\frac{1}{4}$ inch achromatic objective, the sub stage condenser being Prof. Abbe's three-lens condenser with the front lens removed. In all three cases the eye pieces used are Zeiss Huyghens No. 2 and No. 3.

In each instance I will mention the magnification in diameters, as well as the number of times when reckoned by area, for the appreciation of those who estimate by area, and I will also give the size to which a penny postage stamp would be increased, supposing it to be made of india rubber, and stretchable to any extent in all directions. In presenting these figures I do not pretend that they are absolutely correct, but as they have been ascertained under conditions similar to those now existing the errors will not be very great.

In consequence of the field not being quite flat, and the sections having a certain thickness, although extremely thin in most cases, the whole of the object cannot be in focus upon the screen at the same time. By shifting the focussing screw slightly all parts may be brought into focus successively. So called greater depth of focus is obtained by using an increased working distance, and for projection work over correction for flatness can alone give a sharp picture all over with very considerable depth of focus, the difficulty of over-correction being that, unless extreme care is taken, certain forms of distortion may be introduced. By stopping down the objective greater flatness of field may be secured, but at the expense of light. There is thus a choice of difficulties, and the least one should be taken.

Turning now to the polariscope. Polarized light teaches us a great deal concerning the structure of matter, it is also a means of confirming the undulatory theory of light. This subject is so large that no attempt can be made to give even a general idea of the field it covers, and the experiments, which will be shown in the polariscope, may be taken simply as a few illustrations of the subject and nothing more, but they will, at any rate, be suggestive of the large field to which this method of analysis can be applied. A vast amount of mathematical proof can be illustrated graphically by various experiments with polarized light. I will show on the screen a diagram of the polariscope. (Shown.)

With reference to showing the spectrum. The method of projecting a spectrum, I think, is new, as I have not seen it described anywhere. It gives practically a direct spectrum with an ordinary prism, without turning the lantern round to an angle with the screen, and here is a diagram of the method.

The details of the apparatus, as well as those of the methods of working, I have modified in almost every instance, for five reasons:—(1) That more certain results may be ensured, (2) that rapidity may be obtained; (3) that only one operator may be needed, (4) that, as far as possible, all parts of the apparatus may be interchangeable; and (5) that loose screws and pieces may be dispensed with.

There were then shown by projection a number of slides illustrating various microscopic optical systems, and a number of microscopic slides, followed by a series of general polariscopic projections, some of them to illustrate the strains existing in many forms of matter, also a spectrum by a carbon disulphide prism, in conjunction with a reflecting prism and with a mirror, which, apart from any other result, demonstrates that the loss of light with a reflecting prism is less than with an ordinary glass mirror. Slides and other projections were also thrown upon the screen.

The details are as follows:—

The Microscope.—Screen distance, 21 feet. First, 35 millimetres Zeiss projection objective, 4 inch sub-stage condenser, Zeiss Huyghens eye piece 2, 500 diameters = 250,000 times = penny stamp stretched to cover about 147 square yards. Subjects shown: proboscis of blowfly, permanent molar displacing milk-tooth (kitten), human scalp, vertical, human scalp, surface, fossil ammonites and belemnite. Second, 1 inch Newton's projection objective, 4 inch sub-stage condenser, Zeiss Huyghen's eye-piece 2. 1,000 diameters = 1,000,000 times = stamp stretched to about 588 square yards. Objects shown: proboscis of blow-fly, foot of a caterpillar, section of human skin, showing the sweat ducts, phylloxera vastatrix of the vine. Third, 1-inch Newton's projection objective, 4-inch sub stage condenser, Zeiss Huyghens eye-piece 3, 1,300 diameters = 1,690,000 times = stamp stretched to about one fifth of an acre. Slides shown: proboscis of blow-fly, wings of bee (showing hooklets and ridge), sting of bee (showing the two stings, sheath, and poison sack), sting of wasp (showing same as last slide), eye of beetle (showing the facets). Fourth, $\frac{1}{4}$ inch Zeiss's achromatic objective. Abbé's 3-lens sub stage condenser, with top lens removed, Zeiss Huyghens eye piece 3, 4,500 diameters = 20,250,000 times = stamp extended to nearly $2\frac{1}{2}$ acres. Slides shown: proboscis of blow fly, hair of reindeer (showing cell structure), hair of Indian bat (showing the peculiar funnel-like structure), sting of bee (showing the barbs), foot of spider, stage of the micrometer (the closest lines ruled to thousandth of an inch, which measure $4\frac{1}{2}$ inches apart under this magnification), a wave length $\frac{1}{40000}$ inch, therefore, on screen measures about $\frac{1}{9}$ inch.

The Polariscope.—Shown with parallel light: plain glass, glass under pressure, chilled glass (round, oval, and waved peripheries), Prince Rupert's drop (broken in the field), horn, selenites (over-lapped), butterfly (selenite), bunch of grapes (selenite), bi-quartz, with $\frac{1}{4}$-wave plate (the $\frac{1}{4}$ wave plate in this experiment produces the same effect upon the bi-quartz as if a column, 20 centimetres long, of a $7\frac{1}{2}$ per cent. solution of cane sugar were placed between the polarizing nicol and the bi-quartz. The analyser has to be rotated about 10°), a piece of sapphire to show asterism. Shown with convergent light, hemitrope (cut in a plane, not at right angles to the axis), ruby, topaz, grape sugar (diabetic), cane sugar, quartz, superposed right and left-handed quartz (spirals), calcite and phosphate superposed (showing transition from negative to positive ... passing through the apophyllite stage).

The Solidiscope.—New form of apparatus for showing solids, and consisting of two reflecting prisms and suitable projecting lenses. With this instrument were shown:—Barton's button, the works of a watch, a coin.

Spectrum Analysis.—Spectrum thrown by means of a disulphide prism combined with a reflecting prism, the result being that a good spectrum is thrown upon the screen direct without turning the lantern. There were shown:—The spectrum, absorption bands of chlorophyll, &c., effects produced by passing the light through coloured gelatine films.

Projection of Slides.—Decomposition of water; expansion of a wire by means of heat, combination of colours to form white light, various diagrams, coloured photographs of a workshop, &c. As an extra experiment there was shown, in the polariscope, with a convergent light, Mitscherlisch's experiment (illustrating the changes which take place in a selenite under the influence of heat).

There are but few who would disagree with me in the opinion that the microscopic world, as regards its design and its molecular structure, is quite as wonderful as the great works around us seen with the unaided eye. A magnifying glass of low power opens up a world far larger than that which we are accustomed to see. At the present time, even with the most perfect apparatus that exist, only a small portion of the universe is known to us.

Scientific study should be pursued by all in a greater or less degree It teaches more important lessons than the most impressive discourse ever preached During the investigation of what is generally termed the invisible world, men should at time pause to reflect, and ask themselves such questions as these What is the meaning of, and to what end is, creation? Is it all mere chance? Were such wonderful designs and properties created at the beginning? Was there in matter at the beginning an inherent, or implanted, power of development? Simple as these questions may seem, man in the flesh will never be able to find the true answers The extraordinary design and structure which have existed in the unseen world for millions of years, or possibly in all past time, and even at the present day known to so few, demonstrate at least that the great Power has bestowed the same care upon what appear to us the most insignificant portions of creation, as upon what we think are the greatest works in the universe. These silent sermons must surely influence the mind, and set it thinking of the supernatural and of our duties during life

It may now with truth be said that science gives us means, such as never before existed, of appreciating the greatness of the Supreme Spirit, by enabling us to read fresh chapters in the book of nature

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE —Prof Darwin has been appointed to represent the University at the approaching tercentenary of Galileo's appointment to a chair in the University of Padua The celebration will take place in Padua at the beginning of December

Prof Green, of Oxford, is appointed an Elector to the Harkness University Scholarship in Geology in the place of the late Mr T Roberts, assistant to the Woodwardian Professor

The discussion in the Senate of the proposal to found a mechanical sciences tripos for engineering students was unexpectedly favourable, in marked contrast to the reception accorded to former schemes Prof Ewing is to be congratulated on the skill with which the new plan has been framed, and the success with which he has met and conciliated the original opposition of the more mathematical members of the Senate The grants for the approval of the plan have been sanctioned by the Council, and it is not likely that they will now be opposed Some fifteen students are already at work in the engineering laboratory in preparation for the new tripos, which bids fair to take a good place among the honours schools, and cannot fail to stimulate the growth of the engineering department under its present energetic head

DUBLIN —At the meeting of Council of the Royal College of Science, Dublin, held on the 5th inst , a letter was read from H M Commissioners for the Exhibition of 1851, announcing that they had been pleased to place at the disposal of the College a science scholarship of the annual value of £150 for the year 1893. These scholarships are specially instituted for the encouragement of scientific research and are tenable for two years, and one of them has already been nominated to by the Council of the College for the year 1891 92

SCIENTIFIC SERIALS

American Journal of Science, October —On a colour system, by O N Rood —An ottrelite-bearing phase of a metamorphic conglomerate in the Green Mountains, by C L Whittle —The age coating in incandescent lamps, by E L Nichols The diminution of efficiency in incandescent lamps is due to three causes, viz , loss of vacuum, increase of resistance due to the the disintegration of the filament, and finally the deposition of disintegrated carbon upon the inner surface of the lamp-bulb This deposition gives rise to what is called the age-coating It appears that the rate of deposit of the coating in incandescent lamp-bulbs is greatest in the early part of the life of the lamp For example, in the case of a lamp which lasted 800 hours, more than half the coating was deposited during the first 200 hours The loss of brightness due to the absorbing power of the age-coating is a variable part of the total loss, being greatest in lamps of high initial efficiency The coating does not appreciably modify the character of the light transmitted, as shown by a series of photo-spectroscopic measurements The distribution of the coating within the bulb is nearly uniform. No marked difference between treated and untreated filaments appears to exist as regards the coating produced from them It has been pointed out, however, that in the case of lamps exhausted without the aid of mercury the age-coating is scarcely perceptible —Mica-peridotite from Kentucky, by J S Diller —Glaciation in the Finger Lake region of New York, by D F Lincoln —Certain points in the interaction of potassium permanganate and sulphuric acid, by F A Gooch and E W Danner When these two bodies are brought into solution together there is developed a tendency towards reduction on the part of the permanganate, which is the greater as the strength of the acid is increased, as the temperature is raised, and as the duration of the action is extended At first, the oxygen lost to the permanganate is liberated, whereas in the later stages manganese is precipitated in the form of a higher oxide or retained in solution in the form of a higher sulphate —Crystallography of the cæsium mercuric halides, by S L Penfield —Silver hemisulphate, by M C Lea —Restorations of Claosaurus and Ceratosaurus, by O C Marsh —Restoration of *Mastodon Americanus* (Cuvier), by the same

THE number of the *Nuovo Giornale Botanico Italiano* for October is entirely occupied by the continuation of Sig Nicotia's Statistics of the Flora of Sicily

American Journal of Mathematics, vol xiv , No 3 (Baltimore, the John Hopkins Press, 1892) —The title of Prof Cayley's communication, "Corrected Seminoniant tables for the Weights 11 and 12" (pp 195-200) explains itself It contains a better form of tables, which were given in a previous volume (vii , pp 59-73) Weierstrass, in his memoir "Zur Funktionenlehre," called attention to certain functions, which offer special singularities "Au lieu de présenter un nombre fini ou infini de points singuliers essentiels *isolés* elles offrent des lignes singulières essentielles ou même des *espaces lacunaires* à l'intérieur desquels elles cessent d'exister "— By request of Mr Hermit, M H Poincaré discusses the subject in an article "Sur les fonctions à espaces lacunaires " (pp 201 221) —J C Field, writes on "Transformation of a System of Independent Variables" (pp 230-236) —Mansfield Merriman discusses "The deduction of final formulas for the Algebraic Solution of the Quartic Equation" (pp 237-245), and I S Hulburt in remarks on "A class of new theorems on the number and arrangement of the real branches of plane Algebraic Curves" (pp 246-250), follows up recent work, in the same direction, by Messrs Harnack and Hilbert "—"The Symbolic notation of Aronhold and Clebsch" (pp 251-261) has for its object the exposition of this notation, "so well adapted to the expression of functional invariants," in an English form The same writer, W F Osgood, also contributes a note on "the System of two simultaneous Ternary Quadratic forms" (pp 262-273) This, likewise, is a simplification for the benefit of English readers It contains an account of Gordon's method, and employs the notation of the preceding article —H S White communicates notes "on generating systems of Ternary and Quaternary Linear transformations" (pp 274-282), and "a Symbolic demonstration of Hilbert's method for deriving Invariants and Covariants of given Ternary forms" (pp 283-290) This latter paper also uses the symbolic notation of Aronhold and Clebsch in a simplified statement of recent results developed in Hilbert's notable paper "Ueber die Theorie der Algebraischen Formen" (Math - Aca , vol 36, pp 524-6). The only paper, in the present number, which was read before the New York Mathematical Society is one by the President, Emory McClintock, "On the Computation of Covariants by Transvection" (pp 222-229)

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 17 —M Duchartre in the chair —On Mr Barnard's discovery of the fifth satellite of Jupiter, by M F Tisserand —On the application of certain methods of successive approximation to ordinary differential equations, by M Emile Picard — On a reaction alleged to be peculiar to spermine, by M Duclaux.—Observations of three new small planets discovered at the Nice observatory by means of photography, by M Charlois ; report by M Perrotin (see Astronomical Column) —On the coexistence of dielectric power and electrolytic conductivity, by M E Bouty A vindication of priority.—On the polarization of light of various colours by the atmosphere, by M N Piltschikoff There is a well marked difference between the intensity of polarization of blue light and that of red in the atmosphere The intensities are measured by

means of a Cornu photo polarimeter The eye-end of this instrument is covered with a cobalt glass, the quantity of polarized light from the chosen point in the sky is measured, the blue glass replaced by a ruby glass, and the determination repeated for the latter Generally, the intensity of polarization for blue light is sensibly greater than that of the red This is not favourable to Lallemand's theory of the blue colour of the sky as a phenomenon of fluorescence The difference of polarization is, however, not constant, but depends upon the direction of the wind A series of observations made at Kharkoff between April and September, 1892, show a maximum difference with a south easterly wind, diminishing symmetrically on both sides, and even becoming negative at W N W. The amount of polarization of the blue shows the opposite distribution, so that when the polarization of the atmosphere rises or falls, the effect is greater in the less refrangible radiations than in the others There is also a notable relation between polarization and atmospheric moisture The S.E brings the greatest amount of precipitation, the northerly winds the least It is also probable that dust and dry fogs exert a considerable influence, as shown by the circumstance that the greatest differences have been obtained in high winds, when the whole town was covered with dust -On a new way of preparing acetylene, by M I Maquenne (see Notes) —On the analysis of mixtures of ammonia and methylamines, by M H Quantin —On the nervous tissues of some invertebrates, by M. A B Griffiths —Examination of some rocks collected by Prince Henry of Orléans on the lower Black River in Tonkin, by M. Stanislas Meunier —Note on the miocene formations of western Algeria, by M Jules Welsch The miocene formations occur in normal succession near Hamman Riva, where they rest on the Cretaceous It appears certain that the last upheaval of the Atlas did not take place at the end of the Helvetian epoch (middle miocene), as hitherto believed It was post Tortonian, and took place at the end of the upper miocene For the formations of Gontas, Ben Chicao, Mascara, &c , are Tortonian , they are within the block of the Atlas Mountains, and have been lifted to heights of 800, 1000, and even 1700 metres This result tends to confirm the general idea worked out within the last few years that the zones of folding are nearer the equator in proportion as they are more recent

AMSTERDAM

Royal Academy of Sciences, September 24, Prof Van de Sande Bakhuysen in the chair —Mr H A Lorentz dealt with the reflection of light by moving bodies In a former paper ("Arch neerlandaises," t xxv p 363) the author considered the propagation of light through a ponderable dielectric which has a movement of translation, but leaves at rest the inclosed ether The equations then arrived at may be written in the form—

$$\operatorname{div} D = 0, \quad \operatorname{div} H = 0,$$

$$\operatorname{curl} E = -H, \operatorname{curl}\left[H + \frac{1}{v^2}\operatorname{vect}(Fp)\right] 4\pi D,$$

$$4\pi V^2 D = n^2 E + \operatorname{vect}(Hp),$$

the vectors H, D, E, and p representing the magnetic force, the dielectric displacement, the electric force, and the velocity of the ponderable matter The signs "div" and "curl" have the same meaning as in Heaviside's formulæ (*Phil Mag*, 5th ser vol xxii p 118), and Vect (Ep) indicates the vector product Finally, V is the velocity of light in vacuum, and n the index of refraction At the boundary of two media, possessing a common translation, there will be continuity of the normal components of D and H, and of the tangential components of E and $\left[H + \frac{1}{v^2}\operatorname{vect}(Ep)\right]$ If i and r are the angles of incidence and refraction for the relative rays ("Arch neerlandaises," t 21, pp 129–134), Fresnel's expressions for the amplitude of the reflected ray—

$$\frac{\sin(i-r)}{\sin(i+r)} \text{ and } \frac{tg(i-r)}{tg(i+r)}$$

have to be multiplied by

$$1 - \frac{2p_1 \cos i}{Vn_1},$$

where n_1 relates to the first medium, and p_1 is the velocity, in the direction of the normal, with which the reflecting surface recedes. This result may be shown to be consistent with the conservation of energy, provided that the pressure exerted, according to Maxwell, by the vibratory motion, be taken into account.—M van Bemmelen made a second communication on the existence of the crystalline hydrate of Fe_2O_3. He obtained the ferrite of sodium ($Fe_2O_3Na_2O$) in different crystal forms Under certain circumstances this form was a hexagonal plate These crystals could be metamorphosed by the action of water in the hydrate of Fe_2O_3, without loss of their optical properties

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS —The Student's Hand book of Physical Geology A J Jukes-Browne, 2nd Edition (Bell) The Beauties of Nature Sir John Lubbock (Macmillan) —Notes on Qualitative Chemical Analysis P L N Nayudu (Madras, Chetty) —Amherst Trees J E Humphrey (Amherst, Mass, Carpenter).—Magnetical and Meteorological Observations made at the Government Observatory, Bombay, 1890 (Bombay) —Explosives and their Power M Berthelot, translated by C N Hake and W Macnab (Murray) —Domestic Electric Lighting, treated from the Consumer's Point of View F C de Segundo (Alabaster) —Introduction to Physiological Psychology Dr T Ziehen, translated by C C van Liew and Dr O Beyer (Sonnenschein) —Notes by a Naturalist H N Moseley New Edition (Murray) — The Science and Practice of Lighting W H Y Webber (W King).— Commercial Organic Analysis, vol 3 Part 2, 2nd Edition A H Allen (Churchill) —Comite International des Poids et Mesures Proces Verbaux des Séances de 1891 (Paris Gauthier Villars).—The Reliquary, vol 6, New Series (Bemrose) —Vergleichende Morphologie der Pilze Dr F v Tavel (Jena, Fischer) —Beiträge zur Biologie und Anatomie der Lianen Erster Theil , Beiträge zur Biologie der Lianen Dr H Schenck (Jena Fischer) —Dissections Illustrated, Part 1 the Upper Limb C J Brodie (Whittaker) —Science Instruments (Newcastle on-Tyne, Brady and Martin) Treatise on Thermodynamics P Alexander (Longmans) —Vegetable Wasps and Plant Worms Dr M C Cooke (S P C K) Text book of Petrology Dr F H Hatch, 2nd Edition (Sonnenschein) —Meteorological Service Report, 1888 C Carmichael (Ottawa Dawson).

PAMPHLETS —The Inaugural Robert Boyle Lecture Sir H W Acland (Frowde) —Astronomical Observations made at the University Observatory, Oxford, No 4, Researches in Stellar Parallax by the Aid of Photography, Part 2 Prof Pritchard (Oxford, Clarendon Press)

SERIALS —Records of the Australian Museum, vol 2, Nos 2 and 3 (Sydney) Journal of State Medicine, vol 1 No 2 (Griffin) —Journal of the Chemical Society, October (Gurney and Jackson) —Zeitschrift fur Wissenschaftliche Zoologie, 51 Band, 3 Heft (Williams and Norgate) —Journal of the Royal Microscopical Society, October (Williams and Norgate) — Journal of Anatomy and Physiology, vol 27 New Series, vol 7, Part 1 (Griffin)

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June 1, 1893.

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME XLVII

NOVEMBER 1892 to APRIL 1893

"*To the solid ground*
Of Nature trusts the mind which builds for aye"—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

"*To the solid ground
Of Nature trusts the mind which builds for aye*"—WORDSWORTH

THURSDAY, NOVEMBER 3, 1892

THE UNIVERSITY COMMISSION

THE University Commission is sitting frequently and has heard witnesses representing nearly every interest and every shade of opinion which have a right to be represented before it We have no knowledge of the effect which the evidence laid before them has produced upon the minds of the Commissioners, but we are sure that it must largely depend on the view which they have adopted as to the nature of their duties They may regard themselves as entrusted with the task of finding the terms on which a heterogeneous crowd of colleges and mechanics' institutes may be huddled together, called a university, and allowed to confer degrees on such conditions as the rivalries of competing institutions may permit when tempered by the moderating influence of Crown nominees, county councillors, representatives of the School Board and of the learned societies, and any other assessors whom fancy may suggest Such a solution might no doubt secure peace in the sense that, wearied out by long debate and hopeless of a satisfactory solution, those who are most nearly interested in the question might at last be compelled to make the best of a bad job

This, however, must be urged against it That almost every teacher of eminence in London, together with a large number of those best qualified to represent the educational views of the provinces, have declared *a priori* that it would be unsatisfactory

The other view which the Commissioners may take is that they are charged with the responsible task of defining the ideal system which would best provide for the supply of the higher education in London That having defined this ideal they are then to proceed to show by what means the closest approximation to it which present circumstances will allow can be made, and so to fashion the constitution of the University as to ensure in the future a closer approximation still That this is the wider and more statesmanlike view is beyond question, and we sincerely hope that the Commission will adopt it We may further hope that they will remember that although the new University should be able and willing to undertake all the multifarious duties which modern Universities have accepted as their own, the provision of the highest education and the doing all that in it lies for the advancement of learning must after all be the first and the highest duty of a University worthy of the name As to the means which would best realize these ideals there cannot be a doubt The present educational chaos must be reduced to order, the unwholesome rivalry between the London Colleges must be checked

On this point Prof Rucker, in an address recently delivered at the Yorkshire College in Leeds, made some remarks which we cannot do better than quote in full —

"The great provincial colleges are grouping themselves into greater Universities In the north Manchester, Liverpool, and Leeds have concluded a formal alliance. Negotiations are already in progress for the establishment of a similar confederation in Wales The Midlands will no doubt follow suit But if these afford, if in particular the north of England affords in the Victoria University, one of the happiest illustrations of the advantage of allowing free play to the tendencies which make for union no less than to those which encourage separation, we have, unfortunately, in London a striking instance of the harm which follows if the action of either the one or other is artificially restrained

"The northern colleges were indeed happy in that the tendency to union was called into play while they were still in a sufficiently early and plastic stage of their history to yield easily to its influence. In London difficulties, which seemed far more serious half a century ago than they do to most of us now, have unfortunately retarded all centralizing action, till the sentiment and traditions which accumulate round institutions that have long moved independently, have enormously increased the inertia which tends to keep them in their separate paths

"This is the more unfortunate, as if a new University of London is to be a really great teaching university, the relations between the London colleges must ultimately be closer than those which obtain between Manchester, Liverpool, and Leeds The principle of recognizing as colleges of the University institutions for the teaching and management of which the University is not responsible, has worked and is working admirably in the north of England It does not follow that it would succeed in London There

is indeed a fundamental difference between the two cases The colleges of the Victoria University are widely separated, and appeal to the strong local feeling of powerful and independent districts A generous rivalry may therefore exist between them without ill result. Each should be left, as they have been left, to work out their own success with as little external interference as possible.

"It is sometimes argued that because the population of London largely exceeds that even of such districts as Lancashire or the West Riding, there ought to be room within it for the separate and independent institutions in which teaching of the highest type could be provided This view ignores the importance of geographical separation, and unduly exalts that of the numerical magnitude of the population whose wants are to be met If Manchester and Leeds were on opposite sides of the Irwell or the Aire, if they were connected by an elaborate system of over-ground and underground railways, then it would be more economical to concentrate, in one or the other, the higher teaching which must now perforce be given in both The loss of time to the students in reaching the scene of their daily labours would be but imperceptibly increased, while the prestige of the colleges, great as it already is, their claims on the State, strong as they already are, would be enhanced in a proportion greater than that calculated by merely adding their separate reputations and resources In a city of the size of London it is desirable to multiply institutions in which preparatory work of all sorts is undertaken, but I think it may be assumed as almost axiomatic that it is impossible, at present at all events, to create in one town more than one institution in which laboratories and lecture rooms and the other machinery of scientific instruction shall be provided on the large scale which the elaboration of the highest modern scientific teaching demands In London, then, the teachers in almost all existing institutions feel the necessity for a combination of forces. They have expressed themselves as willing to be formed into battalions and regiments rather than to be left to carry on their work as isolated companies I will not dwell on the fact that this desire could only be declared by men who were willing to risk their personal position for the public good, but I want you to observe how in this case also the work of decentralization, which began with the foundation of University College, London, has been followed and would have been far more effective had it been accompanied by a corresponding manifestation of centralizing force"

With these views we heartily agree.

If ever we are to have in London laboratories such as those which are to be found in Germany, it can only be if the higher teaching in each subject is concentrated in some one great central institution, and if rival colleges are allowed to combine their forces for the public good, instead of being compelled as at present to fritter them in suicidal competition

Taking it for granted that all will admit that such an ideal would be the best if it could be realized, we believe that the possibility of its realization is chiefly doubted on two grounds, to neither of which any real importance is to be attached.

It has been supposed, in the first place, that those who advocate a policy of union among the London colleges think that this union must be carried out in all particulars immediately; and secondly that in order to secure this end it must be carried out by compulsion, even if the practical confiscation of the property of the existing colleges were necessary.

It need hardly be said that such a statement is a parody of the views of men who have had at least as much experience as their critics (of the tone of mind of the governing bodies of great educational institutions, and who therefore would be the first to anticipate the difficulties which such demands would inevitably cause

No responsible body has, as far as we are aware, advocated more than the establishment of a University on a basis which would permit the union of the various colleges, in whose buildings the University teaching might at first be carried on, if the colleges were themselves willing that such a union should be effected The advocates of union have all along been striving, not to attain an immediate and complete realization of their ideal University of London, but to prevent the Charter being drawn so as to make that realization impossible It cannot be beyond the limits of human skill to frame a scheme which shall offer every inducement to the London colleges to effect an immediate fusion, and shall further provide that any approximation which may at first take place shall easily become closer in the future.

The Victoria University does not consist of competing colleges A federal University of London would consist of colleges which from their mere local proximity would, whether they willed it or no, be necessarily antagonistic Unless the Commissioners fairly grasp this fact and realize that they have it in their power to lay down the lines on which a great institution shall be founded in close connection with the State, which shall concentrate under one central directing power all the educational efforts which are at present partly wasted through want of joint action, they will have failed to make the most of a great opportunity, and will have frittered the forces which, if allowed free play, are competent to do for the higher education of London all that the best friends of London can desire

THE STUDY OF ANIMAL LIFE

The Study of Animal Life By J Arthu Thomson, M A, F R S E "University Extension Manuals" (London Murray, 1892)

THE chief aim of an "Extension Manual" as of "Extension lectures" is to stimulate interest and to spread information In natural science, at any rate, it is impracticable through the medium of either Extension lectures or Extension manuals, to give that training which the student, be he specialist or generalist, can obtain only by practical work, aided by practical instruction But there are a great number of people, some already busily engaged, others on the threshold of their life's work, who possess some interest in, and some information about, those matters, with the study of which scientific men are occupied For them Extension lectures and manuals are a great boon, and to them Mr Thomson's work on "The Study of Animal Life" may be cordially recommended We trust it will stimulate them, as he would desire, to become themselves observers.

The work is divided into four parts, of which the first, entitled "The Everyday Life of Animals," deals with the wealth of life, the web of life, the struggle of life, the shifts for a living, the social life of animals, the domestic life of animals, and the industries of animals The second part, on "The Powers of Life," contributed by Mr Norman Wyld, treats of vitality, the divided labours of the body, and instinct The third par describes "The Forms of Animal Life" and includes chapters on the life-history of animals, and their past history as read in the geological record The fourth and last part treats of "The Evolution of Animal Life" and, besides a discussion of the influence of habits and surroundings, and of heredity, gives a sketch of the evolution of evolution theories Appendices on the relation of animal life to human life, and on some of the best books on animal life bring the work to a conclusion

The general arrangement of the subject-matter is, as will be seen by the above summary, well and carefully thought out, and the facts given in elucidation of the varied tendencies of organic development are skilfully marshalled and are derived from the most trustworthy sources The information given is therefore accurate and up to date The only suggestion we have to offer in this connection is that a little more selective elimination might have been exercised Some facts are given in so terse and condensed a form that no one but a zoologist could appreciate their value If a considerable number of these had been struck out and the space thus gained had been utilized in expanding those that remained, the Extensionee would have been the gainer "The Zoological Summary of the Animal Kingdom" (pp 210-272) might by some such process have been replaced by a sketch with more life and go in it As it stands it will, by many readers, be gracefully skipped

In such a work style is an important element Here Mr Thomson is often exceedingly happy He has imagination and a feeling for the poetic aspect of nature But his imagination and poetry need at times just a little chastening When he tells us that in birds "the breathing powers are perfected and economized by a *set of balloons around the lungs*," and that their brains "are not *wrinkled with thought* like that of mammals", when he speaks of the sponge as "*a Venice-like city of cells*", when he describes the ciliated cells of the windpipe as "*lashed* cells," or the embryonic membranes as "*birth-robes*," and when he says that in ponds subject to drought the organism often "*sweats off a protective sheath which is not a shroud*, and waits until the rain refreshes the pools", in these and sundry other cases of which these are samples, one may question whether the expressions which we have underlined are justified either by special elegancy or by real helpfulness to a beginner And this we say in no spirit of hypercriticism, but as desirous of aiding the author in what is by no means an easy task

Somewhat deeper would be our criticism of sundry expressions which are of essentially human implication and which in our opinion should not lightly be applied to animal activities. Much is said of the "love" of animals for their mates when some such phrase as "sexual appetence" would be more appropriate. For example, concerning ants we read :—"After this midsummer day's delight of love death awaits many, and sometimes most." And in the analysis of the forms of struggle for existence, we have the "struggle between rivals in love" Again, of the cuckoo it is said that, "in spite of the poets, the note of this 'blessed bird' must be regarded as suggestive of sin"! And again, "It is not quite correct to say that the cuckoo-mother is immoral because she shirks the duties of maternity, it is rather that she puts her young out to nurse because she is immoral' It is true that Mr Thomson adds this footnote —"The student will notice that I have occasionally used words which are not strictly accurate I may therefore say definitely that I do not believe that we are warranted in crediting animals with moral, æsthetic, or, indeed, any conceptions" We are glad to be thus assured But why implant notions in the text which have to be eradicated in a footnote? Does not Mr Thomson know how easy it is to sow tares and how difficult to root them out?

Mr Norman Wyld's chapter on "Instinct" is short, but quite to the point We hope that he may further observe and experiment in the field of comparative psychology, for he is fully alive to the peculiar difficulties of the subject, and there is a wide field before him in which the scientific workers are none too many In criticizing Mr Lloyd Morgan's definition of instincts as "oft-recurring or essential to the continuance of the species," Mr Wyld says —"This is not quite satisfactory, for many actions that are instinctive are not oft-recurring, and many are not necessary to the preservation of the species" He does not show that there are any such actions which are neither the one nor the other We have reason for supposing that he understood Mr Lloyd Morgan to say that instinctive actions were "oft-recurring *and* essential to the continuance of the species" But this he did not say

In conclusion we may repeat that "The Study of Animal Life," though by no means faultless, may be recommended to Extension students and the general reader as, in the main, accurate, readable, and suggestive

C LL. M

VECTOR ALGEBRA

Principles of the Algebra of Vectors By A Macfarlane, M A, D Sc, LL D, F R S Edin., Professor of Physics in the University of Texas Reprint from the Proceedings of the American Association for the Advancement of Science, Vol XL, 1891, pp 65-117 (Salem Press, Salem, Mass, 1891).

THIS is a very suggestive contribution to the foundations of the Algebra of Vectors as recently so strongly advocated in America by Prof Willard Gibbs, and in this country by Mr Oliver Heaviside

The extensive use of quaternions among physicists has been prevented by the fact that the meaning of a product of vectors has been made to depend on the use of a vector as a quadrantal versor, and by the fact that this method leads to the square of a vector being negative. The advocates of the new algebra define a product of vectors independently and in such way that the square of a vector is positive Rotations are expressed by means of dyadics, or ratios between vectors

and the quaternion notion of a vector being also a quadrantal versor is not entertained at all

The author of this pamphlet devotes a portion of it to the consideration of quaternions, which he holds should form a distinct algebra by themselves, and he suggests a special notation for them He restricts a quaternion proper to a *pure number* (a stretching factor) combined with a certain amount of turning A vector, on the contrary, may be a quantity of any dimensions, possessing direction, with no suggestion of turning attached to it

He clearly shows that the objectionable *minus* which occurs in scalar products in quaternions arises from the attempt to use the same symbol both for a quadrantal versor and for a vector, so that the laws established for dealing with one set of quantities may hold also for the other set, or for a combination of the two

It may be worth while to notice that this minus sign of the quaternionists would disappear as an explicit symbol if they considered the second vector as being drawn from the end of the first, as AB, BC, and then took the angle ABC as being the angle between the vectors—that is to say, if, in a polygon of vectors, they were to define the angles between the successive vectors to be the *internal* angles of the polygon Indeed, by many the internal angles of a polygon (or triangle) are considered as being *the* angles between the sides, though there is loss of real naturalness and of symmetry caused by so considering them for instance, the connection between A, B, C and a, b, c in a spherical triangle would be greatly simplified if A, B, C were to denote the *external* angles However, if we consider these internal angles to be the angles considered by the quaternionists, the reason for the square of a vector being negative appears at once, for if a be the quantitative part (freed from the notion of direction) of a vector **A**, we have $\mathbf{A}\ \mathbf{A} = a^2 \cos 180°$, **A** and **A** being consecutive sides of the polygon which have straightened out till the internal angle between them is 180°

It may therefore be contended that the quaternionists' *minus* is not quite irrational in vector algebra (though it cannot be said not to be inconvenient there), and that the advantage of being able to treat a vector as a quadrantal versor without having to establish a new set of formulæ far more than compensates for the loss of symmetry On the other hand, the advocates of vector algebra without the *minus* would probably reply that they have to deal with vectors which are not in any sense the same as quadrantal or any other kind of versors, and that the imaginary completeness gained does not in any degree whatever compensate for the loss of naturalness and loss of symmetry involved in the *minus*

The author differs from Prof Gibbs and Mr Heaviside in the mode in which he defines the product of two vectors, as he considers the *complete* product formed on the understanding that the multiplication shall obey the distributive law. He then finds that this complete product consists of a non-directed part, and of a directed or vector part, the former consisting of the product of the two quantities into the cosine of the angle between them, and the latter of the product of the two quantities into the sine of the same angle, having as axis the normal to the plane containing the two vectors The angle is the angle through which the first vector (occurring on the left-hand side of the product) would have to turn to make its direction coincide with that of the second

Prof Gibbs and Mr Heaviside, on the contrary, define the scalar product and the vector product as if they were entirely distinct and independent quantities Finally the same result is attained, but Prof Macfarlane's mode of introducing these partial products as arising naturally from applying the distributive law of multiplication would seem to have an advantage from the point of view of a student.

Prof Macfarlane dwells emphatically on the importance of considering *dimensions* of vectors, as well as their direction, and to emphasize this he separates his vector, not into *tensor* and *unit-vector*, but into *quantity* and *direction* Thus in the equation $\mathbf{X} = xi$, x is the quantity, and i denotes the axis Hence the equation $jk = i$ is not a violation of dimensions, but is merely a convention as to the interpretation of a composite direction, a convention, moreover, which could only be adopted in space of three dimensions, and is the statement that the plane in which j and k lie has its orientation sufficiently indicated by the normal direction i, with the further convention that the angle from j to k shall be considered positive

The author's notation is novel, and forms a very important feature in his treatment of the subject The scalar product of **AB**, which is $ab \cos (ab)$, he calls cos (**AB**) and the vector product he calls *Sin* **AB**, its magnitude, irrespective of direction, being denoted by *sin* **AB** Possibly an improvement in this latter would be to denote it by *sin ab*, and then the capital letter in the complete vector would become unnecessary

The particular symbol used to denote a scalar or a vector product is a matter of secondary importance, but is a matter which must sooner or later be settled if vector-algebra is to come into general use Lord Kelvin is of opinion that a function-symbol should be written with not less than three letters, and Prof. Macfarlane's notation obeys that law, and is moreover easy to work with, but is incomplete, being applicable to products of two vectors only Mr Heaviside uses no prefix at all to a scalar product, but considers that **AB** means the scalar product. He uses the quaternionic expression *V* **AB** for the vector product Prof. Gibbs uses no prefix for either, but denotes the scalar product by **A** **B**, and the vector product by **A**×**B** The three-lettered prefix seems the clearest in both cases to denote the special product intended, and the symbols *cos* and *sin* are more or less suggestive

In forming a product of three vectors, Prof Macfarlane makes the convention that **ABC** shall mean (**AB**)**C**, the combination commencing on the left. In his notation this product expands into

$$(\cos \mathbf{AB} + \mathrm{Sin}\,\mathbf{AB})\mathbf{C}$$
$$= \cos(\cos \mathbf{AB}\ \mathbf{C} + \mathrm{Sin}\,\mathbf{AB}\,.\,\mathbf{C}) + \mathrm{Sin}(\cos \mathbf{AB}\,.\,\mathbf{C} + \mathrm{Sin}\,\mathbf{AB}\,.\,\mathbf{C})$$
$$= \cos(\mathrm{Sin}\,\mathbf{AB}\,.\,\mathbf{C}) + \mathrm{Sin}(\cos \mathbf{AB}\ \mathbf{C}) + \mathrm{Sin}(\mathrm{Sin}\,\mathbf{AB}\,.\,\mathbf{C})$$
$$= \mathrm{vol}\,\mathbf{ABC} + \mathbf{C}\,.\,\cos \mathbf{AB} + \mathrm{Sin}(\mathrm{Sin}\,\mathbf{AB}\,.\,\mathbf{C})$$

which finally becomes

$$= \mathrm{vol}\,\mathbf{ABC} + \mathbf{C}\cos \mathbf{AB} + \mathbf{B}\cos \mathbf{AC} - \mathbf{A}\cos \mathbf{BC}\,;$$

where vol (**ABC**) denotes the volume of the parallelopiped of which **ABC** are three adjacent edges. The only objection to this name lies in its suggesting that **A**, **B**, **C** are *linear* vectors.

Here appears the defect in the author's *cos* and *sin* notation, in that it cannot be applied to the products of three vectors, or at least that the special reason for its use has disappeared, and the author does not suggest so applying it.

But there is a certain perspicuity attained by this very limitation of the *cos* and *sin* notation to the products of only two vectors, inasmuch as there can be no ambiguity in the meaning of an expression in which they occur, even if brackets are omitted or placed differently. Indeed, instead of cos (Sin **AB** **C**) the author writes cos (Sin **AB**)**C**, which seems a curious use of the bracket. But cos Sin **AB** **C**, or preferably cos **C** Sin **AB**, is just as explicit, and even cos Sin **ABC**, though wrong to write as being puzzling, can only have the same meaning.

The author concludes with short sections on dyads and matrices, on scalar- and vector-differentiation, including scalar-differentiation of a quaternion. On the last page are a series of propositions relating to the addition of scalar and vector quantities situate at, or passing through, specified points.

The pamphlet is confined solely to statements of principles and the section devoted to dyads and matrices is very condensed, so that it is not in any sense a text-book for students. It is rather a synopsis of the subject, with the introduction of a special notation which the author has found useful. A text-book of vector algebra, with examples showing its application to problems in geometry, mechanics, and general physics, and contrasting the method with the Cartesian method of treating the same problems, is much needed, as many physicists are becoming interested in the new algebra, owing in great measure to Mr. O. Heaviside's able exposition of its principles and applications in the *Electrician* and elsewhere.

THE LAKE OF GENEVA

Le Léman. Monographie Limnologique. F. A. Forel. Tome Premier. (Lausanne: F. Rouge, 189-.)

PROF. FOREL has been for some years occupied in studying the Lake of Geneva, and has now published the first instalment of the fruits of his labours. The work, when finished, is intended to be a complete monograph of the history of a single lake, and will be a most important contribution to an interesting branch of physical geography. In the present volume the geography, the hydrography, the geology, the climatology, and the hydrology of Lake Léman are discussed, after some introductory matter relating to the instruments employed in sounding with other preliminaries. But, though only a single volume, the work embraces so many questions that we must, for want of space, confine our notice mainly to one, which, of late years, has attracted the most attention, at any rate in this country, viz. What has been the origin of the lake basin? Was it formed by the old Rhone glacier or in some other way? The especial value of Prof. Forel's memoir is the number of new facts which it brings to bear on the problem thus propounded.

The Lake of Geneva, however it may have been caused, is more modern than the middle of the Miocene period. "Le lac n'existait pas encore, la vallée du Léman n'était pas même indiquée quand la mer helvétienne déposait les mollasses d'Epalinges et du Mont." Its slopes, and almost certainly its bed, are covered with glacial deposits, of later date than the formation of its basin. Terraces around its shore indicate that its waters once reached a higher level, the greatest elevation which can be identified with certainty, being about 30m. above the present surface. The next pause was at 10m., after that the lake sank (the fall always being rapid) to its present level. Traces of still higher terraces are to be found on the north shore, but as these neither can be identified on the opposite side, nor correspond with any natural barrier in the course of the Rhone below the lake, Prof. Forel doubts whether they indicate old levels of its waters.

Lake Léman consists of two basins. The first and larger extends from the embouchure of the Rhone to the narrow of Promenthoux. At the east end the slope of the cone of alluvium deposited by the Rhone in no part exceeds 25°. First comes a zone of very shallow water off the actual shore line; to this succeeds a more rapid slope, which gradually eases off as it descends. The current of the Rhone has made and maintains a well-marked channel in this mass of detritus, and the contour lines are affected down to 250m. At the embouchure of the Dranse, on the south shore, another alluvial cone has been deposited. This, however, is rather steeper, but it is much smaller, and does not perceptibly affect the course of the subaqueous contour lines below about 200m. On the north side of the basin the slope varies. Under the walls of Chillon the descent is rapid, amounting to 137 in 100; it is nearly the same near St. Gingolph on the opposite shore, doubtless indicating submerged crags; but it is generally more moderate. West of Vevay it is about one in four, whence it changes gradually to one in ten opposite to Ouchy.

West of this port the descent is still more gentle, and so it continues round the western end of the basin, the lip of the latter being 75m. below the surface. The contours of the south side correspond generally with those of the north, and the form of the basin is evidently related to the geology of the district, being narrower and steeper among the harder rocks at the eastern end. The deepest part is a large rudely triangular area, the apex pointing towards the west, and the base lying roughly north and south, extending from almost opposite to the embouchure of the Dranse to near Lutry. All this area is an almost level plain, for it is wholly below the 300m. contour line, but the greatest depth obtained was only 309.7m.

The Petit Lac may be described as a comparatively narrow and shallow trough, rising very slowly from a depth of about 70 to 50 metres, and then gradually mounting to the embouchure of the Rhone, its bed being slightly interrupted by five small shallow basins, which roughly speaking, have a linear arrangement, but their floors only sink four or six yards at most below the general level.

The lake to some extent is still held up by the huge mass of gravel brought down by the Arve, through which the two rivers have now cut their channels on either side of the plateau of La Bâtie below Geneva. But it is

in the main a true rock basin, though its bed no doubt is concealed beneath glacial deposits and the finer mud brought down by rivers This alluvium has been studied by Prof Forel, but into the matter we are unable to enter

Both the origin of lake basins in general and of that of Léman in particular are carefully discussed by Prof Forel He examines, only to reject as attended by insuperable difficulties, the hypothesis that it was excavated by the old glacier of the Rhone He shows that the subaqueous portion corresponds in its general features with a river valley, and is only a prolongation of that of the Rhone This valley was first defined at a very early period in the uprising of the Alps, its excavation progressed with their growth, it was practically completed at a time when they were higher, perhaps by some 1000 m, than at present Then the lake was formed by a general subsidence of the mountain region, the lowland remaining comparatively unaffected The movements of the parts depressed may have been to some extent differential, but this, in Prof Forel's opinion, is not a necessary assumption To us, however, it appears that it would be very difficult to explain the rock barrier at St Maurice between the upper and lower plains without some amount of differential movement Prof Forel's view, of course, is not novel, for it has been long maintained in England as a general explanation of the greater Alpine lakes by a few geologists, who never bowed the knee to the glacial Baal With their writings, however, Prof Forel does not appear to be acquainted, though they appeared in publications generally accessible

The remainder of the present volume is occupied by a discussion of the temperature, rainfall, and general hydrology of the Lake Léman region It is full of interesting facts and discussions, which we would gladly notice did space permit The book is well printed, and contains many illustrations, together with a large map of the lake on which the subaqueous contours are depicted If the book were less diffuse its scientific value would have been greater, but Prof Forel pleads in excuse that he aimed at writing a volume which would be also acceptable to the general public, or in other words, would combine meat for men with milk for babes As a comprehensive history of a lake is a great desideratum, it would be ungracious to find fault with Prof Forel's very natural desire to secure a large number of readers and of purchasers.

T G BONNEY

OUR BOOK SHELF

Horn Measurements and Weights of the Great Game of the World, being a Record for the use of Sportsmen and Naturalists By Rowland Ward, F Z S (London Published by the Author, 1892)

IN these days, when every one is striving to "beat the record," it is only right that sportsmen should have clearly put before them the results already arrived at as regards the size of the trophies and the weight of game-animals already obtained by their brother Nimrods. No one is in so good a position to do this as Mr Rowland Ward, to whose well-known "jungle" in Piccadilly all the leading shooters of the present day send their "heads" to be mounted and their "skins" to be stuffed. It is, however, much to be regretted that Mr Ward did not take into his councils some brother "F Z S" more versed in scientific knowledge than himself when he prepared this volume, or at any rate did not have the proof sheets revised by some zoologist with a good knowledge of the Mammalia The consequence of this want of foresight is that the nomenclature and localities upon which the importance of the records entirely depends are in a very confused state, and in many cases quite erroneous

Take the Deer (Cervidæ), for instance Of this family a very correct and accessible list, drawn up by the late Sir Victor Brooke, has been published in the "Proceedings" of the Zoological Society for 1878, which Mr Ward would have done well to follow But we find under the Sambur (*Cervus aristotelis*) a head from "Java," where this species certainly does not occur, recorded in the list Next to this (p 10) comes the "Central and South Indian Sambur, *Rusa hippelaphus*" (whatever this may be), but three out of the four specimens assigned to it are from Nepal! On the other hand, several heads from Java are attributed (p 22) to *Cervus rusa*, which is merely a synonym of *Cervus hippelaphus*

The heads of the large Deer of the Caucasus obtained by Mr St George Littiedale are assigned (p 28) to the Red Deer (*Cervus elaphus*) But we have good reason to know that they really belong to the Persian Deer (*C maral*), quite a different species

Looking over the list of Antelopes, we find similar errors prevalent, though perhaps not quite to so great an extent The specimens of the Chiru (*Panthalops hodgsoni*) are assigned to "India," whereas this Antelope is only met with in the snow-fields of Ladakh and Tibet Nor can the "Takin" (*Budorcas taxicolor*) be properly stated to be from "India" It occurs only in the Mishmi Hills on the frontiers of Assam

These and many like mistakes are the more serious as Mr Ward's volume is well got up, nicely illustrated, and likely to be frequently used by the sporting naturalist But the statements contained in it cannot be relied upon for scientific accuracy

Der Peloponnes Versuch einer Landeskunde auf geologischer Grundlage Von Dr Alfred Philippson (Berlin R Friedlander and Son, 1891-1892)

GREECE has hitherto been interesting mainly to scholars, archæologists, and lovers of art, and no doubt it is from their various points of view that the country will always be most eagerly studied The subject, however, has also elements of attraction for students of natural science, and it is to these elements, so far as the Peloponnese is concerned, that Dr Philippson has sought to do justice in the present work His results have been obtained by direct personal observation, and are set forth with admirable clearness The book is divided into two parts, the first of which is called "special," the second "general" In the "special" part the author deals with particular regions of the Peloponnese, in the "general" part he presents an account of the peninsula as a whole Dr Philippson is a careful and accomplished geologist, and has been remarkably successful not only in throwing fresh light on the geological phenomena of the country, but in showing their relation to the various orders of facts which come more especially within the province of the geographer He has also excellent chapters on the forms and phenomena of the surface, on climate, on vegetation, on the animal world, and on the population In dealing with the last of these subjects he has much that is valuable to say about productive industry, means of communication, density of population, and towns, villages, and other settlements. The interest of the work is greatly increased by maps and profile sketches

Traité Encyclopédique de Photographie By Charles Fabre (Paris: Gautier-Villars and Sons, 1892.)

IN a previous number of NATURE (vol xlvi p 464) we noticed the first part of the supplement which M. Fabre

proposes to bring out triennially. The present two volumes form a continuation, and extend as far as § 5 of the second chapter in the second book. The author proceeds on the same lines as formerly, and places before the reader in a concise way all the new methods of development, measuring lenses, apparatus, &c., from the particulars of constitution which characterize developers down to the latest form of kodak or tie camera. Not only is each subject treated with the greatest care, but illustrations are numerously distributed. That which will add great value to the work as a whole is the insertion of references, for what, after all, is more annoying than having to wade through a great quantity of literature when the presence of one or two words would have eliminated all trouble? W.

The Reliquary: Quarterly Archæological Journal and Review. Vol. VI. (New Series.) (London: Bemrose and Sons, 1892.)

THIS volume consists of the four numbers of *The Reliquary* which have appeared during the present year. The contents include many things which do not quite come within the scope of NATURE, but it is satisfactory to be able to note that the writers, speaking generally, have done their work in a thoroughly scientific spirit. Mr. J. Lewis André contributes an interesting and well-illustrated paper on leather in the useful and ornamental arts, and a clear account is given by the editor of a part of an early dial, bearing runes, which he was lucky enough to find some months ago in the churchyard of Skelton, Cleveland. An illustration gives a good impression of the general character of the stone, the runes on which, according to Canon Browne, are "Danish." Among the other papers are two articles, by Mr. D. A. Walter, on ancient woodwork, and a discussion, by the Rev. A. Donovan, of some of the problems connected with the career of Columbus.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Nova Aurigæ

ON October 5 the Nova Aurigæ was again observed under favourable circumstances, and the observation as to precautions in focussing necessary on account of chromatic aberration of the refractor was amply verified [NATURE, September 22, p. 489, in which note two corrections should be made: eighth line, for "varying" read "ranging," and fourteenth line, for "(? F)" read "(? G)"]. The line near C was distinctly seen at times, but the blue and violet lines observed on September 14 were not seen; the three green lines were very distinct.

On October 14 the red line was much fainter, but there was an obvious bright line in the yellow, which may be the line which Dr. Copeland estimated as 580 ± on August 28 (NATURE, September 15), or may be that which has been measured several times at the Lick Observatory (*Astrophysics*, October, p. 717), and appears to have a wave length of about 575. It had escaped my notice before, but I was induced to look most carefully in the yellow by considerations arising out of an attempt to reconcile Mr. Barnard's observations of apparent nebulosity surrounding the Nova, as seen in the 36-inch refractor at Mount Hamilton, with my own observations of September 14. Mr. Barnard's "stellar *nucleus*" was the difficulty. There appears to be no doubt that the Nova is emitting a spectrum similar to that of a planetary nebula, but it seems to me necessary to have further spectroscopic evidence before it is established that nebulous extension can be seen; if it is to be seen with a simple eyepiece, it must be looked for in a reflecting telescope, as the following considerations will show.

Prof. Keeler's study of the chromatic correction of the Lick Refractor shows ("Pub. Ast. Soc. Pacific," Vol. II. p. 164) that the circle of aberration of F light on the focal plane for the D line has a diameter which is in terms of the focal length 0.000349. We may take this diameter as very nearly that of the circle of aberration of D light on the focal plane for the F line. Thus if a star emits only D and F light, and the F light is focussed, then the D light will fill a circle nearly 7″ in diameter, and the star will look like a planetary nebula with a stellar nucleus. If the star emits light of wave lengths 500 and 575, then interpolation based on Keeler's measurements shows that round a stellar nucleus in the focus for wave length 500 there must be a circle of aberration of nearly 4″ diameter.

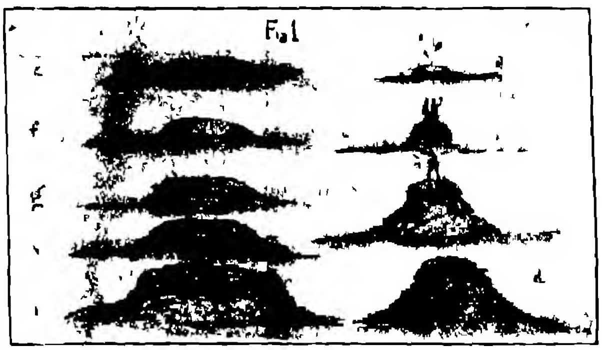
Mr. Campbell found lines of wave lengths 500 and 575 in the spectrum of Nova Aurigæ with respective intensities 10 and 1. Mr. Barnard describes the appearance of nebulosity as "pretty bright and dense," and as measuring 3″ diameter. My own inability to see either the circle of aberration for the yellow line when the green was focussed, or the alleged nebulosity, may be explained in several ways (*e.g.* smaller aperture of object glass, climatic conditions, &c.). The spectroscope could probably decide the question at Mount Hamilton by showing whether the *minimum* length of any of the lines is that corresponding with 3″ diameter on the slit. I have not been able to do more than observe that the yellow line is not visible when the 500 line is focussed on the slit of a spectroscope having an effective dispersion of two 60° prisms. H. F. NEWALL.

Observatory, Cambridge, October 24.

Formation of Lunar Volcanoes

WHILE we have, on the lunar surface, a series of markings so evidently volcanic that no one thinks of applying any other term to them, we have on the other hand no explanation of their mode of formation which will stand examination. The explanation given by Messrs. Nasmyth and Carpenter in their splendid work on the moon, founded upon explosive expulsion of lava, fails to satisfy the mind when applied to wide craters with a low wall such as Shickard or Grimaldi, of which there are so many on the moon, and which look more like some disturbance in a semi-liquid surface than an accumulation of volcanic débris.

The umbrella like eruption figured in Messrs. Nasmyth and Carpenter's book does not represent any phenomenon within our experience, as the erupted material (unless light enough to be driven by wind) invariably falls back into the neighbourhood of



the vent, and we could not conceive of its being shot neatly out twenty-five miles on every side to form the familiar ring.

An explanation of the mode of formation founded upon lunar tidal motion occurred to me about seventeen years ago, from observations on a cooling slag; but until the recent publication of Mr. Darwin's work on the history of the tides I was doubtful if that force were sufficient to account for observed results.

I had noticed that the rise and fall of a fused slag through holes in its solidifying crust, formed craters exactly like those in the moon; and I enclose a photograph of a piece of that slag in which is reproduced all the salient features of the lunar surface.

The mode of formation was as follows:—

The fused liquid (which was potash "black ash" containing a mixture of substances of very varied melting point) was still giving off some gas, which escaped as at *a* in Fig. 1, building up

a miniature crater as at b, c, d But the crater vent becoming intermittently choked, the accumulation of gas beneath the crust caused the liquid "lava" to rise through any neighbouring holes as at e, f, giving rise to a ring crater The pressure of the accumulated gas now drove out the obstruction in a, when the liquid lava receded in e as at g This intermittent action went on till the crater i was built up—entirely by "rise and fall" (as of a tide), no gas escaping at this hole

In the case of the moon the rise and fall would be caused by the tidal motion of the still liquid interior. The solid crust would resist the periodic rise of the liquid interior, and the liquid would well through the crust and recede again as the wave passed

When the crust was thin, and the lava very liquid, the large ring structures would be formed, as the lava would flow far, but

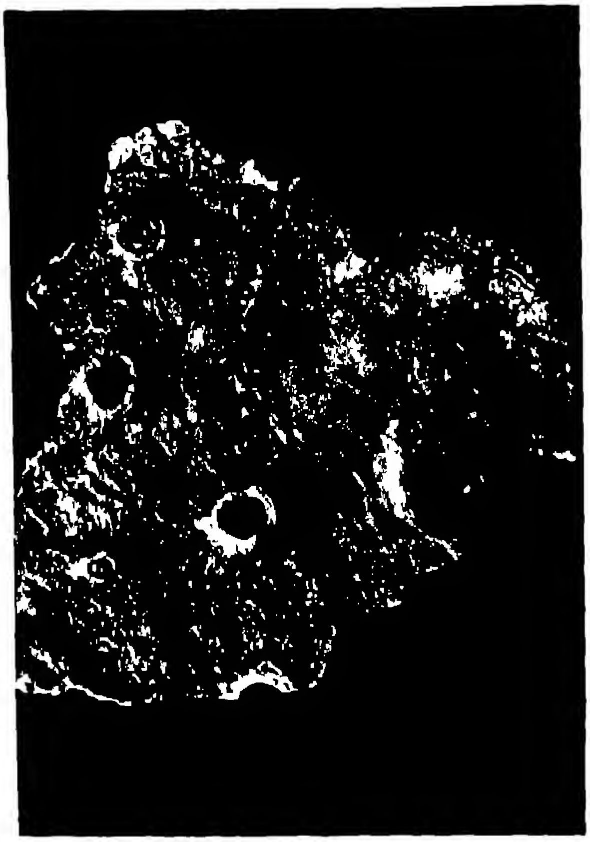


FIG. 2.

as the crust got thicker and the lava more viscid, the more striking craters like Copernicus would be built up. When the vent was very small, or the lava very viscid, the exuded lava would build up mountain ranges, or peaks like Pico, as it could not flow far, and would be cooled too much to allow of its flowing back with the ebb tide.

The existence of the cause proposed by Messrs Nasmyth and Carpenter, viz., expansion on solidification, is very doubtful. The proof they adduced was that a piece of solid slag would float on liquid slag. But when slag solidifies it becomes filled with small cracks, which doubtless contain air, and so aid in the flotation When I was working at this subject I had some slag poured into an iron mould kept cool by immersion in water. When the slag had cooled a distinct depression was seen on the upper free surface, showing that the slag had contracted during solidification. No doubt its contraction or expansion will depend upon its composition, and we do not know the composition of the moon's surface, but we need not depend upon a doubtful property for an explanation when a set of conditions have existed which must have yielded an ample force for the production of the observed results.

In the photograph marked Fig. 2, at a can be seen a crater with a raised floor and a central cone, at b a crater filled to the lip like "Wargentin," while on the plain near b, and round the open crater c, will be seen numerous minute craters, as on the moon's surface in the neighbourhood of "Aristotle" or "Copernicus," while in other photographs are seen walled plains like the "Mare Crisium," so that all the important features of lunar topography are reproduced in this slag, and there are many minor points of agreement which cannot be gone into in the limits of a letter.

Although I have always considered the tides the cause of the wonderful lunar configuration, I was not satisfied that that cause alone was of sufficient magnitude, till the work of Mr Darwin placed the matter in such a clear light that I now venture to submit the idea to your readers as a feasible explanation of the familiar lunar features J B HANNAY.

On the Need of a New Geometrical Term—"Conjugate Angles"

IN geometrical discussions, such as arise out of a great variety of physical problems, it is frequently necessary to refer to an acute or obtuse angle A as being equal to another acute or obtuse angle B, because contained by two straight lines which are respectively perpendicular to those containing the angle B Such a statement of the reason of the equality is, however, cumbrous Sometimes, indeed, such angles when acute might be described as equal because they are the complements of equal (because vertically opposite) angles, but it will often happen that the figure does not show the vertically opposite angles that would be referred to

I should be glad to know whether there is any term expressing the relation in question in use among either English or foreign writers, and, in default of such, would suggest that such angles be called *conjugate*, or if greater precision is required, *rectangularly conjugate*, the general term *conjugate* to be used when we wish to refer to an angle A as equal to an angle B because contained by sides whose directions are the directions of the sides of B, after each has experienced an equal and similar rotation in the plane of the diagram, whether the rotation is through a right angle or not

The shorter inclusive term *conjugate* could always be used for the less general but longer term *rectangularly conjugate*, when brevity was aimed at A M WORTHINGTON

R N E College, Devonport, October 30

Printing Mathematics

THE main features of mathematical work that give trouble in printing are three the expressing of (1) fractions, (2) powers, (3) roots

(1) To simplify the expression of fractions we have the solidus suggested by Sir G Stokes. But the solidus has been hitherto much less used than it might be, on account of the uncertainty as to how far its influence reaches in any expression more complicated than the simplest fractions This uncertainty can easily be removed, and the usefulness of the solidus greatly extended by defining more definitely its exact meaning. This is done in the simple conventions proposed below.

(2) To express the process of involution, the sign $\diagdown$, suggested by Mr C T Mitchell in the *Electrician*, is more concise and clearer than that mentioned by Prof S P Thompson in NATURE And Mr. Mitchell's sign, if defined by conventions similar to those applied below to the solidus, is capable of a like extensive application.

(3) To express roots we have the sign $\surd$ But, when accompanied by a horizontal line above to show the extent of its influence, this sign also requires special spacing But it can be brought into line with the rest by the use of the same conventions.

Taking then for

α. the sign of division	.. .	$/$
β. ,, ,, involution	..	$\diagdown$
γ. ,, ,, evolution	.	$\surd$

we may use each of these signs in either of two ways:—

I. Simply as a sign of operation, in which case it can influence only the quantities immediately adjacent to it

II In a double capacity—

(1) As a sign of operation.

(2) As one end of a bracket, of which the other end is | This bracketing influence may be directed either forwards or backwards, or both ways at once

Examples

a Division

$$\frac{a+b}{c} + d = |\, a + b/c + d,$$

$$a + \frac{b}{c+d} = a + b/c + d\,|,$$

$$\frac{a+b}{c+d} = |\, a + b/c + d\,|,$$

$$a\,\frac{b}{c}\,d = ab/cd, \quad a\,\frac{b}{cd} = ab/cd\,|,$$

$$\frac{a}{b+c}(d+e) = a/(b+c)(d+e),$$

$$\frac{a}{(b+c)(d+e)} = a/(b+c)(d+e)\,|,$$

$$\sin\frac{\theta}{n} = \sin\theta/n, \quad \frac{\sin\theta}{n} = |\,\sin\theta/n$$

Continued fractions also can readily be brought into one line by this notation —

$$\frac{a}{b+}\,\frac{c}{d+e+}\,\frac{f}{g} = |\,a/b + c/(d+e) + f/g\,|,$$

β. Involution

$$a^b = a\backslash b, \quad a^{-b} = a\backslash -b,$$

$$(a+b)^c + d = |\,a + b\backslash c + d,$$

$$a + b^{c+d} = a + b\backslash c + d\,|,$$

$$(a+b)^{c+d} = |\,a + b\backslash c + d\,|,$$

$$(a+b)^{\frac{c+d}{e+f}} = |\,a + b\backslash|\,c + d/e + f\,|$$

$a\backslash b/c$ and $a/b\backslash c$ are ambiguous, but $|\,a\backslash b/c = \frac{a^b}{c}$, because | being unnecessary for $\backslash$ in this case, can apply only to $/$. $\frac{(a+b)^c}{d}$ is $\|\,a + b\backslash c/d$, two vertical lines being required. Similarly $|\,a/b\backslash c = \left(\frac{a}{b}\right)^c$, $a/b\backslash c\,| = \frac{a}{b^c}$, $a\backslash b/c\,| = a^{\frac{b}{c}}$, $a\backslash b\backslash c\backslash d = a^{b^{c^d}}$.

γ Evolution—

$$\sqrt[n]{a+b+c} = |\,n\sqrt{a+b+c}\,|,$$

$$\sqrt[a+b]{c+d} = |\,a+b\sqrt{c+d}\,|,$$

$$\sqrt[a+b]{c} + d = |\,a + b\sqrt{c} + d,$$

$$a + b\,\sqrt{c+d} = a + b\sqrt{c} + d\,|,$$

$$a + \sqrt[b]{c} + d = a + |\,b\sqrt{c} + d$$

In some cases lines of differing thickness might be advisable, for instance—

$$\frac{b^{\frac{1}{2}}}{c(d+e)^3} = |\,b\backslash 1/2\,|\ /\,c\,|\,d + e\backslash 3\,|$$

There are many other ways in which this notation might be used; but the above will suffice to illustrate the advantages of it. And these advantages are substantial. It enables the work to be printed in the same space as ordinary letterpress, and thus avoids the special spacing, from which nine tenths of the troubles in mathematical printing arise. It requires no new types, except, perhaps, $\backslash$, and each of the signs used is suggestive of the original mode of writing for which it is a substitute. It can be used without confusion in conjunction with all ordinary brackets. How far this notation would suit very complicated expressions, is a point that would have to be determined by experience; but for printing mathematics of ordinary complexity it would be useful in economising space and diminishing the risk of printers' errors without any sacrifice of clearness.

Cambridge, October 27. W. CASSIE.

"Sunshine"

IN acknowledging the courteous criticism and the kind remarks which "C. V. B." has been pleased to make about my little book, may I be permitted to comment on one or two points, which I think he has imperfectly understood from the text. We all know that when "C. V. B." undertakes to review a book, he does his work in a thorough and searching manner, and from his critique it is evident that "Sunshine" has been well read. Notwithstanding this, in one or two of the instances selected for criticism the meaning, at once simple and obvious to a little child, who neither knows nor suspects any other, seems to have missed him, presumably because he knows all the bearings of the subject. Thus it is sometimes a disadvantage to be learned. Of this I propose presently to give an instance in the order which it occurs.

After poking fun at me, because, the "Sunshine" course being ended, Tommy meets King Sol face to face and "has it out with him," my critic proceeds to discuss the limits within which the imagination may be appealed to as a factor in scientific education, and while I agree with him in the main, I am tempted in passing to remind him of what Tyndall terms "the scientific use of the imagination," to which the clearness and (to me) the charm of his own lectures is largely due. Be that as it may, in one of "Nature's Story Books" I feel fully justified in employing, *within the limits of scientific accuracy*, any or all of the powers of the mind, which shall help children and others to *realise* the relation they bear to their surroundings, assured that in a course based upon some hundreds of experiments synthetically worked out and deductions made—a course whose main object is to lead children to go direct to Nature, *via* experiment, for their knowledge, there is little danger that the imagination be cultivated at the expense of the reasoning faculties. The experience of the writer is that the children attending the lectures became extremely critical—a state of mind which, although of inestimable value in acquiring knowledge, is not one of the happiest in other respects. Therefore it was thought desirable to provide them with some necessary ballast, and this is my defence of the hypnotic visit to the moon, and the other two chapters to which the critic alludes.

Natural science apart, it seems to me that the tendency of the school teaching of to-day is calculated rather to make children hard and matter of fact. For this reason I have endeavoured in these Sunshine Stories to interest children in the poetry of their common lives, myself playing somewhat the *rôle* of an optical instrument, presenting images sometimes real, sometimes virtual of those physical beauties which touch them at every point. The fact that "C. V. B." recognizes in "Sunshine" the *realism* which the "picturesque language" was intended to convey, disposes of the case of my Cape Town reviewer, who mildly insinuates that I have been guilty of some *fraud* upon little children in calling "Sunshine" a story-book. Therefore I am the more glad that "C. V. B." agrees with me that the mathematical side of these questions should not be obtruded. There are so many excellent text-books which supply that information for older pupils. I need not say that I shall be most happy to add the exception in the case of the rainbow. I thank him also for pointing out a passage in the notes where an additional clause is necessary, owing to the transposition of a paragraph. But I take exception to the statement about the top, for it is evident that the experiment is not made under the same conditions as that which "C. V. B." has in mind, because my boys get green and he gets (he says) white, or nearly white. The home experiment reads: "I am giving each of you squares of coloured paper to take home . . . then you may have the papers to put on your tops—*e.g.*, cover half blue and half yellow, spin the top and you will see green." A note on page 341 refers to the kind of paper. Now it seems to me from the expression "painted disc," which "C. V. B." has made use of, that possibly he may have had Clerk Maxwell's top in mind when he wrote.

When I say to a boy, "Here are two squares of paper, one blue and one yellow; when you've done so and so, you can have the paper to keep—cover your top, half yellow, half blue, &c.," the lad understands me, and when I am not there he takes out his halfpenny whip-top, tears a piece of the blue paper, and rendering it slightly adhesive hammers it down on the top with his right fist, he tears a similar piece and treats it in the same way, and so on until he has covered half. Then he takes the yellow paper and covers the other half with irregular patches of yellow. He spins the top and sees green.

How different is this from Clerk Maxwell's top Clerk Maxwell selected for his top the purest of paper and pigments He endeavoured to match the spectral colours (considerably diluted) He selected a scarlet red with a tinge of orange like *orange-red vermilion*, lying in the spectrum one-third the way towards D, between the lines C and D His green was one fourth the distance from E, between E and F, and resembled emerald green He also selected a blue violet midway between F and G, which was imitated by that purest of colours—ultramarine Now let us try the given experiment under the favourable conditions guaranteed by Maxwell's discs, viz, the purest of colours painted on Whatman's paper Taking up a disc of ultramarine and another of pale (not orange) chrome yellow, and concealing half of one disc behind the other, on rotating the compound disc so that the eye shall receive simultaneously blue and yellow light, the result is not white or even practically white, but a *grey, tinged with yellow* By a careful adjustment, hiding more of the yellow and exposing more of the blue (thereby *altering* the proportions of the text), it is possible to get rid of this yellowness and to obtain an absolutely neutral grey which it might be possible to persuade some grown up people represented white, but which on analysis yields 71½ per cent black to 28½ per cent white This may be proved by revolving a disc of black and white sectors in the above proportions, the results in each case being identical But even this result, unsatisfactory as it is, does not apply to the passage quoted in the text, in which no special conditions are observed. I maintain what is easily proved by experiment in less time than it takes to write it, that when ordinary colours, *e g*, gamboge and Prussian blue, are used, the residual light is green [1]

I fear that already this letter is too long, and since I do not wish to monopolize the space kindly placed at the disposal of your correspondents, I must defer the consideration of the annotations on soap films The other points are dealt with in the preface AMY JOHNSON

52 Lower Sloane Street, S W, October 12

I DO not think that the observations on my review of "Sunshine" require more than a very short answer

I considered that the authoress had not by any means cleared the confusion which usually exists as to the meaning of the expression "mixing of colours" It is applied both to the case where two or more colours are seen superposed, *e g* by spinning coloured paper where the resultant tint is due to the sum of the separate colours in the constituents, and to the case of mixed pigments where the resultant tint is that which is common to the constituents. Now as the common "paint box" rule says that blue and yellow make green, that is that blue and yellow pigments mixed produce a green pigment, it seems to me very misleading to say "Cover half (of your top) blue and half yellow and you will see green" Of course it may happen that the slight departure from white which will be observed may be in a greenish direction, but it may also be inclined towards pink, or, for anything I know, towards any other colour The one thing it will not do, however, is to make a green such as is obtained by mixing the pigments, and such as I fancy from the context any one would expect C V B

The Photography of an Image by Reflection

THE great utility of spark photography for obtaining time records of quickly-moving objects must be apparent to all who know the experiments of Mr C Bell, Prof Boys, and Lord Rayleigh. By means of spark photography the shadow of any object such as a jet of water, a flying bullet, or a broken soap film can be produced with perfect definition The shadow of the moving object illuminated by an electric spark is thrown on to a sensitive plate in a dark room, and the plate is developed in the usual manner The process of spark shadow photography will be found, I believe, of great service in physiological research With a view to try this I attached a long sensitive plate to the traversing carriage of a chronograph; the moving carriage closed and opened the primary circuit of an induction coil at prearranged equal intervals of time In front of the moving plate a frog's heart was placed in a slit on a screen, at each break a shadow of the heart was thrown on to the plate by means of the induced spark By this means thirty positions of the heart were registered, the pictures were all sharp and clear I have also used the same method for photographing the movements of insects

Since these experiments which I showed during the University Extension Meeting in Oxford this year, I have made several attempts to get spark photographs of the front view of objects (not their shadows) In my first experiments the objects were illuminated by an electric spark, the image being received on a plate in an ordinary camera I found that so much useful light was shut off by the lenses that only a dim picture could be produced A quartz lens was next tried and the results were rather better I then determined to use no lens, but in its place a silvered mirror A concave reflector made by silvering a concave lens of about 10 c.m diameter was so placed that it reflected the image of a white paper star 7 c m diameter, revolving about 60 times in a second, on to an ordinary photographic plate, the total length traversed by the light being 80 c m The star was illuminated with a spark exactly similar to that used in the previous experiment, on development a good picture of the star came out The reflector was neither well made nor well silvered The idea was suggested by observing some spark photographs I obtained of waves on the surface of mercury reflecting light When a steady light is used a photograph of any object is readily obtained by reflection from a suitable mirror Probably a steel surface would be best The mirror and plate were placed in a long box provided with a hole at one end through which the light reflected from the object passed A few experiments made on living objects to test the time of exposure in Reflection Photography showed that in order to avoid over-exposure, a very rapid shutter must be used

FREDERICK J SMITH

Trinity College, Oxford, October 25

Induction and Deduction

As your correspondent invites discussion on this subject I hope you will allow me to repeat in a new form the views I expressed upon it in your columns some months ago I quite agree with Mr Russel in maintaining that "true induction is utterly unable to yield us any conclusion that is more than probable and approximate," understanding by induction inference from one or more special cases to a more general rule But on the other hand it appears to me that Miss Jones's criticism is quite destructive of Mr Russel's interpretation of geometrical reasoning The point which both have missed I believe to be this, that a proposition stated in given words, such as the enunciation of Euclid's *pons asinorum* does not always and to every one convey the same information, and if it is meant in one sense its degree of reliability, and the method by which it must be proved, will be quite different from what they would be if it were meant in another There are at least three different kinds of interpretation which may thus be put upon the proposition It may mean (1) the triangle used to illustrate this proposition has equal sides, therefore it has equal angles, or (2) I have conceived a triangle which has equal sides, therefore I have conceived one which has equal angles, or (3) the connotation ascribed by the adjective "isosceles" implies the connotation "having equal sides"

It is not necessary for me here to dwell upon the distinction between the first two interpretations, but the difference between either of them and the third is that this latter gives us no information about any real thing or concept, but only about what is implied by using certain terms And this latter kind of information clearly does not require to be based upon any real knowledge of things, but may be based solely on definitions of words. Arguments with propositions interpreted only in this sense are what I call symbolic arguments; and symbolic conclusions therefore give no real information unless they can be interpreted by the aid of real assertions, such as "I can conceive," or "There actually exist, things possessing the connotations ascribed to these terms by their definitions"

If this distinction has not before been recognized, it is because in most logical discussions we can in this way give a real meaning to our arguments In elementary geometry, for example, we can—with more or less effort—conceive things, or even actually draw them, which answer to our definitions with sufficient accuracy. And, indeed, the reason why "Euclid"

[1] The purport of the experiment will be best understood if I state that it follows a series of chapters on colour, viz the rainbow, the spectrum, its composition by refraction and by reflection, while the last chapter discusses and explains, with experiments, the question of spectral lights *versus* pigments. The common surface papers, which the children are daily in the habit of using, are then analysed by the prism, and found to be anything but monochromatic

and "Newton" are generally considered to yield a more valuable mental training than such subjects as analytical geometry is that the older authors, perhaps because they were a bit afraid of purely symbolic argument, tried constantly to keep real pictures and ideas before the minds of their readers But even so our conviction of the truth of any but the simplest theorems of geometry depends chiefly on the symbolic argument, not on the realization in succession of the actuality of the relations and operations discussed in the course of the proof This is perhaps sufficiently obvious in the higher branches of even Euclidian geometry, but it becomes absolutely indisputable when we reach such theorems as "Any two conics in one plane intersect in four points" Not only may some of these points be at an infinite distance, but some, or all, may be what is called, on the *lucus a non lucendo* principle, "imaginary", that is, they may be such that they cannot be imagined by anybody, much less actually drawn

Accordingly I cannot admit that the theorems of geometry are established by induction at all If they are interpreted in either of the first two ways I have described, they are only particular propositions, and the inference from them to a general proposition would no more yield a "mathematical certainty" in this case than in any other And though the third way of looking at the proposition may be paraphrased into a form which appears general (*e g*, anything which may fairly be called "an isosceles triangle" may also be said "to have two equal angles"), it is really only a particular proposition about the words "isosceles triangle," and so on Its wide applicability and usefulness depends on the fact that we can, and do, often find things which can fairly be called isosceles triangles, but it must be admitted that the assertion that, on any given occasion, we have found such a thing,—is not a mathematical certainty If the triangle in question is an objective one, we can only say that it is probably, or approximately, isosceles, and though perhaps we may subjectively conceive perfectly isosceles triangles, and so regard the *pons asinorum* as a subjective necessary truth, it must be doubtful whether we could do so in the case of a more complex proposition such as Pascal's Theorem, and it is quite certain that we could not do so in the case of such theorems as that about the intersections of two conics

It is to be hoped, therefore, that logicians will come to recognize the importance of symbolic reasoning, as mathematicians have already done And when they do so we may hope for this further advantage, that they in turn will teach mathematicians and others not to confuse a purely symbolic with a real conclusion—not to assume that, because they have correctly proved a conclusion symbolically, that it therefore necessarily gives any information about real things, or even real concepts EDWARD T DIXON

Trin Coll., Cambs, October 22

Bell's Idea of a new Anatomy of the Brain

IN NATURE of October 27 the writer of the review of Mr Horsley's "Structure and Functions of the Brain," speaking of the rarity of the above book, states that he only knows of one copy in London, viz, that in the British Museum It may be useful to some of your readers to know that there is a very interesting copy in the library of the Royal College of Surgeons It is the presentation copy to Dr Roget "from Mr C Bell, 34, Soho Square", by Dr Roget it was given to Lady Bell, who presented it to the Royal College of Surgeons through Mr Alexander Shaw

Mr. Shaw has added in MS a copy of the letter received from the printers fixing the original date of publication, and also the list of persons to whom presentation copies were sent. The letter and the list are both published in Mr Shaw's reprint of the Tract in the *Journal of Anatomy*, vol iii, 1869.

JAS B BAILEY,
October 27 Librarian Roy Coll. Surgeons

Photographic Dry Plates.

IN reference to "Prevention's" note on Photographic Dry Plates, one cannot but agree with him that packets should be dated when issued from the factory.

I would venture, however, to suggest that good makers' plates do not deteriorate within a reasonable length of time.

As an illustration of my experience I may mention that in April this year I opened a box of plates (½ plate Extra Rapid) which I bought in July 1886.

I had carried them on a three months' tour in the Mediterranean in 1888 and had taken no special care of them since

They proved in every way as good as new, both in sensitiveness, and perfection and evenness of film

ARTHUR E BROWN

THE GENUS SPHENOPHYLLUM

NOTWITHSTANDING the small size and comparative scarcity of the plants belonging to this Palæozoic genus, they have long attracted a rather unusual amount of attention This has been partly due to their peculiar external forms, which suggested even to the earliest observers the idea of resemblances to the Marsiliæ, but the interest they have excited has been further increased of late years by discoveries respecting the peculiar organizations of their stems In 1822 Adolph Brongniart assigned to them the name of "Sphenophyllites," and in 1823 Sternberg figured some of them under the generic title of "Rotularia"[1] Sternberg's figures appeared in his 'Versuch einer Geognostisch-Botanischen Darstellung der Flora der Vorwelt," which work is now best known through the French translation of it by Comte de Bray To the first of his specimens figured (*loc cit*, tab xxvi, figs 4*a* and *b*), Sternberg gave the name of *Rotularia pusilla*, and the example so designated is very characteristic of the simpler type of the group, in which we have a somewhat branched stem, with verticils of wedge-shaped leaves at each node A second form was figured on a later plate of the same work It is interesting to note that Sternberg associated with these figures the observation, "Plantæ organisatione foliorum Marsileis, forma caulis Hippuri Maritimæ" The generic name thus given by this author represents the rotate arrangements of the leaves in each verticil, as the wedge-shaped contour of each separate leaf is further indicated by Brongniart's generic term, "Sphenophyllites" In 1820 Von Schlotheim had also included similar examples in his too comprehensive genus, "Palmacites[2]"

In 1828 Brongniart published his classic "Prodrome d'une Histoire des Végétaux Fossiles," in which work we find the generic name of these plants changed to Sphenophyllum, which name they have retained to the present time In this work Brongniart examines in some detail the probable affinities of these plants, which even in 1822 he inclined to regard as having some affinities with the Marsileæ He defines them as having six, eight, ten, or twelve leaves in each nodal verticil, each leaf being wedge-shaped, sometimes entire, truncated at its apex, which is denticulate In some others these leaves are bilobed, and in other species they are not only profoundly bifid, but each of these lobes is either divided into two, or their ends are laciniated Lastly, in some cases the lobes become narrow and linear Brongniart here compares these leaves with those of Ceratophyllum and Marsilea, concluding with the statement, "We cannot for the moment decide between these two relationships" At this date the fructification was wholly unknown

In his introduction to the "Natural System of Botany," p 37, Brongniart again reverts to the idea that Sphenophyllum had Marsileaceous affinities.

In 1831 the authors of the "Fossil Flora of Great Britain" commenced their publication of that work, and in one of its early numbers they figured and described under the name of *Sphenophyllum erosum* what appears to be identical with the first figure published by Sternberg. When discussing the relationships of this plant, Lindley and Hutton

[1] These figures were preceded in 1709 by a still earlier one by Scheuchzer in his "Herbarium Diluvianum" (Coemans and Kickx, "Monographie des Sphenophyllum d'Europe").

[2] "Die Petrefactenkunde auf ihrem jetzigen Standpuncte."

reject Brongniart's idea of its possible affinity to the Marsileæ, inclining to the belief that it approached nearer to the Coniferæ, and especially to Salisburia. This impression they retained when, at a later date, they described a second species of the same genus.

In his "Tableau des Genres de Végétaux Fossiles," published in 1849, Brongniart returns to the subject. He here calls attention to the readiness with which Sphenophyllum may be confounded with the genus Asterophyllites, which some forms of the former genus closely resemble, but he again repeats that the two can be distinguished by the fact that in the former genus the leaves never exceed ten in number, whilst their form is triangular with a truncated summit. He again dwells upon the fact that in some Sphenophylla the leaves become so deeply lobed, narrow, and linear, as to be easily mistaken for those of Asterophyllites. He now affirms that the fructification is closely related to that of Asterophyllites.

As to the affinities of Sphenophyllum, Brongniart now asks, "Does the plant combine the leaves of a Marsilea with the verticillate of an Equisetum, or is it a Gymnospermous Phanerogam, the leaves of which approach those of the Gingko?" He does not answer the question, but concludes that this cannot be done until the fructification of the plant is better understood.

In 1864 a monograph on the species of the genus was published by M. Eugene Coemans and M. J. Kickz, but the authors make no serious effort to solve the vexed question of the affinities of the genus.

We now enter upon a new stage in the history of the genus. In 1870, M. Renault presented an important memoir to the French Academy of Science, which, for the first time, threw light upon the internal organization, especially of the stems, of Sphenophyllum. He described two examples, one from Autun and the other from St. Etienne, both of which exhibited a structure wholly different from that of any plant previously known, recent or fossil. In the centre of each stem was a primary vascular bundle, the transverse section of which was a triangle with three concave sides and three prolonged, narrow, intermediate arms. This axial organ underwent no subsequent growth after its first formation. But it was invested by a secondary zone, which was deposited upon the primary triangle layer after layer like a secondary xylem, producing a circular axis, which enlarged as the plant advanced in age. But this secondary growth did not consist of layers of vessels, but of vertical columns of thick-walled cubical cells. The cortex also exhibited specially distinctive features. These discoveries made it clear that Sphenophyllum constituted, not only a very distinct genus, but a type of plant far removed from everything previously described.

It fell to my lot to make the next advances in our knowledge of this genus. In 1871 I described in the memoirs of the Literary and Philosophical Society of Manchester a new fructification, to which further reference will be made later on. In 1872 I obtained from the Oldham deposits some new stems which obviously belonged to the same type as those discovered by M. Renault, but from which they differed in important points of detail. These were described in my Memoir, Part V., published in the Philosophical Transactions for 1874. Transverse sections of these closely resembled in their dominant features M. Renault's corresponding ones, but with two differences. When my plants attained to a certain stage of their exogenous growth, a well-defined circular boundary marked a temporary arrest of that growth, but which started afresh from a zone of much smaller vessels (*loc. cit.* Pl. II., Figs. 11 and 12), that increased in size as the diameter of the axis increased, as they had previously done in the more internal series. Still greater and more important differences presented themselves in the longitudinal sections. The zones of secondary or exogenously developed xylem, which in M. Renault's examples consisted solely of vertical columns of thick-walled, cubical cells, were composed, in mine, of true tracheidal vessels with reticulated (not with bordered pits) walls, presumably a higher stage of development. Another new and more advanced feature than characterise Renault's cells, seen best in tangential sections of this zone (*loc. cit.* Fig. 13), was the existence, between contiguous tracheids, of vertical, but interrupted, series of small cells, which I can only regard as rudimentary medullary rays. In the same memoir (*loc. cit.* Pl. IV.) a still more distinct form from the Burntisland deposits in Fifeshire was figured and described. M. Renault and Count Solms Laubach refuse to recognize a Sphenophyllum in this type, but they have not yet convinced me that I am in error on the point. The fact is that, though widely aberrant from the form described above, it scarcely differs more from that form than the latter does from M. Renault's examples.

But my Oldham specimens raised another debated question. When the Memoir V. was published, all authorities agreed that the maximum number of true leaves in each verticil was ten or twelve; that, however deeply subdivided, their outline was a sphenoid one, and not linear, and that they were multinerved. But I am still convinced that in my specimens there were more than twenty such leaves, that they were linear in outline, and had a single median nerve. It followed that, continuing to accept the existing definitions of the genus Sphenophyllum, my plant was Asterophylloid rather than Sphenophylloid. I am now prepared to admit that it is a Sphenophyllum, but only on the condition that we alter our definitions of the latter genus, and admit the possibility that some of the forms may possess twenty or more undivided and linear leaves. The accumulating evidence that the foliage of at least some of the Sphenophylla was dimorphic makes the acceptance of my proposition a matter of necessity.

Yet more recent researches have revealed new and important facts connected with the history of these plants. I have already alluded to the new fructification which I described in 1871, and to which I gave the name of *Volkmannia Dawsoni*. M. Renault's memoir already noticed was laid before the French Academy in May 1870, and noticed in the *Comptes Rendus* of that date, but owing to accidents growing out of the Siege of Paris, it was not published until three years later. Meanwhile my memoir on *Volkmannia Dawsoni* was published, and a copy of it forwarded to M. Brongniart. After giving details of the structure of the strobilus I arrived at the conclusion that "it is the fruit either of Asterophyllites or of Sphenophyllum."

Two years later M. Renault's memoir of 1870 was combined with a second one on the same subject, and published. It contained a note by M. Brongniart, referring to my memoir of 1871, in which note he says, "This work agrees in many important points with the results obtained a year previously by M. Renault, though Mr. Williamson was unacquainted with the article in the *Comptes Rendus* of May 30, 1870. The fossil plant studied by Mr. Williamson, and named by him *Volkmannia Dawsoni*, doubtless differs, at least specifically, from that described by M. Renault, by the form of the central vascular bundle, and by the absence of the zones of quadrangular cells which surround it in the French specimens, cells which in consequence of the thickness of their walls would not be readily destroyed."[1]

[1] M. Brongniart has here failed to comprehend an important point. The cells, the absence of which he notices, really belonged to the secondary xylem of the older stem, which did not become developed in the youngest twigs. But it was only upon these twigs that the fructifications were formed, and of which they were but extensions. Hence their absence was merely a consequence of difference of age, and not a feature of specific value.

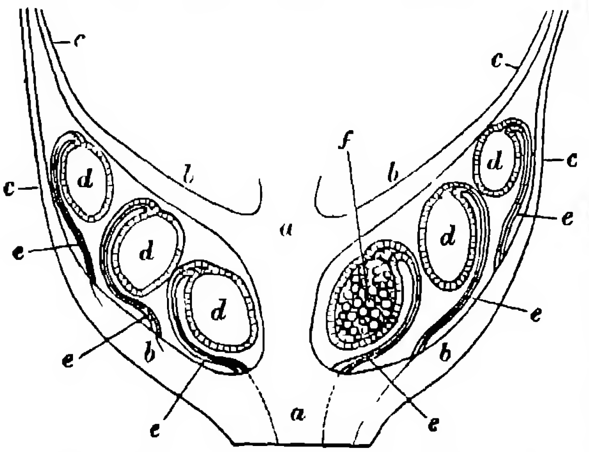
In 1890 I figured in my Memoir XVIII (Phil Trans 1890) a transverse section of what was obviously a stem of *Bowmanites Dawsoni*, in which the primary triangular axis of the strobilus was invested by a thick zone of the secondary xylem So far as the arrangement of its tissues is concerned this stem is constructed on exactly the same plan as appears in M Renault's and my own Sphenophylla. In describing it I further said, "We must unite Sphenophyllum with some forms of Asterophyllites in the same genus It is equally clear that Bowmanites, though its peculiar fructification demonstrates that it constitutes a perfectly distinct genus, has strongly marked features of affinity in the structure of its stem to the Sphenophylloid type"

The above reference to differences between the fructification of Bowmanites and of Sphenophyllum were based upon the minute description of the fruits of the latter plant, published by M Renault ("Études sur le Terrain Houiller de Commentry," pp 481-2) Those descriptions differ widely from what exists in my Bowmanites, but M Renault distinctly identifies them with the fructification of Sphenophyllum I obtained additional and important specimens of Bowmanites in 1890, which threw much new light upon its organization, and which were recorded in my Memoir XVIII (Phil Trans 1891)

In July last an important communication was laid before the Academy of Sciences by my friend M Zeiller, the distinguished director of the Superior National School of Mines at Paris In it he records his identification of a fructification of a Sphenophyllum of the type of *S pusillum* of Sternberg and *S erosum* of Lindley and Hutton, with my *Bowmanites Dawsoni* If this determination is correct, and I see no reason for doubting that it is so, we now have some more definite facts than we have hitherto possessed, guiding us alike in identifying the true fructification of Sphenophyllum and in determining its position in the vegetable kingdom

Before explaining M Zeiller's observations more in detail, a few words explanatory of the structure of Bowmanites will make M Zeiller's views more intelligible to the reader

The accompanying diagram represents two nodes and



one internode from a vertical section of this fruit, with the sporangia and three sporangiophores *in situ*.

So far as external contours are concerned, it is undistinguishable from many of the true Calamarian forms of fructification It is only when cut into sections that its characteristics can be discovered. Its central axis (*a*) has nodes (*b*) at short and regular intervals, and at each node is a verticil of from 16 to 20 sporophylles or fertile bracts (*c*). At their basal portions these bracts are coalesced into a lenticular disk (*d*), from the margin of which the thinner and narrowing bracts extend upwards, overlapping from two to three internodes. From the upper surface of the disk numerous slender sporangiophores (*e*) spring, each one proceeding upwards and outwards, to become attached to the *upper or distal* extremity of a large oval sporangium (*f*) Each of these sporangiophores has running through it a small bundle of barred tracheids, which terminate at the point of attachment to the sporangium Each tracheal bundle is a prolongation of one of a circle of similar ones that ascend from the central axis into the disks These fructifications, besides being manifestly eusporangiate, are extremely characteristic of the plant, nothing identical with them having been observed by any of the authors who have investigated the Carboniferous strobili After these illustrations I will allow M Zeiller to explain his views in his own words After referring to the details given in my Memoir XVIII, M Zeiller says –

"L'aspect de ces sporanges, ainsi attachés au bout de ces pédicelles recourbés, est exactement, à part les dimensions moindres celui de sporocarpes de *Marsilea* L'analogie parait du reste n'être pas purement superficielle, M Williamson a reconnu en effet, dans le pédicelle de chaque sporange, un cordon vasculaire bien caractérisé, qui prouve qu'on n'a pas affaire là à une simple formation épidermique, comme pour les sporanges de Fougères ou de Lycopodinées Il faut, à ce qu'il semble, regarder ces pédicelles comme représentant des lobes ventraux des bractées, analogues au lobe fertile des frondes d'Ophioglossées, ou à ceux des Marsiliacées, seulement ils portent à leur extrémité non pas une série de sporanges comme chez les premières, ou plusieurs sores comme chez ces dernières, mais un sporange unique à paroi formée d'une seule assise de cellules"

"De cette constitution des épis du *Sphen cuneifolium*[1] il report que, si les Sphenophyllum rappellent les Lycopodinées par la structure de leur axe, ils s'en éloignent notablement par la disposition toute spéciale de leur appareil fructificateur, qui tend à les rapprocher plutôt des Rhizocarpées, et qu'ils doivent donc bien décidément être considéré comme formant une classe distincte parmi les Cryptogames vasculaires."[2] Agreeing thoroughly with these conclusions further comments are needless WM CRAWFORD WILLIAMSON

DENDRITIC FORMS.

THE curious appearances presented by certain native specimens of silica have been observed for so long, that it is somewhat surprising that so little is known about their real constitution and mode of formation.

Rock-crystal is frequently found to contain bubbles of liquid, usually either water, carbon dioxide, or petroleum, or crystals, such as scales of mica, forming aventurine, and fibres, such as asbestos, forming cat's-eye. More rarely, however, forms of apparently vegetable origin are seen, one of the most remarkable specimens is a prolate spheroid, about five inches long and four inches across, cut from a clear colourless rock-crystal, in which are embedded numerous fragments about the size of a large pea, presenting the exact appearance of club-moss.

Agate is frequently found with distinct coloured layers, either flat or distorted, and usually milk-white, red, brown, or black. It is then known as onyx.

More rarely, agates are found with markings like moss or foliage distributed through them, they are then known as moss-agates, or Mocha stones

In 1814, Dr J. MacCulloch described some cryptogamic forms in the agates of Dunglas (Geological Trans, ii,

[1] The species of Sphenophyllum to which M Zeiller's strobili were attached.

[2] *Comptes Rendus des Séances de l'Académie des Sciences*, Paris, July 11, 1892.

iv, 398) It is stated that the Earl of Powys possesses an onyx containing the chrysalis of a moth

It seems to be generally assumed, without any strong evidence, that rock-crystal and agate have been formed from solution in water, possibly superheated, and that in such cases as those mentioned above, various crystalline or fibrous minerals and low forms of plant life have been inclosed during the process of solidification

Though this explanation is very possibly true in many cases, it does not account for all the appearances seen in moss-agates, and another possible mode of formation may be suggested by a brief account of some experiments made more than twenty years ago

Ordinary crystals of ferrous sulphate dissolve readily in cold water, but if they are placed in a dilute solution of an alkaline silicate, an entirely new series of phenomena are produced, which were first described by J D Heaton, M D, in a paper "On certain Simulations of Vegetable Growths by Mineral Substances" (Brit. Assoc Report, 1867, p 83) On immersing crystals of ferrous sulphate in a solution of sodium silicate of the density 1 065, very beautiful arborizations will soon begin to shoot perpendicularly upwards, attaining the height of three or four inches in a few hours In a weaker solution roots can be caused to shoot downwards from a suspended crystal The fibres contain silica and iron (less the weaker the solution), they are brittle, and more dense than the liquid in which they are formed Examined by the microscope, the ultimate ramifications are cylindrical, tapering tubes, the walls of which are granular, showing no sign of crystallization The roots are more abrupt and occasionally club-shaped in their terminations The growth is interstitial like that of organized living tissue "Supposing such purely mineral substances to have been formed in by gone geological eras, and to have been accidentally fossilized in some primary or other ancient rock, they would very probably, when discovered by recent investigation, be pronounced to be an evidence of organized beings having existed contemporaneously with the formation of such rock"

In the following year a similar observation was made by Prof W C Roberts-Austen (J C S, 1868, xxi, 274) A solution containing 49 per cent of silica, when allowed to gelatinize, and dried for two days over sulphuric acid, left a solid residue similar to opal from Zimapan, but containing 21 4 per cent of water All the specimens of jelly dried in air contained dendritic forms, varying in size from 0 2 to 0 5 mm When magnified 90 times they appeared as radiating fibres, when the power was increased to 700 times linear, each fibre resolved itself into a series of elongated beaded cells with clusters of circular cells at intervals Mr Slack indicated their remarkable analogy to common blue mould or mildew The cells appeared to be hollow, and did not blacken with sulphuric acid

A few years later I repeated Dr Heaton's experiments, and made some additional ones, a brief account of which may induce some one with better means at his disposal to investigate an interesting and somewhat neglected subject.

If a crystal of copper sulphate be suspended in a solution of potassium silicate, which has been carefully neutralized and has a density of 1 065, in the course of a few minutes a hollow green column will be seen to run down from the crystal to the bottom of the beaker. Sodium silicate may be used instead of potassium silicate, but the appearance and rapidity of the growth is somewhat changed The solution may be neutralized with hydrogen sulphate, chloride, or acetate, but hydrogen fluoride appears to prevent all growth. If the solution has a density less than 1 06, no growth occurs, and the crystals generally dissolve; the weaker the solution down to this limit the more rapid the growth. If the solution be stronger, the time required for the growth to commence may be lengthened from minutes to many days If the density be above 1 25, no growth takes place

Copper sulphate gives the best results, but it may be replaced by ferrous, manganous, or nickel sulphate, with changes in the shape, and of course in the colour, of the growths The growths take place most readily from a clean sharp crystal, and always from an angle or edge, an edge obtained by cleavage requires more time Other salts besides the sulphates may be used, but do not act so rapidly, probably owing to less perfect crystallization of the specimens used

In a neutral or very feebly alkaline solution the growths are comparatively rapid, and consist of long, branching, tapering fibres, not unlike the roots of a tree They grow rather more rapidly downwards than upwards If the solutions be decidedly alkaline, the growths are much slower, and consist of fine stalks with comparatively large lumps at the extremities

The tubes seem to be composed of silica with a small proportion of the metal used, they differ much in colour, are more dense than the liquid in which they grow, and are insoluble in water or dilute acids When magnified 100 times, the substance of the tube shows no appearance of crystalline form, but seems to consist of concretions of ovoid granules In this particular it differs from the substance of lead or silver trees, and from the curious fibres of potassium, iodide, and chloride described by Mr Warington (J C S, v, 136, viii, 31)

It is generally assumed that the formation of onyx is due to the successive deposition of layers of silica coloured by different substances, but the following experiment suggests another possible method of formation, especially when the extreme permeability of gelatinous silica by liquids is remembered So readily are even the hardest agates permeated by hot aqueous solutions of salts, that "staining" is a common commercial process

A little too much sulphuric acid was accidentally added to a moderately strong solution of potassium silicate in which some crystals of copper sulphate were lying The copper sulphate dissolved, and the solution set to a uniform blue jelly After standing for about a week, the blue colour at the top of the jelly had separated into a series of thin parallel coloured plates, leaving the jelly between them colourless This curious separation of the colouring-matter gradually proceeded downwards, and reached the bottom of the precipitating glass in about a month The jelly gradually shrank, dried, and hardened, forming fragments consisting of blue bands in a white mass

SYDNEY LUPTON

NOTES

THERE will be a memorial celebration for A W von Hofmann on November 12, arranged by the Deutsche Chemische Gesellschaft, at Berlin on the 25th anniversary of its foundation The Empress Frederick and many German and foreign celebrities have been invited to be present The proceedings, which will take place at the Berlin Town Hall, will include speeches on the history of the Society and on Hofmann, a review of progress in chemical science by Hr Wislicenus, and choral music, performed by the members of the cathedral choir.

WE regret to have to record the death of Mr. Robert Grant, F R.S., Professor of Practical Astronomy at the University of Glasgow He died at Grantown on-Spey, his native place, at the age of seventy-eight

THE death of Dr. Löwenherz, director of the Imperial Physical Institute, Berlin, has been announced. He died at Berlin on Sunday last

PROF VIRCHOW has been appointed an honorary member of the Imperial Russian Natural Philosophy Society

AN International ethnographical exhibition is to be held next year in St Petersburg It will be organized by the Russian Geographical Society

THE American Microscopical Society offers prizes for the encouragement of microscopical research, two of the value of 50 dollars each, and two of the value of 25 dollars each, for the best papers which shall give the results of an original investigation made with the microscope, and relating to animal and plant life respectively, also two of the value of 30 and 15 dollars respectively for the best six photomicrographs in some subject of animal or vegetable histology, and two of the same value for the best collections of six mounted slides illustrating some one biological subject

IN a letter to the *Times* on scientific titles and their abuse Prof Tilden has opened a subject of considerable interest to men of science It is well known that the letters indicating membership of a society are sometimes used by persons who have no right to use them, and Prof Tilden notes that an effort is to be made to deal with this evil by getting a Bill before Parliament "for the purpose of securing to the respective societies the copyright of these letters" This, however, is a comparatively unimportant aspect of the question The real difficulty is that membership of scientific societies is frequently "represented in courts of law or by candidates for public appointments as evidence of professional trustworthiness," whereas in very many cases it does not at all necessarily imply any extensive or accurate knowledge of the subjects in which the societies are especially interested "Fellowship of the Royal Society indicated by the letters F R S," says Prof Tilden, "is a real distinction which is justly prized But what is the public to understand regarding such alliterations as F B S, F C S, F E S, F G S, F L S, F S S, F Z S, and of F S A, M R I, F R A S, F R M S, F R G S, F R S E, &c? With the exception of one or two of the societies represented here, admission is to be gained by almost any one who is willing to pay the customary contribution to the funds of the society, and who can get two or more members of the society to testify to his fitness for admission, which generally means respectability and a profession of interest in the subject, the cultivation of which is the object of the society" He adds that if the public knew all about the societies no harm would arise, but "judges and barristers, and county councillors and town councillors cannot be expected to have this knowledge" Prof Tilden thinks that "the only chance for a better state of things is for every member of these societies who respects himself to abandon the use of these unmeaning letters altogether", but he fears that there is very little prospect of such a general reform while "an Institute having for its president no less a person than the Heir Apparent to the throne condescends to bait its advertisements for subscribers with the offer of more letters The *Times*, discussing the subject in a leading article, expresses the opinion that in the main "we must trust, imperfect though the security is, to the ability of grown-up men and women to protect themselves against a form of deception which has most hold over those who themselves covet the meaningless letters to which they blindly pin their faith."

THE weather during the past week has been characterized by a marked increase of temperature and excessive rainfall, accompanied by strong southerly winds and gales Between Wednesday the 26th and Friday the 28th October, the temperature in parts of England increased upwards of 30°, while the air became very humid and unpleasant. The continuance of comparatively high temperature, during which the thermometer reached 60° in the central and southern parts of the kingdom, was due to the track of the depressions, causing a continual indraught of warm air from off the Atlantic. On Thursday the 27th ult, about 1½ inch of rain was measured in the West of Ireland, and heavy falls occurred on the following days in the Midland counties A further downpour, amounting to 1½ inch in the Channel Islands, and to 1 3 inch in London, occurred on Sunday night, and the amount which has fallen on the east coast of Norfolk during the month of October is about equal to three times the average During the first part of the present week, the disturbance which caused the heavy rainfall passed away, and a small area of high pressure temporarily advanced over the United Kingdom from the Atlantic, while the temperature fell several degrees, with mist or fog in places, but conditions were very unsettled, and a change of wind to the south-eastward in Ireland gave indications of probable further disturbances During the week ended the 29th ultimo, the amount of bright sunshine exceeded the mean in nearly all districts

THE Meteorological Council have recently issued a summary of the *Weekly Weather Report* for the quarter ending September 1892 which shows the rainfall and mean temperature in each district for each similar quarter for the twenty-seven years 1866–92, grouped in five yearly averages, and also the means for individual years from 1881 The average rainfall of the quarter for the whole of the British Islands was 10 2 inches, or only 0 7 inch in excess of the mean for the whole period This result is almost entirely due to an excess in the grazing or western districts, amounting to 1 5 inch, while in the wheat producing or eastern districts the fall for the quarter is slightly below the mean The temperature for the quarter has been below the mean generally, for the whole of the country the deficiency amounted to 1° 8, and was 1° 7 in the grazing districts and 1° 9 in the wheat-producing districts Similar returns show that the excess of rainfall amounted to 1 5 inch in the same quarter of 1891, prior to which there had been a series of seven dry quarters, while the temperature has been uniformly below the mean for six corresponding quarters The coldest quarter was in 1888, when the deficiency amounted to 2° 5, this being, in fact, the coldest corresponding quarter during the last twenty seven years

THE late Mr George Grote, the historian of Greece, expressed in writing, eight years before his death, a desire that after his decease his cranium should be opened and his brain weighed and examined The task was undertaken by the late Prof John Marshall, and the results of his observations are set forth in a full report printed in the current number of the *Journal of Anatomy and Physiology*. The entire encephalon was somewhat above the average in size, if compared with the adult male brain at all ages If allowance be made for the effects of senile wasting, it must be regarded as a rather large brain, but not as an actually or especially large one There can be no doubt, however, that it was, at death, further diminished in size and weight through the effects of disease, as shown by its marked deviation from the ordinary ratio as compared with the body-weight. As tested by the standard of macrocephaly adopted by Welcker, its utmost allowable weight was below that standard, and as contrasted with the encephala of certain other eminent men, it would find its place about one-third up from the lower end of the list The general form of the cranium was rather or nearly brachycephalic, but it was decidedly higher than usual The cerebrum itself was, in accordance with the shape of the cranium, short, broad, and deep The cerebral convolutions were very massive, being not only broad and deep, but well folded, and marked with secondary sulci This condition was observable all over the cerebrum, but chiefly remarkable in the frontal and parietal regions Studied in reference to Dr. Ferrier's researches into the localization of function in the brain, the relative size of certain convolutions or groups of convolutions suggested some reflections as to individual peculiarities, but these reflections did not seem to Prof Marshall

to be quite trustworthy. From the size and richness of the convolutions, the sufficiency of the grey matter both on the surface and in the interior of the hemispheres, and from the remarkable number of the white fibres, especially of the transverse commissural ones, the brain of Mr Grote is pronounced to have been of very perfect and high organization

THE method of cleaning mercury adopted at the Physikalisch-technische Reichsanstalt at Berlin is described in the *Zeitschrift fur Instrumentenkunde* The raw material is brought in iron bottles from Idria It is filtered and dried, and twice distilled in a vacuum to get rid of the heavy metals Great care is taken to eliminate fatty vapours derived from greased valves and cocks, which is accomplished by means of a mercury pump working without a stopcock Finally, the electro-positive metals, such as zinc and the alkalies, are separated by electrolysis The mercury is precipitated from a solution of mercurous nitrate obtained by the action of nitric acid on excess of mercury The solution, together with the impure mercury acting as an anode, is contained in an outside glass vessel, into which a current from a Gulcher thermopile is conducted by an insulated platinum rod. The cathode rod dips into an interior shallow glass vessel, in which the pure mercury is collected On careful analysis it was found that no perceptible non-volatile residue was left by 200 grammes of the purified metal Thus the mercury is well fit for use in standard barometers and resistances.

WITH regard to the revival of animals after exposure to great cold, Herr Kochs (in the *Biologisches Centralblatt*) points out two things which retard formation of ice in the animal body First, the body does not contain pure water, but salt and albumen solutions, which only freeze under zero C Then capillarity and adhesion hinder freezing. Herr Kochs states that water in a glass tube of 0 3 to 0 4 mm. diameter may be cooled to $-7°$ and even $-10°$ C without freezing. With a diameter of only 0 1 to 0 2 mm. the water is not frozen, even though the end of the tube be put in freezing liquid Thin liquid sheets between two glass plates behave in the same way If a salt solution freezes, the salts are excluded, and pure water, in freezing, gets rid of its absorbed gas. Fresh blood, according to the author's experiments, freezes only after being strongly cooled to $-15°$C., and after complete elimination of gases and salts The blood corpuscles are dissolved and the blood loses colour. The same elimination doubtless occurs in freezing of protoplasm Experiments cited to show the possibility of "anabiosis" may probably be explained by the decomposition process not having gone so far as to bring life completely to a standstill Similar results were obtained in experiments on drying of seeds and various animals It was shown with what tenacity many animals, under most unfavourable circumstances, retain the moisture necessary to life.

THE very destructive American disease of the vine known as the "Black rot" has, for some years past, made its appearance in Europe, and its life-history has now been thoroughly investigated by Viala, Rathay, and others The ravages of the disease have been traced to a parasitic fungus, *Læstadia Bidwellii*, the mycele of which develops in the interior of the organ attacked, chiefly the young branches and berries, and produces spermogones and pycnids in the course of the summer. It is especially by the pycnospores that the fungus is disseminated. Towards the end of the period of vegetation sclerotes are formed, usually within the pycnids, and the conidiophores spring from these. Peritheces are also formed in May and June on the fallen and infected berries of the previous year. Until recently the ravages of this pest in Europe were confined to the French vineyards, but it has recently been detected in Austria and in Italy. The most effectual remedy for it is salts of copper.

THE results obtained from the botanical work done at the various experiment stations in the United States will in future be published in the form of an "Experiment Station Record," issued by the Department of Agriculture, under the editorship of Mr. Walter H Evans

ANGLO INDIAN papers record the presentation of an interesting "piece of architecture" to the Madras Central Museum by Lord Wenlock It is a hornets' nest, belonging probably to the species *Vespa cincta* It is conical in shape, and is constructed of a material resembling rough paper or cardboard composed of woody portions of plants gummed up by the insects, and brought into the condition of paste by means of a viscid salivary secretion. The combs are placed in tiers and attached to each other by small columns of the same paper like material of which the nest is composed It is two feet in height, and about the same in circumference at the base It was obtained in the course of one of His Excellency's tours

M DE NADAILLAC, in the current number of *La Nature*, discusses the significance of some of the facts which have been brought to light by the recent excavations of mounds in the Ohio Valley The mound builders knew how to construct earth fortifications, which were of considerable extent and always remarkably adapted to the sites chosen They buried their dead under tumuli of astonishing dimensions Copper was the only metal they could work, and they undertook long journeys in search of it. Their weapons and implements were of stone They made vases of pottery, and were able to produce representations of the human figure and of animals, both by sculpturing them in stone and by modelling them in clay. At least in some districts they were sedentary, and, like all sedentary populations, they had to obtain the means of subsistence in part by cultivation of the soil They were often engaged in fighting, and numerous burials in which the bodies are crowded together bear witness to the fury of their struggles Whence did they come and who are their descendants? M de Nadaillac thinks that these questions can never be definitely answered unless investigators discover some traces of the language of the mound-builders

AN interesting and valuable paper on the association of shipping disasters with colour-blind and defective far-sighted sailors, read by Dr T H. Bickerton before the section of Ophthalmology at the last annual meeting of the British Medical Association, has been reprinted for the author from the *British Medical Journal* Dr. Bickerton takes anything but a hopeful view of the prospects of legislation on this important question. He greatly fears that "many a shipping disaster will occur before the Royal Society's suggestions become part of the law of the land." Accordingly he urges all who interest themselves in the subject to abate not a tittle of their endeavours. "There are none," he says, "so difficult to convince as those who will not believe, and the men who have had the framing of the rules of the road at sea are the very men who hitherto have turned from all suggestions on the eyesight question with contempt. True it is that their language, judged from examples to be found in the *Nautical Magazine*, is becoming moderate, and even polite, but they lack knowledge of this subject, and they will still require our best attention" Meanwhile, Dr. Bickerton presses on the attention of the public the following facts.—that 4 per cent. of the whole male population are colour blind, that about 8 per cent. more have marked impairment of sight from refractive errors; that there is no official test whatever as to a sailor's eyesight; that a man may be the subject of any of the forms of eye disease, may have any degree of blindness, or may be so short-sighted as to be unable to see distinctly more than a few inches in front of his nose, and yet be at perfect liberty to be a sailor and to become an officer; and that, although there is a

compulsory colour examination (in many cases a most inefficient one) to be passed before a sailor can become an officer, there is no check to a colour blind man being a sailor, or to his remaining one to his life's end

THE Rev T A Marshall describes in the November number of the *Entomologist's Monthly Magazine* a new genus and species of Belytidæ from New Zealand The paper is accompanied by representations of two insects in fine condition Mr Marshall abstains from giving tedious details, as the figures will, he believes, convey a better idea of these creatures than many words, and he thinks they will now be unmistakable, at least until other species of the same genus shall be discovered He has not taken any characters from the under-side, the specimens being carded, hence the oral organs could not be described, but they may be pretty safely assumed to resemble those of *Belyta, Anectata*, &c, and their details would have been of little value

A CORRESPONDENT of the New York journal *Electricity*, writing from Paris, describes some electrical peculiarities which he has seen in a cat This cat, called Michon, is a half wild animal, and dislikes handling It belongs to the household of Dame Gais, whose residence on the Carnier Monnt, near Monte Carlo, looks directly down on the noted gambling casino and its botanical reservation On some of the cold and very dry nights common to Monte Carlo in the winter, Michon, while in the dark, is quite a spectacle Every movement of its body sends off hundreds of minute bluish sparks, something like those thrown off by ill-adjusted brushes, though not so pronounced in colour. They make a noise on a small scale, like the crackling of burning furze Stroking the cat increases the sparking, and ruffling its fur the reverse way produces a miniature pyrotechnic display quite remarkable The cat itself does not seem to mind the sparking, but, like all cats, dislikes to have its fur rubbed in a wrong direction The writer has never seen the electric element so abundant in a cat, and many who have seen the coruscations that have given notoriety to Michon, confirm him in the opinion that the cat is an electrical curiosity

A USEFUL account of "Biological Teaching in the Colleges of the United States," by Prof John A Campbell, of the University of Georgia, has been issued by the United States Bureau of Education The writer's object is to present the actual extent and scope of the biological courses offered by the colleges of the United States, together with the methods of teaching employed. He also aims at presenting as fully as possible an account of the equipment and facilities for teaching which the various colleges possess The statements he makes are therefore based largely upon the printed accounts found in the college catalogues, supplemented in many cases by letters containing additional information These have usually been re-written, but where they are in suitable form they are quoted directly Prof Campbell notes that many of the colleges announce more in their catalogues than they can possibly do thoroughly with the teaching force employed. This is often perfectly apparent, but in more than one letter received the statement has been made that certain courses have no existence save on paper Prof Campbell, however, thinks that it is worth while to record the views of the professors in charge in regard to the nature and aims of such work, and the ideals towards which they are striving.

THE "Treatise on Hygiene and Public Health," edited by Dr. T. Stevenson and Mr. Shirley Murphy, and reviewed in NATURE last week, is published by Messrs. J. and A Churchill.

MESSRS J AND A. CHURCHILL are publishing a second edition, revised and enlarged, of "Commercial Organic Analysis," by Alfred H Allen The second part of the third volume has just appeared The third part of the same volume will be issued as soon as possible, and will complete the work In the second part he has sought to describe fully and accurately such of the organic bases as have any practical interest, and to give trustworthy information as to their sources

THE new number of *Natural Science* includes articles on the evolution of consciousness, by C Lloyd Morgan; primæval man a palæolithic floor near Dunstable, by W G Smith, the evolution of sharks' teeth, by A S Woodward, the walk of arthropods, by G H Carpenter, the falling of leaves, by A B Rendle, and Norwich Castle as a museum, by H Woodward

A REVISED edition of "London Birds and London Insects," by Mr T Digby Pigott, has been issued by Mr H Porter Along with the essays on these subjects have been printed several other bright and attractive sketches

AN elaborate index to the genera and species described in the "Palæontologia Indica," up to the year 1891, by W Theobald, has just been issued It is included among the Memoirs of the Geological Survey of India. Mr Theobald has also prepared "Contents and Index of the Memoirs of the Geological Survey of India, 1859 to 1883"

A SECOND edition of Dr F H Hatch's "Text-book of Petrology' has been issued by Messrs. Swan Sonnenschein and Co. The author explains that he has taken advantage of this opportunity to revise the book thoroughly, while largely increasing its scope

THE Society for Promoting Christian Knowledge has published a second edition of Klein's "Star Atlas" Mr E. McClure, the translator of Dr Klein's explanatory text, has sought to bring up to date the German writer's descriptions of the more interesting fixed stars, star clusters, and nebulæ

MESSRS ROBERT GRANT AND SON, Edinburgh, and Messrs Williams and Norgate, London, have issued Parts II. and III of Vol XXXVI of the Transactions of the Royal Society of Edinburgh The following are the subjects of some of the papers:—the foundations of the kinetic theory of gases (IV), by Prof Tait, the solid and liquid particles in clouds, by J. Aitken, the development of the carapace of the chelonia, by J B Haycraft, the composition of oceanic and littoral manganese nodules, by J Y Buchanan, the winds of Ben Nevis, by R. T Omond and A Rankin, and the Clyde sea area, by H R Mill

THE University College of Wales, Aberystwith, has issued its calendar for its twenty-first session, 1892-3

THE City and Guilds of London Institute has issued its programme of technological examinations for the session 1892-93.

MESSRS GEORGE PHILIP AND SON announce that a work on "British New Guinea," by Mr J P. Thomson, Hon Sec. to the Brisbane Branch of the Royal Geographical Society of Australasia, is almost ready for publication. An appendix will contain contributions to the geology, fauna, flora, &c., by Sir William Macgregor, K C M.G, Baron Ferdinand von Mueller, Professor Liversidge, F R S, and others. The proof sheets have been revised by Dr H Robert Mill and Dr. Bowdler Sharpe.

ANOTHER and apparently much more convenient mode of preparing glycol aldehyde, CH_2OH CHO, the first member of the series of aldehyde-alcohols, is described in the current number of the *Berichte*, by Drs. Marckwald and Ellinger, of

Berlin It may be remembered that in our note of a fortnight ago (vol 46, p 596), it was announced that Prof Emil Fischer and Dr Landsteiner had succeeded for the first time in preparing this interesting substance in a state of tolerable purity by a reaction analogous to that of barium hydrate upon acrolein dibromide, the reaction which yielded the first synthetical glucose They first prepared the mono-bromine, derivative of common aldehyde, $CH_2Br\ CHO$, and subsequently reacted upon this new substance, a liquid possessing an intolerably sharp odour, with baryta water After removal of the baryta by sulphuric acid, and the hydrobromic and sulphuric acids by means of carbonate of lead, a liquid was obtained which possessed the properties of a dilute solution of glycol aldehyde Some time ago Pinner obtained a derivative of this aldehyde which bore the same relation to glycol aldehyde, that the compound known as acetal, $CH_3\ CH\langle{}^{OC_2H_5}_{OC_2H_5}$, bears to common aldehyde This substance, glycol acetal, $CH_2OH\ CH\langle{}^{OC_2H_5}_{OC_2H_5}$, Pinner attempted to decompose, by the action of mineral acids, into ethyl alcohol and glycol aldehyde The attempt, however, did not succeed, inasmuch as the decomposition went further, any glycol aldehyde that may have been formed during the first stage of the reaction being subsequently broken up Drs Marckwald and Ellinger now find that the reaction succeeds admirably, provided the acid employed is extremely dilute, and as glycol acetal is a substance very easily prepared, they show that the reaction affords a very convenient and advantageous method of preparing large quantities of glycol aldehyde The glycol acetal is added to an equal volume of water acidified with only a few drops of sulphuric acid. The liquid is then heated to boiling After a short time the two liquids mix, and the reaction is completed when upon the addition of water to a few drops of it no separation of oil occurs Upon distilling the liquid product, alcohol first passes over, then there distils a mixture of water and glycol aldehyde until decomposition of the residue commences Glycol aldehyde, as thus obtained in a tolerably concentrated form, appears to be much more volatile in steam than was observed by Prof Fischer and Dr Landsteiner, in case of their more dilute solutions From a few cubic centimetres of the distillate Drs. Marckwald and Ellinger obtained a very considerable quantity of Prof Fischer's phenylhydrazine compound, and confirm in every detail the other properties of glycol aldehyde described in our previous note above referred to The chemistry of this first member of the series which includes the sugars is now, therefore, fairly complete, and the difficulties in the way of its preparation surmounted

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mr Pascoe Grenfell, F Z S, a Philantomba Antelope (*Cephalophus maxwelli*) from West Africa, three Gambian Pouched Rats (*Cricetomys gambianus*) from West Africa, a Ground Rat (*Aulacodus swindernianus*) from West Africa, and a White-faced Tree Duck (*Dendrocygna viduata*) from West Africa, presented by Mr. C B. Mitford; a Martial Hawk-Eagle (*Spizaetus bellicosus*) from South Africa, presented by Mr T. White, two Weaver Birds (*Hyphantornis sp. inc.*) from South Africa, presented by Mr A W Arrowsmith, two Silver Pheasants (*Euplocamus nycthemerus* ♂ ♂) from China, presented by Mr. E Mitchener, a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Miss Kate Higgins; a Thick-tailed Opossum (*Didelphys crassicaudata*) from South America, a Garden's Night-Heron (*Nycticorax gardeni*); and two Saracura Rails (*Aramides saracura*) from South America, purchased, and a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, deposited

OUR ASTRONOMICAL COLUMN.

COMET BROOKS (AUGUST 28) —The following ephemeris, which we take from *Astronomische Nachrichten*, No 3125, gives the apparent Right Ascensions and Declinations of Comet Brooks, which is brightening very rapidly —

12h Berlin M T

1892	R A app h m s.	Decl app ° ′	Log r	Log Δ	Br
Nov 3	9 23 51	+9 55 8			
4	27 50	9 9 8	0 1265	0 0225	11 60
5	31 51	8 22 7			
6	35 55	7 34 6			
7	40 1	6 45 4			
8	44 10	5 55 2	0 1125	0 0034	13 51
9	48 21	5 4 0			
10	52 34	4 11 8			

Lying in the extreme northern corner of the constellation of Sextans, and nearly midway between ρ Leonis and ι Hydræ, it will not be an easy object for observation owing to its very late rising

COMET BARNARD (OCTOBER 12) —Prof R Schorr, of Hamburg, communicates to *Astronomische Nachrichten*, No 3125, the elements and ephemeris of Comet Barnard, deduced from observations made on October 16, 18, and 20, at Vienna, Hamburg, and Pulkowa respectively As this ephemeris differs rather considerably from the one we gave last week, the following places may prove of service to observers —

12h Berlin M T

1892	R A h m s	Decl ° ′	Log r	Log Δ	Br
Nov 3	20 24 38	+5 3 7			
4	27 20	4 44 0			
5	30 4	4 24 6	0 2298	0 1539	1 00
6	32 48	4 5 4			
7	35 34	3 46 4			
8	38 21	3 27 8			
9	41 9	3 9 4	0 2278	0·1590	0 99
10	43 58	2 51 2			

This comet will still be found to form approximately an equilateral triangle with α Aquilæ and β Delphini on November 5

TABULAR HISTORY OF ASTRONOMY TO THE YEAR 1500 A D —Dr Felix Muller, of Berlin, has just completed a small volume entitled "Zeittafeln zur Geschichte der Mathemathik, Phisik und Astronomie bis zum Jahre 1500," which will be welcomed by all interested in the very early history of the exact sciences. The book is arranged chronologically and gives a short account of the chief workers in these branches of science up to the year 1500 At the end of each reference a list of the literature likely to be needed is added The work is published by Messrs. B G Teubner, Leipzig

A LARGE TELESCOPE —The Americans seem to have made up their minds to be the possessors of the largest telescopes in existence, for in spite of their owning the great Lick Refractor (36-inch) we hear now that the University of Chicago are about to have "the largest and most powerful telescope in the world" This instrument will be the gift of Mr Charles Jerkes, and will cost half a million dollars The object glass will have a diameter of 45 inches and will be made by Messrs. Alvan Clark, of Cambridge, Mass.

THE ATMOSPHERES OF PLANETS —Of all the planets that revolve round our sun, Jupiter affords the most suitable of them for the study of atmospheric circulation That his circulation will not be exactly like ours will be at once evident, for not only does the sun pour his rays on his vast surface, but he possesses himself heat, as is suggested by the rapid changes which these cloud masses undergo A recent hypothesis, explaining the various movements in this planet's atmosphere, has been put forward by Mr Marsden Manson, in the fifth number (vol ix.) of the "Transactions of the Technical Society of the Pacific Coast," San Francisco. The chief element which produces these movements is the action of the sun, and it is on this reasoning that he attempts to unravel the laws underlying the circulation in Jupiter's atmosphere In this pamphlet he first brings together some of the facts relating to our own wind system, which are generally conceded, together with the important results that were gathered from the path taken by the Krakatoa

dust-cloud. The spots observed on Jupiter's surface are next dealt with, a table of their rotation periods and latitudes being included. From the latter he deduces that the mean periods of rotation of matter in the following latitudes are:—

Lat.			h.	m.	s.
12° N.	from 17 N. Temp. spots		9	55	36.49
4° N.	,, 5 N. Equat.	,,	9	50	40.06
8° S.	,, 21 S. Equat.	,,	9	50	22.4
30° S.	,, 3 spots		9	55	17.1

In treating of the spots themselves, he suggests that those which are of a white appearance are gyrating uprushes of warm air from the lower regions, while the dark ones are simply descending columns of cool air, "the two forming parts of the system of vertical circulation." The red spot, he suggests, is caused by a local escape of internal heat, the repellent force it appears to possess being due to the "spreading of the heated currents as they rise." He explains the retardation and acceleration of its period of revolution by the increasing force of the west winds, brought about by the exposure of the southern hemisphere during Jupiter's half-year (5.93 of our years), in this way the spot is sometimes situated over and sometimes to one side of the source of heat underneath. The author also deals with other spots in a similar manner.

GEOGRAPHICAL NOTES.

MR. SVEN HEDIN's account of his ascent of Mount Demavend is published in the last number of the *Verhandlungen* of the Berlin Geographical Society. Demavend is a volcanic peak rising abruptly from the sedimentary rocks of the parallel Elburz chains. Starting from the village of Ranah on the south-eastern slope with two guides on July 10, 1890, Hedin reached the summit on the afternoon of the next day. On the summit a large elliptical crater was found, the edges of which were strewn with blocks of porphyritic lava and sulphur. After discussing the aneroid and boiling point observations, Mr. Hedin arrived at 5465 metres (17,930 feet) as the height of the summit. This is lower than any of twelve earlier estimates which are cited, the highest of them being 6559 metres.

THE Italian possession of Eritrea on the coast of the Red Sea gives some promise of becoming useful agriculturally. Several small settlements of Italians on the plateau have succeeded in growing large crops of wheat and barley, and only the unsettled state of the surrounding natives threatens the prosperity of the farmers. The districts of Ocule Cusai and Guro are already fully cultivated, and Sarae, as yet almost unoccupied, has fertile land and plenty of room for colonists. The Italians are able to work in climatic conditions which would rapidly exhaust the natives of northern Europe.

THE general summary of Mr. Conway's expedition in the Karakoram range telegraphed from India (p. 525) has now been supplemented by a full narrative, written to the secretaries of the Royal Geographical Society from a camp on the Baltoro Glacier on August 29, with a postscript added at Skardo, on the way to Leh, on September 12. The difficulties of the preliminary journey were very great, not the least being the fording of several swollen glacier streams by a party numbering four Europeans, four sepoys, seventy coolies, an indefinite number of followers, and flocks of goats and sheep. The moraines on the Baltoro glacier were of almost incredible extent, for two thirds of its entire length the ice is entirely concealed by stones, except where crevasses or lakes occur, and the irregularity of the surface made travelling extremely slow. Mr. Conway limits the name of Godwin-Austen to the highest peak of "K²," giving to the whole mountain the somewhat cumbrous title of the Watch Tower of India. One branch of the Baltoro Glacier results from the union of seven glaciers from this mass; the larger branch descends from the snow-swathed, throne-shaped mountain, hitherto unmapped, for which the auriferous quartz found in its rocks suggested the name of The Golden Throne. This was fixed upon as the goal to be attained. The first attempt landed the Europeans and Ghoorkas, who made excellent climbers, on Crystal Peak, 20,000 feet in elevation, a peak as hard to climb as the Matterhorn, and isolated from the surrounding higher summits. No inconvenience was felt from the rarity of the air, and the party remained on the summit for an hour and a quarter. In the grand attempt on the Golden Throne serious difficulty was encountered from the terrible extremes of heat and cold. The last few thousand feet proved very exhausting, one of the Ghoorkas had to be left behind, suffering from mountain sickness. Every step had to be cut in hard ice. Finally the summit was reached at an elevation of 23,000 feet, but the Golden Throne stood revealed much higher, and separated by a deep depression. From the summit of Pioneer Peak, probably the highest yet reached by man, a series of photographic views was obtained and prismatic compass bearings taken to the surrounding features. As long as the party were at rest they felt no discomfort, but the sphygmograph showed that the heart's action was very laboured. A stay of an hour and a quarter was made on the summit, the view from which baffled description. The descent was safely made, but fatigue and bad weather stopped further exploration.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON the evenings of Wednesday and Thursday of last week, the 26th and 27th ult., an ordinary general meeting of the Institution of Mechanical Engineers was held in the theatre of the Institution of Civil Engineers, by permission of the council of the latter Society. The President, Dr. William Anderson, occupied the chair during the proceedings.

There were two papers on the agenda. The first was the report of the Institution's committee appointed to enquire into the value of the steam jacket. Mr. Henry Davey is the chairman of this committee, and he had prepared the report, which is a bare record of facts without comment, and in this respect is, we think, defective. Numberless experiments have been made in time past as to the value of the steam jacket, and those now added by the labours of the committee do not largely differ from many that have gone before. We take it that the general opinion of competent engineers is that an advantage in efficiency is to be obtained by jacketing engine cylinders in an efficient manner, and cases in which the jacket has not been proved efficient are those in which it has not been properly applied. What was wanted, therefore, was guidance as to the proper method of application, and it is significant that the most help in this direction came, during the discussion, from those who were not members of the committee. Timidity in expressing opinion will be excusably construed as indicating something of incompetence, and if the members are not capable of expressing opinion they are not suitable persons to form a research committee of an important institution. We frame our remarks hypothetically, because, with such names as Unwin, Bryan Donkin, and Mair-Rumley on the title page, there can be no doubt that the power to afford guidance was present, and for this reason the decision to give only bare fact is the more to be regretted. The general conclusion to be drawn from the experiments, as quoted, is that "the expenditure of a quantity of steam in an efficient jacket produces a saving of a greater quantity in the cylinder." It does not follow from this that the jacket is always desirable, as the saving may be so small as not to justify the additional complication and increased outlay at first cost. That, however, is a matter upon which steam users must themselves decide upon a commercial basis, and is, of course, outside the province of the committee, but what would have been valued would have been some critical remarks giving guidance as to what goes to constitute the "efficient jacket," what fresh engineering practice is opened up by the use of the efficient-jacket, and under what conditions it may be most effectually applied.

The first series of experiments quoted were carried out by Mr. J. G. Mair-Rumley, of the firm of James Simpson and Co., of Pimlico, upon a compound jet condensing beam pumping-engine. The diameters of the cylinders are 29 inches and 47.5 inches, with strokes of 65.1 and 96 inches respectively. Only the body of each cylinder is jacketed, the steam being supplied direct from the boiler at a pressure of 49lbs. per square inch above atmosphere. Experiments were made both with and without steam in the jackets. The total feed water per indicated horse power per hour when the jackets were not in use was 18.20 lbs., with the jackets in use the corresponding figures were 16.64 lbs., thus showing a percentage of less steam used due to the jackets of 8.6. The quantity of jacket water condensed was 1.20 lbs. per I.H.P. per hour. The boiler pressure here was not high, 49.7 lbs. without and 49 lbs. with jackets

The number of revolutions were also low, 14 8 without jackets and 15 78 with jackets. This was evidently an engine which should pay for jacketing. We next come to an experiment of a different nature, carried out by Mr. Davey and Mr W B Bryan. The engine is triple expansion surface-condensing engine of the inverted direct acting marine type, and is placed in the Waltham Abbey pumping station of the East London Water Works. The cylinders were 18", 30 5", and 51" in diameter, by 36 inches stroke. There is a Meyer expansion valve to the high pressure cylinder, by means of which the speed of the engine was regulated during the experiment. The bodies and both ends of all three cylinders are steam-jacketed. The jacket steam of the high pressure cylinder is at full boiler pressure, but the other two cylinders have the pressure reduced to a little above that of their steam chests by means of reducing valves. Each cylinder is therefore jacketed with steam a little above its own initial pressure. Without the jackets in use the amount of feed water per I H P per hour was 17 22 lbs, and with the jackets in use 15 45 lbs, showing a percentage of less steam used owing to the jacket of 10 3. The total jacket water was 1 72 lbs per I H P per hour. The coal consumption is given in these experiments, being 2 09 lbs per I H P per hour without the jackets, and 1 79 lbs with. The amount of coal burnt is not, of course, necessarily a measure of economy of the engine, but possibly the steam-generating plant —which included an economizer—was practically constant in its duty during both trials, and if so the commercial gain by the use of the jacket is quite an appreciable quantity. The boiler pressure here was 130 lbs above atmosphere, the number of expansions without the jacket 22, and with the jacket 30. The revolutions were 23 per minute, so that the jacket had again a favourable chance.

The next series of experiments were carried out by Colonel English, Mr Davey, and Mr Bryan Donkin, and in these we reach a much higher piston speed, so that the results stand on a somewhat different footing in this respect to those before quoted. We have no positive knowledge of this engine beyond that given in the report, but it would be desirable to know something more of its working before accepting the very high percentage of gain in steam used—19 0 per cent —as that due to a steam jacket used on a good engine. The feed used per I H P per hour was 24 68 lbs without the jacket, and with the jacket in use the quantity was 20 lbs. The following are the particulars of this trial.—Horizontal surface condensing compound engine, with intermediate receiver cylinders, 18 and 32 ins by 48 ins stroke. The ends of the cylinders are not jacketed, and the receiver jacket was not in use during the experiment. The boiler pressure was 50 lbs, the revolutions 57 06 without jackets, and 63 62 with, the feed water supply as stated, and the jacket water condensed per I H P per hour 1 13 lbs. The coal used without jackets was 3 26 lbs per I H P per hour, and with jackets 2 66 lbs.

The last set of experiments we shall quote were made by Prof Unwin, upon the experimental engine[1] at the City and Guilds of London Central Institution, South Kensington. It is a two-cylinder horizontal surface condensing engine, and can be worked either simple or compound. The cylinders are 8 73 inch and 15 76 in diameter, by 22" stroke. The high pressure cylinder is fitted with Hartnell expansion gear, and the low pressure with Meyer expansion gear. Only the bodies and the back ends of the cylinders are covered. We will first give results of trials working the engine with the low pressure cylinder only. The pressure was 60 lbs above atmosphere, the jacket pressure being taken direct from the boiler. The revolutions without the jacket were 112 40, and with the jacket 101 73. The feed water per I H P per hour without the jacket was 32 14 lbs., and with the jacket 26 69 lbs. This gives a saving of 17 per cent working simple. It will be seen presently that when the engine was working compound, the saving was 7 3 per cent. The jacket-water per I H P. per hour was 1 88 lbs. We will now take the records of the compound trial. The boiler pressure was 66·73 lbs. without the cylinders, and 67 80 lbs with the jackets. The revolutions were 93 66 without the jacket, and 96·11 with. The feed water used per I H.P per hour was 21 06 lbs. without the jackets in use, and 19 52 lbs. with. The saving, as stated, made by the use of the jacket was therefore 7 3 per cent. The jacket water used per I H P per hour was 2·40 lbs. We regret we are not able to give all the interesting details which Prof Unwin includes in his instructive report, but for these we must refer our readers to the original paper.

Probably Prof Unwin's 7 3 per cent saving in steam used is a far better measure of the value of the jacket than the inflated promise of 19 per cent in Major English's trial. It should be remembered that the jacket is more effective in small than in large engines, the area of cylinder will be in a higher ratio to the contained steam in the former than in the latter case. The number of expansions in the South Kensington engine working without jackets was 7 23, and with jackets 9 29. The corresponding figures in the case of the Woolwich engine were 9 4 and 12 6. The boiler pressure with the Woolwich engine was, however, 16 to 17 lbs higher than in the other case. The revolutions were 57 06 and 63 62 respectively in the two trials at Woolwich, whilst at South Kensington they were 93 66 and 96 11. It would have been instructive if the committee had had the courage to attempt some balance of these figures, and then have endeavoured to account for the large difference which we believe would have remained still to be accounted for.

The next experiments quoted comprise a series made by Mr Bryan Donkin, junr, at the works of his firm at Bermondsey. Mr Donkin's labours in this field are well known, and engineering science is largely indebted to him for the contributions he has made to its lore. One most valuable feature in connection with these investigations is the means he has used to ascertain the temperature of the walls of the cylinder at various distances from the surface. In this lies the essence of the problem. If the Jackets Committee would give us minute and trustworthy information on this point we could evolve the rest from existing data. If we do not quote Donkin's figures in full it is partly because his experiments are not yet complete and partly because they have been dealt with more fully in "another place," namely, the Proceedings of a Society other than tha with which we are now dealing.[1] We may state, however, that in one case when the steam in the jacket space was 298° Fahr the cylinder walls averaged 290° Fahr, whilst at 0 06 in from the piston the temperature of the cylinder wall was 284° Fahr. These temperatures were ascertained by thermometers placed in holes drilled in the cylinder. Other instances are given, but the matter is far too interesting to deal with in a cursory manner, such as a report of this nature alone warrants. The difficulty that suggests itself is the fact that a thermometer itself has a very appreciable thickness, and the record will be but a mean of the temperature due to that thickness. It is possible that Mr Donkin gets over this difficulty in some way. Perhaps the thermo-couple as used by Le Chatelier might afford a solution, although this apparatus is not so useful for recording small differences at low temperatures, being rather adapted for such work as hot blast stoves and other metallurgical purposes. Mr Bryan Donkin's experiments are the most suggestive in the report, as might be anticipated. Trials were made with steam at various rates of expansion to determine the effects of the steam jacket on the speed of engine and temperature of the cylinder walls, and on superheating. The engine used was a small one (6" × 8"), but it was specially constructed and arranged for the work. We again repeat Mr. Donkin's investigations are well worthy of the study of all interested in these matters.

The report concludes with a valuable appendix in the shape of suggestions for the use of those desirous of experimenting in this field.

The discussion on this paper was of a protracted nature, but was not of a kind altogether worthy of the leading mechanical institution of the country. Mr Morrison, of Hartlepool, made the most weighty contribution amongst the speakers. He pointed out the difficulty of maintaining a good circulation of steam in the jacket—one of the most important points to which the designer of jacketed engines should turn his attention—and illustrated a simple method by which he had secured this end. His arrangement consisted of a series of diaphragms, by means of which the steam was made to take a devious course through the jacket. Mr. Schonheyder pointed out a mistake the committee had made in placing an air cock on the top of the jacket, when it was required to draw off air from the steam. Of course, this is one of those little slips which the wisest are apt to make, for it would be absurd to suppose such authorities as those en-

[1] This engine is stated in the report to have been fully illustrated and described in *Engineering* of November 16, 1888. The triple expansion engine at Waltham Abbey is also said to have been illustrated and described in the issue of August 8, 1891, of the same publication.

[1] See Proceedings Inst. Civil Engineers.

gaged did not know that air is heavier than steam. One might as well say one's grocer did not know sand from sugar.

The Jackets Committee has not yet concluded its labours, and another report will be forthcoming in due course. Mr. Aspinall has offered a locomotive for trial, and we heard that Mr. Yarrow will put a torpedo boat at the disposal of the committee, and has even promised to cast special cylinders for experimental purposes. The locomotive will afford an interesting field of research, running as it does so largely linked up. The torpedo boat experiments will be no less interesting, especially in view of the great number of revolutions the engines of these craft make in a given time.

On the second day of the meeting the paper by Mr. Walker of Bristol on the screw propeller. This paper gives the details of some experiments made by the author on a form of screw propeller invented by the late Mr. B. Dickinson. It would be in vain for us to attempt to condense this paper within the limits at our disposal. With regard to the merits of the Dickinson propeller we have nothing to say. It consists essentially of two narrow blades in place of one, and reminds us strongly of a Mangin propeller with one blade set somewhat back on the shaft. Mr. Walker contends that his researches prove the advantages of long narrow blades, but he did not appear to have converted the high authorities present, including Mr. Froude, Mr. Thorneycroft, and Mr. Barnaby—the three best-known names in connection with the subject—to his views. It is difficult to see wherein the value of the paper exists. Prof. Kennedy in the discussion stated that the generally received opinion as to the increase of the friction of the load was erroneous, and that the power absorbed in this way does not increase in the manner stated, a fact which he illustrated by means of a diagram. Mr. Thorneycroft pointed out that "life was not long enough" for the larger trials proposed by the author, but that he might decide one point if he would confine himself to models. Mr. Barnaby stated that a broad bladed propeller should not be a uniform pitch. Mr. Froude's speech was a lucid criticism of the author's paper, the speaker pointing out in a kindly but convincing manner that the conclusions arrived at by the author might be subject to revision. Mr. Dunell, whose previous experiments the author had quoted, added to the information given by putting forward some other experiments he had made upon screw propellers fitted to a torpedo boat, in this case the results being opposed to those claimed by the author, inasmuch as the shorter and broader blade had proved the more advantageous. Mr. Shield, of Liverpool, described a form of propeller which has been in use on the Mersey, and appears to offer some advantages. The blades are attached to the boss in two parts, and are joined in a loop at the top. According to Mr. Shield's statement, the arrangement gives great advantages in towing, and also increased steadiness in running. The latter we can accept as a fact, but the great increase in towing capacity seems almost too good to be accepted literally. Twenty five per cent. additional efficiency is a very large gain without further expenditure than an exchange of screws; but this is what the propeller in question is said to realize.

The meeting concluded with the usual votes of thanks.

INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES

THE International Committee of Weights and Measures, which was established in consequence of the Metric Convention of 1873, has recently issued its fifteenth annual report to the Governments represented at that Convention.[1] The committee have also lately published the minutes of their proceedings (Procès-Verbaux des Séances. Paris, 1892. 1 vol. 8vo) at the annual meeting held at Paris in September, 1891. It appears to be hardly possible that the proceedings of the committee at their meeting which was held last month may be issued before next year, but from the above publications, as well as from a recent volume of their "Travaux et Mémoires," we gather that they continue to carry on their investigations with all despatch.

In their last report the committee deplore the death of their colleague, Jean Servais Stas, whose analyses of the platinum alloys have, together with those of St. Claire Deville and George Matthey, so largely helped forward the principal work of the committee; the metallurgical studies of Stas are indeed recognized as veritable models of classical research in this particular field.

The new instruments added to the Bureau at Sèvres during the last year include a normal barometer (le Baromètre Fuess) and manometer, originally verified for reference as an international standard in accordance with the decisions of the Meteorological Conferences, particularly that at Munich last year. The committee have also obtained a new apparatus for determining the normal thermometric "boiling point," or the temperature of 100° Centigrade, as it has been found that the form of apparatus used by Regnault was unreliable for this purpose. In the reading of the standard manometer it would appear that higher accuracy has been obtained by raising the surface of the mercury up to a fixed point, the image of the point in the mercury being observed at the same time by means of a microscope. The Wild-Pernet barometer has been re mounted, and the Bureau are now prepared to undertake the verification of any standard barometer.

The readings of all mercurial thermometers are given at the Bureau in terms of the hydrogen thermometer; and a 30 litre holder for methyl chloride, or liquid carbonic acid, has been made by Brigonnet and Navile. The low temperature experiments have been continued by M. Chappuis down to −75° Cent., and toluol and alcohol thermometers have been compared with the hydrogen thermometer. It has been found that "toluol" is more sensitive and reliable for low temperatures than alcohol.

We note that the meteorological work of the committee has largely developed itself, and that, as in geodetic research, the Bureau at Sèvres is now recognized as a central and international station of reference. Standard thermometers have been verified, for instance during 1892, for the Governments of Russia, France, and Roumania; for the Universities of Rome, St. Petersburg, and Odessa; for Owens College, Manchester; and for several recognized meteorological observatories. Great Britain has also been supplied by the committee with standard thermometers similar to those supplied to other contracting States.

Besides the standard metre and kilogramme already delivered to this country, the Bureau is undertaking the construction of a further standard metre for the Board of Trade, at a cost of 12,588 francs. The new standard appears to have been nearly two years in construction, but its verification is now promised this year.

There are twenty one different governments who have joined the Convention and who contribute annually towards the expenses of the Bureau (the annual budget of which is 75,000 francs), sums varying from 134 francs (Denmark) to 9482 francs (Germany): the annual contribution of Great Britain and Ireland for 1892 being stated at 4699 francs, or nearly £188; and that of the United States at 8471 francs.

At the instance of Dr. B. A. Gould the committee are now also undertaking an inquiry affecting measurement by light waves. By the use of the "Refractometer" Dr. Michelson found (*Philosophical Magazine*, April, 1891, and September, 1892) that accuracy of measurement by light waves may be increased to a high degree of accuracy. By the best spectroscopic instruments now in use it has been stated to be difficult to "resolve" lines as close together as the components of the yellow sodium lines, but that if the width of the lines themselves be less than their distances apart, then there is no limit to their accuracy of measurement by the "Refractometer." We shall look forward with interest to the publication of Dr. Michelson's further results, in the next volume of the "Travaux et Mémoires" of this committee.

The new instrument designed by M. Gustave Tresca, of the Conservatoire des Arts et Metiers at Paris, for the adjustment and polishing of the terminal surfaces of end measures of length appears also to be better than anything yet adopted in England.

The committee not only undertakes the verification of standards and instruments for the High Contracting Governments (who have the right to demand such verifications), but they also verify for any scientific authorities or persons. To those of our readers, therefore, who may desire to have standards or instruments verified by the committee, the following information may be useful:—

Applications for the verification of instruments should first be made to M. le Directeur du Bureau International (Dr. René-Benoît), au Pavillon de Breteuil, Sèvres, près de Paris.

[1] Rapport du Comité International. Gauthier-Villars. Paris. 1 Vol. 50 pp., 1892.

Standards may be sent to Sevres by post or railway (at the cost and risk of the owner), or still better, they may be delivered and removed from the Bureau by the owner or his agent. A certificate of verification will be given when the standards are ready for removal In any application to the director the denomination of the standard, or the description of the instrument, should be stated, and the nature and extent of the verification demanded

The committee will verify metric standards of length of one, two, three, and four metres, or subdivisions of the standard metre, if made in metal or some durable stone Line measures should have their graduations so fine as to be well observed with a microscopic power of sixty diameters, and end measures should have their terminal surfaces sufficiently adjusted and polished so as accurately to define the length of the bar Measures of mass may be made also of metal or some durable stone, but each must be in one piece without handles, grooves, or adjusting holes For thermometers and barometers special regulations are issued, which may be obtained at a small charge from MM Gauthier Villars, 55, Quai des Grand Augustins, Paris

The fees on verification of measures of length vary from 60 to 400 francs, according, of course, to the extent of the verification demanded, for metric weights from 20 to 120 francs, and for thermometers and barometers from 10 to 80 francs

What should be the true equivalent length of the yard measure in terms of the metre, may appear to some to be almost a trifling matter - because the measurement in dispute, or probable error of the equivalent at present adopted in this country, amounts only to 0 0008 inch It is, however, a fact that so small a difference as 0 0008 in this equivalent would not only be felt in scientific researches but also in practical work Messrs Comstock and Tittman, of the United Coast Survey, as well as Dr Peters, of Germany, and the Director of the International Committee, have found that the equivalent length of the metre (39 3708 inches) as ascertained by Kater and Arago, in 1818, is inaccurate, to the extent of 0 0008 inch, and that the true equivalent ought to be nearly 39 3700 inches This latter value will, we have no doubt, be ultimately recognized in scientific work

In the field of electrical measurements, we find that Dr Guillaume is continuing his investigations as to the measurement of temperature by electrical methods, and as to the variations of mercurial standards of resistance, a work originally begun at the Bureau, by Dr Benoît, in connection with the standard ohm It would not appear that mercurial thermometers can be superseded for ordinary measurements of temperature, but that measurement by resistances may afford useful results in determining the temperature of a given mass or space, as the whole length of a column of mercury Dr Guillaume gives an account of his work on mercurial standards in the Procès-Verbaux recently issued (page 183)

During the past year Commandant Defforges, of the Geographical service of the French army, has been undertaking at the Bureau an inquiry into the effect of the force of gravity at the latitude of Breteuil, by means of a seconds pendulum and apparatus constructed by Brunner M Defforges found that at Breteuil (longitude east of Paris 0° 131, latitude north 54 260, and altitude 70 4 metres) $G = 9\ 80991$ m

We cannot conclude this glance at the recent work of the International Committee without expressing an opinion that the scientific success of their work and the accuracy of its record, owe much to the energy and watchful care of the new president, Dr Foerster, and the secretary of the committee, Dr. A. Hirsch.

NOTES ON SOME ANCIENT DYES[1]

THE fragments of ancient dyed fabrics which I have examined I owe to the kindness of Mr R D Darbishire They are specimens from a lot found by Mr. Flinders Petrie in a tomb at Garob, Lower Egypt, supposed to date from 400–500 A D They were used apparently for filling the mummy cases where required, not strictly speaking as grave clothes My object in examining them was to ascertain, if possible, what were the materials employed in producing the various colours seen on them The fabrics examined consisted almost entirely of wool Here and there in the warp of some of the specimens were threads, conspicuous for difference in colour, consisting of linen The following colours could be distinguished:—blue, yellow, green, red, maroon, purple or claret, black I will take them in the order named

Blue —The colour of the fabric was a dull medium blue On treatment with hot caustic lye a great part of the wool dissolved The residue, which was dark blue, having been filtered off, washed and dried, was treated with boiling aniline, to which it communicated a bright blue colour The blue solution having been filtered boiling, deposited on cooling a quantity of blue crystalline scales, which, after being filtered off, washed with alcohol and dried, were found to consist of indigo blue On being treated in a tube they gave a sublimate of regular crystals, blue by transmitted, copper-coloured by reflected, light, they dissolved in concentrated sulphuric acid, giving a blue solution, and the solution in aniline showed the absorption spectrum of indigo blue It is evident, therefore, that indigo in some form or other was the material used in dyeing this colour

Yellow —The colour of the patches dyed yellow was so evidently faded, and showed so little intensity, as to make it very uncertain whether analysis would lead to any precise result, the examination was therefore omitted

Green —Of the material dyed this colour, I had but a small quantity, but it was sufficient to allow of some conclusion regarding the means whereby the colour was produced On being treated for some days with dilute hydrochloric acid it imparted to the latter a deep yellow colour The portion left by the acid, after being washed and dried, yielded indigo blue on treatment with boiling aniline It is probable, therefore, that the colour was produced by first dyeing the fabric with indigo, then treating with some mordant, such as alum, and, lastly, dyeing with some yellow colouring matter, most likely of vegetable origin With the small quantity of material at my disposal, I found it impossible to ascertain the nature of the yellow colouring matter employed

Red —This was the most pronounced, and at the same time the most interesting, of the colours examined The colour of the fabric was a full deep red It might be called a Turkey red, the dye, in fact, proved on examination to be a kind of Turkey red as having the characteristic properties of that dye

On being burnt, the fabric left a considerable quantity of ash, consisting of calcium sulphate, alumina, aluminium phosphate, ferric oxide, and silica A large portion of this ash no doubt represents the mordant employed in producing the colour On treatment with hot dilute hydrochloric acid, the fabric lost its red colour and became yellow After removal of the acid by washing with water, and pressing between blotting paper, treatment with boiling alcohol deprived the wool of the greater part of the yellow colour, a faint tinge only being left. The deep yellow alcoholic liquid obtained left on evaporation a reddish-brown amorphous residue This, on being treated with a boiling solution of alum, dissolved in part, yielding a pink fluorescent liquid, which had exactly the same colour, and showed precisely the same absorption bands as a solution of purpurin from madder in alum liquor On adding hydrochloric acid to the pink solution and heating, the colouring matter was precipitated in orange-coloured flocks, the liquid becoming almost colourless The flocks after being filtered off and washed with water dissolved easily in boiling alcohol, yielding a yellow solution, which, on spontaneous evaporation, left a quantity of dark yellow needles arranged in rosettes These needles dissolved in caustic alkali, giving a cherry red solution, which showed the absorption bands of purpurin. The solution, on exposure to air and light, became colourless

Some of the precipitated colouring matter, on being employed in the usual way for dyeing a bit of calico to which various mordants had been applied, yielded colours exactly like those obtained with purpurin from madder, *i e*, the alumina mordant gave a bright red, the iron mordant dull purple to black tints The matter left undissolved, after repeated treatment with boiling alum liquor, was still highly coloured. It dissolved easily in alcohol, the solution leaving on evaporation a brown amorphous residue, which remained soft even after long standing. This residue consisted for the most part of fatty matter, but it also contained some colouring matter insoluble in alum liquor. That this colouring matter was alizarin seemed probable, since the colour which the mixture imparted to alka-

[1] Reprinted from "Memoirs and Proceedings of the Manchester Literary and Philosophical Society," 1891-92 (Fourth Series, vol 5, No. 2).

line lye resembled that of an alkaline solution of impure alizarin

These experiments lead to the conclusion that the red colour of the fabric was produced by dyeing with some kind of madder, either wild or cultivated, the fabric having been previously treated with a mixed aluminous and ferric mordant, and then probably oiled—that it was, in fact really a kind of Turkey red

Maroon —The dull chestnut colour of this fabric presented a striking contrast to the bright red of the preceding Its constitution was, however, similar Having treated it in the same way as the other, I found that the colouring matter must have been derived from madder, fatty matter was also present, but the mordant contained a larger proportion of ferric oxide, a fact which sufficiently explains the brown tint of the dyed fabric

Purple —The fabric in which this colour was seen was made up of a pale yellow warp, and a weft of a dull purple or claret colour The latter colour was found to be due to an intimate mixture of red and blue, for the threads, on examination under the microscope, were seen to consist partly of red, partly of blue fibres, the former predominating The two sets of fibres had, of course, been mixed before spinning The blue fibres were certainly dyed with indigo, the red probably with madder

Black —The colour of the black fabric, like that of the green, was a compound of two colours, one overlying the other Under the microscope the individual threads appeared grey On treatment with a mixture of alcohol and hydrochloric acid they changed colour, a yellow liquid being obtained, while the fabric itself now appeared blue, and after washing and drying yielded indigo by appropriate treatment The yellow alcoholic liquid was found to contain purpurin. The colour may be supposed to have been produced in the following manner —The woollen fabric having first been dyed blue was mordanted, to use a modern phrase, and then dyed with madder, the two colours together producing the effect of black

EDWARD SCHUNCK

SCIENTIFIC SERIALS

IN the *Botanical Gazette* for July, August, and September, there are several papers of general interest Mr G A Rex presents a further contribution to our knowledge of the Myxomycetes in an account of the genus *Lindbladia* —Mr D T McDougal gives a detailed account of the morphology and anatomy of the tendrils of *Passiflora cærulea* —Mr M B Thomas describes and figures an apparatus for determining the periodicity of root pressure in plants —Mr C L Holtzman has a short paper on the Apical growth of the stem and the development of the sporange in *Botrychium virginianum*, his observations favouring the view that the Ophioglossaceæ are a more primitive form than the typical Filices —Mr A F. Foerste continues his observations on the Relation of autumn to spring blossoming plants —Mr Charles Robertson gives a further instalment of his series of papers on Flowers and insects —A brief report is given of the botanical papers read at the recent meeting of the American Association for the Advancement of Science

IN the *Journal of Botany* for September and October, no less than four new species are added to the British flora and to science—*Hieracium hibernicum*, *H duriceps*, and *H Breadalbanense*, by Mr F J Hanbury, and *Ranunculus petiolaris* (sect. Flammula) by Rev E S Marshall —Rev W Moyle Rogers continues his Essay at a key to British Rubi, Mr E G Baker his Synopsis of genera and species of Malveæ, and Mr W. A. Clark his First Records of British Flowering Plants

Bulletin of the New York Mathematical Society Vol ii No. 1, October, 1892. (New York)—Prof Cajori opens this number with an interesting note on the evolution of criteria of convergence (pp 1–10), in which he discusses some special and general criteria furnished in the writings of Gauss, Cauchy, Abel, DeMorgan, Bertrand, Kummer, and others, and notices specially the remarkable advance made by Pringsheim (*Math Ann.* vol. xxxv.).—Dr. A Martin calls attention (pp. 10–11) to a slip in Ball's "Short History of Mathematics" (p. 102), the probable origin of which is accounted for by Mr Ball.—There is a slight review of Chapman's "Elementary Course in the Theory of Equations" (pp 11–12), and the rest of the issue is taken up with the usual list of new publications and notes In these last Dr Martin points out a curious error in the Royal Society "Catalogue of Scientific Papers," vol ix (1874–1883), where, of the papers accredited, on p 790, to Ezekiel Brown Elliott, Nos 5 11, 14–17 should be assigned to Mr Edwin Bailey Elliott, of Oxford, and not to the late Mr Ezekiel Brown Elliott, of America, to whom Nos 4, 12, 13 are rightly attributed

IN the *Bullettino* of the Botanical Society of Italy, we find in addition to papers of more local interest, a further communication from Sig Macchiati on the Cultivation of diatoms, in which he states that the presence of infusoria and of diatoms in the water is mutually beneficial to one another, while the most destructive enemies of the latter are bacteria —A paper by Sig Piccioli on the Biological relations between plants and snails, is chiefly devoted to the protective contrivances found in the former against the attacks of the latter, the most important of which are of a chemical nature—tannin, latex, oleiferous glands, and poisonous salts such as calcium oxalate mechanical means of protection, such as hairs and a comparatively thick cuticle, play a subordinate part —In a further communication by Prof Arcangeli on the Cultivation of *Cynomorium coccineum*, he states that he does not find such an intimate parasitism with its host as is the case with the Rafflesiaceæ and the Balanophoraceæ.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 24.—M de Lacaze Duthiers in the chair —Researches on the fixation of atmospheric nitrogen by microbes, by M Berthelot The investigation was made in order to elucidate the mechanism of the fixation of atmospheric nitrogen It appears that the presence of green vegetable material is not essential to the process The colourless bacteria are able to absorb nitrogen when supplied with humic acid only as nutriment The assimilation takes place more readily with natural than with artificial humic acid, probably because the former contains more nitrogen. In experiments with hermetically sealed cultivations it was found that the gain of nitrogen by the organic material under cultivation was 6 or 9 per cent in excess of that supplied by the humic acid, the difference being derived from the enclosed air With an occasional stream of dust laden air this was brought up to 30 per cent —Coloured photographs of the spectrum on albumen and bichromated gelatine, by M G Lippmann Albumenized and gelatinized plates soaked in bichromate of potash may be employed for photographing in colours They are used like silver-salt plates, being placed so that the mercury is in contact with the film The colours will appear immediately after immersion in water, which develops and also fixes the image It disappears on drying, but reappears as soon as the plate is soaked The colours are very brilliant, and visible at all angles Those of gelatine plates are brought out by simple breathing The theory is analogous to that of silver plates, the maxima and minima of interference producing hygroscopic and non hygroscopic layers with varying refractive indices —The irrigation canals of the Rhone, by M Chambrelent —A new apparatus, the schiseophone, serving the purpose of exploring the internal structure of metallic masses by means of an electro mechanical process, by M de Place. The apparatus consists of a microphone and an induction sonometer To the microphone is attached a rod of hard steel, kept oscillating once or twice per second, and striking each time against the casting or other mass of metal under investigation The sonometer, consisting of two coils movable towards or away from each other along a divided scale, with a telephone connected with one of the coils, is placed in another room, and joined by wires to the microphone. The coils being so adjusted that the tapping is scarcely perceptible at the sonometer, the casting is moved so as to expose various portions to the impacts. If the thickness be uniform, any flaw or fissure will be at once indicated by a change in the sound —Observations of the comet Barnard (D 1892), made at the Paris Observatory, by M G Bigourdan

—Elements of the comet Barnard, of October 12, 1892, by M. L. Schulhof.—On the algebraic integrals of the differential equation of the first order, by M. L. Autonne.—On centres of geodesic curvature, by M. Th. Caronnet.—On Pfaff's problem, by M. A. J. Stodolkievitz.—Sunspots and magnetic disturbances in 1892, by M. Ricco.—On considerations of homogeneity in physics, reply to M. Clavenad, by M. Vaschy.—Verification of parallelism of optic axes in uniaxial crystalline plates, by M. Bernard Brunhes.—On a photoptometric photometer, for the measurement of feeble illuminations, by M. Charles Henry. This is based upon the constancy of the phosphorescent sulphide of zinc. Its law of loss of brilliance being determined, it may be used for measuring very feeble illuminations, such as distant artificial light or the general luminosity of the sky due to the stars. The decrease of light after the first 900 seconds being given by $i^{0.5}(t - 18.5) = \text{const.}$, it is easy to calculate the luminosity at any instant. In the instrument in question there are two screens of ground glass, one of which is illuminated by the phosphorescent sulphide, brought to its maximum glow at a certain time by burning magnesium ribbon, the other exposed to the source of light. It is then only necessary to wait till both the screens are equally illuminated, and to note the time.—On the dissociation of chrome alum, by MM. H. Baubigny and E. Pechard.—On the temperatures of maximum density of aqueous solutions, by M. L. de Coppet.—On some double salts of quinine, by M. E. Grimaux.—On the thermal value of the three functions of orthophosphoric acid, and on its constitution, by M. de Forcrand.—Preparation and properties of fibroine, by M. Leo Vignon.—Regeneration of the so-called sporangial form in the diatoms, by M. P. Miquel.—On the hematozoaria of cold-blooded vertebrates, by M. Alphonse Labbé.—Influence of coloured light on the development of animals, by M. E. Yung.—On the mode of fixation of the hexapod parasitic larvæ of the acarians, by M. S. Jourdain.—The cavern of Brassempouy, by M. Édouard Piette.—Discovery of a skeleton of *Elephas meridionalis* in the basaltic ashes of the volcano of Seneze, by M. Marcellin Boule.—Vegetable prints of the Dover boring, by M. R. Zeiller.

Berlin

Meteorological Society, October 11.—Prof. von Bezold, president, in the chair.—Dr. Berson reported on an interesting relationship which he had discovered between insolation and temperature. Since it has not yet been possible to determine accurately the absorption due to the atmosphere, the speaker had calculated the insolation at the external limit of the atmosphere, which admits of rigid mathematical treatment, both for the whole year and for the months of January and July. The mean of insolation for the whole year was found to lie at the thirtieth degrees of northerly and southerly latitude, so that the zone between these parallels, or about 60 per cent. of the whole external surface, receives more insolation than the mean, whereas the two polar caps, or the remaining 40 per cent., receive less. A similar calculation of the annual temperature gave the mean as at latitude 38° N. and 35° S., giving as before 60 per cent. of the surface with the temperature above the mean, and 40 per cent. below. In January 61.35 per cent. of the surface experienced an insolation above the mean and 60 per cent. a temperature above the mean, while in July the percentages were respectively 61.37 and 61.33.—Dr. Zenker gave a short account of a research on the relationship between temperature and insolation on the earth's surface. He had accurately calculated the relationship both for regions comprising land only and water only, and arrived at some interesting conclusions as to the theoretical temperatures at various latitudes of continents and oceans.

Physical Society, October 21.—Prof. Kundt, president, in the chair.—Dr. Jager gave an account of the measurements he had made, in conjunction with Dr. Kreischgauer, of the temperature-coefficient of electric conductivity of mercury. Dr. Arons demonstrated an arc light between mercurial electrodes in vacuo. It yielded a dazzling white light, which was steady at the anode but flickered and jumped at the cathode. Its intensity approximated to that of an ordinary carbon arc-light. The heat given off by it was but slight so that the tube could be held in the hand; the temperature was highest at the cathode. Attempts were made to determine the resistance of the arc, but without result. It was found by the use of a telephone that the current is discontinuous. A spectroscopic investigation of the light revealed a lime-spectrum showing very brilliantly a yellow, a green, and a blue line. In addition to the ordinary lines due to mercury some twenty new lines were observed. No satisfactory results were obtained by using amalgams instead of mercury, with the one exception of sodium amalgam. It is proposed to make further experiments with fluid amalgams of sodium and potassium.

BOOKS and SERIALS RECEIVED

Books.—The Great World's Farm: S. Gaye (Seeley).—The Zoological Record, 1891 (Gurney and Jackson).—Castorologia, or the History and Traditions of the Canadian Beaver: H. T. Martin (Stanford).—Transactions of the Royal Society of Edinburgh, vol. xxxvi. Parts 2 and 3 (Edinburgh).—Les Alpes Françaises: A. Falsan (Paris, Baillière).—Calendar of the University College of Wales, Aberystwith, 1892-93 (Manchester, Cornish).—London Birds and other Sketches, revised edition: T. D. Pigott (Porter).—Contents and Index of the First Twenty Volumes of the Memoirs of the Geological Survey of India, 1859-83: W. Theobald (Calcutta).—Memoirs of the Geological Survey of India, Index to the Genera and Species described in the Palæontologia Indica, up to the Year 1891: W. Theobald (Calcutta).—Star Atlas: Dr. H. J. Klein, translated, &c., by E. McClure, new edition (S.P.C.K.).—City and Guilds of London Institute Programme of Technological Examinations, 1892-93 (London).—Appareils d'Essai à froid et à chaud des Moteurs à Vapeur: M. Dudebout (Paris, Gauthier Villars).—Canon Torpilles et Cuirasse: A. Croneau (Paris, Gauthier Villars).—Ostwald's Klassiker der Exakten Wissenschaften, Nos. 31-37 (Leipzig, Engelmann).—Gesammelte Abhandlungen über Pflanzen-Physiologie. Erster Band: J. Sachs (Leipzig, Engelmann).—On the American Iron Trade and its Progress during Sixteen Years: Sir L. Bell (Ballantyne).—Universal Atlas, Part 20 (Cassell).

Serials.—The Physical Society of London, Proceedings, vol. xi. Part 4 (Taylor and Francis).—Botanical Gazette, October (Bloomington, Indiana).—Traité Encyclopédique de Photographie. Premier Supplément A, quat. fasc.: C. Fabre (Paris, Gauthier Villars).—Zeitschrift für Wissenschaftliche Zoologie, liv. Band, 4 Heft (Williams and Norgate).—Morphologisches Jahrbuch, xix. Band, 1 Heft (Williams and Norgate).

CONTENTS.

THURSDAY, NOVEMBER 10, 1892

EXPERIMENTAL BIOLOGY

Experimental Evolution By Henry de Varigny, D Sc. (London Macmillan, 1892)

DR HENRY DE VARIGNY has enriched the literature of biology by publishing in the "Nature Series" the lectures on "Experimental Evolution" delivered by him in 1891 to the Summer School of Art and Science in Edinburgh. This school, as is well known, has been doing good work on Extension lines in Edinburgh, and Prof Geddes is to be congratulated on having secured the co-operation of so able a biologist and so lucid an exponent of the special aspects of biology with which he has identified himself as M de Varigny The lectures are well worthy of publication, for they contain a rich, well-ordered, and, for the most part, well sifted body of facts collected from many sources, and especially from the publications of French naturalists But the author is more than a collector of facts recorded by other workers, he is himself a worker in this special field of biological science And some of the most valuable of the observations contained in the work are the result of his own careful and exact investigations

Experimental biology is still in its infancy It is true that our domesticated animals and plants are the result of much experimental work in the past, but the experiments were not planned with the object of explaining organic nature, and were therefore not biological in their aim There is pressing need at the present time for experiments with such definite scientific aim, for experiments, that is to say, carried out with the express object of testing the truth of biological principles And that this work be well done there is pressing need for organization We have only to look at the results which have been reached by well-planned and well-directed marine stations in extending our biological knowledge, faunal, morphological, and embryological, to see what may be done by organization of research. What Dr de Varigny eloquently pleads for, and what our own countryman, Dr Romanes, is also pleading for, is an experimental institute, well planned and adequately supported, the purpose of which shall be to carry out extensive experiments for testing evolution hypotheses in all their bearings

"It appears to me," says Dr. de Varigny, "that this institution should comprise the following essential elements :—Rather extensive grounds, a farm with men experienced in breeding, agriculture, and horticulture, some greenhouses, and a laboratory with the common appliances of chemistry, physiology, and histology Of course this must be located in the country. It is very important to have experienced farm hands, and a good chemist and histologist are necessary in the staff of the institution. As to the general management, it seems advisable to have a director with a board of competent men, whose functions would be to decide, after careful investigation and exchange of views, what are the fundamental experiments to be performed These experiments, when once decided upon, should be pursued during a long period of years, and nothing should be altered in their execution unless considered advisable by the board, or unless the experiment should be found useless, or devoid of chance of success The main thing should be to provide for the duration of the experiment, whether the originators were living or dead, and to follow it out for a long time Time is an indispensable element in such investigations, and experiments of this sort will surely exceed the normal duration of human lifetime"

A special branch of the work of such an institute should be experimental investigations in comparative psychology Of this there is nowadays some need Speaking of the transmission of acquired characters, Dr de Varigny says, "Psychology affords similar instances A kitten which has never seen a dog is afraid from the first moment it perceives one, young birds of many species instinctively fear the hawk and other birds of prey, while remaining unaffected by the presence of other birds Are not these psychological 'attitudes' due to environment (acting on the *mens* of ancestors) which have been transmitted by inheritance, are these not *acquired characters?*" From observations of my own I am prepared to say that it is by no means universally true that a kitten which has never seen a dog is afraid from the first moment it perceives one Mr Spalding does indeed describe how the smell of his hand with which he had been fondling a dog set four blind kittens puffing and spitting in a most comical fashion But a careful observer, Mr Mann Jones, writes to me that a young kitten with which he experimented "took eight days to connect the smell or odour of his hand with the thing—dog" And my own observations are confirmatory of those of Mr Mann Jones. Mr Hudson, in a very interesting chapter of the "Naturalist in La Plata," gives observations which tend to show that young birds afford little evidence of instinctive fear of particular enemies, and my own experiments with young chicks lead me to believe that they have no instinctive knowledge of the things of this world Any unusual and sharp sound (*e g*, a chord on the violin), any large approaching object (*e g.*, a ball rolled towards them), causes alarm There is no evidence of instinctive particularisation of alarming objects Such observations lead me to look with suspicion on any arguments for the transmission of acquired characters based on supposed instinctive knowledge of things And they show the need of further research in comparative psychology such as could be carried out at the Institute of Experimental Biology

It may be said that the central hypothesis of modern evolution, that of natural selection, stands in no need of experimental verification. But it will presumably be admitted, even by those who are firm in their belief, among whom I count myself, that further experimental support will be of the utmost value There are many who assume a sceptical attitude, and who say—We grant the inexorable logic of your conclusions if your premisses be established More individuals are born than can or do survive, the devil devours the hindmost, and a beneficent selection rewards the survivors with the privilege of procreation. hence, progress towards increased adaptation A very pretty piece of logic But now, they say, show us the devil at work. We pretend to no particular knowledge

of these matters, but we are quite ready to be convinced by proven facts. Prove to us this devil's work, and we acquiesce in your conclusion But do not put us off with a logical "must be," the recognized symbol of an assumption Do not tell us that since a hundred were born and only two survive, the ninety-eight must be in some way and for some reason unfit This is just the very fact of which we require definite and indubitable evidence.

Now what solid and unimpeachable body of evidence have we wherewith to conclusively refute this scepticism? If animals or plants removed to a new environment assume a new habit, in how many cases is it clearly *proved* that this is due to the elimination of all those who failed to vary in the direction of this habit? It behoves us to be careful that the very strength of the natural selection hypothesis be not a source of weakness, by leading us to neglect the duty of experimental verification That there should be a central institute or institutes for the purpose of such experimental verification, is what Dr de Varigny and Dr Romanes are pleading for It would produce a salutary organization of research, for the institute would have carefully selected correspondents in all parts of the world who would carry out their experiments in concert It would bring scattered energies to a focus It would by its journal show individual workers where research is specially needed It is bound to come sooner or later We hope to see it an established fact before the close of the present century.

C LL M

BRITISH FUNGUS FLORA

British Fungus-Flora, a Classified Text-Book of Mycology By George Massee In 3 vols Vol. I (London and New York George Bell and Sons, 1892)

IT was in 1836 that Berkeley published his "British Fungi" as a part of Hooker's "British Flora," and for about a quarter of a century this was the standard work In 1860 appeared Berkeley's "Outlines of British Fungology," which from the first was disappointing, inasmuch as it was only a barren catalogue for all except the large and conspicuous species, and even the latter were so compressed in description, by the exigencies of confining the book within narrow and definite limits, that it did not wholly supersede the use of the old "British Fungi" In 1871 an effort was made to repair the error by the publication of Cooke's "Handbook of British Fungi," which brought the whole subject up to date, and gave a new impetus to British mycology On account of the considerable acquisition of species, new to the British flora, it was deemed fitting in 1871 to produce a new work which should include these additions, and then Stevenson's "British Fungi" appeared. This new work only included the "Hymenomycetes," or, in effect, part of the first volume of Cooke's "Handbook," leaving all the rest untouched. In order to remedy this deficiency in part, Cooke's "Myxomycetes" was issued in 1877, and Phillips' "Manual of British Discomycetes" in 1887. Meanwhile a second edition of a portion of Cooke's "Handbook" was being issued as a supplement to "Grevillea," but confined exclusively to the *Agaricini*. With the exception of Plowright's "British Uredineæ" published in 1889, all the rest of the orders contained in the "Handbook" remained as they were in 1871 The unrevised portions included the *Pyrenomycetes*, or Sphæriaceous fungi, the *Sphæropsideæ*, or imperfect Pyrenomycetes, and the *Hyphomycetes*, or moulds. Hence the announcement of a complete work which should include *all* the British fungi, of whatever denomination, brought up to date, did not come as a surprise

The volume before us consists of 430 pages, and professes to be the first of three volumes, which are to contain the whole "British Fungus Flora" in full, and upon the same plan as this first volume We have heard of wonderful feats of "strong men," but these will be nothing in comparison to the feat which is ostensibly promised on the title-page, *when* it is accomplished In our simplicity we should have calculated *six* volumes as nearer the minimum If the result proves to be *less*, we shall be content to bear the odium of a false prophet We may premise that the author who has undertaken the preseut work is eminently fitted to carry it out successfully, inasmuch as he is a practical field naturalist, with independent views, and by no means afraid of hard work

To return to the volume in question, we must recognize clearness of typography, and distinctness in the isolation of species, which will facilitate reference and increase its practical utility. The illustrations are rather rough outlines, but quite sufficient for practical purposes, and will exhibit the distinctions between the several genera as far as illustrations can do it Of the systematic arrangement we are not prepared to speak so highly, but perhaps some may consider this a matter of detail The contents may be summarized thus, in the order of their appearance The *Gastromycetes*, or puff-ball fungi, commencing with the subterranean species, followed by the *Sclerodermeæ* and the *Nidularieæ*, then the *Lycoperdeæ*, concluding with the *Phalloideæ* These are succeeded by the *Hymenomycetes*, in like manner inverted, commencing with the *Tremellineæ*, and backwards through the other families to the *Agaricini*, which are commenced in the last 120 pages, but not half completed We imagine that half another volume will be required to complete the *Basidiomycetes*

Under ordinary circumstances, when we take up a flora, we are accustomed to meet with the adoption of either one of two methods The one consists of a regular sequence, from what the author regards as the highest developments in his congeries to the lowest, the other an equally regular sequence from the lowest to the highest This is conventional, but the present book is not conventional. In one sense there undoubtedly is a regular sequence from the lowest forms to the highest in the *Basidiomycetes*, which this volume contains; but we must not infer that Mr. Massee regards the *Basidiomycetes* as the lowest order of Fungi, or that he commences with the simplest organisms, proceeding upwards by regular gradations to the most complex, when he starts with the *Gastromycetes*. Undoubtedly our author has not made a special study of the puff balls in order to degrade them to the lowest rank. Hence we can only arrive at one conclusion, and that is, that such portions of the work have now been printed as were ready for the press, and no conclusions are to be drawn from the sequence adopted as a convenience, as if it were adopted by premeditation

Continental mycologists have now for some time accepted the genera of the *Agaricini* as defined by Fries, with the exception of the large genus *Agaricus*, which Fries himself subdivided into numerous smaller groups as subgenera, but they have elevated all these smaller groups to the rank of genera, and placed them upon an equality with the other veritable genera of *Agaricini*. Against this metamorphosis we feel bound to contend, on the ground that the distinctions, although sufficient for the subdivision of a genus, are not of generic value, and that the genera so constituted are unnecessary, and of unequal value, with the old genera beside which they are placed. For instance, *Amanitopsis* differs only from *Amanitæ* in the absence of a ring, and *Annellaria* differs only from *Panæolus* in the presence of a ring. Let any one of practice and experience compare these pseudo-genera with *Coprinus*, *Cantharellus*, or *Schizophyllum*, and judge of what we say. For the first time these pseudo-genera now find a place in a British flora, and, although not of overwhelming importance, we cannot permit them to pass without protest.

Spore measurements are a recent addition to the diagnoses of *Hymenomycetes*, and, although we contend that they should be employed with caution and discrimination, it is very satisfactory that so much attention should have been given to them in this work. Not only does the spore vary in size in a given species in different seasons, but at different periods in the same year. This is certainly true in some species which have been tested, and should lead us to accept spore measurements as approximate rather than absolute.

In conclusion, we are bound to remark that this is a student's book, written with a full appreciation of the wants of a student, and giving all the information which a student might require. In all cases, whether under families, genera, or species, will be found just the details which the novice will be most anxious to obtain, and, although the study of these interesting but rather difficult plants has been of late somewhat upon the decline, we doubt not that it will revive and prosper by the aid of the new "British Fungus Flora," which will become the "text-book of British mycology." M. C. C.

SOUTH AFRICAN SHELLS

Marine Shells of South Africa. A Catalogue of all the Known Species, with References to Figures in Various Works, Descriptions of New Species, and Figures of such as are new, little known, or hitherto unfigured. By G. B. Sowerby, F.L.S., F.Z.S. Pp. 89, 5 pls. [drawn by the author]. (London, 1892.)

SINCE 1848, when Krauss published his well-known work, entitled "Die Sudafrikanischen Mollusken," no such list as the one before us dealing with the Molluscan Fauna of this interesting and important marine province has appeared.

Krauss, who included the non-marine forms of the South African region in his work, recorded 403 marine species, of which 213 were considered to be peculiar to the province. Many other species have been subsequently cited or described as coming from that quarter, notably by E. von Martens and by our present author.

Conchologists undoubtedly owe much to Mr. Sowerby for thus bringing together within the small compass of this single volume, the scope and aim of which are sufficiently indicated in its title, the scattered records of the various species as known to him; but they will equally regret that the author did not include the whole molluscan fauna instead of confining himself to the testaceous forms, and thereby raise the work from the level of a mere shell-collector's catalogue to the rank of a work of reference of real scientific value.

Mr. Sowerby enumerates 740 species, and estimates that 323 of these are confined to South Africa, whilst 67 also occur in European seas, and 340 have been found on other coasts. Unfortunately, it is our disagreeable duty to point out that this record does not include "all the known species," and hence is not what the author fully intended it to be, viz., "as complete as possible." An important paper by Von Martens[1] appears to have been overlooked, for there are about thirty species named in it, including some which were then new, not mentioned by Mr. Sowerby. Still more remarkable is the omission of the new forms described by Mr. Watson in his report upon the Scaphopoda and Gastropoda, obtained during the voyage of the *Challenger*. Davidson's "Monograph of recent Brachiopoda," had it been more closely scanned, would have yielded not only two species reputed to have come from the Cape, but also *Terebratulina Davidsoni*, King, the type specimens of which, dredged on the Agulhas Bank, were passed on to their describer by Mr. G. B. Sowerby (the elder, we presume) in 1871.

A number of species have been recorded by Mr. E. A. Smith in an appendix to a "Report on the Marine Molluscan Fauna of the Island of St. Helena,"[2] as found there on what is locally known as "Sea-horn." This substance appears to consist of portions of a large species of Tangle, probably *Echlonia buccinalis*, which occurs at the Cape, whence it drifts to St. Helena. Some allusion should have been made to these forms. Hints might also have been gleaned from the same report, which deserves to be more widely known than seemingly it is, of undoubted South African species whose names do not appear in Mr. Sowerby's catalogue.

The presence of a good index, while it obviates the necessity, does not abolish the desirability of a good classification, and, in the present state of our knowledge in matters conchological, that of Woodward's Manual is hardly up to date; it is somewhat late in the day to find *Dentalium* still in its old place in the Gastropoda.

Some few changes in nomenclature are made in deference to the law of priority, and these are set forth at the end of the preface. Amongst them is *Ovula*, Bruguière, 1789 = *Ovulum*, Sowerby, &c., though, according to some, *Ovula* is itself a synonym for *Amphiperas*, Gronovius, 1781; *Calliostoma* is erroneously attributed to Bruguière instead of Swainson.

There are also some oversights in the text, as, for instance, "*Columbella cerealis*, Menke (Buccinum), Krauss = *C. Kraussii*, Sowerby," where, since Menke's name was given merely in MS., Sowerby's name stands, having four years' priority over Krauss's; *Triforis* is treated as though of the masculine gender; whilst the references to "figures in various works" require careful checking.

[1] "Ueber einige südafrikanische Mollusken nach der Sammlung von Dr. G. Fritsch." Jahrb. Deutsch. Malak. Gesell. 1874, pp. 119–146.

[2] Proc. Zool. Soc. 1890, pp. 247–317.

As regards the figures that accompany the work itself, it is a matter for regret that they cannot be commended. Few objects are more difficult to draw or require more skill in their delineation than do the shells of mollusca, and the amateur is rarely able to do them justice The want of finish in the present instance is all the more noticeable from the contrast they afford to the rest of the "get up" of the work, which is admirable

These shortcomings are not thus dwelt on in any captious spirit, but are pointed out in the friendly hope that a future edition of the work may shortly be forthcoming, in which the defects of the present one, compiled under great difficulties and at much disadvantage, may be made good and a really complete catalogue result

(BV)[2].

OUR BOOK SHELF

The Framework of Chemistry Part I By W M Williams, M A. (London George Bell and Sons, 1892)

THIS is the first part of a book which has been specially written as a supplement to the oral lessons and experimental demonstrations given by a teacher It is intended to contain nothing but what is absolutely necessary to give definite and precise impressions regarding the salient points of the lessons, all details relating to laboratory manipulation being omitted The more important introductory facts, divested of theoretical considerations, are first discussed, then come "atoms and molecules," treated in an elementary fashion and leading the way to the explanation of the use of symbols and formulæ

How the system adopted by the author will work out can only be ascertained when the other parts are to hand So far as the information in the present volume goes, it is to a great extent useful and clearly stated

Objection may be taken to the classification of solutions as mechanical and chemical, for, were it for no other reason, it is still a disputed point whether any solution may be considered a mixture

The concise style of the book lends itself to incomplete statements For instance, to say that one of the oxides of carbon "contains exactly twice as much oxygen as the other," is hardly accurate, a constant quantity of carbon is essential to the accurate conception of the facts The most serious blunder made by the author lies in the confusion of force and energy This is manifest in statements involving the conversion of "chemical force" into an "equivalent amount of heat" or of "electrical force," and culminates in the assertion that "Force, like matter, cannot be destroyed."

The Beauties of Nature, and the Wonders of the World we Live In By the Right Hon Sir John Lubbock, Bart. M P, F R S (London Macmillan and Co, 1892.)

SO many writers of the present day adopt a pessimistic tone that a pleasant impression is always produced by Sir John Lubbock's genial and imperturbable optimism In the present volume he undertakes to show how many sources of interest men might find in the world around them, if they would only take the trouble to train themselves to appreciate the scientific significance of ordinary facts. He begins with a study of animal life, and has much that is fresh and suggestive to say about various aspects of the subject. Then there are chapters on plant life, woods and fields, mountains, water, rivers and lakes, the sea, and the starry heavens The volume is written in the clear, frank style with which all readers of Sir John Lubbock's books are familiar, and it ought to do much to foster among the class to which he appeals habits of careful and exact observation His readers have the satisfaction of knowing that of the many things they may learn from him none will afterwards have to be unlearned

Algebra for Beginners By H S Hall and S R Knight (London Macmillan & Co 1892)

THIS work is intended as an "easy introduction" to the author's "Elementary Algebra for Schools," and, besides being treated on lines similar to those of the last-mentioned book, is published in a cheaper form The idea throughout seems to have been to present the beginner with the practical side of the subject, and with this intention the examples are made as interesting as such examples can be The usual sequence has not here been strictly adhered to, but a beginner will find that he will still be able to reach the "as far as quadratic equations" limit It is needless to say that the explanations are stated in clear and simple language, while the examples are all new That this book will be widely used is undoubted, for it will form an excellent forerunner to the more advanced one referred to above

Introduction to Physiological Psychology By Dr. Theodor Ziehen Translated by C C van Liew and Dr Otto Beyer (London Swan Sonnenschein and Co 1892)

IN reviewing the book of which this is a translation (NATURE, vol xliv p 145), we pointed out that such a book was badly wanted in English We are glad, therefore, to welcome a translation of Dr Ziehen's work, which will serve well as an introduction to the new science of physiological psychology

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

The *Volucellæ* as Examples of Aggressive Mimicry

AN interesting point in the *Volucellæ* as examples of aggressive mimicry is the fact that they were first used to support the teleological theories of an earlier day, and were subsequently claimed by natural selection. Thus Messrs Kirby and Spence speak of them (Second Edition, 1817, vol ii, p 223) as affording "a beautiful instance of the wisdom of Providence in adapting means to their end," and after describing the resemblance of the flies to the bees, they continue, "Thus has the Author of nature provided that they may enter these nests and deposit their eggs undiscovered Did these intruders venture themselves amongst the humble bees in a less kindred form, their lives would probably pay the forfeit of their presumption" In this theory of Providence it is hard to see where the bees come in In 1867, A. R. Wallace published an article on "Mimicry and other Protective Resemblances among Animals," which was in 1875 republished in his "Essays on Natural Selection" In this essay (p 75 of the volume) he spoke of this interpretation as the only case in which an example of mimicry had been "thought to be useful, and to have been designed as a means to a definite and intelligible purpose" He accepts it as a product of natural selection, and since that time it has been constantly used as a well-known example of this principle, so well known, indeed, that the history of it became unnecessary in any publication where space was an object.

I neither originated the principle of aggressive mimicry nor the *Volucella* as examples of it, although I accepted, and still accept, both. Under these circumstances I must, in justice to Kirby and Spence and A R. Wallace, repudiate the discovery of a significance I should have been proud to have made, but which was made, as a matter of fact, about half a century before I was born. It is only fair to these writers to say this, for Mr. Bateson, although mentioning Kirby and Spence, seems

throughout to give me the sole, or, at any rate, the chief, responsibility for both hypothesis and examples

In writing my book I made great use of a very interesting series of specimens in the Museum of the Royal College of Surgeons, lately brought together by Prof Stewart The aggressive mimicry of the *Volucellæ* was illustrated in one of these cases, and I briefly described the contents of the case in the passage Mr Bateson quotes I was glad to give a few more details than those supplied by Mr Wallace, and at the same time to mention examples which could be actually seen by readers, for I referred to the collection more than once I was, however, anxious to obtain confirmation from one who had studied the Hymenoptera and their parasites much more minutely than I had, so I referred the proofs to Mr R C L Perkins, a most observant naturalist, specially interested in these insects He made some valuable suggestions, but did not modify the account of the case in the Royal College of Surgeons I think I may claim, therefore, that I took all reasonable precautions to avoid error in a part of the subject which had not then come under my own personal observation Prof Lloyd Morgan, in his interesting "Animal Life and Intelligence," has also mentioned this example, and figures the *Volucella* and *Bombus muscorum* He tells me that his figures were copied from a case in the Natural History Museum, so that my selection appears to be supported by the two great biological museums of London

Within a few weeks of the appearance of my book, I had found out the omission of the other banded humble bees also mimicked by the *mystacea* variety of *Volucella bombylans*, and I showed one of these (I think *B hortorum*) at a lecture given to the British Association at Leeds in 1890 I had intended, and intend, to repair the omission in any reprint that may be required

There is, however, nothing inaccurate in the statement that *B muscorum* is mimicked We require something more than dogmatic assertions and question begging metaphor of tabby-cat and fox to establish this as an error of the two museums and the two volumes which have followed them in this respect Mr Bateson appears to have been studying the literature of *Volucellæ* rather carefully, if he now extends his investigations to the perfect insects themselves, and compares the individuals in a series of moderate length, he will find that the *mystacea* variety differs much in the demarcation of its rings or zones, and also that the appearance of each individual varies with the direction from which it is observed. The less sharply-marked appearances resemble *B muscorum*, the likeness being increased by a slight indication of zoning to be seen in the latter

On July 7 of the present year I captured, in a wood near Newbury, a pair of the variety *mystacea* in copula The male, the larger insect, was unusually indistinctly zoned I have submitted the specimens to Mr Verrall who kindly tells me that the large male is certainly the variety *mystacea*, and he evidently thinks there is nothing remarkable about it On the other hand, the female, which was unusually small, is more interesting, being somewhat an intermediate variety As, Mr Verrall informs me, Rondani has made about a score of intermediate species, this little capture of mine may turn out to be of interest, and it is comforting in a controversy of this kind to be able to add one fresh observation which may be of some use, if only in the way of confirmation

Now as to the statement, in which no ambiguity was intended, that the two varieties lay in the nests of the bees they respectively mimic. This was, as Mr Bateson says, a very general impression, the impression of naturalists who knew these insects far better than I did, an impression which had already been expressed in the case at the College of Surgeons If I was mistaken in adopting it, was it not well that I made the mistake, if by its means the general impression should be corrected, having in my book assumed a tangible shape? What man who cares for the advance of science more than for his own advancement would regret to have made a mistake under such circumstances?

But I am not yet satisfied that the impression is not substantially correct. I do not regard the dimorphism of *V. bombylans* as the unique phenomenon it appears to be in the opinion of Mr. Bateson I fail to see any essential biological difference between it and the dimorphism of many Lepidopterous larvæ—a dimorphism which extends into the pupal stage of most species of the genus *Ephyra*—or between it and the distinct types into which certain butterflies of the genus *Kallima* can be divided according to the colouring of the under sides of the wings, or certain moths of the genus *Triphæna* according to that of the upper sides of the upper wings But we know that in those cases which have been tested, while the majority of the offspring resemble the variety to which the parents belonged, a certain proportion follow the other variety, and when the parents belong to different varieties the offspring are more equally divided It is therefore only to be expected, so far as our present knowledge goes, that both varieties should emerge from the same nest. The important thing to be ascertained, from the point of view of the theory of aggressive mimicry, is not the colour of the offspring which emerge, although this is of high interest on other accounts, *but the colour of the parents which enter* It might be supposed that Mr Bateson would have understood this, but it is perhaps too much to expect from a critic who is so aggressively uninterested.

It would be interesting to know the grounds upon which Mr Bateson considers the dimorphism of *V bombylans* to be almost unique At present he contents himself with assertions If we were ever to return to the *régime* of authority and dogmatism in place of reason and experiment, Mr Bateson's scientific position would be indeed assured

Years ago I was satisfied that the evidence for the statement in my book was insufficient, and this, too, I had intended to modify when the opportunity occurred In lecturing I have often alluded to the investigation as an interesting one, and only a fortnight ago suggested it to the members of the Natural History Society at Marlborough College Two years ago I endeavoured to breed *Volucellæ* in the manner described by Mr Bateson, I am sorry to say without success I may therefore claim that the statement quoted by Mr Bateson had produced no paralysis of effort on my part either as regards my own work or that which I have been able to suggest to others.

I may add that the upshot of this inquiry—even if it lead to the conclusion that both varieties lay indiscriminately in the nests of all the species they resemble—would not, in my opinion, remove the *Volucellæ* from their place as examples of aggressive mimicry, but the working of the principle would be more complex I do not, however, propose to render myself liable to further sneers about "ingenuity" by discussing it on the present occasion

Mr Bateson's letter appropriately ends by putting into my mouth a defence I should never have advanced—a defence which was obviously inserted in order to impute discredit—and then proceeding to the easy task of demolishing it Let me therefore say that a mistake is to me a mistake, whether in a volume intended for the public or a paper presented to a scientific society Indeed, I regret the former more than the latter Unfortunately, too, mistakes are more liable to occur in the volume, because the ground is wider, and passes in some directions into less familiar regions But I can honestly say that I have always done my best to avoid mistakes, and that I correct them as the opportunity arises, in fresh papers or in reprints of volumes And I derive much comfort from Mr Phelps' dictum, which I am sure appeals to every one who works, that "people who never make mistakes never make anything" EDWARD B POULTON

Oxford, October 24.

P S—I wish to take this opportunity of correcting certain mistakes in my book ("Colours of Animals," Internat Sci. Ser), as it may be some time before the book can be reprinted, owing to the number of copies struck off

Pages 49, 50—Dr Hurst informs me that my abstract of Weismann's work on seasonal dimorphism is wrong. This will be carefully reconsidered in any reprint

Page 73—I wish to withdraw the account of *Phrynocephalus* Although the structures alluded to are probably alluring, there is not sufficient evidence as to the manner in which they are used

Page 85—Professor Howes calls my attention to the description of the nerve-terminations in pigment cells.

Page 94, *et seq.*—Sir J Ross should be Captain James Ross.

Page 105—I ought to have added that Mr Sharpe's conclusions are not accepted by Professor Newton

Pages 142-146—Mr. Bateson has shown that the white cocoons of *Saturnia* and *Eriogaster* are not due to the white backgrounds employed, but to disturbance of the larvæ. It is still probable that the principle holds in *Halias prasinana*

Page 156.—For the above reason I withdraw the argument about the cocoons of *Rumia*, although I believe that it still holds if *H. prasinana* be substituted.

Chapters x., xi. should be read in connection with the experiments on Warning Colours since made by Mr. Beddard and published in his volume, "Animal Coloration."

Page 161.—The cockroach is not a good example. As Prof. Weldon pointed out to me, there is no evidence that its unpleasant smell renders it unfit for food. The hive bee would be a better instance.

Page 193, line 7 from bottom.—*Fibrous* should be *fulvous*.

Page 203, line 6 from bottom.—For *suited for* read *bearing*.

Page 208, line 13 from top.—*Divert* should be *direct*.

Page 224.—I have since heard from Mr. Skertchly that he did not intend the argument which I quote at the bottom of the page to be taken seriously.

Page 236.—*Diadema bolina* should be *D. misippus*, and it and the *Danais* it mimics occur in *three* varieties, not in *two*. I owe this to Col. Swinhoe; the error was copied from Trimen. E. B. P.

The Geology of the Asiatic Loess

In the spring and early summer of this year I had the opportunity, in company with Mr. S. B. J. Skertchly, of examining closely the loess deposits of Shantung, stretching from Chefoo to Tsinan, the provincial capital.

The investigation convinced us both that the original loess of China must be regarded as a marine deposit. Subsequent to the time of Mr. Skertchly's leaving the province, on June 17, I was able to supplement these conclusions by the discovery of a band of limestone rocks bored by pholades and crustaceans up to a height of about 1100 feet, above which line no indications of late marine action were visible. The rocks in the locality near Tsinan fu are carboniferous limestones interbedded with dioritic porphyries, and are still horizontal and unbroken for some thousands of square miles, having received their present contour in pre loess ages. The dip for hundreds of square miles in this locality seldom exceeds from 2° to 8°. These facts we hope to make the subject of a joint memoir.

The loess of China has, however, been traced almost continuously beyond the limits of the eighteen provinces to the foot of the Pamîrs. West of the Pamîrs loess occurs in the valley of the upper Oxus, probably in the Kizil Kum, and up to the Caspian, and its marine origin requires us to believe in the submergence within late geologic time of the greater part of Central Asia. Most geologists recoil at such a suggestion, and I am in a small minority in accepting the view that the present distribution of ocean and continent is of very recent date. I may, however, in condonation of heterodox views, refer to the position of the argument with regard to the alleged shifting of the terrestrial axis of rotation, which has within the last few years entered on a new phase. When some years ago I presented these views to the Council of the Geological Society of London they were scouted as utterly untenable. Since that time, while English astronomers have held the view that practically the axis of rotation has undergone, within the limits of observation, no change, American astronomers have come to the conclusion that a secular movement is actually in progress. My own geological observations in Europe, North America, and Asia have led me to infer that the North Pole has within recent geological time shifted, and that a shift is in all probability in progress at the present time along a line following approximately the direction of the 70th meridian of west longitude. This shift is not to be taken to involve a change in the direction in celestial space, but is rather a rolling of the earth over its axis, the latter remaining practically stationary.

Dynamical causes sufficient to account for the change of position of the terrestrial poles, and in consequence of the parallels of latitude, seem to me to be at work. Prof. G. Darwin has calculated the probable change in the position of the pole due to an elevation of the bed of the Pacific Ocean, but no one has touched the converse effect of the change of the pole on the relative levels of the oceans and continents. In addition to the cause suggested in the possible elevation of large tracts of continental land, there are other influences at work tending in the same direction. The different distribution of the large masses of ice around the poles, which probably varies within somewhat large limits, and the slow disturbance of equilibrium resulting from the growth of deltas and deep sea deposits, have frequently been adduced. More important still is perhaps the differential influence of tidal friction in retarding the rotation, the effect of which must be sensibly unequal in the two hemispheres north and south of the equator; another cause may be looked for in the action of aerial currents, the effect of which in the northern hemisphere as containing greater masses of elevated land must be greater.

Another potential cause of shifting has never, that I am aware of, been formulated. Although at present of comparatively small influence, it must at various geological periods have been of great importance. It leads on to dynamic considerations of tidal energy beyond the compass of a letter to explain. The relative part played by the sun and moon, as deduced from gravitational formulæ, does not quite agree with the observed phenomena of our daily tides. It is believed by many that the ordinary lunar tide, affecting mainly the oceanic envelope, is complicated by the presence of a terrene tide largely influenced by the sun, and that the earth does to an appreciable extent yield twice in the twenty-four hours to the deforming force of solar gravitation. So long as this oscillation takes place at regularly recurrent intervals no energy is wasted. Should, however, a sudden snap occur, breaking the rhythm of the oscillation, some energy is evidently spent, and this can only be made up from the *vis viva* of rotation. Such snaps do occur occasionally; the regular oscillation is momentarily suspended, and the waters of the ocean rush in to restore the equilibrium. This is the well-known "tidal" wave that so frequently occurs in connection with earthquakes.

Such a snap on the equatorial line would simply retard the rotational period generally. North or south of this line, as the moments of rotation would be instantly unequal, the sphere would roll over its axis of rotation, and a shift in the position of the poles occur. The earth is not a perfectly rigid mass. Were it as rigid as steel, the interior within a depth of 200 miles would yet, under the pressure of gravitation, behave as a liquid; a shift in the pole would then be met either by a corresponding shift in the equatorial protuberance, or a change in the ocean level; or, more probably, by a compound action of both. In the latter case, to fulfil the conditions of equilibrium, the ocean surface in the neighbourhood of the new equator would rise, and if the shift were sufficiently great, would overflow the lowlands. If the equator, in the longitude of Central Asia, had at any former time passed north of its present position, and the rock masses of the Continent had not been elevated, a mid-Asian sea must have resulted. The undisturbed position of the carboniferous rocks, and the plain evidence that the surface sculpturing of the rocks was of pre-loess age, show that the process was unaccompanied by violent movements.

The theory of the shift of the earth over its momentary axis accounts better than any other for the geological condition of polar lands, and I venture to state it again in brief, as on this occasion the initiative has come from the astronomers, not the geologists. THOS. W. KINGSMILL.

Shanghai, China, August 20.

Note on Mr. Kingsmill's paper

I think it will be difficult for Mr. Kingsmill to adduce evidence of geological changes large enough to produce any considerable shifting of the position of the principal axes of the earth, and accordingly I should feel sceptical as to a theory which postulates that such change has been sufficient to explain considerable changes of climate.

With respect to a later part of the paper, I am entirely at variance with his views. As far as I know "the relative part played by the sun and moon" in producing oceanic tides is in exact accordance with gravitational formulæ.

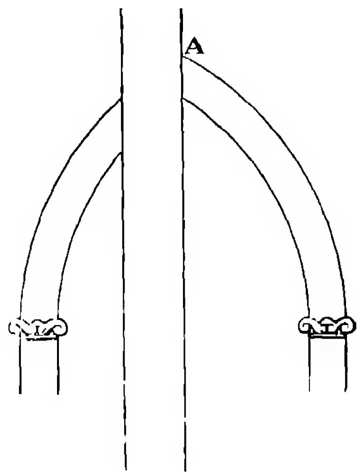
The existence of a terrene tide is a matter of speculation, but, as the earth cannot be perfectly rigid, it must exist to some extent. The amplitude of the lunar terrene tide must certainly bear to that of the solar the same ratio that holds in the case of oceanic tides, and there is no reason, that I know of, for attributing a greater efficiency to solar action in the case of the deformation of the solid portion of the earth.

I am quite unable to follow the argument by which the so-called "tidal" wave produced by earthquake shock is supposed to produce a retardation of the earth's rotation.

October 21. G. H. DARWIN.

Optical Illusions.

REFERRING to the article in NATURE for October 20, may I mention a rather common optical illusion which I do not remember to have yet seen in print If a gothic arch is unequally divided by a space between two vertical parallel lines, these lines will not only seem to diverge slightly where they intersect the lines of the arch, but the arch itself is caused to appear as if one half had slipped bodily down from the other to an extent



equal to its own thickness In the figure given above it is impossible to believe that but for the intervention of the vertical interlinear space the two halves would be seen to meet perfectly with the apex at A This illusion is worth the notice of architects who desire to avoid the disquieting effect upon the eyes of observant persons which is produced by the intersection of the chancel arch of a church by an intervening pillar

28 Mount Park Crescent, Ealing, W R T LEWIS

A Remarkable Rainfall.

THE rainfall here of October has been so remarkable that it seems worth while to place it on record in your columns Rain fell on twenty-five days during the month, making a total fall of 10 32 inches As the annual rainfall on an average of eleven years is 31 10 inches, it will be seen that very nearly one-third of this amount fell in one month This is by far the highest amount I have recorded since I began to make records in January, 1878, the next highest month being August, 1879 On that occasion five inches fell in thirty hours on the 17th and 18th, and many bridges were carried away in Flintshire and Denbighshire, but the total fall for the month was only 7 89 inches Dr. Nicol, of Llandudno (six miles from here), who has registered the rainfall since, and including 1861, informs me that it amounted last month to 8 56 inches there, this also being the highest month he has ever recorded

In September rain fell on twenty-three days, and though the total fall was only 3 77 inches, yet the constant rain, combined with an unusually low temperature (the mean maximum being only 56°6, and the highest shade temperature 67°4, against 64°6 and 81°2 respectively in 1891), made it almost impossible to get in the harvest ALFRED O WALKER.

Nant-y-Glyn, Colwyn Bay, November 5.

On a Supposed New Species of Earthworm and on the Nomenclature of Earthworms

IN yesterday's NATURE I find that the Rev Hilderic Friend has again given the name *L. rubescens* (Friend) to a supposed new species of earthworm. This worm appears to me to be identical with *Enterion festivum* (Savigny), described under the name *Lumbricus festivus* by Rosa. Though comparatively rare, it is by no means new, nor even new to Britain, though I know of no published record of its occurrence here. I met with two or three specimens among the worms supplied to me when I was working at the chapter on Lumbricus in "Marshall and Hurst," and identified them subsequently by the help of Rosa's table. At the time I took them for mere varieties, and put them into a bottle for future study I believe the specimens are now in the possession of Dr Benham, who has entirely overlooked the species in his "Attempt to Classify Earthworms" (*Quart Journ Micr. Sci* xxxi)

The specific name *terrestris* must also, it appears to me, be dropped Linnæus did not define a species under that name, but applied it to what are now universally regarded as several distinct species The species so called by Mr Friend was, I believe, first defined by Savigny under the name *Enterion herculeum* The diagnostic characters of the species are given by Rosa in his useful table of the species ("I Lumbricidi del Piemonte," p 25), and he calls it *Lumbricus herculeus*, to which name the usual rules of nomenclature bind us

I would therefore suggest the following alterations in Mr Friend's "Chart of the Genus Lumbricus" —

1 For "Terrestris (Linn.)" read "herculeus (Sav)"
2 For "Rubescens (Friend)" read "festivus (Sav)"

Owens College, October 28 C HERBERT HURST

Ice Crystals

DURING the cutting of the formation for a railway I observed on Tuesday morning, the 18th inst, a peculiar series of ice crystals The ground is composed of arenaceous clay largely mixed with sand and small gravel, and is of a very open nature, the surface being covered with moorland grass, rushes, and coarse ferns These crystals were only found in a length of about nine feet, the ground on both sides of the patch being hard frozen

These crystals were acicular, and sprang from a base of very porous opaque ice, but every needle was entirely free and distinct throughout its height, and at first sight appeared to be bound together with two bands, one at one third and the other at two thirds of the height A closer examination proved that the band appearance was due to a slight enlargement of the crystals at these points, the ice being opaque, whilst the needles were perfectly translucent

The average height of these crystals was about one inch, the needles having a diameter of about $\frac{1}{80}$th part of an inch, and were grouped together in clusters of forty or fifty, forming an irregular square of about $\frac{1}{4}$-inch on the side Some of these crystals were growing vertically from the ground, others springing out horizontally from the side of the cutting, and were either straight, curved, or bent round forming a half circle This morning the same form of crystals existed, but were much larger, being fully two inches long On both occasions the air was calm and clear, the min ther reading 30° on the 18th, and 24° to day

Lesmahagow, October 25 C. M IRVINE

Lunar Craters

THE letter and illustration offering a suggestion as to the formation of lunar craters remind me of an experiment I once saw during a chemical lecture, bringing out the same point very clearly

A shallow dish containing a layer of damp sand, $\frac{1}{2}$", was flooded with 1-inch coating of Paris plaister, of the consistence of cream, and the dish set to dry over a Bunsen flame

As the plaister set, the surface was pitted with crater-like holes, formed by the escape of steam from the sand at the bottom of the dish, giving a perfect representation of a lunar surface.

As some of your readers might care to try this experiment, I take the liberty of sending you this "recollection."

M H MAW.

Walk House, Barrow-on-Humber, Hull, Nov 7

A Fork-tailed Petrel.

THE occurrence of a Fork-tailed Petrel as far inland as Macclesfield may perhaps interest some of the readers of NATURE.

It was picked up by a man on the 11th ult., two days after the stranding of the *Sirene* in a gale at Blackpool, and being unacquainted with the species he sent it to me as a curiosity. I identified it as a Fork-tailed Petrel, and Mr J. H Salter, of Aberystwyth College, has kindly confirmed this decision

Some of the feathers on the forehead are tipped with white Does this indicate a young bird, as I can find no mention of it in any of the plumage descriptions that I have seen?

NEWMAN NEAVE.

Rainow, near Macclesfield, November 5.

THE ORIGIN OF THE YEAR[1]

III

IN the previous articles I have endeavoured to show that the Egyptians had the Sirius year and the vague year so related to each other that the successive coincidences of the 1st Thoth in both years took place after intervals of 1460 Sirian years With a real year, the length of which would be brought home to them by the regular recurrence of the solstices and Nile flood (to say nothing of the equinoxes) and the year of 360 days which they would soon find to be quite artificial and unreal, they would be much more likely to refer the dates in the artificial year to the real one, than to take the opposite course, and, as I have shown, the artificial dates would sweep backwards through the real ones Such a method of reckoning, however, would be useless for calendar purposes, as they not only wanted to define the days of the year but the years themselves, and I pointed out that something more was necessary, and that an easy way of defining *years* would be to conceive a great year, or *annus magnus*, consisting of 1460 years, each "day" of which would represent four years in actual time, and further to consider every event, the year of which had to be chronicled in relation to others to take place on the day of the heliacal rising of Sirius or the nearly coincident Nile flood, which, was employed to mark the first year of each series of four

Now as a matter of fact it is known (I have the high authority of Dr Krall for the statement) that each king was supposed to begin his reign on the 1st Thoth (or 1st Pachons) of the particular year in which that event took place, and the fact that this was so supports the suggestion we are considering During the reign its length and the smaller events might be recorded in vague years and days so long as the date of its commencement had been referred to a cycle

We have next to consider more especially the vague year

One argument which has been used to show that a vague year was not in use during the time of the Ramessids has been derived from some inscriptions at Silsilis which refer to the dates on which sacred offerings were presented there to the Nile god As the dates 15th of Thoth and 15th of Epiphi are the same in all three inscriptions, although they cover the period from Ramses II to Ramses III—120 years—it has been argued by Brugsch that a fixed year is in question

Brugsch points out that the two dates are separated by 65 days that this is the exact interval between the Coptic festivals of the commencement of the flow and the marriage of the Nile the time of highest water, and

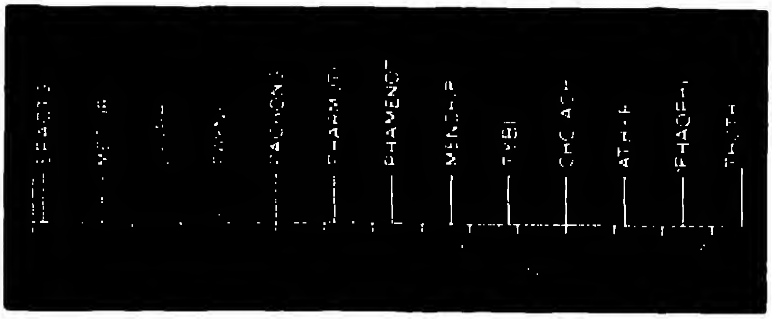


FIG 5.—The distribution of the 1st of Thoth (representing the rising of Sirius) among the Egyptian months in the 1460 year Sothic cycle

as we shall see, occurred, at different periods of Egyptian history, on the 1st Thoth and 1st Pachons

A diagram, which may here be repeated, was given to show how such a system would work From any coincidence of 1st Thoth (or 1st Pachons) in both the Sirian and the vague year, since the vague year is the shorter, the 1st Thoth (to deal only with Thoth) of the vague year would recede, so that in such a cycle it would fall first among the Epacts, then in Mesori, and so on through the months, till the next coincidence was reached.

The diagram will show how readily the cycle year can be determined for any vague year If for instance the 1st Thoth in the vague year falls on 1 Tybi of the cycle, we see that 980 years must have elapsed since the beginning of the cycle, and so on.

Here, then, we have a true calendar system, if the Egyptians had not this, what had they?

Such a calendar system as this it will be seen, however, is good only for groups of four years. Thus during the first four years of a cycle the 1st Thoth vague would happen on 1st Thoth of the cycle, during the next four years on the 5th Epact, and so on

Now a system which went no further than this would be a very coarse one. We find, however, that special precautions were taken to define which year of the four was in question Brugsch[2] shows that a special sign that, therefore, in all probability these are the two natural phenomena to commemorate which the offerings on the dates in question were made

But Brugsch does not give the whole of the inscription A part of it, translated by De Rougé,[1] runs thus —

"I (the king) know what is said in the depot of the writings which are in the House of the Books The Nile emerges from its fountains to give the fullness of life-necessaries to the gods," &c

De Rougé justly remarks, "Le langage singulier que tient le Pharaon dédicateur pourrait même faire soupçonner *qu'il ne s'agit pas de la venue effective de l'eau sainte du Nil à l'une des deux dates précitées*"

Krall (*loc cit* p 51) adds the following interesting remarks —"Consider, now, what these 'Scriptures of the House of Life' were like. In a catalogue of books from the temple of Edfu, we find, besides a series of purely religious writings, 'The knowledge of the periodical recurrence of the double stars (sun and moon),' and the 'Law of the periodical recurrence of the stars'

" . The knowledge embodied in these writings dated from the oldest times of the Egyptian empire, in which the priests placed, rightly or wrongly, the origin of all their sacred rolls" (cf. Manetho's 'History," p. 130)

Now to investigate this question we have to approach some considerations which at first sight may seem to be

[1] Continued from vol. xlvi p. 107

[2] "Matériaux pour servir à la reconstruction du calendrier," p 89

[1] "Aeg Zeit," 1886, p 5, quoted by Krall.

foreign to our subject I shall be able to show, however, that this is not so

Imprimis we must remember that it is a question of Silsilis, where we know both from tradition and geological evidence, in ancient times the first cataract was encountered The phrase "The Nile emerges from its fountains" would be much more applicable to Silsilis, the seat of a cataract than as it is at present We do not know when the river made its way through this impediment, but we do know that after it took place and the Nile stream was cleared as far as the cataract that still remains at Elephantine, a Nilometer was erected there and that during the whole of later Egyptian history at all events the time of the rise of the river has been carefully recorded both there and at Rhoda

From this it is fair to infer that in those more ancient times the same thing took place at Silsilis, if this were so the reason of the record of the coming of the inundation at Silsilis is not far to seek, and hence the suggestion lies on the surface that the records in question may state the date of the arrival *in relation to Memphis time*

So far in my inquiries I have not been able to find a complete discussion of the influence upon local calendars, in different parts of the Nile valley, of the variations of the phenomena upon which the Egyptians depended for the marking of New Year's day

If the *solstice* had been taken alone, the date of it would have been the same for all parts of the valley, but certainly the solstice was not taken alone, and for the obvious reason that they wanted something to warn them of the Nile rise, and in the lower reaches of the river the rise precedes the solstice

Nor was the heliacal rising of Sirius taken alone

As we have seen, according to Biot the heliacal rising of Sirius *at the solstice* took place on July 20 (Julian) in the year 3285 B C, and according to Oppolzer, it took place on July 18 (Julian) in the year 3000 ± B C

But this is too general a statement, and it must be modified here There was a difference of 7 days in the date of the heliacal rising, according to the latitude, from southern Elephantine and Philæ, where the heliacal rising at the solstice was noted first, to northern Bubastis There was a difference of four days between Memphis and Thebes, so that the connection between the heliacal rising and the solstice depended simply upon the latitude of the place The further south, the earlier the coincidence occurred

Here we have an *astronomical* reason for the variation in the date of New Year's day

But it was chiefly a question of the arrival of the Nile flood, and the date of the commencement of the Nile flood was by no means common to all parts of Egypt!

I cannot find any statement of the dates of the arrival of any one Nile flood at places between Elephantine and Cairo Dr Wallis Budge[1] states "The indications of the rise of the river may be seen at the cataracts as early as the end of May"

Now if we take the 1st cataract to be here meant, and deal with May 31, since the average day of arrival of the inundation at Cairo is 3 days after the solstice—that is June 20 (Greg)—we have 24 days for the flood-travel for the 600 miles between Elephantine and Cairo, four-fifths of a month elapsing between the times at which the Green Nile colours the pool at Syene below the Cataracts, and the river at Memphis; so that the further south, the earlier the flood was noted This gives us about a mile an hour. This certainly seems too slow

But if we assume 16 days, this would give us about 15 days between Silsilis and Cairo, and 12 days between Thebes and Cairo, taking Cairo to represent the ancient Memphis. Now this represented a difference in the new year's days of different places, compared to which our modern differences of local time sink into insignificance, for they only touch hours of the day, and the reason that I have referred to them here is to point out that if the assumption made is anything like accurate, if, for instance, in Pepi's time a Nile rise were observed at Silsilis, there might easily be a difference of 15 days between the rise of the Nile at Silsilis and the Memphic 1st of Thoth If both at Silsilis and Memphis the Nile rise marked 1st Thoth, the day of the rise at Memphis would correspond to 15th Thoth at Silsilis, so that a king reaching Silsilis with Memphis local time, would be struck with this difference, and anxious to record it, may not this then have been the important datum recorded in the sacred books? If so, it would not touch the question of the fixed or vague year at all

[1] "The Nile," p. 46

Let it, then, be for the present conceded that there was a vague year, and that at least some of the inscriptions which suggest the use of only a fixed year in these early times may be explained in another way I do not say the above explanation is the correct one, for the assumption of 16 days may be wrong, even if difference in the dates of the heliacal rising at the two places be taken into account

The dates we have found—trying to take the very simplest way of writing a calendar in pre-temple times, and using the calendar inscriptions in the most natural way—are for the coincidence of the heliacal rising of Sirius at, or near, the solstice—

270 B C
1728 B C
3192 B C

Now here we meet with a difficulty which, if it cannot be explained, evidently proves that the Egyptians did not

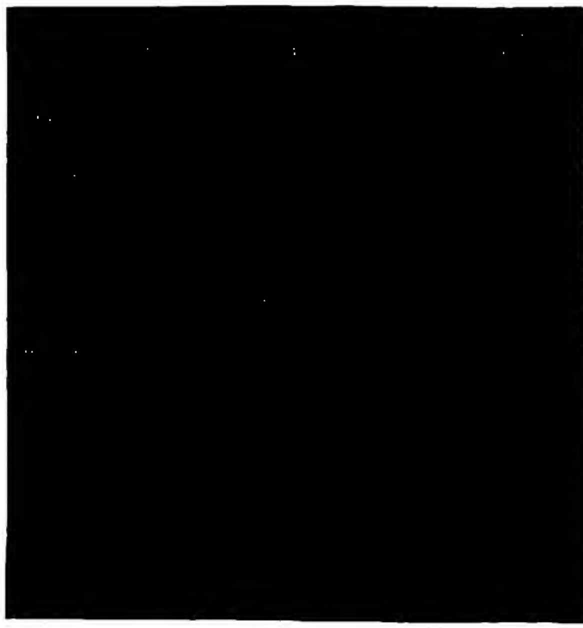


Fig 6.—Julian dates of the 1st of Thoth (vague) from 23 A D to 240 A D

construct and use their calendar in the way we have supposed.

We have it on the authority of Censorinus that a Sothic period was completed in 139 A D, and that there was then a vague year in partial use It is here that the work of Oppolzer is of such high value to us. He discussed all the statements made by Censorinus, and comes to the conclusion that his account is to be depended upon It

has followed from the inquiries of chronologists that in this year the 1st of Thoth took place on July 20 (Julian), the date originally of the heliacal rising of Sirius, the beginning of the year

This being so, then, in the year 23 A D —in which the Alexandrine reform of the calendar, of which more presently, was introduced—the 1st of Thoth would take place on August 29, a very important date Censorinus also said that in his own time (A D 238) the 1st of Thoth of the vague year fell on June 25 Fig 5 will show the connection of these three dates in reference to the vague year The relations of the statements made as to the years 139 and 238 are very clearly discussed by Dr Oppolzer

Oppolzer, then, being satisfied as to the justice of taking the year 139 A D as a time of coincidence of the fixed and vague years—the latter being determined alone by the heliacal rising of Sirius, and, be it remembered, not by the solstices—calculated with great fulness, using Leverrier's modern values, the years in which, in the various Egyptian latitudes, chiefly taking Memphis (lat 30°) and Thebes (lat. 25°), the coincidence between the two Thoths occurred in the previous periods of Egyptian history He finds these dates for latitude 30° as follow —

	Julian year	Historical year [1]
0	− 4235	4236
1	− 2774	2775
2	− 1316	1317
3	+ 139	139
4	+ 1591	1591
5	+ 3039	3039

Now the date which Oppolzer gives for the coincidence which is nearest the date we had previously determined at 270 B C is 139 A.D There is a difference of 409 years

The question is, Can this fundamental difference be explained? I think it can

In the first place, it is beyond doubt that, in the interval between the Ramessids and the Ptolemies, the calendar, even supposing the vague year to have been used and to have been retained, had been fundamentally altered, and the meanings of the hieroglyphics of the tetramenes had been changed—in other words, the designations of the three seasons had been changed.

On this point I quote Krall in a note.[2]

[1] It should be observed that a distinction is made between the Julian and the historical year This comes from the fact that when astronomical phenomena are calculated for dates B C, it must be remembered that chronologists are in the habit of designating by 1, or rather by − 1, the first year which precedes the instant of time at which the chronological year commenced, while astronomers mark this year in their tables by 0 It follows, therefore, that the rank of any year B C is always marked by an additional unit in the chronological dates. For the Christian era, of course, chronologists and astronomers work in the same way The following table, given by Biot, exhibits the connection between these two methods In the latter Biot shows the leap-years marked B, and the corresponding years in the Scaligerian chronological period are also given

Dates of Julian Years commencing on January 1

According to Chronologists.	According to Astronomers	Corresponding years of the period of Scaliger
− 6	− 5	4708
− 5B	− 4B	4709
− 4	− 3	4710
− 3	− 2	4711
− 2	− 1	4712
− 1B	− 0B	4713B
Physical instant when the era commenced		
+ 1	+ 1	4714
+ 2	+ 2	4715
+ 3	+ 3	4716
+ 4B	+ 4B	4717B
+ 5	+ 5	4718

[2] *Loc cit* p. 29. "It is well known that the interpretation of the seasons and the months given by Champollion was opposed by Brugsch, who propounded another, which is now universally adopted by experts. Something has happened here which is often repeated in the course of Egyptian history —the signs have changed their meaning Under the circumstance that the vague year during 1461 years wanders through the seasons in a great cycle, it is natural that the signs for the tetramenes should have changed their significations in the course of millenniums

"While Thoth was the first month of the inundation in the documents of the Thutmosids and Ramessids, we have in the time of the Ptolemies the month Pachons as the first month of the flood season Whilst Brugsch's explanation is valid for the time of the Ramessids, it is not so for that of the Ptolemies, to which Champollion's view is applicable"

The three hieroglyphic signs used for the tetramenes are supposed to represent water, flowers, and a barn, and the natural order would be that the first should represent the inundation, the second the sowing which succeeds it, and the last harvest time If this be conceded, the initial system would have had the month Thoth connected with the water sign, as Thoth in early Egyptian times was the first inundation month But in the times of the Ramessids even this is not so Thoth has the sowing sign assigned to it In the time of the Ptolemies the flood is no longer in Thoth, but in Pachons, and Pachons has the barn sign attached to it, while the month Thoth is marked by the water sign, thereby bringing back the hypothetical relation *between the name of the month and the sign*, although, as we have seen, Thoth is no longer the flood month

Egyptologists declare that all or at least part of this change took place between the periods named, they are undoubtedly justified as regards a part

At one point in this interval we are fortunately supplied with some precise information In the year 238 B C. a famous decree was published, variously called the decree of Canopus and the decree of Tanis, since it was inscribed on a stone found there

It is perfectly clear that one of the functions of this decree was to change, or to approve an already made change in, the designation of the season or tetramene in which the inundation commenced, from Thoth to Pachons

Another function was to establish a fixed year, as we shall see presently We must assume then that a vague year was in vogue prior to the decree Now the decree tells us that at its date the heliacal rising of Sirius took place on 1 Payni Assuming that this date had any relation to the system we have been considering, the cycle to which it belonged must have begun

Days	
5	Epacts
30	Mesori
30	Epiphi
30	Payni
95 × 4 = 380 years previously, that is, in the year 618 B C.	

Now here at first sight it would seem that the Sothic cycles we have been considering have no relation to the one now in question; for, according to my view, the last Sothic cycle began in 1728 B.C

A little consideration, however, will lead to the contrary view, and show that the time about 600 B C, was very convenient for a revision of the calendar

In the first place nearly a month now elapsed between the coming of the flood and the heliacal rising, and in the second, by making the year for the future *to begin with the flood*, a change might be made involving tetramenes only.

Thus, commencement of cycle		1728 B.C
Epacts	5	
Two tetramenes	240	
Month between flood and rising of Sirius	30 [1]	
	275 × 4 =	1100
		628 B C.

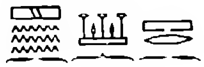
Nor is this all A very simple diagrammatic statement will show what might also have happened about 618 B.C

[1] Probably too great a value by 2 or 3 days.

if a reformer of the calendar (and one especially of conservative tendencies) appeared upon the scene, who believed that the ancient sign for the inundation-tetramene was the water sign, and that the ancient name was Thoth Finding the cycle beginning in 1728 with the signs as shown—

1728 B C Thoth Phaophi Athyr Choiach Tybi Mechir Phamenot Pharmuti Pachons Payni Epiphi Mesori

when starting fresh, he would seize the opportunity of effecting a change, not only by dealing with a tetramene, but he would change the names of the tetramenes allocated to the signs



B C 618 Thoth Phaophi Athyr Choiach Tybi Mechir Phamenot Pharmuti Pachons Payni Epiphi Mesori

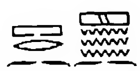
As Krall remarks, it was almost merely a question of a change of the sign! It really was more, because the new tetramene began with the flood

Assuming this, we can see exactly what was done in 238 B C, i e about 380 years later We have seen that the 380 years is made up of

5 Epacts
30 Mesori
30 Epiphi
30 Payni

$95 \times 4 = 380$

the heliacal rising of Sirius occurring on 1 Payni, having swept backwards along the months in the manner already explained We had then—



B C 238 Pachons Payni Epiphi Mesori Thoth Phaophi Athyr Choiach &c

To sum up, so far as we have gone we have the three inscriptions at Philæ, Elephantine, and the still more ancient one of Pepi, indicating on the simple system we have suggested beginnings of Sothic cycles on the 1st Thoth about the years

270 }
1728 } B C
3192 }

On the other hand, we have the decree of Canopus, giving us by exactly the same system a local revision of the Calendar about 600 B C. I say *about* 600 B C because it must be remembered that a difference of $2\frac{1}{2}$ days in the phenomena observed will make a difference of 10 years in the date, and we do not know in what part of the valley the revision took place, and therefore at what precise time in relation to the heliacal rising the Nile-rise was observed

Whenever presumably it took place, New Year's day was reckoned by the Flood, and the rising of Sirius followed nearly, if not quite, a month afterwards. The equivalent of the old 1st Thoth was therefore 1 Payni In months, then, the old 1st Thoth was separated from the new one (= 1 Payni) by 3 months (Payni, Mesori, Epiphi) and the Epacts.

In this way, then, we can exactly account for the difference of 409 years referred to above as the dates assigned by Censorinus and myself for the beginning of the Sirius cycle

Difference between 270 and 239	=	31	years
3 months = 90 days × 4	=	360	,,
5 epacts × 4	=	20	,,
		411	,,

The difference of two years is equal only to half a day!

It seems, then, pretty clear from this that the suggestion I have ventured to make on astronomical grounds may be worth consideration on the part of Egyptologists If our inquiries have really led us to the true beginnings of the Sothic periods, it is clear that those who informed Censorinus that the year 139 A D was the end of a cycle omitted to tell him what we now can learn from the decree of Tanis

J NORMAN LOCKYER

(*To be continued*)

TECHNOLOGICAL EXAMINATIONS

THE report of the results of the Technological Examinations, held this year under the direction of the City and Guilds of London Institute, has a special interest, seeing that after this year the system of payment on results in connection with all classes outside the Metropolis will be discontinued There is no doubt that the offer of payment to teachers helped very greatly in 1879 to stimulate the formation of technical, as distinct from science, classes, and the great extension of this work of the Institute is largely due to the offer then wisely made of contributing towards the cost of instruction The tables furnished in the report, and the diagram of results, are very interesting as showing the great development of these trade classes Since 1880 the number of candidates for examination has increased more than tenfold, the numbers being 816 in 1880 and 8,534 in 1892 In 1885 there were 263 technological classes in different parts of the country, and in the session 1891–2 this number had increased to 610 There is, of course, a corresponding increase in the number of students in attendance at these classes In 1881 the number of students was 2,500, this year it was 16,565 This record of progress is certainly satisfactory, and particularly so, seeing that prior to 1891 there was no sort of organization to carry on the work of directing and assisting technical classes for artisans in different parts of the country As a pioneer movement, the work of the City Guilds Institute has been eminently successful, and many of the Technical Schools which have now been brought under the control of County Councils undoubtedly owe their origin to the technological classes promoted by the City Guilds The question now demanding attention is the future of these classes Much is to be said in favour of associating them more closely with the science classes, which are held in the same schools, but what is wanted for the permanent improvement of such classes is a system of efficient inspection by persons competent to advise County Councils with respect to the important work now under their control

From the report and programme it appears that year by year the Institute adds to the extent and efficiency of its examinations by the introduction of new subjects and of practical tests. Practical examinations were held this year for the first time in photography, goldsmiths' work, boot and shoe manufacture, and in wood-working in connection with the examination in manual training for teachers of public elementary schools This last examination is somewhat different in kind from the other examinations of the Institute. It is not a trade examination. Its purpose seems to be to encourage instruction of a distinctly educational character. Moreover, it is a

close examination None but teachers of public elementary schools are eligible, and these must have regularly attended a course of practical lessons in a registered class under a teacher approved by the Institute Notwithstanding these restrictions, 615 candidates presented themselves at the first examination held by the Institute, and of these 350 passed, 195 obtaining the Teacher's Certificate

The report contains full statistics of the results of the examinations in each of the 61 subjects included in the programme, and it also shows the results in each of the 210 towns where the examinations were held Of the centres outside London, Manchester sent up the largest number of successful candidates, whilst Glasgow, Dundee, and Leeds come next in order The report calls attention to the fact that the proportion of candidates to the population is far less in London than in Manchester, whilst the hope is expressed that the larger facilities for technical instruction which will be available within the next few years will lead to an increase in the number of students and of candidates for examination This increase will no doubt take place with the opening of new polytechnic institutions, but we venture to think that the real improvement in technical education cannot be correctly measured by any mere increase in the number of candidates for examination It depends much more upon the character and quality of the instruction which the candidates receive The great defect of our present organization is the poverty in knowledge and practical experience of the teachers of our science and technical classes Some improvement in the qualifications of teachers, and in the conditions of their training, is needed before progress can be measured by the increase in the number of students in attendance, or of candidates for examination

We notice that in future the Institute proposes to award two kinds of certificates—the one kind to students who have regularly attended a course of instruction under an approved teacher, and the other to candidates who may present themselves for examination without giving any evidence as to their training In this way the Institute proposes to combine the functions of a teaching and an examining body The certificate indicating that the candidate has received some training at a school of recognized position will doubtless acquire a distinct value, but much will depend upon the ability and the reputation of the teacher under whom the candidate may have studied

Of the many alterations in the new programme the most important is the addition of a practical part to the examination in mechanical engineering This examination of the Institute has never seemed to us wholly satisfactory, as overlapping, to too great an extent, the examinations of the Science and Art Department in applied mechanics, machine construction, and steam But in future the examination will consist of two parts, one of which will be distinctly specialized with a view to the candidate's occupation Moreover, in the honours grade, candidates will be required to undergo a practical examination in either machine designing or workshop practice. At the last examination in this subject 966 candidates presented themselves, of whom 536 passed It is satisfactory to note the continuous increase in the number of candidates In plumbers' work, a trade in the successful practice of which every householder is interested In this subject a high standard for passing is wisely maintained Of the 816 candidates who presented themselves, 235 came up for the practical part of the examination, and of these only 85 succeeded in passing in both parts of the examination, and are qualified for certificates.

There is little doubt that the statistics furnished in this report go far to show that a high value is attached by artizans and their employers to the Institute's certificates, and that the progress of technical education has been advanced by the cautious and judicious manner in which the Institute has conducted this department of its operations

ROBERT GRANT.

In Robert Grant, who at the ripe age of seventy-eight died at the place of his birth, Grantown-on-Spey, on October 24, 1892, science loses one of her ablest historians His education was interrupted by a serious illness, which confined him to his bed from his fourteenth to his twentieth year. With surprising energy, however, on his recovery he set about the study of mathematics and the acquisition of ancient and modern languages After studying for a time at King's College, Aberdeen, he went to London to collect materials for a history of physical astronomy Thence he proceeded to Paris in 1845, where for two years he attended the lectures of Arago at the Observatory, and those of Leverrier and others at the Sorbonne Returning to London, he lost little time in beginning the great work with which his name will always be associated It was published in numbers, the first of which appeared in September, 1848, but it was not until March, 1852, that the whole work was issued It bears the title "History of Physical Astronomy from the Earliest Ages to the Middle of the Nineteenth Century, comprehending a detailed account of the establishment of the Theory of Gravitation by Newton, and its development by his successors, with an exposition of the progress of research in all the other subjects of Celestial Physics" Most completely do the contents of the volume fulfil every expectation raised by this comprehensive programme The fame of its author was at once established Four years later he received from the hands of the late Mr Manuel J Johnson, President of the Royal Astronomical Society, the gold medal, then for the first time awarded for literary service to astronomical science One paragraph of the address delivered on that occasion may here be quoted as characterizing most justly the work as well as its author "Throughout the book no one can fail to be struck with the rare skill, integrity, and discernment the author has displayed in tracing the successive stages of progress, or with the scrupulous care he has taken to assign to each of the great men whom he reviews their proper share in the common labour Nowhere is this more conspicuous than in the discussion relative to the discovery of the planet Neptune. By a simple narration of facts he has placed the history of that great event in so clear and so true a light, that I believe I am not wrong in saying he has gained an author's highest praise under such circumstances—the approval of both the eminent persons concerned' Even now, forty years after its publication, the "History" has lost none of its value as a mine of information, and as a delightful guide to those who desire to make a closer acquaintance with the astronomers of the past, as well as their works.

For some time Mr. Grant edited the "Monthly Notices" of the Royal Astronomical Society, and was a member of their Council. In conjunction with the late Admiral Smyth, he translated and edited Arago's "Popular Astronomy" (2 vols 1855 and 1858). Meanwhile his health had so far improved that in 1858 he was able to go through a course of observational astronomy at Greenwich Observatory In the following year, on the death of Prof J Pringle Nichol, he was appointed Professor of Astronomy, and director of the Observatory in the University of Glasgow.

As a member of the party that went to Spain in the troop-ship *Himalaya*, to observe the total solar eclipse of July 18, 1860, Prof. Grant, from his station near Vittoria, had the satisfaction of seeing a portion of the chromosphere, the existence of which as a thin layer en-

veloping the photosphere he had abundantly demonstrated in the winter of 1850-51, from a discussion of all the observations extant ("History," pp 395, 396). It can excite no surprise that Prof Grant assumed the red layer and also the prominences to shine by reflected light, when it is recollected that the sun's light and heat were then supposed to originate wholly in the photosphere while the nucleus was thought to be so cool as possibly to be habitable When Prof Grant took charge of the Glasgow Observatory the only useful instrument he found was the transit-circle by Ertel and Son, of Munich, but through the liberality of a few friends, chiefly in Glasgow, a nine-inch Cooke Equatorial was added to the Observatory some years afterwards After thoroughly testing the transit-circle the new director commenced a series of observations of Mercury, Neptune, the minor planets, and a selection of stars from the British Association Catalogue Gradually, however, his attention was concentrated entirely on the stars the list being correspondingly expanded The observations of planets were communicated from time to time to the *Astronomische Nachrichten* or to the "Monthly Notices"

The stellar observations were published at the expense of her Majesty's Government in 1883 in the well-known "Catalogue of 6415 Stars for the epoch 1870, deduced from Observations made at the Glasgow University Observatory during the years 1860 to 1881, preceded by a Synopsis of the Annual Results of each Star arranged in the order of Right Ascension"

In the introduction will be found a discussion of the Proper Motions of 99 stars A very complete and appreciative review of this work from the pen of Prof Auwers of Berlin appeared in the *Vierteljahrsschrift der Astronomischen Gesellschaft* (19 Jahrgang) The Glasgow star places were at once looked on with confidence by the numerous observers of comets and minor planets One point connected with the Catalogue deserves special mention, viz that, although the observations from which it is derived extend over a space of twenty-one years, the work appeared within two years of the close of the series This promptitude excites the greater admiration when we learn that, exclusive of Prof Grant's personal share in the work, no less than thirteen young assistants at various times took part in the observations, and two others in the computations Many of these personal changes, each of which brought its quota of extra work to Prof Grant, were no doubt in some measure due to the smallness of the allowance provided for assistance, viz £100 per annum Prof. Grant, however, was the last man to waste his energies in useless complaint, and dismisses this point with the remark that "in recent years the work of scrutinizing, reducing to a common epoch, and combining together the vast mass of the observations of the catalogue, extending over a period of more than twenty-one years, has pressed very heavily upon the slender resources of the observatory" The important time service of the City of Glasgow was originated by Prof Grant some thirty years ago, and continues in operation up to the present moment In 1855 he received from the University of Aberdeen the degree of M A, followed by that of the honorary LL.D in 1865, in which latter year he was elected a Fellow of the Royal Society of London For three years he presided over the Philosophical Society of Glasgow, to whose proceedings he made various contributions It may also be noted that among his writings are two remarkable letters proving beyond a shadow of a doubt the spurious character of the pretended Pascal correspondence. These letters were printed in the *Comptes Rendus* by special permission of the French Academy

In manner Prof. Grant was singularly vivacious, and to the last he greeted with the warmest enthusiasm every fresh discovery in the science to which his life was devoted. R. C.

NOTES

THE following is the list of names recommended by the President and Council of the Royal Society for election into the Council for the year 1893 The ballot will take place at the anniversary meeting on November 30 —President, The Lord Kelvin, D C L, LL D, treasurer, Sir John Evans, K C B, D C L, LL D, secretaries, Prof Michael Foster, The Lord Rayleigh, D C.L, foreign secretary, Sir Archibald Geikie, LL.D, other members of the Council, Captain William de Wiveleslie Abney, C B, Sir Benjamin Baker, K.C M G, LL D, Prof Isaac Bayley Balfour, William Thomas Blanford, Prof George Carey Foster, Richard Tetley Glazebrook, Frederick Ducane Godman, John Hopkinson, Prof Joseph Norman Lockyer, F R A S, Prof. John Gray McKendrick, William Davidson Niven, William Henry Perkin, LL D, Rev Prof B Price, The Marquess of Salisbury, K.G., Adam Sedgwick, Prof William Augustus Tilden

AN international subscription for a testimonial to M Pasteur on the occasion of his seventieth birthday on December 27 is to be opened by the French Academy of Science Many men of science in all parts of the world will be glad to have this opportunity of expressing their high appreciation of M Pasteur's labours

SOME time ago we announced that Baron Nordenskiold proposed to edit a number of very remarkable letters and memoirs of Carl Wilhelm Scheele, who died in 1786 It has now been decided that the one hundred and-fiftieth anniversary of the birth of this great Swedish chemist, on December 9, shall be made the occasion of a brilliant celebration in his native country A monument to Scheele is to be unveiled in Stockholm

THE Naturforschende Gesellschaft of Danzig are issuing invitations to the celebration of the 150th anniversary of their foundation on January 2 and 3, 1893 The meetings will take place on the Monday evening in the Friedrich-Wilhelm-Schutzenhaus, and on the Tuesday morning in the large hall of the Landeshaus, and the proceedings will wind up on the latter day with a dinner at 4 p m in the Schutzenhaus.

PROF. EDWARD PRINCE, of Glasgow, has been offered the important post of Commissioner and General Inspector of Fisheries for Canada by the Dominion Government, and has accepted the office Prof Prince is well known as an authority in Fishery Science. He holds the chair of Zoology in St Mungo's College, Glasgow, and is President of the Anderson's College Scientific Society, and Vice-President of the Glasgow Natural History Society

IT is announced that the King of Italy will open in person the International Medical Congress, which is to be held in Rome next year An English committee is being formed to do what it can to secure the success of the Congress

THE New York Academy of Sciences has organized a Biological Section, which is to hold monthly meetings. The opening meeting, at which Prof H. F Osborn presided, was held on October 17.

THE Victoria University has issued a list of University Extension lectures which are to be delivered in the course of the session 1892-93. They are to be given at many different centres, and include a wide range of subjects, among which various departments of physical and natural science hold a prominent place.

LIVERPOOL has sustained a real loss by the death of Mr. T J. Moore, the late curator of the Liverpool Derby Museum Mr Moore had a wide knowledge of various branches of science, and did much to foster popular interest in the results of scientific inquiry. He died on October 31.

DURING the latter part of last week the weather continued very unsettled, the depressions which advanced from the Atlantic causing strong southerly winds or gales in many places, with frequent and heavy rain, while the temperature was uniformly high for the time of year, the daily maxima reaching nearly 60° in the southern parts, and exceeding 50° in the northern parts of the kingdom On Saturday night a considerable decrease of temperature occurred, owing to the advance of an anti cyclone which subsequently spread over most of the country, the southerly winds gradually disappeared, and were succeeded by calm and variable airs In the early part of the present week fog became prevalent in many parts of England, but the weather was generally fair with frosts over the inland districts On Tuesday, however, fresh depressions were passing along our north-west coasts, and rain squalls became general over Ireland and Scotland, while southerly winds again became prevalent. The *Weekly Weather Report*, issued on the 5th instant, showed that the rainfall greatly exceeded the mean in the east and south of England, while in Scotland and the northern parts of England the fall was below the average Since the beginning of the year, the eastern, Midland, and north-west districts of England have had three inches of rainfall in excess of the normal amount, while in the south-west of England there is a deficiency of 7 6 inches

THE U S Hydrographic Office has issued a chart showing the submarine cables of the world, with their principal land connections. The chart is described by *Goldthwaite's Geographical Magazine* as a necessity to foreign commerce It contains tables for the computation of rates to any part of the world

THE November number of the *Kew Bulletin* contains sections on coffee cultivation in British Honduras, the prune industry of California, sugar cane borers in the West Indies, sisal hemp industry in Yucatan, Liberian coffee in the Malay native states, and Bombay aloe fibre There are also miscellaneous notes, from one of which botanists will be glad to learn that after many unsuccessful attempts to introduce living examples of the interesting plant, *Dischidia rafflesiana*, Kew has at last succeeded, thanks mainly to the generosity of Dr Treub, the distinguished director of the Botanic Gardens, Java, who sent a plant of it in a Wardian case two years ago This plant is now established and growing freely, producing numerous large pitcher-like leaves as well as the small normal hoya like foliage The morphological meaning of these pitchers has not yet been thoroughly worked out. "The species of dischidia all want a careful study. They cannot be described satisfactorily from dried specimens The leaves change in form, and it is not ascertained in respect of many species whether they may or may not be converted into pitchers (ascidia)" (Hooker in "Flora of British India") The plant at Kew is now under the special observation of Dr Scott, hon keeper of the Jodrell Laboratory *D bengalensis* is an old garden plant It is cultivated at Kew in the Palm House. *D rafflesiana* is for the present kept in one of the propagating pits.

AT the opening meeting of the twelfth session of the Junior Engineering Society on November 4, an excellent address was delivered by the president, Dr. John Hopkinson, F R S, on the cost of electric supply His general conclusion on the subject is that to be ready to supply a customer with electricity at any moment he wants it, will cost those giving the supply not much less than £11 per annum for every kilowatt, that is for every unit per hour, and afterwards to give the supply will not cost very much more than ½d per unit. The clear apprehension of this point Dr. Hopkinson believes to be essential to the commercial success of electric supply It is hopeless, he thinks, for electricity to compete with gas in this country all along the line, if price is the only consideration. But with selected customers, electricity is cheaper than gas Surely, he adds, it is the interest of those who supply electricity to secure such customers by charging them a rate having some sort of relation to the cost of supplying them.

AN address delivered by Prof. Virchow at the opening of the recent International Congress of Archæology at Moscow is printed in the current number of the *Revue Scientifique* Prof Virchow repeats in this address what he has often said before—that no trace of "the missing link" between man and the lower animals has been discovered either in the human skulls which are believed to be most ancient or in the physical organization of modern savages He urges that the immediate task for anthropologists is to explain the origin of the existing human races, and to determine the causes by which these races, while retaining the power of hereditary transmission, have acquired their distinctive characteristics At first sight, he says, it is easy to suppose that a dolichocephalic skull may be transformed into one of brachycephalic form, but it has not yet been shown that any dolichocephalic race has been actually transformed into a brachycephalic one, or *vice versâ* Prehistoric anthropology ought, he thinks, to find methods which would facilitate the recognition of the types of ancient races and peoples, and enable us to find them again among the races and peoples of the present day It ought also, as occasion offers, to collect data with regard to those strange individual cases about which theories, as Dr Virchow holds, have been prematurely formed, and which should be kept in "the scientific baggage" until we have secured intermediate links which will render it possible for us to unite them in a series

ACCORDING to an official report of Captain von François, the dromedaries which have been introduced into the German territories in South-west Africa in connection with the parcel post service have more than fulfilled the expectations that had been formed about them The climate suits them, and they are not affected by any of the prevalent cattle diseases On the road between Lehuititang and Geinab they were six days without water, and on the seventh day, at Geinab, they did not seem to be very thirsty In stony regions their feet do not, like those of unshod horses or oxen, suffer any injury When loaded with a weight of 250 pounds, a dromedary advances at much the same rate as an ox-waggon. The only drawback connected with these useful creatures is that they are rather costly.

MR A E DOUGLASS, first assistant at the Boydun station of the Harvard College Observatory, Arequipa, contributes an interesting paper to *Science*, October 21, on indications of a rainy period in Southern Peru. There is evidence to show, he thinks, that for many thousands of years, going back far beyond the recognized period of human habitation, the climate of Peru has been very much as it is at present That was preceded by a slow rise of the land out of the sea, which caused the climate to change from wet to dry But under the wet climate the elevation of the land was still too great, and perhaps the duration of the epoch was too short, to produce a luxuriant tropical vegetation, otherwise there would be to-day extensive coal-fields. The wet climate, however, was sufficient greatly to alter the face of the country Lake Titicaca was of enormous area, fed perhaps by the melting glaciers. In the almost continuous rainy season, huge turbid rivers roared and tumbled down these western slopes of the Cordillera, while on each mountain summit vast quantities of snow fell, only to pursue its way down the steep slopes, carving out valleys, building up ridges, and by its melting wearing out deep ravines, which grow smaller as they become lost in the broad level plain below Under such luxuriance of moisture the valley of Arequipa must have teemed with animal and vegetable life, the barren hills to the south were clothed in green, and the desert of La Joya blossomed like a garden.

A CAPITAL annotated catalogue of the mammals collected by Dr W L Abbott in the Kilima-Njaro region, East Africa, has been prepared by Mr F W True, and printed in the Proceedings of the fifteenth volume of the U S. National Museum, with several plates Dr Abbott has presented to the National Museum many African collections, but none of them, according to Mr True, is of more interest than the collection of mammals The specimens have been prepared with much care, the skins being almost invariably accompanied by the skulls and furnished with labels giving the locality and date of capture, sex, and other data In determining the species Mr True has found it necessary to depend almost exclusively on the literature, on account of the lack of specimens for comparison, but the identifications have been made with much care, and may, he thinks, on the whole, be relied upon Several species apparently new are represented in the collection *Dendrohyrax validus*, *Mus aquilus*, *Dendromys nigrifrons*, *Sciurus undulatus*, *Cephalophus spadix* On one who has studied the North American mammalian fauna in detail, Mr True says, the thought impresses itself that the condition of species, as regards variation, is different in the Ethiopian and Nearctic regions In North America individual variation seems far less extensive than in Africa, while geographical variation appears to be more extensive and constant In Dr Abbott's collection great individual variation is especially apparent in the genera *Galago*, *Genetta*, and *Canis* It is true that the species of the last named genus everywhere present much individual variation, but in North America its chief variations appear to be geographical in character The known range of several species is considerably extended by Dr Abbott's labours

AN important contribution to spectroscopy appears in No 10 of Wiedemann's *Annalen* in the shape of a paper on the infra red emission spectrum of the alkali metals, by Benjamin W Snow The method is distinguished by the adoption of a modified form of the bolometer and a very delicate galvanometer with quartz fibre suspension The fibre, supplied by Prof Boys, was 40 cm long With a scale at a distance of 3m, a deflection of 1mm corresponded to a current of $1\ 5 \times 10^{-11}$ amp The spectra were obtained by means of a silicate flint prism, so as to avoid the overlapping of the infra-red spectra which seems to be inevitable where gratings are used Since no infra-red lines could be traced in the spectrum produced in the Bunsen or the oxy-hydrogen flame, the electric arc was used, the current being derived from the very uniform Berlin Central supply The best arrangement for the arc was found to be a hole bored through the centre of the carbon, containing a "wick" of the compressed salt. The bolometer consisted of two platinum-thread resistances. A platinum wire embedded in silver was hammered flat, so as to have a breadth of 0 05mm and a thickness of 0 00036mm Two such threads were fastened side by side with shellac on a mica frame One of them was blackened in a turpentine flame and exposed to the light, the other being covered The difference of resistance produced by the incident rays was measured by a Wheatstone bridge arrangement, with a shunt contrivance for enlarging the scale of the bridge wire The resistance of each of the platinum ribbons under ordinary conditions was 75 ohms. The other branches of the bridge were made of German silver wire. The slit of the spectrometer was adjusted to 0 1mm, corresponding to an angle of 1 68 minutes of arc in the spectrum, whilst the breadth of the platinum thread corresponded to an arc of 1'·6 The current through the bridge was maintained at one-fortieth ampere. In the measurement of the intensity of the lines, the energy of radiation was taken as proportional to the first throw. It was found that a standard candle at 1m. distance gave a throw of 150mm. A preliminary investigation of the carbon spectrum revealed a large number of bands reaching up to λ 20620, the principal less refrangible bands being between

7000 and 7700
7850 and 8600
9000 and 10000
10750 and 11600
13700 and 15000

These were made up of innumerable fine lines It was also observed that the carbon spectrum vanished in comparison with the metallic spectrum as soon as the latter was brought into play Of the five metals investigated, viz, sodium, potassium, rubidium, lithium, and cæsium, the two rarest were found to be specially rich in infra-red lines Sodium showed maxima at 818-, 11270, 12400, and 18360, potassium at 7670, 10820, 11580, 12250, and 14610, lithium at 8070, rubidium at 7910, 9980, 13120, and 14760, and cæsium at 8380, a large one at 8820, and others at 9980, 13270, and 14530 Kayser and Runge's empirical law for the alkalies was confirmed for the infra-red of lithium and sodium, but not for the other three metals.

MR ELLIOTT COUES, of the Smithsonian Institution, defends in *Science* the rule, in biological nomenclature, "once a synonym, always a synonym," for the form of which he believes himself to be in some degree responsible He illustrates the real meaning of the aphorism in the following way. Let there be a genus *Smithia* in botany Let a genus *Jonesia* then be named Let *Jonesia* then be found to be the same genus as *Smithia* Then the name *Jonesia* "lapses into synonomy," and cannot be thereafter applied to any other genus in botany That is all that is meant by the saying "once a synonym always a synonym" In other words, if *Jonesia* is not good for what it originally meant, it is good for nothing, it is to be deleted absolutely, and cannot come into re-existence by transfer to any other genus Mr Coues shows that the same principle holds for all specific names within their respective genera Example Let there be a *Rosa Smithi* Let some one then name a *Rosa Jonesi* Let *R Jonesi* be considered to be the same species as *R Smithi* Then there can never be a *R Jonesi*, that is to say, no other species of *Rosa* can be specified as *Jonesi* But, of course, if any one discovers, after this reduction of *Jonesi* to a synonym of *Smithi*, that what had been called *R Jonesi* is a good species, then *Jonesi* revives as the name of *that* species, and the fact that it had been (erroneously) regarded as a synonym of *Smithi* is no bar to its use in its original sense

THE Geological Survey of America has published a paper, by Mr J S Diller, on the Geology of the Taylorville region in the Sierra Nevada, California, immediately north of the fortieth parallel In this region there are eighteen sedimentary formations and seventeen eruptive masses The former have a total thickness of 24,500 feet, 17,500 feet are probably Palæozoic, and 7000 feet are Mesozoic Among the sedimentary rocks, one horizon in the Silurian, two in the Carboniferous, three or more in the Trias, and five in the Jura have been definitely recognized by fossils Among the eruptives there is great variety Their extravasation, beginning early in the Palæozoic, recurred vigorously in the Triassic and at the close of the Jurassic, and, finally, also in the Neocene and Pleistocene The dioritic rocks of the region are a portion of the great granitoid mass of the upper Sierra Nevada, and are evidently eruptive, with well-defined contact phenomena in Triassic formations. Their eruption is certainly post-Triassic, and may have taken place immediately at its close or after the deposition of the Jurassic. There are at least four unconformities in the geologic column of the Taylorville region. During the greater part, if not the whole, of the Palæozoic, the sea covered the region now occupied by the northern portion of the Sierra Nevada The great disturbance at the close of the Carboniferous may

have been accompanied by an uplift, forming land during the early Triassic, but if so, it subsided and was ready to receive the deposits of the upper Triassic. The disturbance at the close of the Triassic formed no land in the northern Sierra region, but that which closed the Jurassic was accompanied by a great upheaval, excluding the sea to the western base of the Sierras The general structure of the Taylorville region involves a synclinal and two limiting anticlinals After the folds were overturned toward the north-east, the Grizzly anticlinal was affected by an overthrust fault in the same direction The throw along this fault in the older strata is so much greater than in those of Jurassic age as to suggest that a large part of the displacement took place at the close of the Triassic, and was followed by movement on the same plane at the close of the Jurassic.

MR STANFORD has issued an interesting and valuable contoured map of the county of London The scale is three inches to a mile The contour lines or lines of equal altitude are drawn at 25 feet intervals. The lowest contour is 25 feet above the level of the sea, ordnance datum, which is 12 feet 6 inches below Trinity high water The whole of the alluvial flat lying below the lowest contour, or at a less altitude than 12 feet 6 inches above the river Thames (Trinity high water mark), is covered by a dark brown tint.

THE third volume of reports upon the fauna of Liverpool Bay and the neighbouring seas has been issued The reports have been written by members of the Liverpool Marine Biology committee and other naturalists, and edited by Prof W A Herdman, F R S

MESSRS GURNEY AND JACKSON have published the *Zoological Record* for 1891 It is the twenty-eighth volume of the series. Mr D Sharp, F R S, has acted as editor, and has had the co operation of many able zoologists It is intended that in future the volume shall be published in August or September

PHOTOGRAPHERS will read with great interest an admirable paper by Captain Abney, in the November number of the *Journal of the Camera Club*, on "shutters," which he describes as "a piece of apparatus which is the very joy and toy of the photographer's existence" The paper is fully illustrated.

THE Rev L A Walker sends to the current number of the *Entomologist* some statistics of the entomology of the Hague, where he acted as chaplain during July The entomology of Holland seemed to him very disappointing in number of species, and also in individuals in the great majority of cases, less productive, in fact, than the ordinary run of country places at home

AT the meeting of the Linnean Society of New South Wales on September 28, Mr R. Etheridge, junior, exhibited seeds of the "Bean-tree," possibly an *Erythrina*, from Macdonald ranges, Central Australia. The seeds are strong and used as necklaces by the aborigines, who use the wood of the same tree for producing fire by friction, and also for shields, on account of its lightness

A COMPOUND of gold and cadmium of the composition AuCd has been isolated by Messrs Heycock and Neville, and is described by them in the November number of the Journal of the Chemical Society. During the course of a series of experiments last year upon solutions of gold and cadmium in melted tin, it was observed that the amount of lowering of the freezing-point of the tin by the simultaneous introduction of gold and cadmium was considerably less than the sum of the effects which each of the two latter metals would produce alone. It was surmised that this difference must be due to combination between the gold and the cadmium. Moreover, the product o this combination appeared to be only sparingly soluble in tin, for a considerable quantity of a crystalline precipitate was produced, but owing to the difficulty of freeing it from the tin which solidified over it upon removal, the compound was not obtained in a state of sufficient purity to enable a definite conclusion concerning its composition to be arrived at Messrs Heycock and Neville now announce that they have succeeded in preparing the compound in an entirely different manner, and in isolating it in a state of comparative purity The following is the best mode of procedure —A piece of the hardest combustion tubing is sealed at one end and slightly bent in the middle so as to form a V-tube of very large angle A quantity of pure gold is placed in the sealed limb, together with three or four times its equivalent of cadmium The open end is then drawn off so as to enable the tube to be exhausted by means of the Sprengel pump As high a vacuum as possible should be obtained, and the tube subsequently sealed The apparatus is then arranged upon a combustion furnace in such a manner that the excess of cadmium when liquefied may run away from the alloy When the cadmium first melts it is advisable to vigorously shake the tube so as to diffuse the gold well among the cadmium The combination then occurs suddenly, accompanied by bright incandescence of the gold When the larger excess of cadmium has been allowed to run away from the compound, the end of the tube containing the latter is heated for about five hours to a temperature about that of the softening of glass, when the remainder of the excess of cadmium distils regularly off, until towards the expiration of the five hours no further condensation occurs. The product thus left behind was found in three successive experiments to contain about 63 7 per cent of gold, the percentage required for a compound of the composition AuCd The compound of gold and cadmium thus obtained presents a silvery greyish white appearance, is very brittle, and exhibits a crystalline fracture The action of acids upon it is somewhat singular Cold acids appear to be without material action upon it, but hot nitric or hydrochloric acid attacks it with great energy, the cadmium passing into solution and the gold being left in the shape of the original ingot

THE additions to the Zoological Society's Gardens during the past week include a Purple faced Monkey (*Semnopithecus leucoprymnus*) from Ceylon, presented by Mrs Elgee, six Short-tailed Voles (*Arvicola agrestis*) from Scotland, presented by Mr J E Harting, F Z S, two Laughing Kingfishers (*Dacelo gigantea*) from Australia, presented by Mr J W Hornsby, a Golden Eagle (*Aquila chrysaetus*) from Labrador, presented by Mr J. G. Baxter, a Jackdaw (*Corvus monedula*) British, presented by the Rev H. W. Reynolds, three —— Geckos (*Gecko verticillatus*) from Burmah, presented by Mr W G Bligh; two American Darters (*Plotus anhinga*), a Common Boa (*Boa constrictor*) from South America, four Bar tailed Pheasants (*Phasianus reevesi* ♂ ♂ ♀ ♀) from China, purchased.

OUR ASTRONOMICAL COLUMN

A BRIGHT COMET is announced in Andromeda, seventy seconds preceding Struve 72.

COMET BARNARD (OCTOBER 12) —The following is a continuation of the ephemeris we gave last week of Comet Barnard taken from *Astronomische Nachrichten*, No 3125.

Ephemeris for 12h. Berlin M.T.

1892.	R.A. h. m. s.	Decl. ° ′	Log r	Log Δ	Br
Nov 11	20 46 49	+2 33 3			
12	49 40	2 15 7			
13	52 38	1 58·3	0·2262	0 1648	0·97
14	55 25	1 41 2			
15	20 58 19	1 24·4			
16	21 1 14	1 7·9			
17	21 4 9	+0 51·6	0·2250	0·1713	0·94

It may be mentioned that an *Astronomische Nachrichten* circular note contains rather a modified edition of the above places deduced from observations made on October 16, 20, and 25

Thus for the 13th, the R A is given as 20h 54m 24s (app), and declination (app) + 1° 54′ 5 , and for the 17th, R A (app) 21h 6m 39s, and declination (app) + 0° 46′ 4.

COMET BROOKS (AUGUST 28) —Owing to the rapid brightening of Comet Brooks, we give the following ephemeris continued from the same source as mentioned last week (*Astronomische Nachrichten*, No 3125)

12h Berlin M T

1892.	R A app h m s	Decl app ° ′	Log r	Log Δ	Br
Nov 11	9 56 50	+3 18 7			
12	10 1 8	2 24 6	0 0985	9 9861	15 61
13	5 29	1 29 6			
14	9 52	+0 33 8			
15	14 17	−0 22 9			
16	18 45	1 20 3	0 0847	9 9712	17 81
17	23 15	2 18 4			

OCCULTATION OF MARS AND JUPITER BY THE MOON — Prof. Barnard communicates his observations of the occultation of Mars and Jupiter by the moon, which occurred in one week during last September, to the *Astronomical Journal*, No 276 The instrument used was the 12 inch equatorial and the seeing was defined as being very fine on both occasions At the disappearance of the former planet, which took place at the dark limb of the moon, nothing very striking was noticed, the moon's limb at that point being sharp and not dusky, as had been previously seen in an occultation of Jupiter The times of disappearance and appearance (Mount Hamilton mean time) were —

	Disappearance h m s	Reappearance h m s
1st contact	9 9 35 8	10 45 56 0 (1s late ?)
Half obscured	9 10 4	10 26 17
2nd contact	9 10 37 1	10 26 52 2

In the case of Jupiter, which disappeared at the bright limb, a narrow shadow band was noticed fringing the limb where the planet appeared to cut it This is due, as Prof Barnard thinks, to the effect of contrast The times of contacts were as follows —

	Disappearance h m s	Reappearance. h m s
1st contact	17 28 10 4	18 33 17 5 (2s late ?)
Half obscured	17 28 55 0	18 33 50
2nd contact	17 29 45 7	18 34 33 7

MOTION OF THE SOLAR SYSTEM —The question of the exact position of the point in the heavens to which the sun with his system is travelling has been the object of much research and computation, and the present co-ordinates are now considered as being about R A 267° and declination + 31°

The determination under consideration (*Astronomical Journal*, No 276) has been undertaken by Prof J G Porter, and is based on the proper motions of 1340 stars, contained in the Publication of the Cincinnati Observatory, No 12 The method employed for computing the co-ordinates of the apex of the sun's way is that of Prof Schonfeld , the stars were grouped in four divisions, Division I including those whose yearly proper motion was less than 0″ 30 and contained 576 stars ; Division II , motion from 0″ 30 to 0″ 60, containing 533 stars , Division III , motion from 0″ 60 to 1″ 20, containing 142 stars , and lastly, Division IV , the motion exceeding 1″ 20, 70 stars being included From these four groups the following values have been deduced, where σ and τ represent the co ordinates of the apex of the sun's course and $\frac{c}{\rho}$ the velocity of the sun's motion —

	σ °	τ °	$\frac{c}{\rho}$ ″
I	281 9	+51 7	0 16
II.	280 7	+40 1	0·30
III.	285·2	+34·0	0 55
IV.	277·0	+34 9	0 66

The last determination of these co-ordinates was made, if we are not mistaken, by Prof. Stumpe, and were given in *Astronomische Nachrichten*, Nos. 2999–3000. The values there deduced agree very well with those in question, with the exception of τ in Group I and σ in Group IV , which consequently throw the mean values rather out Adopting the same notation, he obtained—

	σ °	τ °	$\frac{c}{\rho}$ ″
I Group	287 4	+42 0	0 140
II ,,	279 7	40 5	0 295
III ,,	287 9	32 1	0 608
IV ,,	285 2	30 4	2 057

Summing up the values obtained by some previous workers, the following table gives the co-ordinates obtained —

Name	R A	Decl	No of stars used in reduction
Gauss	259 2	+30 8	—
Argelander	259 9	32 5	390
O Struve	261 5	37 6	392
Mädler	261 6	39 9	2163
Airy	261 5	24 7	113
Dunkin	263 7	25 0	1167
Kancken	284 6	31 9	106
Birchoff	285 2	48 5	480
L Struve	273 3	27·3	2509
Stumpe	285 1	36 2	1054
Porter	281 2	40 7	1340

SOME REMINISCENCES OF THE MAORIS

MR W COLENSO, F.R S , has often been asked to record some of his reminiscences of the Maoris, whom he has for very many years had opportunities of studying This he has now done in a paper printed in the Transactions of the New Zealand Institute (vol xxiv), some extracts from which may be of interest for various classes of readers He says —

Of the Mako Shark —Fifty years ago (to go no further back) a Maori chief would be known by wearing certain emblems or insignia indicative of rank, one of which was the tooth of the *mako* as an ear pendant ; and, as such were plentiful, though distributed, the thought often occurred to me in my early travelling days, What a number of the fish *mako* there must have been captured or obtained by the Maoris to yield such a large number of teeth ! Moreover, on inquiry I invariably found that all the teeth I saw were prized heirlooms, and had descended to the present possessor through several generations, and (as far as I could learn) none had been recently acquired. And while, when travelling along the sea coasts for many a league on both sides of the North Island during several years, and always on foot, I had both seen and heard of a number of large sea animals (fishes and mammals) that were driven on shore on the sandy beaches in severe gales from the sea, I never knew of a single *mako* shark, nor had the Maoris resident on those shores ever heard of one being cast up

In replying to my numerous inquiries by letter respecting the *mako*, made many years ago, an intelligent aged Maori chief living on the east coast wrote as follows (or, rather, he being of the old school, and unable himself to write, a young adherent did so at his dictation). I give a literal translation of portions of his letter —

"You ask, did I ever see a *mako* fish ? Yes ; and it is a very large creature, the biggest of all the sharks (*mango*)—in length 2 fathoms measured (*erua maro whanganga nei*), and in thickness 1 foot It is a true shark, but called by us a *mako* on account of its teeth. You also inquire concerning its fat or oil, and the edible qualities of its flesh, whether considered choice by us Maoris Now, there are many kinds of shark, as the *mako*, the *karaerae*, the *poke*, the *ururoa*, the *matini*, the *tahapounamu*, the *tatari*, the *tatere*, and the *mangotara*, and I have not eaten of them all, and therefore I do not know how nice or how fat they all are ; and so of this one, the *mako*. But, my friend, this fish was never desired as an article of food—never so used by us Maoris The only part of it that we sought and greatly desired to have was its head, and *this solely* on account of its teeth. When caught out at the deep-sea fishing-grounds its body was never hauled into the canoe, but the head was cut off while it was still in the sea and alongside of the canoe (*ka tapahia moanaia te upoko*) : this done, and the head secured, the body was left to drift away on the sea. The head was also immediately wrapped up securely in a clothing-mat (*kahu*), lest it should be noisily wondered at by those who

were strangers or unacquainted with it (*koi umerehia e nga tangata tauhou*) You also ask what instrument was used for cutting off the head of the *mako* What, indeed! Why, the saw made of the teeth of the *tatere* shark firmly fixed on to a wooden blade (*he niho tatere, he mea hohou ki runga ki te rakau*). You further inquire respecting the number of its teeth There are eight—that is, large ones from within—and also eight smaller ones of them outside. Besides those there were several much smaller ones in front or outside (*o waho rawa*), but these I never counted, and therefore cannot give their exact number"

He also wrote (in another and subsequent letter) in answer to my further inquiries "There are four very large teeth from the beginning, or within These are called *rei*, and are kept for ear-pendants. Altogether there are eight teeth—that is, four very large ones, and four smaller, making eight in all The outside teeth resemble those of the *tatere* shark, and are only termed teeth (*niho*), these have no other name, but those that are kept for ear-pendants are called *au rei* Then, you wish to know how the *mako* was captured by us Maoris in the olden times Listen This fish was never taken as other sharks (*mango*) were, with hook and bait none of our fish hooks would be strong enough to hold it, they would soon be broken Now, when the fishing-canoe was out fishing, and had been a long time there catching fishes of various kinds, suddenly a *mako* would be seen coming leisurely along on the surface of the water (*e hara mai noa ana i te kiri o te wai, ara i te kare o te wai*) Then the man who saw it would shout out to his companions in the canoe, 'Haul up our land' (*Hutia mai to tatou whenua*), not naming the fish, and when the *mako* was pretty near to the canoe, about three yards off, then the big tempting bait was let low down before it, and on the *mako* seeing the bait it would bend down its head to seize it (*ka tupou te upoko*), when its tail would be upraised above water Then a noosed rope would be flung over its tail (lasso-fashion) and quickly hauled tight, which would secure the tail within the noose hard and fast And away would speed the canoe at a fleet rate towards all sides of the sea and sky, being continually turned about in all directions by the fish, the man who had noosed it always holding on to the rope. At last, being exhausted, the *mako* died, then it floated, when its head would be cut off, as I said before This was our common manner of catching the *mako* fish (*ko tona hii tonu tenei o tenei ika o te mako*), often also called by us a monster (*taniwha*), and hence arose the term of monster-binding (*heretaniwha*), owing to it being securely noosed and bound with a rope flung over its tail" Here ends the interesting narration of my worthy old Maori correspondent, who died soon after

I have never seen a *mako* fish, and I am in doubt whether it is yet fully known to science It is evidently one of the deep-water fishes The first mention of it by skilled scientific observers that I have noticed is in Sir James Ross's "Voyage to the South Seas," wherein it is stated that on nearing the Chatham Islands, in November, 1841 (within a week after leaving their winter quarters and anchorage in the Bay of Islands), "the long snouted porpoises were particularly numerous One of these creatures was struck with a harpoon, and in its formidable jaws we found the teeth which the New-Zealanders value highly as ornaments, and which had puzzled us greatly to ascertain to what animal they belonged" (vol ii, p 134) Those Antarctic Expedition ships had spent several months in the Bay of Islands, and the officers had frequent opportunities of seeing and examining the teeth of the *mako*, and very likely had purchased some from the Maoris, as they were diligent in acquiring natural specimens, and curios and ornaments of all kinds.

Professor Hutton, in his "Catalogue of the Fishes of New Zealand" (published by the Government in 1872), considered the *mako* to be the "*Lamna glauca* = tiger-shark," but he says, "The shark from which the Maoris obtain the teeth with which they decorate their ears is probably this species, but I have seen teeth only" (*l.c.*, p. 77)

Subsequently Professor Julius von Haast (in 1874) read a paper before the Philosophical Institute of Canterbury (Trans. N.Z. Inst, vol. vii., p. 237) on the *mako* of the Maoris, which, he says, is *Lamna cornubica*, the porbeagle shark, and not *L. glauca* as had been supposed by Professor Hutton. But Professor von Haast had only a small young specimen (or, rather, its skin) to examine, which two North Island Maoris, then engaged at Christchurch Museum, pronounced to belong to a young *mako*, and informed him that this fish in its adult state was about 12ft long The animal to which the skin belonged was 4ft 10in long Professor von Haast also gives much information relative to the teeth of his small specimen (differing widely from my Maori friend's description given above), their number, form, and size, the colour of its skin, &c Still, as I take it, there are reasonable doubts as to that specimen being a true *mako*, I think it is highly probable that his two Maori informants had never seen a real *mako* shark

Couch, in his celebrated work on "British Fishes," in his account of the porbeagle shark, gives a drawing of it from nature, and also others of its teeth and jaws, which appear to be different from those of the *mako*, being much more slender, and semi-terete, undulate, and sharply pointed (vol i, pp 41-44)

My object in writing this notice of the *mako* shark is mainly to relate the ancient Maori mode of capturing it

Of the Preparation of Black Pigment for Tattooing—The ancient Maoris had more ways than one of obtaining the black substance used in tattooing, which colouring matter also varied in quality, partly owing to what it was made from, that for the countenance being superior to that used for the lower parts of the body One way of obtaining the best kind was as follows —

First, two proper careful men were selected for the work This, too, was done with ceremony, they being (for the time) *tapu* (*i e*, under the laws of *taboo*)—rigidly set apart. A small kiln-like furnace (*ruangarehu*) was excavated in the side of a hill suitably situated The substances to be used in burning for their soot—*kauri*-resin (*kapia*) and the resinous veins of white pine wood (*kapara*)—were got ready, a net made from the *wharanui* flax leaves finely split, composed of very small and close meshes, and beaten well, so as to be rough and scabrous from long broken fibres, in order the better to catch and retain the soot (*awe*), which was intended to adhere only to the network this net was fixed properly and securely over the top opening or chimney of the kiln, and above it were placed thick mats and such like, to prevent the escape of the burning soot and smoke All being ready, a very calm fine night was chosen for the firing of the kiln—a night in which there should not be the least breath of moving air, and, the kiln being fired, those two men remained all night at their post, attending to their work, carefully feeding the fire When all the resinous substances were burnt up, and the kiln cold—the calm weather still continuing—the soot was carefully collected and mixed up with the fat of birds, and then given to a Maori dog to eat, which dog had also been early set apart for this work—tied up, made to fast, and kept hungry, that it might perform its part and eat the prepared morsels with avidity After devouring the mixed food the dog was still kept tied up, and not allowed to eat any other aliment until it had voided the former. When the fæces were evacuated they were carefully gathered, and mixed up and kneaded with bird's oil and a little water, and, when this mixture became dry and hard, it was put up securely into a large shell, or into a hollowed pumice or soft stone, and laid by carefully, buried in the earth, for future use. It is said to have possessed no disagreeable odour when dry (though it had while fresh), and, though long kept, it did not become bad nor spoil through keeping, which, on the contrary, was said to improve it, and it was very much prized

It was this pigment, so put up and kept, that was the origin of one of their proverbs, "*Puritia to ngarahu kauri*" = Keep to thyself thy kauri-resin-soot pigment This saying was used when a person was unwilling to give what was asked, the same being some common thing, and not at all needed by the avaricious owner. But there is a double meaning here in this simple sentence (proverb)—namely, "You may never require it, or live to use it" (See Trans. N Z. Inst, vol xii., p 145)

Of the Manufacture of their Long Spears—Some of their spears were very long Of these there were two kinds One kind was made of hardwood, *rimu* (*Dacrydium cupressinum*) This was used in defending their forts and stockades before the introduction of firearms, being thrust through the palisades at close quarters against the legs and bodies of the invaders. The other kind was much lighter, though longer, being made of the light wood of the *tawa*-tree (*Beilschmiedia tawa*), and used only for the spearing of pigeons when they were sitting on the top of a high tree. This spear was tipped with a flattish serrated bone 3 inches—5 inches long, usually coarsely barbed on one lateral edge, and sharply pointed; the bone being human, and a portion of that of the arm or leg, and, of course, of their

deadly enemies Seeing that these long spears were always made from heartwood of their tallest trees, it was a mystery to me how they managed to manufacture them, the hardwood ones being from 16 feet to 20 feet and the others from 20 feet to 35 feet long, and it was not until my first visit to the Urewera Tribe, at Ruatahuna, in the interior beyond Waikare Moana, in 1841, that I discovered how it was effected This patient performance has ever seemed to me a notable example of one of their many laborious and persevering works For it must never be forgotten, in considering their ancient laborious and heavy works, especially in hard substances, as wood, bone, and stone, that they accomplished all without the use or knowledge of iron or any other metal

First, a straight, tall, and sound *tawa*-tree was selected in the forest This was felled with their stone axes Its head and branches having been lopped off, it was dragged out into the open ground, and split down the middle into two halves If it split easily and straight, then it would probably serve for two spears, if each half turned out well in the working The next thing was to prepare a long raised bed of hard tramped and beaten clay, 35ft 40ft long—longer than the intended spear—the surface to be made quite regular and smooth (like a good asphalte kerb town walk of the present day) On to this clay bed the half of the *tawa* tree was dragged, and carefully adzed down by degrees, and at various times, to the required size and thickness of the spear It was not constantly worked, but it was continually being turned and fixed by pegs in the ground, to keep it lest it should warp and so become crooked It took a considerable time—about two years—to finish a spear The last operation was that of scraping with a broken shell or fragment of obsidian, and rubbing smooth with pumice-stone When quite finished and ready for use a suitable tall and straight tree was found in, or on the edge of, the forest, its trunk was trimmed of branchlets, &c, the long spear was loosely fixed vertically to it, so as to run easily through small round horizontal loops girt to the tree, and placed at some distance from each other, the tip of the spear concealed, yet protruding near the topmost branches of the tree, and, as the pigeon is a very thirsty bird (especially, I should think, after feeding on the large fruits of the *tawa* and of the *miro*—*Podocarpus ferruginea*—trees, which are hot and piquant), the Maoris made small corrugated vessels of the green bark of the *totara* tree that would hold water, and fixed such on the top of the tree to which the long spear had been lashed, and by-and by, when the bird was settled above after drinking (for it is a very quiet bird, sitting long after feeding), the spear was gently pulled down by its owner below on the ground, and sent up with a jerk into the body of the pigeon I have seen the fixed spear thus used in the forests, and have eaten the bird so captured

I may here mention that I have also seen those totara-bark dishes, with water in them, fixed high up on the big branches of trees in the woods in the Urewera country, having flax nooses so set over the water as to catch and hold fast the pigeon in its drinking I have seen pigeons so caught, the Maoris climbing the trees naked with the agility of monkeys to secure their prizes

From the large amount of labour and the time consumed in the making of a long spear, and its great beneficial use when made, arose a good proverb among them relative to industry in tillage, &c., and to being prepared—"*Kahore he taranga tahere i te ara*" = You cannot hew a bird-spear by the way Meaning Without timely preparation you may die from want of food, though the pigeons are plentiful in the forests near you

Of the Fine Smelling-sense and Taste of the Ancient Maoris for Perfumes.—I have already more than once, and in former papers read here before the Institute, touched on the superior powers of sight of the ancient Maoris,[1] and it has often occurred to my mind that they also possessed a very keenly developed sense of smell, which was largely and quickly shown whenever anything sweetly odoriferous, however fine and subtle, had been used—as eau de Cologne, essence of lavender, &c Indeed, this sense was the more clearly exhibited in the use of their own native perfumes, all highly odorous and collected with labour Yet this sensitive organization always appeared to be the more strange when the horribly stinking smells of two of their common articles of food—often, in the olden times, in daily use—are considered rotten corn (maize, dry and hard, on the cob) long steeped in water to soften it, and dried shark. The former, however, has long been abandoned, yet at one period every village at the North had its steeping-pit

In a paper I read here at our June meeting I mentioned some of the very small Hepaticæ (*Lophocolea* and *Chiloscyphus* species) as being used for perfume by the Maoris, who called them *piripiri* Their scent was pleasant, powerful, and lasting Hooker, in describing those plants, has mentioned it from dried and old specimens Of one species, *Lophocolea pallida*, he says, "odour sweet," of another, *L novæzealandiæ*, "often fragrant," of another, *L allodonta*, "odour strong, aromatic," of another, *Chiloscyphus fissistipus*, "a handsome strongly-scented species" and he has further preserved it to one of them in its specific name, *C piperitus*, "odour of black pepper"

There were also two or three ferns—viz, *Hymenophyllum sanguinolentum*, a very strong smelling species, hence too its specific name, dried specimens not only retain their powerful odour, but impart it to the drying papers *Polypodium pustulatum*, having an agreeable delicate scent and *Doodia fragrans*, a neat little species, this last was so far esteemed as sometimes to give name to the locality where it grew, as *Puke mokimoki*,[1] the little isolated hill which once stood where the Recreation ground now is in Napier, that hill having been levelled to fill in the deep middle swamp in Monroe Street

One of the *Pittosporum* trees, *tawhiri* (*P tenuifolium*), also yielded a fragrant gum, but the choicest and the rarest was obtained from the peculiar plant *taramea* (*Aciphylla colensoi*), which inhabits the alpine zone, and which I have only met with near the summits of the Ruahine Mountain-range, where it is very common and very troublesome to the traveller that way The gum of this plant was only collected through much labour, toil, and difficulty, accompanied, too, with certain ceremonial (*taboo*) observances An old *tohunga* (skilled man, and priest) once informed me that the *taramea* gum could only be got by very young women—virgins, and by them only after certain prayers, charms, &c, duly said by the *tohunga*

There is a sweet little nursery song of endearment, expressive of much love, containing the names of all four of their perfumes, which I have not unfrequently heard affectionately and soothingly sung by a Maori mother to her child while nursing and fondling it —

Taku hei piripiri,
Taku hei mokimoki,
Taku hei tawhiri,
Taku kati taramea.

My little neck-satchel of sweet-scented moss,
My little neck-satchel of fragrant fern,
My little neck-satchel of odoriferous gum
My sweet smelling neck locket of sharp-pointed *taramea*.[2]

Here I may observe that to the last one of the four the word *kati* is prefixed this word—meaning, to sting, to bite, to puncture, to wound sharply and painfully—is added to indicate the excessive sharpness of the numerous leaves and leaflets of the *taramea* plant (hence judiciously generically named by its early discoverer, Forster, *Aciphylla* = needle pointed leaf), and the consequent pains, with loss of blood, attending the collecting of its prized gum, thus enhancing its value

This natural and agreeable little stanza, one of the olden time, has proved so generally taking to the Maori people that it has passed into a proverbial saying, and is often used, hummed, to express delight and satisfaction—pleasurable feelings And sometimes, when it has been so quietly and privately sung in a low voice, I have known a whole company of grey headed Maoris, men and women, to join in the singing · to me, such was always indicative of an affectionate and simple heart How true it is, "One touch of nature makes the whole world kin"![3]

In the summer season the sleeping-houses of their chiefs were often strewed with the large sweet-scented flowering grass *karetu* (*Hierochloe redolens*) Its odour when fresh, confined in a small house, was always to me too powerful[4]

[1] Trans N Z Inst vol xiv p 67, &c.

[1] Mokimoki Hill, from *mokimoki*, the name of that fern

[2] See Trans N Z Inst., vol. xii, p 148

[3] It is pleasing to notice that the observant artist Parkinson (who was with Sir Joseph Banks as his botanical draughtsman, and Cook on his *first* voyage to New Zealand) makes special mention of those little satchels in his Journal, saying of these Maoris who came off to the ship in their canoes, "The principals among them had their hair tied up on the crown of their heads with some feathers, and a little bundle of perfume hung about their necks" (Journal, p 93) Captain Cook, also, has similar remarks respecting the young women.

[4] Sir J. D. Hooker thus writes of this fine, sweet-smelling grass in his "Flora Novæ Zelandiæ" "A large and handsome grass conspicuous for its delicious odour, like that of the common vernal grass (*Anthoxanthum*) of England, that gives the sweet scent to new-made hay" (*l c*, vol ii, p. 300). A closely-allied northern species (*H borealis*), which was also supposed to

Here, in conclusion, I may briefly mention an instance of their correct discrimination on the contrary side, clearly showing how well and closely the ancient New-Zealander agreed in his opinion of a plant with the highly civilized scientific visitor already named above, the botanist Forster. Forster named the *Coprosma* genus from the fetid odour of the first species he discovered in the South Island, which signification he also continued in its specific name, *C. fœtidissima*: this shrub also bears a similar Maori name, *hupiro*, highly expressive of its very disagreeable smell.

Of their Textile Manufactures.—These were formerly prominent among the great industrial achievements of the Maoris, and always elicited the admiration of their wondering visitors.

I divide them into two great classes—(1) of garments, which were woven; and (2) of threads, cords, lines, and ropes, which were spun.

Nature had given to the Maoris one of her choicest gifts in the well known flax plant (*Phormium*), of which there are two ascertained and valid species (*P. tenax* and *P. colensoi*), and several varieties. These plants are pretty general throughout New Zealand, and are well known to the Maoris by the common names of *harakeke*, *wharanui*, *wharariki*, and *tihore*—excluding those of the many varieties as known to them.[1] So that what they may have lost on the one hand through not having the valuable wild edible fruits of other South Sea Islands (as the cocoanut, bread fruit, plantain, &c.) they more than merely gained in their flax plant, which is also common, and almost endemic, being only found outside New Zealand in Norfolk Island.

And here I may briefly mention an anecdote of the flax plant. On my arrival in this country the Maoris (who knew nothing, or very little, of any other land) would often inquire after the vegetable productions of England; and nothing astonished them more than to be told there was no *harakeke* growing there. On more than one occasion I have heard chiefs say, "How is it possible to live there without it?" also, "I would not dwell in such a land as that." This serves to show how highly they valued it. Moreover, at first and for many years the principal export from New Zealand prepared by the Maoris was the fibre of this plant—all, too, scraped with a broken shell, leaf by leaf.

1. *Of their Woven Articles (or Garments).*—I do not intend to say much of them in this paper. Many of them are well known, and still to be found in use among the Maoris, but their manufacture has for many years sadly deteriorated: indeed, I have not seen a newly-made first quality clothing mat for the last twenty to thirty years, and I very much doubt if such can now be made at all. Not that the art of weaving them has been entirely lost, but the requisite taste, skill, and patience in seeking and carefully preparing and using the several parts (including their dyes) are no longer to be found among the Maoris. I sometimes indulge in a contemplating reminiscence—an idea—a pleasing reverie of the long past—of great gatherings of Maoris, tribes and chiefs; and at such times the figures of some head men I have known, clothed in their handsome, clean, and lustrous dress-mats (*kaitaka* and *aronui*), would stand forth in pleasing high relief. The close and regular weaving of such flax dresses, having their silky threads carefully selected as to fineness and uniformity of colour, and their smooth, almost satiny appearance, as if ironed or calendered when worn new, was to me a matter of great satisfaction—a thing to be remembered—"a joy for ever."

Those best dress-mats were always highly prized, both by Maoris and Europeans, and brought a high price. I well recollect a young lady, daughter of very respectable early English settlers in the Bay of Islands, who, when she came across the inner harbour in a boat with her parents to attend the English Church service on Sunday mornings in the Mission chapel at Paihia, often wore one of them folded as a shawl, and to me it seemed a neat and graceful article of dress.

Three things more in connection with these fine mats I will just relate: one, the cross-threads in weaving were always of a different sort of flax—the weft and the woof of these mats were not both taken from the same kind of flax; the second, that extremely soft lustrous appearance was given to the flax fibres by repeated tawing done at different times—it was a pretty sight to see the various skeins of flax fibres in their several stages of preparation neatly hung up in the weaving shed; the third, that in the weaving of one of these garments, if a thread showed itself of a different shade of colour, that part of the garment was carefully unravelled to take it out, and to substitute another better suited in its stead. It was also from this superior knowledge and close attention to their work that the principal chiefs frequently took women who were clever at making those things to be their wives, in order to secure to themselves their valued manufactures.

They also wove very good and useful floor and bed-mats of unscraped flax-leaves, split into narrow lengths and carefully bleached in the sun—these were very strong and lasting; also baskets and kits of all sizes. Some of them were woven in regular patterns with black (dyed) and uncoloured flax; others were skilfully and pleasingly semi damasked (if I may so term it) by changing sides to the flax leaves used to form the pattern, the upper side of the leaf being smooth and shining, the under side not shining and of a glaucous colour. The little kit, or basket, for a first-born child was often a little gem of weaving art, and made by the mother.

Besides the flax plant they had other fibrous plants whose leaves and fibres were also used in making articles of dress: (1) the *toii* (*Cordyline indivisa*), of which they made black everlasting wraps or cloaks. The making of these was confined to the natives of the mountainous interior, where alone those plants grow. (2) The long orange-coloured leaves of the *pingao* (*Desmoschœnus spiralis*), a prostrate spreading sea side plant, also afforded them good materials for weaving useful folded belts, which were strong and looked and wore well, and were highly valued. (3) The climbing *kiekie* (*Freycinetia banksii*) was also used; likewise the long, slender, and soft leaves of the *kahakaha* (*Astelia banksii*), but not frequently. (4) Of the leaves of the common swamp plant *raupo* = bulrush (*Typha angustifolia*), they formed large sails for their canoes. These leaves the Maoris curiously laced together. (5) I should not omit to mention their flying kites (*pakaukau* and *manuaute*), formerly in great esteem among them, and made of the manufactured bark of the *aute* shrub = paper mulberry (*Broussonetia papyrifera*), which was formerly cultivated by the ancient Maoris for its bark. Inferior ones, however, were made of the prepared leaves of some of the larger sedges. They were prettily made, requiring both time and skill in their construction, and much more resembled a bird flying than our English ones. They always served to remind me of those of the Chinese, as we see them in their own drawings and on their chinaware. The old chiefs would sometimes quietly spend hours amusing themselves in flying them and singing (*sotto voce*) the kite's song, using a very long string.[1] Kites being flown at any village or fort was a sure sign of peace. These, too, gave rise to proverbs, some being quaint and highly expressive. A pleasing one I give as a sample: "*He manuaute e taea te whakahoro*" = A flying kite made of paper-mulberry bark can be made to fly fast (away, by lengthening the cord). Used by a lover, expressive of impatience at not being able to get away to see the beloved one.

2. *Of their Spun Fibrous Articles.*—These were very numerous in kind, size, and quality, according to the particular use for which they were required; and, while the larger number of them were composed of scraped and prepared flax-fibres there were also other fibrous leaved plants used by the Maoris, particularly the leaves of the erect cabbage-tree = *ti* (*Cordyline australis*) and of the *kiekie*, already mentioned. Here, too, in this department, the different kinds of varieties of the flax would be used for making the different sorts of threads, cords, and ropes, some of the varieties of flax enduring much greater strain when scraped and spun into lines than others; and of such their deep-sea fishing-lines were made. It was ever to me an interesting sight to see an old chief diligently spinning such lines and cords—always done by hand, and on his bare thigh. The dexterity and rapidity with which he produced his long hanks and coils of twine and cord, keeping them regular, too, as to thickness, was truly wonderful. Some of their smallest twisted cords or threads were very fine. Such were used for binding on the barbs to their fishing hooks, and for binding the long queues of

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be found here in New Zealand, is also used on the Continent of Europe for similar purposes. In some parts of Germany it is dedicated to the Virgin Mary (hence, too, its generic name of *Hierochloe* = sacred grass), and is strewed before the doors of the churches on festival days as the *sweet sedge* (*Acorus calamus*) is strewed on the floor of the cathedral at Norwich for the same purpose at such seasons.

[1] Sir James Hector, in his book on the *Phormium* plants, enumerates fifty five named varieties, but it is doubtful whether more than half of that number are permanent ones.

[1] See an interesting historical tradition respecting such (Trans. N.Z. Inst., vol. xiii., p. 48).

dog's hair to their chiefs' staffs. One of those peculiar cords was a very remarkable one; it was a small cord, bound closely round throughout its whole length with a much smaller one (something like the silver or fourth string of a violin). I never saw this kind but once, and that was at the East Cape, in 1838. A specimen of it I shall now exhibit. This cord was used for a single and particular purpose, attached to the small under aprons of girls—chiefs' daughters.

Their larger cords and ropes were composed of several strands, well twisted and put together. Besides their round ropes so made, they had also flat ones of various widths, which were plaited or woven, resembling our webs and bands, and much used as shoulder straps in carrying back loads; also double twisted ropes, and three strand ones; likewise a remarkably strong one that was four sided. This was made of the unscraped leaves of the cabbage tree, that had been gathered, and carefully wilted in the shade, and then soaked in water to make them pliant. It was used for their anchors, and other heavy canoe and house requirements. The leaves of the flax would not be suitable for this purpose. I have had all those different kinds of cords and ropes made for me in former years, but I much fear the art of making them is lost.

There were also their nets for catching fish and for other purposes, with their meshes of various dimensions. Their smaller ones (hand nets) were made of all manner of shapes and sizes. Some of them were dexterously stretched over circular skeleton framework. And their large seine-nets, used for catching mackerel and other summer fish that swam in shoals, were very long and very strong, made of the leaves of flax, split and prepared, but not scraped, and completely fitted up with floats, and sinkers, and ropes, and other needful appurtenances. Cook, who was astonished at their length, has written much in praise of them. I make one striking quotation: "When we showed the natives our seine, which is such as the King's ships are generally furnished with, they laughed at it, and in triumph produced their own, which was indeed of an enormous size, and made of a kind of grass [*Phormium*] which is very strong. It was five fathoms deep, and by the room it took up could not be less than three or four hundred fathoms long."[1] (Voyages, vol. ii., first voyage, pp. 369, 370.)

In residing at Dannevirke, in the Forty-mile Bush district, during several months, I have often noticed the Maoris from neighbouring villages coming to the stores there to purchase tether and other ropes and lines (large and small) for their use with their horses, ploughs, carts, pigs, &c., while on their own lands and close to them the flax plants grew in abundance. These Maoris had very little to occupy their time, and could easily have made common lines and ropes for their own use if they knew how to spin them as their fathers did, and also possessed their forefathers' love of work.

UGANDA

AT a special meeting of the Royal Geographical Society on the evening of November 3, Captain F. D. Lugard gave an account of the geographical aspects of his work in Uganda. The hall of the University of London was crowded, and although the issue of extra tickets was suspended, a large number of Fellows and their friends failed to get admittance. An excellent hand-map, by Mr. Ravenstein, enabled the audience to follow Captain Lugard's route. The first part of the paper was concerned with the journey from Mombasa along the Sabakhi river, an unnavigable stream, to Machako, the furthest station of the I. B. E. A. Company at that time, the district passed through being almost uninhabited, and supplies difficult to procure. The greater part of the paper related to Uganda and the other countries surrounding the Victoria Nyanza, where Captain Lugard was in command for two years. On the Kavirondo plateau, east of the lake, there is a promising field for European colonisation. The plateau is crossed by the Equator, but at elevations of from 7000 to 8000 feet the climate is cool and exhilarating. It is possible, judging from experience in other places, that highlands close to the Equator are healthier for Europeans than those of similar mean climate lying nearer the tropics. Kavirondo is admirably adapted for grazing, and ranches similar to those of the west of America might be tried. From the pasture lands of this plateau the transition to the rich plantations of bananas and casava of Usoga and Uganda is very marked, and the unclothed natives of Kavirondo give place to the comfortably-dressed Waganda, a warlike people, but skilful in all the arts of peace.

Uganda is a land of low hills and valleys. The hills are of red marl, or marl gravel, and shale, generally covered with pasture grass of a kind apparently peculiar to these countries. The valleys are generally of rich black soil, and most frequently the lowest part of the dip is a river swamp. The swamp varies from a few score of yards to a mile or more in breadth, usually being from half to three quarters of a mile. There is a slight trickling current—but very slight; the river is choked with dense papyrus, with an undergrowth of marsh ferns, grass, reeds, &c. The water is usually the colour of coffee, and red with iron rust. Most of these swamps are of treacherous quagmire without bottom; and unless the roots of the papyrus form a sufficient foothold it is necessary to cut down reeds and boughs of trees to effect a crossing. It is a singular characteristic of these countries that, spite of their altitude and hilly character, rushing water is rarely, almost never, to be seen. Thus Uganda has a mean elevation of some 4200 feet, and borders the trough of the Victoria Nyanza at 3700 feet only, and is a country full of hills and valleys. Kitagwenda, at about the same altitude, borders the Albert Edward Lake at 3300 feet. Unyoro, with more lofty hills and peaks of granite, with an altitude gradually increasing in the south, as you near the Albert Lake, to some 5300 feet, similarly borders the trough of the Albert, which has an elevation of only 2000 feet. Yet nowhere are these river swamps more frequent than here in South Unyoro at the highest altitudes. The origin of the water to supply the enormous Lake Victoria is an interesting problem. Throughout the British sphere, on the north and west of the lake, there is no single river, except the Nzoia, which is worthy of the name flowing into the Victoria. The Katonga—marked on the maps as a big river—is merely a broad papyrus swamp. It is by no means so important a drainage as the Marengo; and all the endless river-swamps (including the Marengo) send their sluggish streams northwards to the Kafur and the Somerset Nile. The superficial area of the Victoria being 27,000 square miles, crossed by the Equator, and at an altitude of about 3800 feet, an enormous amount of evaporation must occur, and yet spite of this evaporation, there issues from its north-western corner the magnificent Somerset Nile, a deep, broad, silent river.

The close of the year 1891 and the early part of 1892 were exceptional in the matter of rainfall. Usually in this part of Africa the lesser rains begin early in October and cease in the middle of December. From that time the heat and drought increase, and the grass dries up and is burnt, till in the beginning of March the greater rains set in, and a tropical downpour continues with few breaks till the end of May. Last October and November the lesser rains were unusually heavy, and continued with little intermission till the time of the regular rains in March. There was a little check, and then the rain continued up to the middle of June and later. The result was, that the Lake Victoria was some six feet perhaps above its ordinary level, and may probably rise still higher. Unusual floods occurred in the Nile in Egypt during September, this not being the time at which the usual high Nile due to the Atbara floods occurs.

Uganda is divided into ten provinces, and the ten chiefs who rule these districts entirely drop their personal names, and are called by the traditional title attached to those provinces. Of these the four largest and most important have separate titles. Thus, the chief of Chagwe is the Sekibobo; of Singo, the Mukwenda; of Buddu, the Pokino; and of Bulamwezi, the Kangao. The remaining six are called by the title of their province, viz. Kitunzi, Katambala, Kasuju, Mugema, Kago, and Kaima. Superior in rank to these ten governors of provinces are the Katikiro (the vizier and chief magistrate of Uganda), and the Kimbugwe. These two hold innumerable estates, scattered throughout the country.

In June, 1891, Captain Lugard left Uganda with the object of coming in touch with the Soudanese refugees from the Equatorial Province, who had assembled at Kavalli's, on the south-

[1] An interesting historical tragic story of the cleverly-planned taking and death of a large number of Maoris in one of these seine-nets, together with the fish (illustrating what Cook has written of their immense size), and of the deadly warfare that followed, is given in the Transactions N.Z. Institute vol. xiii., p. 43.

west shore of the Albert Lake Marching from near Masaka, the capital of Buddu, he traversed Northern Ankole, a district hitherto unvisited by any European, though Mr Stanley, in 1876, had travelled parallel to it within the boundaries of Uganda, and reaching the borders of Kitagwenda, proceeded south-west to the narrow channel or river which connects the upper lake of Rusango with the main waters of the Albert Edward Lake Crossing this narrow channel (at most 500 yards wide) the force camped in the hostile country of the Wasura, a tribe subject to Kabarega of Unyoro, and identified with the Wanyora. Here they crossed Mr Stanley's route at the Salt Lake; but since his book nor maps had not then reached Central Africa the journey was in the nature of entirely new exploration, though of course the discovery of the Albert Edward Lake and of Ruwenzori had been anticipated. The natives, too, being hostile, no one was met with who had seen Mr Stanley, or could give information of his route, or tell of his exploits On the route to the Albert Lake many deep and almost symmetrically circular depressions like the crater of a volcano, or a dried up pond, were passed A few of these, as shown on the map, were tiny lakes no bigger than a mill-pond, but apparently of great depth, with clear blue water, and all the characteristics of a lake The alligator and great fish eagle haunted their waters Others, again, were dry, the bottoms being perhaps 100 feet or more below the level of the surrounding country, which is about 4200 feet above the sea.

The Lake Albert Edward consists of two portions, the Mwutan-zigé (Barrier to Locusts), or the Great Lake and the Rusango on the north east This latter is in reality a separate lake, connected with Mwutan-zigé by a river Its general direction is north-west and south-east There is no swamp around it except at the north west end, where dense jungle and impenetrable marsh afford a home for great herds of elephant. It is at this point that the rivers Wami and Mpanga, into which the countless streams from Ruwenzori flow, bring their waters to the lake The gorge through which the latter flows is picturesque in the extreme, especially in the rains. The great body of water confined between its rocky walls boils and eddies over the sunken rocks below The gorge is some 700 feet deep, and is full of tropical forest The orchids, ferns, and mosses which are found in such a natural forcing-house, where the damp vapours hang, are extremely luxuriant

Captain Lugard followed the eastern base of the Ruwenzori Mountain, crossing the endless streams which descend from its perpetual snows, and hear their clear, sparkling, icy-cold water to the Wami and Mpanga, and so to the Albert Edward The drainage of the eastern Ruwenzori is not towards the Albert and so to the Nile, but to the southern lake, from which the only overflow is the Semliki, a river which at its exit probably conveys a lesser volume of water from the Lake than is contributed to it by the Mpanga alone The ground rises gradually from the level of the Albert Edward 3300 feet to some 5300 feet at Kiaya. Here the route descends into the head of a narrow valley, while the plateau trends away to the right, and forms the uplands of Unyoro, its bold outline appearing from the Semliki Valley and the Albert Lake like a lofty range of hills The valley of Kiaya is extremely fertile, intersected with streams, and studded with banana groves and cultivated land. Between the edge of the plateau on the east and the base of Ruwenzori there is a deep trough, or gorge, the hills rising steep as it were from their own foundations without connection with the plateau, which reaches to their very feet Leaving Kiaya, they passed through a wild country of quartz and scrub jungle, cut at right-angles by gigantic ravines of rich soil, in which are villages, forest, and cultivation This led to the edge of a lower plateau, overlooking the Semliki valley Simultaneously the massive peaks of Ruwenzori sloped down to lesser hills, and mingled with the plain, and a new range of mountains, increasing in height from south to north, appeared opposite Mountains they appear, but, like those left behind, they are really the escarpment of the plateaus on which the sources of the Ituri, and the other great affluents of the Congo, take their rise, which, for convenience, may be called the Kavalli plateau. From Kavalli's Captain Lugard escorted 8000 Soudanese troops, who had by their vacillation retarded the departure of Stanley with Emin for the coast Some of these he settled in forts to protect Uganda from Kabrega's raiders, while others were sent back to Egypt by Mombasa.

SCIENTIFIC SERIALS

American Meteorological Journal, October —A meteorological balloon ascent at Berlin by A L. Rotch The ascent was made on the morning of October 24, 1891, and at the same time a captive balloon was sent up to 600 metres The weather was hazy up to about 1000 feet, but above that the sky was nearly clear The mean decrease of temperature between the ground and the captive balloon was 0°6 C. per 100 metres. In the stratum of air between the captive and free balloon (700 to 1000 metres) the decrease was much slower during the morning, there being at first an increase, the temperature at 693 metres was 10° C, and at 858 metres 10°4. In the afternoon the rate of decrease in the upper stratum became nearly the same as that which prevailed in the lower stratum during the morning —Improvement of weather forecasts, by Prof H A Hazen The author recommends the study of moisture conditions at various heights in the atmosphere, and considers that the greatest hope of improvement is in the observation of atmospheric electricity —The storms of India, by S M Ballou. The storms are divided into three classes (1) the cyclones that occur at the changes of the monsoons, (2) the storms of the summer rains, (3) the winter rains of the northern provinces, he discusses the causes of their formation, and gives a brief description of each of these classes —The ether and its relation to the aurora, by E A Beals The author gives a brief summary of some of the facts respecting our knowledge of auroras, in view of their probable maximum during the coming year in connection with their correlation with frequency of sunspots — There are also short articles on warm and cold seasons, by H. Gawthrop, facts about rain making, by G E. Curtis, and convectional whirls, by Prof H A Hazen

SOCIETIES AND ACADEMIES

LONDON

Anthropological Institute, October 18 —A special meeting was held, the president, Edward B Tylor, D C.L, F R S, in the chair, to receive a communication from Major R C Temple, I S C, on "Developments in Buddhist Architecture and Symbolism as illustrated by the Author's Recent Exploration of Caves in Burma" Major Temple commenced by saying that the object of the paper was chiefly to draw attention to the extraordinarily rich and for the present practically untouched field for the ethnographist and antiquary existing in Burma He exhibited some photographs of life size figures in wood, carved by a well known artist of Maulmain, of the "four sights" shown to Buddha as Prince Siddhartha on his first visits to the outer world, viz., the old man, the sick man, the dead man, and the priest; and also some admirable gilt wooden representations from Rangoon of Buddha in his standing and recumbent postures, with his begging bowl, and seated as King Jambupati, surrounded by priests and other worshippers He next showed a remarkable set of gilt wooden images from the platform of the great Shwedagon pagoda at Rangoon, of *nats*, *belus*, *hanuman myauks*, and other spirits believed in by the Burmese, seated on the steps of a lofty *tagon-dain*, or post, on the top of which is always perched the figure of the hentha (hansu), or sacred goose, which apparently protects pagodas in some way From these he passed on to four representations of large glazed bricks or tiles from Pegu These curious, and (so far as English museums are concerned) probably unique antiquities may be presumed to be at least 400 years old, and formed at one time the ornamentation of the three procession paths round a now completely ruined pagoda. They represent the march, battle, and flight of some foreign army, represented in true Indian fashion with elephant, monkey, and other animal faces. Some of the figures are clad in Siamese and Cambodian fashion The glazing is remarkably good, and Indian influence is clear in their construction They may probably represent a scene from the *Ramayana*, which in a mutilated form is well known to Burmese mythology These were followed by a huge figure of Buddha from Pegu, in his recumbent attitude, which may be referred to King Dhammacheti, who flourished in the fifteenth century. This image is 181 feet long and 46 feet high at the shoulder. It is built of brick, and is well proportioned throughout. Its history is lost, and so was the image itself until 1881. Pegu was utterly destroyed about 1760 by the Burmese,

and the interest in its holy places lost for more than a generation This image became jungle grown and hidden from view, and was accidentally discovered by a railway contractor searching for ballast for the line in the neighbourhood General and detailed views of the Kawgun Cave were shown, exhibiting the wonderful extent of its decoration by a vast number of terra cotta tablets and images in wood, marble, alabaster, and other materials, and the extraordinary variety and multitude of the objects connected with Buddhistic worship, both ancient and modern, to be found in it The Kawgun Cave is the richest of those visited by Major Temple, but he explained that he had examined about half a dozen others in the district, and had since gathered positive information from local native sources of the existence of about forty altogether Many of these are hardly inferior to Kawgun in richness of Buddhistic remains, and several are said to contain in addition ancient MSS, which must now be of inestimable value A few such MSS have actually been found It will thus be seen how great and valuable is the field, and how well worth systematic study by competent students

Royal Microscopical Society, October 19 —Mr G C. Karop, Vice president, in the chair —The chairman exhibited and described Messrs Swift's aluminium microscope, which he believed to be the first microscope made of that metal The chief point in the instrument was its extreme lightness, the whole when complete, and including the condenser and eyepiece, weighing only 2lb 10½oz as against the weight 7lb 13oz of a precisely similar stand made in the usual way of brass It was perhaps not entirely correct to say that every portion was of aluminium, because there were certain mechanical difficulties met with which prevented some portions from being made of that metal, for instance, he believed it was almost impossible to cut a fine screw upon it without the thread "stripping," and it was also found extremely difficult to solder, so that the necessary screws in the instrument were made of brass, the Campbell fine adjustment of steel, the rack and pinion coarse adjustment was also not made of aluminium, and the nose piece was of German silver —Prof F Jeffrey Bell read a letter received from Mr H G A Wright, of Sydney, stating that a scale of Podura in his possession was deeply notched, and that an exclamation mark had become detached and projected from the edge Mr Wright also sent photomicrographs to support his statement The chairman said he could not be sure, from the cursory examination he had been able to make, that the exclamation mark referred to was to be seen —Dr C E Beevor read a paper on methods of staining medullated nerve-fibres, illustrating the subject by photomicrographs, and by a number of preparations under microscopes The chairman said they were very much indebted to Dr Beevor for his interesting paper It was a good thing to be able to differentiate nerve fibres in the ways described, but it was a pity that they could not also so differentiate them as to show from which part of the nervous system they came If this could be done he need hardly say it would be of great value —Prof Bell read a paper by Dr H G Piffard on the use of monochromatic yellow light in photomicrography Mr. T Charters White said that he had himself tried a similar process with monochromatic light obtained by using screens and solutions, but the chief difference he found was that it very much prolonged the time necessary for exposure Mr T. Haughton Gill said that he had used the copper light filter for the same purpose, and had found that by its aid any good ordinary lens would give as good results as were otherwise obtained by using an expensive apochromatic, because it filtered off all the rays except those which were visually strong He had not found, in the course of his work, that the use of this light prolonged the exposure, that was to say, that with a magnifying power of ×300 and an exposure of ten minutes, he could get a good strong printing image with the isochromatic plates —Mr G Massee's paper on *Heterosporium asperatum*, a parasitic fungus, was, in the absence of the author, taken as read

Entomological Society, November 2, Frederick DuCane Godman, F.R S, president, in the chair —Mr. S Stevens exhibited, for Mr J Harrison, a beautiful series of *Arctia lubricipeda* var. *radiata*, which had been bred by Mr Harrison this year.—Mr G. T. Bethune-Baker exhibited specimens of *Polyommatus dispar* var. *rutilus*, taken in England by his father about sixty years ago He stated that it was generally believed that this form of the species was confined to the Continent, but his specimens proved that it formerly occurred in England.—Mr. C G. Barrett exhibited dark varieties of *Acronycta leporina*, bred by Mr J Collins also a white variety of *Triphæna pronuba*, taken at Swansea.—Mr M Jacoby exhibited a specimen of *Sagra femorata*, from India, with differently sculptured elytra, one being rough and the other smooth —Mr J A Clark exhibited a long series of remarkable varieties of *Liparis monacha*, bred from two specimens taken at Scarborough Several of the specimens were as light in colour as the typical form of the species, others were quite black, and others intermediate between these two extremes —The Rev Seymour St John exhibited a monstrosity of *Abraxas grossulariata*, and a specimen of *Tæniocampa stabilis*, with a distinct light band bordering the hind margin of the upper wings —Mr. E B Poulton, F R S, exhibited two series of imagos of *Gnophos obscurata*, which had been subjected to dark and light surroundings respectively The results were seen to be completely negative, the two series being equally light —Mr F Merrifield showed a number of pupæ of *Pieris napi* About eight of them, which had attached themselves to the leaves of the cabbage plant on which they were fed, were of a uniform bright green colour, with light yellowish edgings, of the others, those which had attached themselves to the black net covering the pot, or the brownish twigs which supported it, were dark coloured, with dark spots and lines Mr R Adkin exhibited three bred female specimens of *Vanessa c album*, two of which belonged to the first brood, and the third to the second brood One of the specimens of the first brood was remarkable in having the under side of a very dark colour, identical with typical specimens of the second brood He thought the peculiarity of colouring had been caused by a retarded emergence, due to low temperature and absence of sunshine —Mr F W Frohawk exhibited varieties of *Satyrus hyperanthus*, bred from ova laid by a female taken in the New Forest in July last —Mr F D Godman, F R S, exhibited a specimen of *Amphonyx medon*, Cr, received from Jalapa, Mexico, having a pouch-like excrescence at the apex of its body —Mr C J Gahan communicated a paper entitled "Additions to the Longicornia of Mexico and Central America, with notes on some previously recorded species"—Mr W L Distant communicated a paper entitled "Contributions to a knowledge of the Homopterous family Fulgoridæ"—Mr Oswald Latter read a paper (which was illustrated by the Society's new oxy-hydrogen lantern) entitled "The Secretion of Potassium-hydroxide by *Dicranura vinula*, and the emergence of the imago from the cocoon" The author stated that the imago produced, probably from the mouth, a solution of caustic potash for the purpose of softening the cocoon The solution was obtained for analysis by causing the moths to perforate artificial cocoons made of filter-paper Prof Meldola, F R S, said that the larva of *D vinula* secretes formic acid, and Mr Latter had now shown that the imago secretes potassium hydroxide, a strong alkali He stated that the fact that any animal secreted a strong caustic alkali was a new one Mr Merrifield, Mr Hanbury, Mr Gahan, Mr Poulton, and Prof Meldola continued the discussion —Mr H J Elwes and Mr J Edwards read a paper (also illustrated by the oxy-hydrogen lantern) entitled "A revision of the genus *Ypthima*, principally founded on the form of the genitalia in the male sex" Mr McLachlan, F R S, said he attached great importance to the genitalia as structural characters in determining species, and he believed that he could name almost any species of European Trichoptera simply from an examination of the detached abdomens of the males Mr O Salvin, F R S, said he had examined the genitalia of a large number of Hesperidæ, with the view of considering their value in distinguishing species Mr Bethune-Baker, Colonel Swinhoe, Mr. Lewis, Dr Sharp, F R S, Mr Hampson, and Mr Champion continued the discussion —Mr S H Scudder communicated a paper entitled "New light on the formation of the abdominal pouch in *Parnassius*" Mr Elwes said he had based his classification of the species of this genus largely on the structure of this abdominal pouch in the female Mr Jenner-Weir remarked that a similar abdominal pouch was to be found in the genus *Acræa*, and Mr Hampson referred to a male and female of *Parnassius* in Mr Leech's collection, in which the pouch had come away from the female and was adhering to the male organs.

PARIS.

Academy of Sciences, October 31.—On the geometry of position, by M. H. Poincaré —Observations on M Berthelot's communication regarding the fixation of nitrogen, by M Th.

Schlœsing Reply, by M Berthelot —On the laws of compressibility of liquids, by M E H Amagat Deformations of the piezometers were investigated and allowed for in these experiments, and the pressures carried as far as 3000 atmospheres. The liquids operated upon were ether, alcohol, carbon bisulphide, acetone, the ethyl halides, and chloride of phosphorus In every case the coefficient of compressibility was found to decrease regularly as the pressure increased At 3000 atmospheres that of water was reduced by nearly one half its ordinary value, that of ether by two-thirds This diminution again is greater the higher the temperature The ratio of the difference of the coefficient to the corresponding difference of temperature, $\frac{\Delta\mu}{\Delta t}$, increases rapidly with the temperature, and decreases rapidly as the pressure increases The value of $\frac{1}{\mu}\frac{\Delta\mu}{\Delta t}$ also diminishes rapidly as the pressure increases, but whilst for alcohol it grows decidedly with the temperature, for ether it seems sensibly independent of it It is probable that the ratio passes through a maximum at a certain temperature —Observation of the comet Barnard (October 12), made at the Algiers observatory with the *equatorial coudé*, by M F Sy —Elliptic elements of the comet Barnard, by M Schulhof Discussing the probabilities of the new comet being identical with, or a part of, the comet Wolf, which was subjected to considerable perturbations by Jupiter in 1875 —On the equations of dynamics, by M R Liouville —On the solution of the ballistic problem, by M E Vallier —Displacements of a magnet on mercury under the action of an electric current, by M C Decharme If a light magnetic needle be floated on a bath of perfectly pure mercury, and conductors carrying a current be dipped into the mercury at different places, the needle will, before assuming the position of equilibrium according to Ampère's law, go through a series of excursions, rendered necessary by the difficulty of its motion, perpendicular to its length. If the current crosses the mercury in a direction perpendicular to the length of the needle for instance, with the negative pole of the current on the left of the south-seeking pole, the needle will move away parallel to itself, will turn round, and return to take up the normal position —On the temperature of maximum density of mixtures of alcohol and water, by M L de Coppet The lowering of the freezing-point in solutions of alcohol is sensibly proportional to the quantity of alcohol, in confirmation of Blagden's law But the lowering of the temperature of maximum density is not proportional to the percentage of alcohol For weak solutions there is no lowering, but rather an elevation of the temperature of the maximum —On the dissociation of barium dioxide, by M H. Le Chatelier.—On a limited reaction, by M Albert Colson —On the fixation of free nitrogen by plants, by MM Th Schlœsing, jun , and Em Laurent —Purification of drain waters by ferric sulphate, by MM A and P Buisine —Experiments on bread and biscuit, by M. Balland —Ptomaïnes extracted from urines in erysipelas and puerperal fever, by M A. B Griffiths —Hermerythrine, a respiratory pigment contained in the blood of certain worms, by M A. B Griffiths.—Morphology of the skeleton of the star fish, by M Edm Perrier —The secreting apparatus of the *Copaifera*, by M Léon Guignard —New observations on sexuality and parasitic castration, by M. Ant Magnin —A possible cause of the doubling of the canals of Mars; experimental imitation of the phenomenon, by M Stanislas Meunier —Devonian and permio carboniferous of the Aspe valley, by M J Seunes —A short account of the voyage of the *La Manche* to Iceland, Jan Mayen, and Spitzbergen during the summer of 1892, by M Bienaimé The maps of Jan Mayen were found to be very accurate those of Spitzbergen much less so The barometric change in Iceland, Jan Mayen, and the Faroes agreed strikingly with those of Great Britain and Scandinavia, while those of Spitzbergen were of a particular order Pendulum observations gave $g=9\ 82345$ for Jan Mayen, and 9 82866 for Spitzbergen,—Eruption of Etna of 1892, by M. A. Ricco.—The analysis of complex odours, by M Jacques Passy Proceeding from very small doses, say of amyl alcohol, two different perfumes will be perceived to increase and then diminish in succession, finally giving way to an odour which soon becomes disagreeable as it increases in strength. The transition from perfume to unpleasant odour is very general in volatile substances —Immunity against cholera conferred by milk, by M. N. Ketscher —A new apparatus for hypodermic injections, by M. G Bay

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Books —A Text book of Magnetism and Electricity R W Stewart (Clive).—Public Health Problems J F J Sykes (Scott) —An Elementary Manual on Applied Mechanics Prof A Jamieson (Griffin).—Mind in Matter, 3rd edition Rev J Tait (Griffin) —Arthur Young's Tour in Ireland, 2 vols edited by A. W Hutton (Bell).—Text book of Elementary Biology Dr H J Campbell (Sonnenschein) —The Volcanoes of Japan, Part 1, Fujisan J Milne and W K Burton (Low)—Strange Survivals S Baring Gould (Methuen)—Finger Prints F Galton (Macmillan).—Modern Mechanism edited by P Benjamin (Macmillan) —Catalogue of Eastern and Australian Lepidoptera Heterocera in the Collection of the Oxford University Museum Part 1, Sphinges and Bombyces Col C Swinhoe (Oxford Clarendon Press).—An Introduction to the Study of Botany A Dendy and A H S Lucas (Melville) —Hydrostatics and Elementary Hydrokinetics Prof G M Minchin (Oxford, Clarendon Press) —New Vegetarian Dishes Mrs Bowdich (Bell) —British New Guinea J P Thomson (Philip).—Autres Mondes A Guillemin (Paris, Carré) —Stéréochimie J H Van't Hoff (Paris, Carré) —Théorie Mathématique de la Lumière, II H Poincaré (Paris, Carré) —Traité de Mécanique V Jamet (Paris Carré) —In Savage Isles and Settled Lands F S Baden-Powell (Bentley) —Stanford's Contoured Map of the County of London (Stanford) —Naked Eye Botany F E Kitchener (Percival) —Geometrical Drawing A J Pressland (Percival).—Practical Physics, Part 1, Physical Processes and Measurements, the Properties of Matter Prof Barrett and W Brown (Percival) -Beetles, Butterflies, Moths and other Insects, A W Kappel and W E Kirby (Cassell) —The Principal Starches used as Food W Griffiths (Cirencester, Baily) —Charles Darwin F Darwin (Murray) —University College, Nottingham, Calendar 1892–93 (Nottingham Sands) —Proceedings and Transactions of the Royal Society of Canada, 1891 (Montreal, Dawson)

Pamphlets —Report on the Operations of the Department of Land Records and Agriculture, Madras Presidency, 1890-91 (Madras) —Entwurf einer Neuen Integralrechnung Dr J Bergbohm (Leipzig, Teubner).—Leaves from the Book of Nature L Piers (Ridgway) —Fossil Mammals of the Wahsatch and Wind River Beds, Collection of 1891 H F Osborn and J L Wortman —Present Problems in Evolution and Heredity H F Osborn —Revision of the Species of Coryphodon C Earle.

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THURSDAY, NOVEMBER 17, 1892

THE GEOLOGY OF SCOTLAND

Geological Map of Scotland By Sir Archibald Geikie, D.Sc, LL D, F R S, Director-General of the Geological Survey of Great Britain and Ireland With descriptive text (Edinburgh J Bartholomew and Co, 1892)

THERE have been many attempts to frame a popular definition of man To call him a "story-loving animal" would not be the worst of them It may indeed turn out when we understand monkey-talk a little better than now (and the hope that we may is, we are assured, not unreasonable), then it may be that this will prove to be not an exclusive definition But this by the way, the description will hold for the present Hence the delight with which we listen to all that the various branches of history, the history of the growth of knowledge included, have to tell us It is the stories which first attract us, and they retain their charm long after we have learned that the study of history has other ends to fulfil besides the satisfaction of that craving for story-hearing which lies deep in our being, and the gratification of a natural curiosity to learn about things which we have not seen But the conviction that history should be to us something more than a string of ancedotes soon forces itself upon us

In tracing the growth of any branch of knowledge, in noting the steps by which, one by one, each advance has been made good, our interest lies first of all in the acquaintance, almost of a personal character we may say, which we make with the pioneers of a movement of which we see not perhaps the full development but the ripening fruit. We watch with absorbed attention their approach to the unexplored land, we follow them along the tracks by which they first traversed it, we stand by while they note and record all that is novel and characteristic in its features, we mark the birth and growth of the conceptions which their exploring work gives rise to, we live over again their fascinating life of discovery and deduction But beside and beyond all this, their story, like the stories of all history, carries with it a lesson, and their caution or rashness, as the case may be, in generalizing and drawing conclusions, serves as example or warning to us We look up to candour and a readiness to court criticism and give up explanations which are shown to be untenable, anything like partizanship and a weakly parental predilection for the children of one's own brain we look down upon with sorrowing pity.

The history of the steps by which a knowledge of the geology of a country has been arrived at is written in the successive versions of its geological maps The appearance of a map which embodies the results of the latest researches into the geology of Scotland tempts us to look back upon the earlier efforts to unravel the complications of its geological structure And this all the more because we are dealing with a country in which Geology, as we know it, may be said to have come to the birth; and because it is to Scotchmen that we owe the first showing forth of these principles, whether of observation, deduction, or inductive confirmation, which have been the guide of geologists ever since To Hutton, the precursor of Lyell, to Hall, the scientific ancestor of Daubrée, and to the line of illustrious followers who have carried on with such brilliant success the work which they started

Among the earliest attempts to deal with the geological mapping of Scotland are the maps of Macculloch's "Western Islands," which bear the date of 1819 It is hard for us to realize how much of Scotland was at that time without adequate topographical delineation Our present Ordnance Maps are far from being a credit to the Department which issues them, and the language which attends an attempt to use them on the mountainous moorlands, though not a whit stronger than is justifiable under the circumstances, had better be left to melt into thin air around the spots where it was uttered But our geological life is one of luxury compared with Macculloch's, whose atlas is one string of apologies for the inadequate maps on which he had to record his observations. The map of the Isle of Man "is obviously very inaccurate, but there was only a choice between it and two others equally unworthy of confidence" The map of Staffa "was drawn under every unfavourable circumstance, and cannot fail to be inaccurate, having been merely paced with the assistance of a pocket compass in a severe gale of wind and rain"

Macculloch seems to have projected, but never completed, a geological map of the whole of Scotland The materials collected by him were however utilized by the Highland Society in the construction of a general map in 1832

Passing by the maps of Boué, and a sketch of Murchison's and Sedgwick's, laid before the Geological Society in 1828, we come to the publication of Nicol's "Guide to the Geology of Scotland" in 1844

In a country where the rocks are so largely unfossiliferous, it is natural, even necessary, that the earliest geological maps should be more of a lithological than a stratigraphical character, and this is the case with the maps so far noticed In the map which accompanies Nicol's guide, and which he says is based on Macculloch's, some of the main varieties of the crystalline schists are distinguished, but the order in which they occur is not indicated One colour comprises all the red sandstones, the Torridon, the Old Red, and even the red rocks of Dumfriesshire, under the head of "Porphyry and Trap" are lumped together all the volcanic rocks, including those of the western islands and of the central valley, only two of the groups which we now call formations are separated, the "Carboniferous" and the "Lias and Oolite" But the great leading features in the physical geography of Scotland are sharply marked out, the three regions into which it naturally falls are lucidly delineated, and the work is crowded with local details that betoken acquaintance with the work of others and patient investigation of his own.

At the meeting of the British Association at Glasgow in 1855 Murchison gave an account of the result of the joint work of Nicol and himself in the north western Highlands. The existence of three great sub-divisions had been clearly established; what we now know as the Hebridean or Lewisian Gneiss at the base, the Torridon sandstone resting unconformably on it; while above that, and separated from it by another unconformity, came the

limestones and quartzites of Durness and Loch Erriboll, in which Peach had recently discovered fossils The last group appeared to be conformably overlaid by a great mass of crystalline schists, which came to be known afterwards as the "Upper or Eastern Gneiss" Though the fossil evidence was then incomplete, Murchison saw nothing in it to forbid the belief that the Durness beds were of Lower Silurian age, and his conjecture was confirmed by the discovery of better specimens This conclusion was announced in a paper read before the Geological Society in 1858, in which it was also stated that the author looked upon the Upper Gneiss as metamorphosed Silurian

In the meantime Nicol had read a paper before the Geological Society (1856), in which he describes the joint explorations of himself and Murchison, and some subsequent work of his own He recognizes the same main sub-divisions as Murchison, but still leans to the old notion that the Torridon sandstone belongs to the Old Red, this involves the assigning a later date to the Durness Beds, and these he thinks may be Carboniferous But he is content to hold this merely as a provisional hypothesis till further fossil evidence is forthcoming With respect to the Upper Gneiss he is very cautious, suggesting that it may be a newer metamorphic group, or may be merely a portion of the lower, that is Hebridean, gneiss *forced up by some great convulsion* This latter solution was evidently present very vividly to his mind, for it is repeated, as a possible explanation, no less than three times

Here a very important difference of opinion between Murchison and Nicol makes its appearance

It was probably about this time, but the map bears no date, that Nicol issued a new geological map of Scotland. In this all gneiss is denoted by one colour, but the explanation states that the author does not consider all the Scotch gneiss to be of the same age, that the tract of this rock, with associated quartzite and limestone, stretching from Aberdeenshire through Perthshire to the Breadalbane Highlands of Argyllshire, may be a newer formation; while he is disposed to look upon the great mass of gneiss, extending from the north coast of Sutherland southwards through Ross-shire and Inverness-shire, rather as belonging to an older period The Torridon sandstone is distinguished by a separate colour, though the author is still inclined to class it with the Old Red

Nicol expounded his views to the British Association at Aberdeen in 1859, and again in a paper read before the Geological Society in 1860 He adduces many reasons for doubting the existence of an "upward conformable succession" from the Durness Beds to the Upper Gneiss, and explains the sections on the supposition that this rock is the Hebridean Gneiss brought up by faults Though the expressions, "forced up by convulsion" and "pushed up over," which he uses in his paper of 1856, seem to show that the notion of what we call "Thrust Planes" was present to his mind, the sections of this paper hardly bear out that inference. He neatly twits Murchison with failing to see that the principles which he had applied with such success to an explanation of the structure of the Alps were equally applicable to the North-west Highlands. In 1861 Murchison stoutly maintained his view regarding the Upper Gneiss; with an advocate's skill he hits Nicol hard on his weak point, justly urging "that local interferences of eruptive rock nowise set aside broad data" In the same year was issued the "First Sketch of a new geological map of Scotland by Sir R I Murchison and A (now Sir A.) Geikie," in which Murchison's views vere adopted

Here then was a promise of a fair stand-up fight between two champions, each well able to hold his own. But the promise was not fulfilled The combat would have been far from equal On the one side there were the pull which wealth and social position bring with them, the advantage which accrues from living in London and having thus the ear of a great centre of scientific life, and that pushing ambition, that eagerness to secure precedence in discovery, which so often go along with an active and energetic disposition On the other side there were comparative social insignificance, residence in a hyperborean region far more difficult of access than now, a happy indifference to fame based on a confidence that the settlement might be safely left to time, and that the world would go on pretty much as heretofore, whichever of the two turned out to be nearer the truth more than all a reluctance to embitter the closing years of life with anything that looked like an altercation with an old and esteemed friend and fellow-worker So, because it takes two to make a quarrel, the fight never came off Naturally, under these circumstances, (and can we blame it?) the world took the man who vigorously pushed his views, at his word, he had plenty to say in their favour and said it well, no one gainsaid him, his contention was accepted There will be those who, without presuming to blame, do not covet success on such terms, and whose sympathies go out towards the peace-loving old man who was content to bide his time and possess his soul in silence

And so the "Upper Gneiss" and "the upward conformable succession" held their own, and in the geological map of Scotland, issued in 1876 by the present Director-General of the Geological Survey, the crystalline schists of the Central Highlands are designated "Metamorphosed Lower Silurian" It would be tedious to enumerate all the points in which this map is an improvement on the "First Sketch" of 1861, but the student will find it an instructive exercise to compare the two maps, and ascertain by reference to memoirs on special districts how each correction and addition was arrived at.

The Highland problem remained in abeyance for nigh a quarter of a century, though during that interval the minds of many geologists were constantly recurring to it and evidence was being accumulated to help towards its solution But it came to the front again, and like a giant refreshed with sleep, when Prof Lapworth in his "Secret of the Highlands" (1883), and other workers in the same ground, began to throw doubt on the explanation which had so long held the field. When the Geological Survey were able to take up the question and work out the ground with precision and detail that no observer could attain to single handed, the anticipations of their immediate predecessors were substantially confirmed, and of the earlier observers it came out that Nicol was nearer the truth than his illustrious antagonist.

It calls for no small exercise of judgment, in an endeavour to depict the geology of so complex a district on

a map of small scale, to decide what details must be retained because they are essential to a grasp of its broad general structure, and what may be safely eliminated without impairing the comprehensive view. In the map now before us this end has been compassed with consummate skill. It bristles with detail, but there is nowhere crowding; the colours are well contrasted, and so transparent that they do not hide the topography, which is full and clearly printed.

The richness in detail of the strip of country between Cape Wrath and Loch Torridon marks one scene of the recent work of the Geological Survey. Then follows a broad band of "gneissose and schistose rocks not yet differentiated." A portion of this ground is occupied by the crushed and mangled-out complex of the "Moine schists," but a large part is yet imperfectly explored. To the south-east of the Great Glen we enter again on ground which has been largely worked out by the Geological Survey. We have here a group of various sedimentary deposits in a more or less altered condition, containing sheets of basic igneous rocks. The geological age of this series is not known, and they are provisionally classed as Dalradian.

The presentation of the results of the work of the Geological Survey in the north-west and central Highlands are the two most conspicuous novelties in the map; but during its use other corrections and additions, too small to catch the eye on a general view, become noticeable. In the explanatory notes we have a concise summary of the geology of Scotland, and feel that our thanks are due to the author for having put so much into so small a space without in any way sacrificing descriptive clearness. When the time comes for a new version of the map, may the same hand be with us to draw it up.

A. H. GREEN.

MEDICAL MICROSCOPY.

Medical Microscopy. A Guide to the Use of the Microscope in Medical Practice. By Frank J. Wethered, M.D. (Lond.), &c. With Illustrations. Pp. 412. (London: H. K. Lewis, 1892.)

THIS volume, one of Lewis's practical series, bears an ambitious title, and must necessarily traverse a wide and intricate field of medical work. Its appearance is justified by the distinct need existing at the present time for a manual dealing with the various microscopical methods so essential to diagnostic accuracy and rational treatment.

The subject-matter is arranged in twenty-four chapters, and as an indication of the scope of the book, we instance some of the headings. The earlier ones treat of the microscope and its accessories, the methods of hardening, decalcifying, embedding, section cutting, staining, and injection of tissues. Then follow others on the examination of tissues, urinary deposits, blood, expectoration, and the detection of micro-organisms, and cutaneous parasites; while the latter chapters deal with the examination of food, water, and with bacteriological methods. In fact, the book is almost an epitome of the course pursued by a student earnestly working with the microscope from the commencement to the end of his curriculum. The tendency has been, by the specialized character of the primary examinations in late years, to sever in some degree the knowledge obtained in the earlier part of a student's career from the practical application of the same at the bedside. So much is this the case, that it has been deemed advisable in some quarters to introduce new courses of lectures, their aim being to indicate with precision to students those facts in anatomy and physiology which have a distinct clinical value. One of the chief merits of Dr. Wethered's book is that he has therein demonstrated the important relationship between histology and morbid anatomy, and has shown that any attempt at acquiring a knowledge of the latter is dependent upon a practical and searching training in the former.

Moreover, the book is worthy of more detailed criticism. Necessarily in a first edition there are some points omitted. In speaking of the microscope the author offers a cursory remark on the fine adjustment, no mention is made of the best pattern, and there are many of an inferior and useless description foisted on students; nor are there any directions for the precise use of this portion of the microscope. In the chapter on "Hardening and Decalcifying Tissues," on p. 35, are found some well-meant platitudes on the necessity of immediately labelling specimens; but at the same time the use of lactic acid as a decalcifying agent is omitted. We have succeeded in completely softening small pieces of bone in 4-7 days, and teeth may be cut with the freezing microtome in from two to three weeks.

With certain statements of the author we venture to disagree. In speaking of the celloidin method he advises that the specimen be placed in equal parts of ether and alcohol previously to being placed in celloidin. A mixture of four parts of ether and one part of absolute alcohol ensures more rapid and complete penetration of the embedding material. Also in using paraffin for this purpose we have found by extensive practice that sections containing a large amount of fibrous tissue are useless after being in the paraffin bath for three to five hours, even at a temperature of 48° C.; twenty to thirty minutes is ample, provided that the material is properly dehydrated. The chapter on staining is succinct and comprehensive, and we note the usual and indeed only rational classification of stains, as nuclear, general, and selective. Hæmatoxylin still holds the first place, and Delafield's, or as it is miscalled, Grenacher's, is undoubtedly the best formula. It is here stated that if the sections be overstained, and washing in acid-alcohol be necessary, the colour is not permanent. Our experience is that if after the acid they be washed thoroughly well with "tap water," a very clear nuclear stain results which remains unchanged for years. Gram's method of staining for micro-organisms, with Weigert's modification, is clearly detailed. But here we fail to observe any mention of the brilliant results obtained by the Ehrlich-Biondi method. The employment of rubin for actinomycosis may with confidence be recommended, and the same remark applies to the use of saffranin in bringing out clearly the nuclear figures in karyokinesis. The chapter on mounting is somewhat tedious and the use of origanum oil in clearing celloidin-specimens is not advocated, although it has found general acceptance in Continental laboratories.

Weigert's method of preparing and staining nerve-tissue is given, but with one important detail left out, viz., that on removing the specimen from Muller's fluid or chromic acid solution it should have a brown, and not a green colour. The preparation of individual tissues and organs is well dealt with in chapter xii., but in the succeeding one on the examination of tumours there are such evident signs of hasty composition as to render it of small intrinsic value. On the other hand, the important subjects of urinary and excrementitious matters receive ample treatment; and we have a clear *résumé* up to this date of all that is taught on these subjects. As an example we note with pleasure the account of Dr. Delepine's work on "sable intestinal." The bacillus of Asiatic cholera and the methods of its detection are described on p. 228, and the diagnostic points between it and that of cholera nostras are found on the next page. A large amount of space is necessarily devoted to the examination of sputa. Dr. Wethered's experience at the City of London Hospital for Diseases of the Chest enables him to speak with the voice of authority on the signification of the presence or absence of the tubercle bacillus. Physiologists will find their side of the question well considered in the observations on blood; on Dr. A. Garrod's authority we are told that the blood of the Londoner has not yet been found to contain its true proportion of hæmoglobin. Eosinophile cells are not omitted; but for more detailed information on this point we commend to the notice of pathologists the article by Dr. A. Kanthack in the *British Medical Journal* of June, 1892.

Medical microscopy as a subject is exceedingly elastic, and we believe Dr. Wethered has stretched it to its widest limits when he finds space for describing the examination of various kinds of cereals, also of water. Even the homely tea-leaf has not escaped his notice. A few instances of clerical errors are to be found, thus Hartnach for Hartnack, on p. 122, Richert for Reichert. At the term "collodionization" we venture to express our distaste. A growing practice exists of introducing ungainly expressions of doubtful expediency into scientific works.

We have read this book with considerable attention, and are convinced that it has a most distinct *raison d'être*, and justifies on the whole, by the merit of its execution, the ambition of its title. It treats of the matter in hand with much ability, and in a manner that evidences considerable experience on the part of the author as a pathologist, physician, and teacher.

A. H. TUBBY.

ODOROGRAPHIA

Odorographia: a Natural History of Raw Materials and Drugs used in the Perfume Industry. By J. Ch. Sawer, F.L.S. (London: Gurney and Jackson, 1892.)

CONSIDERING the importance of the subject of perfumes both from a scientific and a commercial point of view, it is somewhat surprising that a really good and authoritative book dealing on the matters encompassed by "Odorographia" has not before been attempted. The delay in the appearance of such a work is probably due to the fact that but few persons possess the requisite knowledge to treat the subject in a thoroughly satisfactory manner in all its bearings, such as the origin and production of the numerous products, whether animal or vegetable, and the chemical aspect of every substance and its commercial value, which are points that could scarcely be expected to be mastered by one mind. In the "Pharmacographia" of Fluckiger and Hanbury, two master minds on the subject of drugs were brought into co-operation, with the result that a most satisfactory and standard work on medicinal plants was produced. That this book was in the mind of the author when he compiled his "Odorographia," and selected its title, is quite apparent, and we are bound to say that on the whole he has done his work remarkably well, though we wish that he had adhered more strictly to the lines of his pattern. Mr. Sawer, however, at the very commencement of his preface, is so modest as to say that "an endeavour has here been made to collect together into one manual the information which has hitherto been only obtainable by reference to an immense number of works and journals, English and foreign, in many cases inaccessible to readers interested in the subject," and that he is thoroughly well acquainted with all that has been written is apparent not only from a glance through the pages, where numerous references occur, but also from the "List of Principal Works referred to." Besides this the author has, as he tells us, obtained information first hand from some of the largest perfume-plant growers and manufacturers of Grasse, Nice, and localities in the Straits Settlements and West Indies. The difficulties attending the compilation of a work of this nature have, no doubt, been very great, because scraps of information are so widely dispersed, and even when found oftentimes very confusing. The botany alone of the subject must have occupied a considerable amount of time in looking up, the plants yielding perfumes being natives of various parts of the globe, and consequently described in the several floras appertaining to those special countries, besides which the chemical and commercial aspects occupy a large portion of the book.

Though we are grateful to Mr. Sawer for giving us a book that was really wanted, we regret, as we said before, that he has not followed more closely the plan of the "Pharmacographia" and arranged his matter under distinct heads, such as History, Botany, Cultivation, Chemistry, Commerce, &c. Practically he has done so to a certain extent, but the paragraphs are not sufficiently distinguished to enable one to turn at once to that upon which information may be specially sought. The arrangement of chapters, in which the most important and marked odours, such as those of musk, rose, violet, the citrine odours, &c., are brought together, is good, but the principal plants in each of these groups might have been treated as we have described, the least important ones being given as they are at the end of the chapters.

Returning to the botany of the book, we cannot but think that the author might well have spared much space by the omission of numerous varietal names and synonyms, many of which are scarcely ever heard of now, and which often only tend to confusion. Under Violet, for instance (p. 104), half a page is given to a list

of the names of nine varieties of the Sweet Violet (*Viola odorata*) Again, at p 309, Vétiver, or Cus Cus, is rightly described as the root of *Andropogon muricatus*, after which follow the names of five synonyms In reference to this Mr Sawer says, referring to the "Asiatic Researches," that "there is a verse in the Sanskrit language composed of nine words, arranged in two lines, purporting to be the nine names under which the plant was known, doubtless they were poetical names, as they are not found in the extensive list of local names recently enumerated by Watt" This would show that Dr Watt, who in his "Dictionary of the Economic Products of India" does not err on the score of brevity in the adoption of synonyms, considered that there was a line to be drawn somewhere We may perhaps also be allowed to draw attention to a paragraph on page 19, where the musk tree of Jamaica and the muskwood of Australia have got confused The paragraph in question runs thus, "The *Eurybia argophylla* or *Guarea Swartzei*, the silver-leaved musk tree of Jamaica, New South Wales, and Tasmania, is a meliaceous tree, attaining a height of twenty-five feet" Eurybia, or more properly *Olearia argophylla* is the muskwood of New South Wales and Tasmania, and belongs to the natural order Compositæ, while *Guarea Swartzii* is a meliaceous tree of Jamaica, where it is known as musk tree Another muskwood, not mentioned by Mr Sawer, is that of *Moschoxylum Swartzii*, a highly fragrant resinous tree, closely allied to *Guarea*, and a native also of Jamaica and Trinidad We refer to these matters in no captious spirit, but simply with the hope that Mr Sawer may see his way to overhaul and modify this part of his useful book in a future edition, so as to make it even more useful and trustworthy We are glad to note that he "is still engaged upon studies in this department, and hopes to publish another volume in due course"

OUR BOOK SHELF

Catalogue of Eastern and Australian Lepidoptera Heterocera in the Collection of the Oxford University Museum By Colonel C Swinhoe Part I Sphinges and Bombyces (Clarendon Press, 1892)

THIS volume is the first part of a Catalogue of the moths from the Oriental and Australian regions in the collection of the late Mr W W Saunders, which was acquired by the Oxford Museum some fifteen years ago, and consists chiefly of specimens collected by Wallace during his famous voyage to the Malay Archipelago, and described by the late Francis Walker in his British Museum Catalogue Since Walker's arrangement of the collection it has remained untouched and mostly neglected by lepidopterists, so that a rearrangement and comparison of the types had become highly necessary, which useful work has been undertaken and very ably carried out by Colonel Swinhoe All the types have been brought to the British Museum, their synonomy carefully worked out and the species placed in their proper families and genera, many of them being figured in the eight coloured plates, and it is to be hoped the other parts will soon follow, and also that a list of the types which should be in the Museum and are missing will be added There is one statement in the preface which requires correction, the only types of Walker's species described in his Catalogue which are in the Oxford Museum are those which are expressly stated to be in "Coll Saunders," all the others are in the British Museum, including those for which a locality is given before the list of British Museum specimens

Charles Darwin His Life Told in an Autobiographical Chapter and in a Selected Series of his published Letters Edited by his son, Francis Darwin (London John Murray, 1892)

PROF DARWIN describes this volume as practically an abbreviation of the well-known "Life and Letters" The task of compression has been accomplished admirably, and there can be little doubt that the work will be cordially appreciated by a large number of readers Of course it has been necessary to omit many details which are of interest to men of science, but everything is included which is really essential to a proper comprehension of Darwin's fine personal character, and a sufficiently full and clear idea is given even of his scientific labours No one will read this fascinating book without feeling anew how much reason England has to rank Darwin among the greatest and noblest of her sons The volume is enriched with a reproduction of an exquisite photograph of Darwin by the late Mrs Cameron

Strange Survivals Some Chapters in the History of Man By S Baring-Gould (London Methuen and Co, 1892)

EVERY one who has given any attention to anthropology is aware that many remarkable customs and beliefs, which are still to be found among the uneducated classes even in highly civilized communities are relics of ancient superstitions. In the present volume Mr Baring-Gould examines various groups of these curious survivals, and traces them back to their origin in the ideas of past ages He knows his subject well, and, being interested in it himself, is able to present it in a way which is likely to make it interesting to others The value of the text is considerably increased by some well-selected illustrations

LETTERS TO THE EDITOR.

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Botanical Nomenclature

IN NATURE for October 6 (p 549) there is a note "on the progress of the negotiations concerning the nomenclature of genera, started by a committee of botanists at Berlin to supplement the decisions of the International Botanical Congress held at Paris in 1867" It is stated that "the botanical authorities of the British Museum favour the suggestions, those at Kew are against them"

Now this requires a little correction It may be remarked to begin with that many botanists are exercised at the present time not merely about the nomenclature of genera, but also about that of species Kew has, however, never given its adhesion to the attempts that have been made to bring about an international agreement on these matters. It has always felt that so many considerations must determine the course taken by the systematist in any particular case, that there is no advantage, but positive inconvenience, in being subjected to a hard and fast rule. It is therefore with no disrespect to, or want of sympathy with, the able school of Berlin botanists, who have recently formulated some new proposals with regard to nomenclature, that Kew has officially refrained from expressing any opinion upon those proposals. It has neither expressed approval nor disapproval.

In America Harvard has long occupied the leading place in the botanical world, and the principles adopted there have been substantially in accord with those adopted at Kew Hitherto,

therefore, the leading English-speaking botanists who have occupied themselves with systematic botany have been in substantial agreement that the adoption of a strict law of priority in nomenclature must give way to considerations of convenience

Well known and accepted names are not therefore to be lightly changed as the result of mere bibliographical research As to specific names the often merely mechanical process of describing a new species is held to be of little value compared with the more difficult task of assigning to the plant described its true affinities and correct systematic position The principle which guides Kew practice in this matter is laid down by Sir Joseph Hooker in the preface to "The Flora of British India" (p vii) He remarks —

"The number of species described by authors who cannot determine their affinities increases annually, and I regard the naturalist who puts a described plant into its proper position in regard to its allies as rendering a greater service to science than its describer when he either puts it into a wrong place or throws it into any of those chaotic heaps miscalled genera with which systematic works still abound"

The following paper on the subject deserves the wider circulation which its reprint in NATURE would give it It represents the Harvard tradition and practice, and is the last scientific utterance of Dr Sereno Watson, who so soon followed to the grave his illustrious predecessor, Asa Gray

Kew, November 14. W T THISELTON DYER

ON NOMENCLATURE [1]

[It was the request of the late Dr Sereno Watson that the following communication, dictated by him in his last illness, should appear at an early date in the *Botanical Gazette* —EDS]

FOR some time I have had a desire to give expression to my views upon botanical nomenclature Under the circumstances, I must speak briefly and somewhat dogmatically. In my opinion botany is the science of plants and not the science of names Nomenclature is only one of those tools which is necessary to botany, and this being the case, points of nomenclature should be subordinated to science.

A principle of botanical convenience has been established by those who prefer one name to another on account of expediency or convenience This principle should have a great deal of influence It has been so recognized by the greatest botanists, and from their authority receives great weight I prefer the word *expediency* as a better term than convenience to designate the principle, that the demands of science over-ride any merely technical claims of priority, &c

Priority of specific names appears to be based entirely upon one section of the code of 1867 That simply says that when a species is transferred from one genus to another, the specific name is maintained. This principle is usually understood and applied in the way that the oldest specific name has a right in all cases to be retained It cannot fairly be so interpreted and applied, since it governs only to the extent that this should be the law, but it is not to be made an *ex post facto* law Thus when a transfer has been made, that ends the matter so far as the choice of a specific name is concerned, and no one is authorized to take up a different name This practice of retaining the oldest name *under the genus*, no matter what older specific names there may be, was adopted by Dr Gray in his later years and by the Kew botanists, for the reason that once established and pretty generally recognized, it would avoid the great mass of synonymy, which is being heaped like an incubus upon the science. I must express surprise that Dr Britton had not considered it his duty to publish the last written words of Dr Gray which were addressed to him upon this subject and which expressed his positive opinions upon this point

There is nothing whatever of an ethical character inherent in a name through any priority of publication or position which should render it morally obligatory upon any one to accept one name rather than another, otherwise it would be applicable or true as well in the case of ordinal names, morphological names, teratological, and every other form of name, to which now no one feels himself bound to apply the law of priority. The application of this law as at present practised by many botanists, which would make it the one great law of botanical nomenclature, before which every other must yield regardless even of common sense, is a mere form of fetichism exemplified in science Many instances of the application of this law are not science but are rather superstition SERENO WATSON

February 22, 1892

[1] From *Botanical Gazette*, vol. xvii

The Reflector with the Projection Microscope

THE lantern is now used for so many purposes—scientific, photographic, and recreative—that any improvement in its construction will be acceptable When we look into this instrument whilst at work we must be disappointed at the large quantity of light lost by reflection and by dispersion—light which ought to go to the illumination of the screen In the ordinary form of the lantern three lenses of dense glass are employed as condensers Each of these six surfaces reflects and scatters the light, and the glass itself is absorbent of its rays

The dioptric construction of the projection lantern has been well worked out by Messrs Wright, Newton, Salomons, and others, but the catoptric principle, which would eliminate almost entirely these disadvantages, has been scarcely at all studied

Although my experiments have been made solely with the limelight in various forms, the following remarks may equally apply to light given by the electric arc :—

If a reflector be used instead of the ordinary condensers it is obvious that the position of the lime cylinder must be reversed This will present no difficulty, for the tube holding the jet can be bent into a helical form The dark image of the lime-cylinder also will have no more practical disadvantage than is experienced by a like image formed by the small plane speculum of the Newtonian telescope

As to the mirror itself, although a parabolic form is the most correct, a spherical surface will be sufficient for mere illuminating purposes, and thus expense may be spared in the grinding of the more difficult curve A speculum of from 5 to 7 inches diameter, having a radial curvation of from 2½ to 3 inches, will grasp a large quantity of light, much more than that obtainable from the 5-inch condenser usually employed.

Silver deposited by one of the various reducing processes on the surface of a clear glass lens will have many advantages over a metal mirror. The front surface will give perhaps the finest definition, but by silvering the back part of a spherical glass film, or that of a ground lens, the brilliant surface will remain untarnished for an indefinite time, and the whitish bloom formed by slow volatilization of the incandescent lime is easily removed This silver film adheres with remarkable tenacity, and it will bear a great deal of heat without blistering or becoming detached

I have had considerable success in constructing such mirrors from the large ornamental glass spheres blown in Germany, and silvered within by Liebig's process, viz with milk sugar and ammonio nitrate of silver A glass sphere of 10 or 11 inches in diameter may be easily cut into eight or nine mirrors by a red-hot iron, and this without disturbing the silvering, which will require only gentle friction with a pad of cotton impregnated with a trifle of rouge to brighten it Thus, at the cost of a few shillings, eight or more mirrors can be made, and also provision be made against possible accidents of cracking by heat

The light radiant is so placed that the secondary focus is intercepted by a plano-concave lens of dense glass, as has been happily proposed by Mr L Wright The convergent rays from the speculum are thus made into a parallel beam, which must be deprived of its heat by an alum-trough, for the light and heat at the substage condenser is very great

Convergence, I find, is usefully promoted by a plano convex lens of about eight inches focus, placed two or three inches before the above-noted plano concave lens. In all other respects the arrangements are like those of the usual modern projection microscope

I have pretty constantly used the ether-oxygen saturator, and I consider it to be perfectly safe, if ordinary precautions be taken. The oxygen, compressed in cylinders, is much recommended, as there can be no mixture of vapour, except at the right place. The U-shaped horizontal saturator, plugged with flannel, must be well charged with ether, or with the best gasolene, and care should be taken, before beginning or ending an exhibition, to shut off the oxygen tap before closing the ether

tap. This will prevent the harmless "snap" from the mixture in the small chamber at the joining of the gas tubes If a disc more than eight feet be required for the microscope, it will be well to use hydrogen gas instead of ether, since the calibre of the jet cannot in the ether light very well exceed $\frac{1}{15}$ of an inch

As an extra security, I pack the mixing chamber with asbestos fibre, moistened with glycerine, but, as before urged, the oxygen must leave the saturator, saturated

To insure the coincidence of the foci of the reflector with the optical axis of the microscope, it will be well to place three adjusting screws in a triangle behind the mirror, and this last may have both a small vertical and horizontal movement

I claim for this catoptric arrangement a larger grasp of light than can be got from ordinary lenses, and this may be effected also at a small outlay For the amateur constructor the plan will afford many advantages G B BUCKTON

Note on the Colours of the Alkali Metals

WHEN these metals are heated in a vacuous tube in such a way as to cause an extremely thin sublimate of the metal to condense upon the glass, the film so obtained will be found to possess a beautiful and strongly marked colour That this colour is not in any way due to the combination of the metal with any lingering minute traces of oxygen, is evident from the fact that vacuous tubes which have contained the clean and bright metal for years, and in which the metal has been frequently melted and rolled about, and even vapourized in places, and in which, therefore, it is impossible to conceive of any oxygen remaining, will continue to show the phenomenon whenever a portion of the contained metal is heated The experiment may readily be made by introducing a freshly cut fragment of the metal into a glass tube sealed at one end and drawn down to a narrow and thickened constriction near the middle The tube is then drawn out at the open end and connected to a Sprengel pump As soon as a good vacuum is obtained the tube is warmed throughout its entire length, the pump being still in operation, and the metal heated sufficiently high to cause it to melt and run out of the crust of oxide When the exhaustion is again as complete as possible the tube is sealed off The metal is once more melted, the whole tube being at the same time gently heated, and the molten mass allowed to filter through the constriction into the other portion of the tube The vacuous condition of the tube allows of the metal freely running through an extremely fine aperture, and in this way it becomes perfectly separated from all dross. The tube is then sealed off at the constriction On gently heating a minute fragment of the bright metal so obtained, by means of a small pointed gas flame, the coloured film of sublimed metal will at once be seen Viewed by transmitted light, the colour of the film of sodium thus obtained is greenish-blue, inclining to green. Potassium gives a sublimate which is of a magnificent rich purple colour, while rubidium, on the other hand, forms a film which is a pure indigo blue

In the cases of sodium and potassium, the colour of the metallic sublimates is different from the colour of the vapour as seen when the metals are boiled in an atmosphere of hydrogen Potassium, it will be remembered, yields under these circumstances a vapour possessing an emerald-green colour, while that of sodium, which appears colourless when seen in small layers, shows a violet or purple colour when viewed through a sufficient thickness

When the liquid alloy of sodium and potassium is treated in the same way, the sublimate obtained is found to be greenish in colour nearest to the source of heat, quickly shading off to blue and purple as it is more remote from that point, indicating apparently that the two metals sublime separately.

As a means of observing these colour phenomena, this alloy is more advantageously employed than the solid metals themselves, for, by rolling the liquid about, the sublimate may be wiped away and the experiment repeated indefinitely in the same tube.

As to whether the colours of these sublimed films are properties intrinsic to the particular metals, or are merely a function of the physical condition of the substances, it is perhaps rash to dogmatise. A number of other elements have been treated in a similar manner, but without similar results; thus lithium, cadmium, mercury, arsenic, tellurium, and selenium, when heated in vacuous tubes are readily sublimed, but in no case does the film appear coloured. On the other hand, however, it is well known that some of the very malleable metals when beaten out into thin films are capable of transmitting light varying in colour from green to violet. G S. NEWTH

Women and Musical Instruments.

IN answer to Prof O T Mason's letter which appeared in a recent number of NATURE (vol xlvi p 561), I may draw attention to the following facts which bear upon a part of the subject which he broaches, namely, the part played by savage women in the use of musical instruments In the South Pacific the "nose-flute" is very generally, though by no means exclusively, played upon by women In the account of the voyage of Capts Cook and King there is in one of the plates a figure of a woman of the Tonga Islands seated under a hut playing upon a "nose-flute" A similar figure of a woman playing upon a "nose flute" may be seen in plate 28 of Labillardière's "Voyage de la *Pérouse*," in the representation of a Tongan double canoe. Melville ("Four Months' Residence in the Marquisas Islands," p 251) mentions playing upon the "nose-flute" as being "a favourite recreation with the females" In Wilkes' "U S Exploring Expedition," iii p 190, there is a description of this instrument as used in the Fiji Islands, and it is stated that "no other instrument but the flute ['nose flute'] is played by the women as an accompaniment to the voice"

Turning now to another genus of primitive instruments, viz, the "musical bow," we find a peculiar local form, the "Pangolo,' occurring at Blanche Bay, New Britain There are specimens of this at Berlin and Vienna This instrument is stated by Dr O Finsch (*Ann des K K Naturhist Hofmuseums*, suppl vol iii pl I, p III) to be only played upon by women of Blanche Bay Guppy too ("Solomon Islands," p 142), says that the women of Treasury Island produce a soft kind of music by playing, somewhat after the fashion of a jew's-harp, on a lightly-made fine stringed bow about 15 inches long

It cannot, I believe, be said that any of these instruments have been *invented* by women, and it is undoubted that women in savagery but seldom figure as performers upon musical instruments It would certainly be interesting to collect all the instances recorded I hope that the above few notes regarding instruments in the South Pacific may be of use to Prof Mason, and I can only regret that lack of the necessary time prevents my going further into the matter

University Museum, Oxford, November 7 HENRY BALFOUR

AN ANCIENT GLACIAL EPOCH IN AUSTRALIA

A VERY interesting "special report" has just been issued by the Department of Mines of Victoria, giving an account of the remarkable evidences of glaciation observed at a locality about twenty miles south-east of Sandhurst, and about the same distance north of the great Dividing Range [1] The report is illustrated by a map and sections on a large scale, and by eight excellent photographic prints, showing the character of the deposit on the surface and in railway cuttings, the striated bed rock, and the striated and grooved blocks and boulders, so that full materials are given for the conclusion that we have here an undoubted glacial deposit A brief summary of this report will therefore be interesting to all students of the phenomena and problems of terrestrial glaciation

The district now specially described is about fifteen miles in one direction by five in another, and over this area of about thirty-six square miles the conglomerate is continuous, overlying the Silurian rocks of the district It has generally a rounded or undulating surface, but shows cliffs about 100 feet high in some of the gullies, and its maximum thickness is estimated at 300 or 400 feet, while its highest point is about 700 feet above sea-level. As well seen in the cliffs and several railway cuttings, the conglomerate consists of a matrix of sand and clayey matter containing huge boulders, great angular and sub-angular masses of rock, pebbles, and rock-fragments of endless variety of size, form, and material Many of these masses are planed, scored, striated, or polished.

[1] "Notes on the Glacial Conglomerate Wild Duck Creek" By E. J Dunn, F G S. (R. S Brain, Government Printer, Melbourne, 1892.)

Planing is very common, and is either flat or with a hollow or a convex surface. Some of the intensely hard hornfels blocks have been ground on one or more sides, several planes being sometimes ground on the same stone, while some very hard rocks are deeply grooved. In other cases the striations and scratches are so fine as only to be seen with a lens; while one surface block of very hard material has been ground down and polished, so that it glitters in the sun. In fact, every form of surface grinding produced by recent glaciation appears to be here present.

The surface of the ground is everywhere strewn with pebbles and boulders, the result of the washing away of the finer materials of the conglomerate; but, besides these, there is a tract of about two and a half miles by one mile near the centre of the conglomerate-area, on the north side of Mount Ida Creek, which is rather thickly strewn with large blocks, termed by the writer "erratics," though they can hardly be erratics in the sense of having been deposited on the present surface by ice. There are forty five of these blocks, which are either of granite, sandstone, or quartz, and vary in size from 6 feet by 4 feet, to 20 by 12 feet. One of the finest, termed "The Stranger," of coarse-grained granite, is 16½ feet by 10½ feet, and 5 feet thick, the estimated weight being 30 tons. It is planed and scored in a remarkable manner, as are most of the other blocks. It is curious that beyond this limited area only three or four large blocks are found on the surface, while no pebbles or boulders derived from the conglomerate are found more than a hundred yards beyond the present limits of that formation.

A striking feature of the conglomerate is the great variety of rocks present in it, seeming as if "the débris of a continent" had been here gathered together. There are an almost infinite variety of granites, syenites, gneisses, schists, quartzites, sandstones (hard and soft, coarse and fine), slates, shales, conglomerates, amygdaloids, porphyries, vein quartz, red, yellow, and grey jaspers, and many others. Some of these can be identified with existing rocks, but others are not known in Victoria. In some cases there is what appears to be river shingle, in others the delicate scratches preserved even on soft shale show that the material has not been exposed to any denuding action. There are also sandstone beds of considerable extent and thickness intercalated with the conglomerate, indicating that there were alternating periods of river or current action while the conglomerate was being formed.

The whole of the phenomena here briefly sketched point unmistakably to glacial action; in fact, there seems to be hardly any part of Wales or Scotland where such action is more clearly indicated. There are, it is true, no moraines, because the period when the conglomerate was laid down is too remote, both newer and older pliocene rocks overlying it in some places. Indeed, from fossils found in shales overlying what appears to be a similar conglomerate at Bacchus Marsh, south of the Dividing Range, the writer of the report is inclined to consider the whole formation to be of Palæozoic age. In one part of the area the bed rock is exposed, and this is covered with abundant striations crossing the stratification lines, indicating either powerful glacier or iceberg action.

A list of localities where similar conglomerates have been found is given, showing that they occur to the northward for about 250 miles along the foot of the hills bordering the Murray valley, disappearing under the Tertiary deposits of the lowlands; they have also been met with forming the floor of the auriferous deposits in mines at Creswick and Carisbrook, on the northern slopes of the Dividing Range, and also, as already stated, at Bacchus Marsh, and a few other localities on the south side of the range. We are not told, however, whether similar indications of glacial action occur in these localities. If these deposits are really all glacial and contemporaneous, they indicate an extent of glaciated country that would imply either a very lofty mountain range or the occurrence of a real glacial epoch in the southern hemisphere.

The direct evidence of the superposition of Tertiary rocks of Pliocene age shows that the glacial conglomerate itself is of great antiquity, but no special attention appears to have been given to the question of the age of the so called "erratics." The fact that they are found in so limited an area seems to show that they are not derived from the conglomerate itself by the process of sub-aerial denudation, and the same thing is indicated by the apparent fact that they all rest upon the present land surface. The photographs seem to indicate this, and nothing is said about their relations to the subjacent conglomerate, or whether any considerable proportion of them still form part of it, merely protruding above the surface, as would certainly be the case if they owe their present position to the mere washing away of the finer parts of the deposit. But, if so, why should they be called "erratics," as distinguished from the blocks and boulders which are still embedded in the formation? If, on the other hand, they are supposed to be true erratics—that is, to have been deposited on the present land-surface by ice agency—they must clearly be much less ancient than the conglomerate itself, or they would hardly retain such fresh-looking striations, grooving, and polishing as some of them exhibit. It is to be hoped that these most interesting deposits will be the subject of very careful study by Australian geologists, since they seem calculated to throw much light on the geological history of the old Australian continent.

ALFRED R. WALLACE.

ON THE WALKING OF ARTHROPODA

IN a letter to NATURE, published January 8, 1891, I described the manner of walking of several insects. Recently I have been able to examine a greater number of Hexapoda, together with several Arachnida and Centipedes, and a few Crustacea. The results of most of these observations were communicated to the Royal Dublin Society a few weeks ago.

I stated in my former letter that most usually the insects examined moved three legs, *e.g.* the 1st and 3rd on one side, and the 2nd on the other, almost, but not quite, simultaneously. In some insects it is the most anterior leg of this tripod which is raised first; in others it is the most posterior. An example of the first case is the cockroach, and of the second the blow-fly. But again exceptions appear to occur in each case. This almost simultaneous raising of the "diagonals" is shown by observations, photographic and otherwise, to be the rule in all the adult Hexapoda which I have examined, except the Thysanura. Of this last group I have observed *Tomocerus longicornus*, and find that, while it often moves by the simultaneous use of the diagonals, it also often raises its opposite legs simultaneously in pairs, especially when the animal is walking on a smooth surface, and using the sucker which is placed on the anterior part of the abdomen.

This use of the opposite legs in pairs was also found very frequently, as well as the diagonal walk, in the larva of one of the Coleoptera, and is always to be observed in caterpillars. Thus it is interesting to find that in one species at least of the Thysanura, which are regarded as having preserved many of the characteristics of primitive insects, the adult walks in the same manner as the larvæ of other insects.

It is to be observed that those insects which have long antennæ move them, and apparently the maxillary palps, in accordance with the diagonal rule; for when the front leg of one side is moved the antenna of that side is twitched.

A midge and some arachnids very frequently use the front pair of walking legs as antennæ. The midge which I observed probably belonged to the Cheironomidæ; it often, when at rest, stood on the two posterior pairs of legs with the anterior pair aloft in the air; when walking it moved them much as a beetle moves its antennæ, gently tapping the ground in front of it with them, their motions being always subject to the diagonal rule; in flight the midges often hold the anterior pair of legs straight out in front, while the last pair are held out in a similar manner behind, and probably have the effect of balancing the insect.

The spiders photographed (*Tegenaria Derhamii* and *Tarantula pulverulenta*) also exhibited the diagonal motion and sometimes the use of the anterior pair of legs as antennæ. When, in order to photograph them, these animals were put on a piece of paper floating in a shallow dish of water, so as to confine them without casting a shadow on the space in which they walked, they used frequently to stand on the three posterior pairs of legs at the edge of the paper, while they moved their anterior pair of legs through the air, or touched the water lightly with them. Several spiders—for instance, *Theridion Sisyphum*—have the anterior pair of legs longer than the others, and very frequently seem to use them as tactile organs. Specialization in this direction is carried very far in the Pedipalpi, in which group the anterior pair of legs are very long, thin, and flagelliform.

The wave of motion in one set of diagonals (*i.e.* the 1st and 3rd of one side, and the 2nd and 4th of the other) in the Tarantula sometimes travelled from before backwards and sometimes in the opposite direction; while in Tegenaria it passed on the whole forwards, but sometimes commenced by the raising of one of the middle legs, or by the raising of the two extreme legs of a set.

When confined on the floating island of paper, the Tarantula sometimes, after a good deal of hesitation, took to the water. When on the surface of the water, its legs, and sometimes the under surface of its abdomen, made conical capillary depressions in the surface, so that the water acted as a diffusing lens to the sunlight, and a dark circular shadow surrounded with a bright line appeared on the bottom of the dish corresponding to the depression at the tip of each leg. This suggested a method of determining the weight supported by each leg, for the diameter of the depressions, and consequently that of the shadows, bears some ratio to the weight on the point which causes the depressions. By fixing the leg of a spider on the end of a straw, hung delicately as a balance-beam, and by measuring the diameters of the shadows caused by the depressions in the surface of the water formed by this leg for various positions of a rider on the straw, I find that these diameters are approximately proportional to the weight on the point causing the depressions. Thus, by dividing the total weight of the spider proportionally to the diameters of the shadows, we get approximately the weight on each leg.

Fig. 1 is from a photograph of the Tarantula standing

FIG. 1.

on water; above the spider in the picture is its shadow on the bottom of the vessel, and at the ends of the three posterior pairs of legs in the shadow appear circular shadows corresponding to the depressions made by the legs; and there is also a shadow thrown by the depression caused by the abdomen. The weight of this spider was 30 mgrs. Thus we find that approximately the weights on the legs are the following:—On the right side, 2nd supports 1·875 mgrs.; 3rd, 7·125 mgrs.; 4th, 3·375. On the left side, 2nd, 4·875 mgrs.; 3rd, 5·250; 4th, 3·000; and the abdomen supports 4·500 mgrs. When walking, the Tarantula usually supported all its weight on a tripod formed by the 2nd and 4th legs on one side, together with the 3rd leg on the other side. The weights on the tips of the legs when one photograph was taken were found to be:—On the 2nd right leg, 9·50 mgrs.; on the 4th right, 10·25; and on the 3rd left, 10·25.

Profile photographs also seem to show that the 1st pair of legs are not generally used to support much weight. Fig. 2 is a diagram of the positions of the 1st pair of legs

a b c d

FIG. 2.

drawn from a number of profile photographs of Tegenaria. The first position, *a*, is that of the leg which has been thrown forward, and is just about to come to the ground; *d* shows the position of the 1st leg when the body has come forward, owing probably to the traction of this leg as well as to the pushing of some of the other legs, and so the leg is bent; *b* and *c* are intermediate positions. The next

a b c d e

FIG. 3.

figure is a somewhat similar diagram of the 4th pair of legs made from profile photographs. At *a* the leg has just been moved forward, and is on the ground, and is in a good position both for bearing the weight of the body and shoving it forward. At *e* it is stretched to its full length, and so is not of any use in driving the spider forwards, while, owing to its almost horizontal position, it is almost useless in supporting the weight of the body. Accordingly the spider has commenced to raise the extremity of the leg prior to lifting the leg completely off the ground.

Last autumn I had the opportunity of observing two scorpions which Mr. R. J. Moss brought from North Africa and exhibited at the Royal Dublin Society. These also appear to proceed according to the diagonal rule; but I do not know what is the order of succession in one set of diagonals, as I have not yet photographed any of these animals.

The hermit crab uses three pairs of legs in walking—the chelæ, and two pairs of thoracic walking legs; these it uses according to the diagonal rule, whether it walks sideways or forwards. Sometimes it simply shoves the chelæ along the ground without lifting them, while it moves the two pairs of legs in a diagonal manner. One of the Asellidae I found often used the opposite legs in pairs simultaneously when walking.

The centipede does not either raise its opposite legs in pairs together, nor does it move its legs according to the diagonal rule. In a number of photographs taken with an exposure of about the $\frac{1}{70}$th of a second the legs appear to move in threes diagonally, for instance, the 3rd, 4th, and 5th, and the 9th, 10th, and 11th on one side move simultaneously with the 6th, 7th, and 8th of the other side, while on the first side mentioned the 6th, 7th, and 8th, with the 12th, 13th, and 14th are on the ground, and on the other side the 3rd, 4th, and 5th, and 9th, 10th, and 11th are also on the ground. At either end of the body this order is usually more or less disturbed; thus on the right side the 14th leg might be on the ground, while on the left the 13th, 14th, and 15th would be also in contact with the ground; but

in none of the photographs was the symmetrical diagonal movement of the successive threes disturbed between the 2nd and 12th pairs of legs inclusive. This apparently simultaneous motion of three adjoining legs may probably be explained by supposing a series of waves, whose crests traverse three legs in the $\frac{1}{70}$th of a second, to be passing along the body, since the different photographs show different legs moving in threes; thus in one photograph the 6th, 7th, and 8th on the left side are seen to be moving forward, while in another the 5th, 6th, and 7th, are moving.

Since reading the paper at the Royal Dublin Society, Mr. G. H. Carpenter brought to my notice two papers by M. Jean Demoor, "Recherches sur la Marche des Insectes et des Arachnides" (*Archives de Biologie*, 1890) and "Recherches sur la Marche des Crustacés" (*Archives de Zoologie Expérimentale et Générale*, 1891). M. Demoor points out the simultaneous use of the tripod in the insects which he examined, but as he did not use photography he does not seem to have observed the minute want of synchronism of the legs of a tripod. Figs. 4 and 5 illustrate this.[1] These are two photographs taken of the same specimen of *Blaps mucronata*. Fig. 4 is from a photo-

FIG. 4.

graph taken with a long exposure, and shows the 1st and 3rd of the left side, and the 2nd of the right moving at the same time, just as it appears to the eye. Fig. 5 is from

FIG. 5.

a photograph taken with less than half the exposure of 4, and shows that while the 1st leg on the right side is raised off the ground, the 3rd on the same side and the 2nd on the left have not yet been raised. That they have not been raised and are now come to rest is shown by their backward position with regard to the body and other legs. These two photographs also show that the antenna is often twitched almost simultaneously with the motion of the 1st leg of its side. M. Demoor also observed a scorpion (*Buthus australis*), but its method of progression does not seem to have agreed with that of the scorpions (*Buthus europæus*) which I observed. He has not, so far as I know, recorded any observations on spiders.

HENRY H. DIXON.

Trinity College, Dublin, June.

[1] Figs. 4 and 5 show the legs, which are raised from the ground, quite sharp. In the negative they are more or less blurred owing to their motion during the exposure.

ON IRON ALLOYS.

THE merely mechanical expert in the working of metals would naturally consider it probable that a given metal when fused with another would communicate its physical properties, roughly, in proportion to the quantity added. A soft, tough metal added to iron would, from his point of view, render the latter softer; a brittle or hard metal would have the contrary effect, and so on throughout the whole series of metallic alloys.

Actual experiment would soon, however, show the fallacy of this, and that in the majority of cases no reliance could be placed on this assumption solely based on the physical properties of the elements severally considered. A further study of the laws which govern chemical combination would quickly show that alloys formed by fusion were not merely intermixtures, but that something else took place, bodies being often produced, or rather formed, differing considerably from the metals severally used. It would therefore be fair to assume that the metals entered into combination with each other, and yet it would be found that the problem even at this stage was not completely solved.

Further inquiry and experiment would indicate that it was not always possible to prove that chemical combinations "were in all instances" formed by fusion alone. Instead of this something closely akin to only an intermixture of the metals occurred; second, one of the metals had apparently dissolved in the other; third, it was difficult to differentiate betwixt intermixture and solution. Here we are on all fours with modern ideas which seem to have met with general acceptance, although it is not denied that elements or metals are capable of chemically combining with each other. We are not, however, quite prepared to draw a hard and fast line betwixt chemical combination of the metals with each other, solutions, and intermixtures of metals. One appears to merge into the other, and no good reason "so far as is known" can be given why solution, as ordinarily understood, or as defined by Van 't Hoff and others, may not be as applicable to fused metals as to the solution of certain salts in water.

Water at 60° is nothing more nor less than fused ice; fused iron, therefore, may obey the same laws, and, "like water," may be capable of dissolving certain substances, and rejecting others, temperature constituting the sole difference—or plainly, solid ice is fusible at 60°, iron at about 2500°.

Now what happens in the case of water? Certain bodies are soluble in it, others not; on lowering the temperature, these bodies are to a certain extent rejected, and nearly, but not quite, pure ice is formed; and so far as we know this equally applies to fused iron. As an instance, on cooling, the carbon is rejected, and appears in the graphitic[1] form, merely diffused throughout the solid cold metal. It is impossible here to treat this matter in detail; but enough, we think, has been said to indicate that the analogy is fairly complete throughout.

But there is another matter—apart from the solution of foreign bodies in fused ice or iron—which requires to be discussed. Ice dissolves in warm water, and so does cold iron or steel in superheated fused iron; the hot fluid metal from the Bessemer converter fuses or dissolves large lumps of solid steel placed in it as easily as ice is thawed in warm water. Temperature here, in both instances, determines the quantity which can be added; the higher the heat, the greater the quantity which can thus be dissolved or fused, ere the bath becomes thick, pasty, and incapable of being poured out into another vessel.

In so-called solutions the same rule appears to hold good; but, as all chemists know, there are many exceptions; in some cases heat is evolved, in others absorbed, and some bodies are more soluble in the cold fluid solvent.

It is, however, believed that no instance can be quoted of a body being more soluble in iron at a low degree of heat than at a high one. Confining ourselves to hot fluid iron or steel, it apparently readily dissolves cold metal. Similarly, other bodies, such as copper, &c., are dissolved in the same way when added to it.

The cold metal is fused by absorption of the enormous

[1] The relations existing betwixt carbon and iron are peculiar, and require to be separately discussed.

extra heat of the bath, but this may not be strictly true, for something like solution may also take place In melting iron in the reverberatory furnace it often happens, when the heat is insufficient, that the iron sets in a pasty semi-fluid mass on the bottom of the furnace, the operator then adds some molten iron, and the whole soon becomes fluid

This process is closely akin to solution It cannot be explained as simple fusion of iron in iron, the molten iron, in fact, seems to exert a solvent action on the pasty metal, and heat alone plays only a secondary part This may seem absurd to those not practically engaged in the manufacture of iron, but the fact remains as the result of the experience of iron-workers.

It follows that other metals can be similarly taken up, and the theory of certain iron alloys simplified There are certain metals intimately related to iron on the periodical scale of the elements, also by atomic volume and atomic weight, and their combination with iron may be achieved by fusion, and possibly something like solution as well, as described, resulting in the production of a similar homogeneous product, which compound metal cannot well be termed either a solidified solution of one metal into another, a chemical combination, or intermixture of metals The physical properties of this alloy, of course, are different from those of iron This seems an extreme view to take, but it may be mentioned that the absolutely pure elements prepared by special experts are known in some instances to differ somewhat from those accepted as such in an ordinary laboratory It has been also noted that the so-called impurity extracted does not differ very greatly from the pure product, and yet is not precisely the same—(quoting from memory, "this applies especially to alumina," why not iron?)

As the result of an extensive experience in the chemical examination of crude iron, steel, and the purest wrought iron, one finds that some metals cling persistently to iron—manganese is always present, nearly all contain copper, nickel also may often be detected if sought for, chromium is not so rare a constituent as might be supposed—all, however, in minute quantities in the case of wrought iron or Bessemer decarbonized metal

It is curious that these particular metals should cling to iron, but the previous exposition of their relation to iron possibly affords a clue accounting for their persistent presence.

Again, one gathers from a study of Crookes's theory of the genesis of the elements, together with his spectroscopic researches on the composition of the rare earths, yttria, &c, that one so-called element apparently merges into another by almost insensible gradations, it is probable that iron is one of these Probably it is, for recently it has been all but demonstrated by Prof Roberts-Austen and others that iron is a compound body, but the relations betwixt these bodies are so close that they have not been isolated, and both are still termed iron

We have evidence of the possibility of one element merging into another and that iron is not an element, and any one who has studied the periodic law cannot fail to see at least the probability that minute variations in the composition of the elementary bodies may occur, which, however, cannot well be differentiated by our present comparatively coarse analytical methods Modern methods, however, have been sufficiently accurate to enable us to show that certain relations can be traced throughout the whole series of the elements, and it is in this way that the periodic law has been formulated; and fairly trustworthy atomic weights have been obtained

Admitting the possibility of minute variations in the composition of elementary bodies, or more correctly that, as urged by Crookes, an element may have more than one atomic weight—the atomic weight accepted being the mean of these: with the periodic law for our guidance, and also attaching due weight to the relations existing betwixt the weights and volume of the atoms, it would seem that the theory advanced of the homogeneous formation of bodies by fusion is in accord with the periodic law, &c, governing the genesis of the elements.

This is equivalent to saying that a fourth state of combination may be imagined, which is—

(1) Neither solution of one metal in another
(2) Chemical combination of bodies
(3) Intermixture of bodies

Hadfield's alloys of iron and manganese may be members of this class

The first series of these alloys are hard, but when the manganese exceeds 7 per cent the metal softens and alloys containing about 12 to 15 per cent of Mn are strong, tough, cannot be annealed, and cannot be termed either iron or steel.

The same to a certain extent, it is believed, applies to the nickel alloys of iron

There are other properties, which show that the FeMn alloys are unique

The alloys of chromium and iron recently made by Mr Hadfield appear to be of the same class, as also those of nickel and copper with iron

More plainly, the homogeneous compound bodies previously commented upon may be practically termed elementary bodies similar to the quasi-elements of the rare earths studied by Prof Crookes These being, however, within the domain of practical chemistry, it is easy to demonstrate their compound nature, not forgetting "that, as previously noted," it is not easy to entirely eliminate these bodies allied to iron

We may even go further and assume that the fourth state indicates a species of combination even more intimate than the chemical combination of the chemists

In fact, reactions "occur quite unlike chemical combination in which atoms only combine with atoms, or bodies are built up atomically" The fourth state may go beyond this, at present this is pure assumption, yet an eminent man of science has suggested that even the atoms may be *smashed*, and this is equivalent to saying that under certain conditions the atom may be nonexistent, or in an alloy of, say, iron and nickel or iron and manganese, the separate atoms of iron and manganese do not exist, or in an alloy of iron and Mn or nickel, the severally separate atoms of Fe and Mn, &c., may have no tangible existence apart from each other, as in the case of true chemical combination Further, this seems more probable if we remember that chemical combinations are, according to modern views, nothing more nor less than structural formations governed by physical laws which regulate their molecular arrangement and the relative positions of the atoms to each other, just as in any structural work built by the hand of man, certain laws or rules must be adhered to In Nature's laboratory something beyond this may be going on—something, indeed, altogether outside our limited knowledge and experience

Iron is only one member of a very complicated group, which are closely in accord both as regards their atomic volumes and weights and position on the periodic scale of the elements, and, if we are to accept the work of Prof. Crookes, the well-known investigations of Prof Roberts-Austen, Osmond, and some data derived from the spectroscopic work of Lockyer, one may be really justified in assuming that quasi-elements may be formed by fusion in the workshop—*i.e.*, elements which can afterwards be dissociated by ordinary chemical processes The accepted elements, it is true, have not been so dissociated; but it is clear something has been done to indicate the compound nature of at least some of these

The theory of the possible existence of iron as a quasi element when fused with other elements of like nature clashes with the generally received ideas of chemical

combinations or solution, because undoubtedly these are formed.

Granting that chemical combinations likewise take place, does it not seem probable that when these latter are present they may be strictly termed impurities?

If so, iron alloys may be divided into two classes—(1) those in the homogeneous or fourth state, "the true alloys," (2) those in which chemical combinations or solution only takes place, and this latter class may be termed impure metal, in contradistinction to the first or quasi elementary body.

In conclusion it is urged that many of our most eminent metallurgists and men of science have "by very different modes of investigation" come to the conclusion that iron itself is a compound very complex body. It is true that we have only indirect proof of this, but it only remains to find methods of isolating these bodies from each other.

NOTES

THE medals of the Royal Society are this year awarded as follows:—The Copley Medal to Prof. Rudolph Virchow, For. Mem. R.S., for his investigations in Pathology, Pathological Anatomy, and Prehistoric Archæology; the Rumford Medal to Mr. Nils C. Dunér, for his Spectroscopic Researches on Stars; a Royal Medal to Mr. John Newport Langley, F.R.S., for his work on Secreting Glands, and on the Nervous System; a Royal Medal to Prof. Charles Pritchard, F.R.S., for his work on Photometry and Stellar Parallax; the Davy Medal to Prof. François Marie Raoult, for his researches on the Freezing Points of Solutions, and on the Vapour Pressures of Solutions; the Darwin Medal to Sir Joseph Dalton Hooker, F.R.S., on account of his important contributions to the progress of Systematic Botany, as evidenced by the "Genera Plantarum" and the "Flora Indica," but more especially on account of his intimate association with Mr. Darwin in the studies preliminary to the "Origin of Species." The award of the Royal Medals has been graciously approved by the Queen.

THE American Ornithologists' Union has been holding its tenth congress at Washington. The meetings began on Tuesday, and were held in the U.S. National Museum.

JAMES PLANT, F.G.S., of Leicester, who has just died in his seventy-fifth year, was well known as a local geologist in the midland counties, and as a member for some years of the Committee of the British Association on Erratic Blocks. Such blocks are numerous in Leicestershire, those on the southern side of the county being chiefly derived from the Charnwood range, and Mr. Plant was diligent in searching out and recording the more important of them. Several large boulders striated and partially polished stand in the grounds of the Leicester Museum, rescued by him from various railway cuttings. In 1868 he collected a very fine series of massive specimens representing all the hard rock formations of his native county, for exhibition at the meeting of the Royal Agricultural Society. These were afterwards built up into a great cone about 8 feet in diameter and 15 feet high in the museum grounds, and when the enlargement of the building necessitated its removal they were formed into a diagrammatic geological section on another site. Having to be again removed two years ago some of them were used to form a rough geological model of Charnwood Forest in the Abbey Park. In his latter years Mr. Plant acted as consulting geologist in several important borings for water and coal. The curious concentric rings on the face of a rock in Charnwood Forest interested him greatly, and with much trouble and labour he succeeded in obtaining plaster casts of them. He was active also in procuring photographs of many of the most remarkable geological features of the district.

DR. R. v. WETTSTEIN, of Vienna, editor of the *Oesterreichische Botanische Zeitschrift*, has been appointed ordinary Professor of Botany at the University of Prague.

THE Prussian Government has decided to introduce the use of the Centigrade thermometer instead of that by Reaumur, which is still in use in some parts, and no further Reaumur thermometers are to be supplied to any public officials. The Centigrade thermometer has long been in use in Germany for scientific purposes.

A VALUABLE collection of fossils, minerals, and shells, comprising several thousand specimens, and particularly rich in specimens from the carboniferous formation, has just been presented to the University College of North Wales by Mr. Evan Roberts, of Manchester. It is hoped that this gift will become the nucleus of an important geological collection suited to the educational requirements of a University College, and that similar gifts will from time to time be made to the College by those interested in the progress of geological study.

THE Oxford Medical Society held its first meeting on Saturday last, at the University Museum. Sir Henry Acland presided. The inaugural address was delivered by Sir James Paget. He said they all knew that the practice and science of medicine, or, as it was sometimes called, the science and art of medicine, were by some regarded as things quite distinct, wide apart, and in study almost incompatible. A few there were who had the capacity of pursuing both. The great mass of those engaged in the pursuit of medicine were either practitioners or men devoting themselves to science. Each method of work was essential to the practice of the other. It might be asked how could practitioners work as men of science even where they had the time for it? He believed that would come about by the increase in the teaching of science in all medical schools and Universities. He pointed out the work which might be undertaken by the society, and spoke at length on various subjects which might be studied with advantage. Prof. Burdon-Sanderson said the society had been established for the furtherance and promotion of science, and they wished to make an advance, so to speak, towards the University. There was a yearning in the minds of the medical profession in Oxford to unite itself more closely than it had hitherto with the scientific studies of the University which depended immediately on medicine.

THE weather has continued very unsettled during the past week, the most notable features being the prevalence of fog and abnormally high temperature. During the latter part of last week fog extended over nearly the whole of England, as well as a large part of the Continent. In London and the suburbs intense darkness occurred on several days, interspersed with very short intervals of sunshine, but in the north western parts of the kingdom the weather was generally fair. These conditions were due to the distribution of pressure, which was cyclonic over the western portion of these islands, but anti-cyclonic over western Europe. Temperature was uniformly high for the season, the daily maxima ranging from about 50° to 60°, and reached 62° in several places in the southern counties on Monday. This maximum is the highest that has been recorded in the neighbourhood of London during the last ten years. In the early part of the present week a deep depression passed to the westward of Ireland from the Atlantic, causing southerly gales in the north and west, with rain in all parts of the country, the amount measured at Valencia Observatory on Monday exceeding an inch. On Tuesday afternoon a fresh depression reached our south-west coasts from the south-eastwards, while a trough of low pressure lay over the Bay of Biscay and France, causing further heavy rains and local fogs. For the week ending the 12th instant the reports show that bright sunshine was, as might have been expected, very deficient generally, especially over northern and eastern England, where the percentage of possible duration was only 9; the lowest

amount was at Stonyhurst, where it was only 2 per cent The south-west of England enjoyed the brightest weather, as there the sunshine amounted to 33 per cent of the possible amount

THE current number of the *Annalen der Hydrographie* contains a short note of a hurricane at Marseilles on October 1, which is said to have been more severe than any experienced during the last thirty years From 8 a.m until 1 p m the wind, rain, hail and lightning were incessant, all the lower parts of the town being under water, while several houses and bridges in the neighbourhood were destroyed The weather charts for the day show that the storm was caused by a small whirl which occurred on the south eastern side of a large depression, whose centre lay in the south of Scotland While the centre of the depression scarcely altered its position, the whirl increased in extent, but diminished in intensity, and on October 3 it had crossed Northern Italy and lay over Hungary

MR. CHARLES CARPMAEL, director of the meteorological service of the Dominion of Canada, urges in his latest report the need for more thorough inspection of the various stations under his control He points out that the stations in Great Britain and Ireland, connected with the Meteorological Office, London, are constantly inspected, and that in every country where meteorology is worked out on a large scale inspection is admitted as the only system whereby trustworthy and satisfactory results can be obtained. He recommends therefore that a sufficient appropriation should be placed at his disposal to enable him to have the meteorological stations in the Dominion inspected and the observers thereof thoroughly instructed in the duties required of them If this is not done the data furnished to the Central Office cannot, he says, be accurate

TWO numbers have now been issued of the new series of the quarterly cryptogamic journal, *Grevillea*, under the editorship of Mr G Massee. It is conducted very much on the old lines, and contains many articles of interest to cryptogamists It is strange that one peculiarity of the journal should still be retained which detracts very much from its usefulness as a work of reference, the absence of any table of contents or index to each separate number.

THE Cambridge University Press has issued the Sedgwick prize essay for 1886, by the late Thomas Roberts, on the Jurassic rocks of the neighbourhood of Cambridge The essay has been edited by Mr Henry Woods, Scholar of St John's College, and Lecturer on Palæontology in the Woodwardian Museum In an interesting preface, Prof. T McKenny Hughes explains the nature of the problem which the author endeavoured to solve, and expresses his belief that the work is indispensable for the student of Cambridge geology, and most valuable for all specialists in the Jurassic rocks.

SIR HENRY H. HOWORTH has completed and will shortly publish a considerable work on which he has been long engaged entitled, "The Glacial Nightmare and the Flood." It begins with an account of the various theories which have been forthcoming to explain the drift phenomena, in which the very large literature on the subject has been for the first time condensed and tabulated. It then proceeds to criticize the extreme glacial views which have recently prevailed among geologists, and to call in question the theory of uniformity as developed by the followers of Lyell and Ramsay, and especially to attack the notion that ice is capable of distributing materials over hundreds of miles of level country, and of producing many of the effects attributed to it by the glacial school of geologists. The author argues that the evidence points to the former existence of much larger glaciers than exist now, but not to an ice/period when the temperate regions were covered with ice. On the contrary, these great glaciers existed side by side of fertile plains. Lastly he argues that the phenomena of the drift can only be explained by reverting in a large measure to the diluvial theories of Sedgwick and Murchison, Von Buch and others, and that the purely geological evidence is completely at one with that collected in the author's previous work on "The Mammoth and the Flood," and establishes that a great diluvial catastrophe forms in the temperate zones the dividing line between the mammoth age and our own

THE Libraries Committee of the Glasgow Town Council, in the eleventh general report on the Mitchell Library, Glasgow, make a suggestion which deserves to be kept in mind It is to the effect that an admirable way of perpetuating the memory of a relative or friend would be to present a public library with a separate collection of books, to be kept together and called by such name as may seem proper to the donors "Such a memorial collection," say the Committee, "would, with propriety, be composed of books devoted to any department of literature or learning in which the person to be commemorated was interested or which the donors desired to see more fully represented"

A VALUABLE paper on the present state of Morocco is contributed to the current number of the *Revue Scientifique*, by M A Le Châtelier He brings out very strikingly the mixed character of the population of Morocco. First he notes the fair-haired, blue-eyed type, which is represented in the sculptures of some tombs of the twelfth Egyptian dynasty Then come the various Berber types, the Arabs, several elements (including the Draoua) which have come down from remote antiquity, Spanish Moors and Jews, and the descendants of Christian captives. M Le Châtelier thinks we must also take into account descendants of Phenicians, Carthaginians, Romans, Byzantines, and Vandals.

Mr C H EIGENMANN has contributed to the Proceedings of the U S National Museum (vol xv) a paper in which he presents a valuable account of the observations made by him on the fishes of San Diego and vicinity from December 11, 1888, to March 4, 1890 Especial attention was paid to the spawning habits and seasons, the embryology, and migration of the fishes of Southern California. A diary was kept of the occurrence of each species throughout the year 1889 and part of 1890 Mr. Eigenmann's knowledge of the occurrence of each species is largely based on observations of the fish brought into the markets, which he visited twice or thrice daily, and of those caught with hook and line by the numerous habitual fishermen found on each of the wharves, and of those caught by the seiners, whom he accompanied on several occasions During the early part of 1888 each individual fisherman sold his catch as best he could and the data for this part of the year are not as full as for the latter part of 1888, when practically the whole catch was brought to two markets, where Mr Eigenmann could see the fish as they were unloaded The knowledge of the ocean fishes is largely derived from frequent visits to ocean tide-pools, from the fish brought to the markets, and from a two weeks' stay on the Cortes Banks As a matter of course, hundreds of specimens of most species have been observed to every one preserved, and the present paper is to be looked upon as a contribution to the economic history of the fishes, rather than to the anatomy of the various species With two exceptions, the types of the new species discovered, and otherwise interesting specimens, have been deposited in the U S. National Museum A nearly complete series of types has been placed in the British Museum, and minor series in the Museum of Comparative Zoology and the California Academy of Sciences.

THE Committee of the Field Naturalists' Club of Victoria have hit upon an excellent plan for interesting the more active members in definite lines of investigation They have arranged that special meetings shall be held once a month for the carrying on of practical work which cannot conveniently be undertaken

at the ordinary monthly meetings. The first of these special meetings assembled on August 22 in the Royal Society's Hall, Melbourne We learn from the Club's journal that there was a good attendance of members, those interested in microscopic work being principally represented. No fewer than twenty-four microscopes were set up Mr J Shephard undertook to give a slight sketch of some interesting forms amongst the rotifera. A typical form was first described, the chief points in its structure being made clear by good diagrams, and then variations in the various orders from this type were briefly referred to—special allusion being made to the modifications in the ciliary wreath and the foot. Mr Shephard had fortunately met with a large number of the Australian member of the rhizotic group (*Lacinularia pedunculata*), and at the conclusion of his remarks a slide of mounted individuals was handed to each member for careful examination under the microscope Half an hour was profitably spent in the endeavour to make out all the points of detail in the specimens, during which time Mr Shephard also supplied full information as to the best methods of mounting and examining these interesting organisms Some four or five entomologists had a quiet corner to themselves, where they compared specimens and talked over some plans for future operations

AT the ordinary monthly meeting of the Field Naturalists' Club of Victoria, on September 12, the feather boots of a native rain-maker from M'Donnell Ranges were exhibited It is believed among the natives of certain tribes in Central Australia that droughts are caused by the swallowing up of all moisture by a rain-devil If this personage can be captured and made to disgorge, rain follows at once. The feather boots are worn by the native rain-maker in order that he may steal noiselessly and unawares on the author of the drought and consequent misery Mr A W Howitt is having drawings made of these boots, which he considers to be one of the most valuable and interesting additions to aboriginal ethnology yet brought to light

AN interesting paper on the anthropology of Spain, contributed to the "Anales" of the "Soc española de Historia Natural" by Luis de Hoyos Sáinz and Telesforo de Aranzadi, has now been published separately at Madrid The paper is accompanied by three excellent maps, in which, by means of various degrees of shading, the authors bring together a number of most interesting conclusions One of these maps shows the cranial types which prevail in different parts of Spain

IN the November number of the *Mediterranean Naturalist*, Mr John H Cooke gives an interesting account of his recent discovery of Ursus arctos in the Malta Pleistocene The late Admiral Spratt and the late Prof Leith Adams found among the cavern deposits of the Maltese Islands a remarkable land fauna, including elephants, hippopotami, land tortoises, gigantic dormice, and aquatic birds. From the fact that many of the remains of elephants presented the appearance of having been fiercely gnawed, it was concluded that carnivoræ had lived in the district, but, notwithstanding the most diligent search extending over a period of twenty years, the only tangible evidences in support of the inference were these gnawed bones Mr. Cooke has now solved the problem His discovery was made in the spring of the present year, when, with the aid of a money grant from the Royal Society, he carried out some excavations in the Har Dalam cavern, a subterraneous gallery situated in a gorge of the same name in the eastern extremity of Malta. After having excavated six large trenches and obtained some hundreds of bones of *Hippotamus pentlandi*, *Elephas mnadraensis*, *Cervus barbaricus*, and numerous other animals, he had the satisfaction of discovering an entire ramus of the lower jaw of a bear, Ursus arctos with its canine and molars *in situ*, as well as five other canines belonging to other individuals of the same species. Afterwards four other canines were discovered, each of which was in a fairly perfect state of preservation One of these Mr A S Woodward has determined as belonging to the left side of the mandible of a species of *Canis* equalling a wolf in size Associated with these remains were found several vertebræ and fragments of limb-bones of hippo, and vertebræ and portions of horns of stags; but none of them presented any evidences of having been gnawed

THERE is some difference of opinion as to whether the process of digestion is promoted or hindered by bodily exertion Herr Rosenberg recently made some experiments on a small dog with reference to this point (*Pflüger's Archiv*). The animal was fed once daily with a certain quantity of lean horseflesh, lard, and rice, and the amount of nitrogen and fat daily absorbed was determined by an examination of the excreta. There were five series of experiments, each consisting of a rest period of several days, followed by a working period of several days, the dog being made to work in a kind of treadmill In some cases these efforts were made during stomachic digestion, in others during intestinal In both series of experiments the differences observed lay within the limits of physiological variations, the inference being, accordingly, that in a healthy dog the utilization of food is quite independent of whether the animal rests during digestion or is energetically at work Whether this applies to man could only be determined by direct experiment Herr Rosenberg thinks it probable, however, as observations on people with heart disease appear to show that the absorption of food is to a certain extent independent of the circulation and distribution of the blood

THE characteristic mantle of ascidians, consisting of a ground mass with cellulose and embedded cells, has been much studied, especially with regard to the origin of the cells The most favoured view is that it is produced by the ectoderm, that it is a thickening of the outer epithelium Recent researches by Kowalevsky, however (described to the St Petersburg Academy) give reason for believing that the mantle-cells are from the mesoderm Studying the metamorphosis of *Phallusia mamillata*, he observed certain mesoderm-cells applying themselves to the ectodermal epithelium, penetrating it and entering the mantle, which (secreted from the ectoderm) was before quite transparent These cells also move freely about in the mantle, and this amœboid movement is further in favour of their mesodermal nature A similar process occurs in vertebrates, viz., the passage of lymph-cells (leucocytes) through epithelium to the surface of a mucous membrane, or the surface of the body (in fishes), the mucous layer is comparable to the ground mass of the mantle But in vertebrates the cells at length disappear, whereas in ascidians they persist. Besides their share in the growth of the mantle, they have an important function as phagocytes. In compound ascidians certain individuals are every now and again perishing, and these dying parts are known to be absorbed by the mantle cells. Also, incoming foreign bodies, such as bacteria, the cells attack and seek to destroy. Numerous bacteria are always present in the mantle of tunicata Moreover, experiments were made by introducing bacteria through fine glass tubes inserted in the mantle; the mesoderm-cells collected round these tubes, entered them, and fought with the bacteria. Kowalevsky attaches great importance to this function, and supposes the above-mentioned passage of wandering cells to the surface of epithelia to be explained as a means of protection against the intrusion of agents of disease.

MR. L. STEJNEGER gives in the fifteenth volume of the Proceedings of the U S. National Museum an interesting preliminary description of a new genus and species of blind cave salamander from North America. The discovery of a blind cave salamander in America is regarded by Mr Stejneger as "one of the

most important and interesting herpetological events of recent years." The discovery is primarily due to Mr F A Sampson, who, in July last year, found the adult animal as well as a larva in the Rock House Cave, Missouri, and forwarded both to the U S National Museum Mr George E Harris afterwards went to great trouble in order to procure additional specimens Unfortunately, he has only succeeded so far in obtaining larvæ, but Mr. Stejneger hopes to be able to secure more adults A more detailed anatomical description of this interesting animal is postponed until then, as he has not felt justified in mutilating the type specimen beyond what was necessary in order to ascertain the character of the vertebræ The present preliminary description is, therefore, only prepared in order to call attention to the discovery and to supply the diagnosis by which the animal may be identified.

DR MORRIS GIBBS contributes to *Science* an interesting paper on the food of humming-birds He has carefully dissected many humming-birds, both old and young, but has never found anything to convince him that the birds live on insects It may be that at times when flowers are scarce some species of insects are captured, but Dr Gibbs is satisfied that in season, when flowers are abundant, the ruby throat of Michigan lives on honey.

IN a recent investigation of the action of accumulators, Herren Neumann and Streintz have shown (*Wied Ann*) that lead has the power of absorbing hydrogen In one case the metal was used as an electrode, and charged with electrolytic hydrogen, in another it was melted, and a current of hydrogen passed through it Care must be taken that the charged metal is not in contact with air, as the oxygen of the latter then unites with the hydrogen, and this, the authors think, is why previous observers have not been able to prove an occlusion of hydrogen by the lead plates of accumulators The authors examined other metals, and they give the following numbers for the gas absorbed per unit volume of metal —Lead, 0 15, palladium, 502 35, spongy platinum, 29 95, platinum black, 49 30, gold, 46 32, silver, 0 00, copper, 4 81, aluminium, 2 72, iron, 19 17, nickel, 16 85, cobalt, 153 00 When the same pieces of metal were repeatedly used, the occluding power generally fell off, in the case of the noble metals this is thought to be due to increased density, but why the occluding power of iron and cobalt should be reduced to one-half or more was not explained Nickel and copper retained their power With regard to the high power of cobalt, the authors tried that metal in a voltameter, but curiously it showed no hydrogen polarization when the charging circuit was opened.

MESSRS. WILLIAMS AND NORGATE's Natural Science Catalogue (No. 9) includes classified lists of books and periodicals on mathematics, astronomy, meteorology, physics, electricity, chemistry, microscopy, optics, mechanics, engineering, technology, &c., in French, German, and other foreign languages

THE opening meeting of the one hundred and thirty-ninth session of the Society of Arts was held yesterday (Wednesday) evening. The following arrangements have been made for the ordinary meetings:—November 23, "The Disposal of the Dead," by F. Seymour Haden, November 30, "The Copper Resources of the United States," by James Douglas, December 7, "The Chicago Exhibition, 1893," by James Dredge; December 14, "The Utilization of Niagara," by Prof. George Forbes, F.R.S. The following papers, for which dates have not yet been fixed, will be read — "Transatlantic Steamships," by Prof. Francis Elgar, "The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air," by Prof. Frank Clowes, "The Purification of the Air Supply to Public Buildings and Dwellings," by William Key; "Pottery Glazes: their Classification and Decorative Value in Ceramic Design," by Wilton P Rix, "The Chemical Technology of Oil Boiling, with a Description of a New Process for the Preparation of Drying Oils, and an Oil Varnish," by Prof. W Noel Hartley, F R S, "The Mining Industries of South Africa," by Bennett H. Brough, "Ten Years of Progress in India," by Sir William Wilson Hunter; "Australasia as a Field for Anglo-Indian Colonization," by Sir Edward N C Braddon, Agent-General for Tasmania, "Indian Manufactures," by Sir Juland Danvers, late Public Works Secretary, India Office, "Caste and Occupation at the last Census of India," by Jervoise Athelstane Baines, Imperial Census Commissioner for India, "Mexico, Past and Present," by Edward J Howell, "Newfoundland," by Cecil Fane "New Zealand," by W B Percival, Agent-General for New Zealand. The following courses of Cantor lectures will be delivered on Monday evenings, at eight o'clock Prof Vivian Lewes, "The Generation of Light from Coal Gas" (four lectures, November 21, 28, December 5, 12), Dr J A Fleming, "The Practical Measurement of Alternating Electric Currents" (four lectures, January 30, February 6, 13, 20), Prof W Chandler Roberts-Austen, F.R S, "Alloys" (three lectures, March 6, 13, 20), Lewis Foreman Day, "Some Masters of Ornament" (four lectures, April 10, 17, 24, May 1), C Harrison Townsend, "The History and Practice of Mosaics" (two lectures, May 8, 15) A special course of six lectures, under the Howard bequest, will be delivered on the following Friday evenings at eight o'clock Prof W C Unwin, F R S, "The Development and Transmission of Power from Central Stations" (January 13, 20, 27, February 3, 10, 17)

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, presented by Mrs K Betts, a Brown Capuchin (*Cebus fatuellus* ♀) from Brazil, presented by Miss L. Blackburn, a Himalayan Bear (*Ursus tibetanus* ♀) from Burmah, presented by Major W H Cunliffe, a Herring Gull (*Larus argentatus*) British, presented by the Rev Sidney Vatcher, a Goshawk (*Astur palumbarius*) captured at sea, presented by Capt F Manley, an Egyptian Vulture (*Neophron percnopterus*) from Africa, presented by Mr J L. Teage, two —— Buntings (——) from North Africa, presented by Lord Lilford, F Z S, eighteen Filfola Lizards (*Lacerta muralis* var *filfolensis*) from the Island of Filfola, eighteen Wall Lizards (*Lacerta muralis* var *tiliguerta*), an Ocellated Sand Skink (*Sepsocellatus*), a Moorish Gecko (*Tarentola mauritanica*), a Turkish Gecko (*Hemidactylus turcicus*) from Malta, presented by Capt Robert A Threshie; a Common Kite (*Milvus ictinus*) from Spain, received in exchange, five Dingos (*Canis dingo*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE NEW COMET —The weather has prevented observations of the new Comet Its brightness is about that of the nebula in Andromeda, and it has been suggested that it is a return of Biela's Comet

COMET BROOKS (AUGUST 28) —The following is a continuation of the ephemeris of Comet Brooks for the present week, extracted from *Astronomische Nachrichten*, No. 312 —

12h *Berlin M.T.*

1892.	R A app. h. m. s.	Decl app ° ′	Log r.	Log Δ	Br
Nov. 17	10 25 3	−2 35 2			
18	29 40	3 34 7			
19	34 20	4 34·8			
20	39 3	5 35 3	0·0674	9 9568	20 51
21	43 48	6 36·2			
22	48 36	7 37·5			
23	53 27	8 39 0			
24	10 58 20	9 40·8	0·0540	9·9483	22 70

The unit of brightness occurred on August 31

The motion of this comet will be noticed from the above ephemeris to be very rapid in a southerly direction, amounting to about 1° per day

THE LIGHT OF PLANETS —The question as to whether the light of planets is capable of casting shadows must have, especially during the last few months, been in the minds of many, and perhaps many observations have already been made, but unfortunately not published With regard to this question, *L'Astronomie* for November contains two notes, the first of which, communicated by M Marcel Moye on August 30, relates to the planet Mars His observations were made just before the meridian passage and in a room where the light of the planet could enter the open window In this way white paper invisible in the corners of the room was easily distinguished when placed on the wall opposite the window, while one could see well the shadows between the fingers of the hand, placing a newspaper in the light of Mars only the place of the table and the number of the words could be recognized, but not read, as was the case with Jupiter M Moye concludes then that Mars certainly casts shadows, less strong than those of Jupiter but still appreciable

In the note on the light of Venus M Léon Guiot tells us that on August 29, when about to get up to observe Jupiter, he was astonished at the brilliancy of the light that entered his window Observing his watch, which was hanging on the wall, he was actually able to trace its shadow on the wall, for he says that all was visible as in the light of the moon, one could even read the newspaper It was about this time that Venus was constantly seen with the naked eye in full daylight

STELLAR MAGNITUDES IN RELATION TO THE MILKY WAY —Prof Kapteyn is the author of an important memoir, which is published in the *Bulletin du Comité International Permanent* pour l'execution photographique de la carte du ciel, relative to an observed systematic difference between the photographic and visual magnitudes of stars depending on their distance from the Milky Way Prof Kapteyn first noticed that a difference existed in 1890, but in the present paper he presents a preliminary account of the results he has obtained The clichés which have been under examination were exclusively those made at the Cape Observatory for the chart mentioned above In this discussion he has adopted the two following laws (1) that increasing the time of exposure in the proportion of 1 to 2 5, the fraction of a magnitude gained is 0 7, and (2) the atmospheric extinction of actinic rays rises to 2½ above the visual rays Since there is an undoubted difference between the photographic and visual magnitudes, denoting this difference by the symbol Δm, the author commences to investigate whether this quantity is ever equal to zero, that is when the photographic and visual magnitudes are equal, and if so to find the locus of these points Charting the points down on a map and connecting them up by means of curves, the latter are found to follow in a striking manner the path of the Milky Way Table II gives the values of Δm obtained from several clichés, and the positive values lie without exception between these two curves, while the negative ones are situated without Taking into consideration both bright and faint stars, that is stars from the 4th to the 10th magnitude, the author finds that there a strong relation depending on their galalactic latitude exists between them, whether they be even very near or distant from the Milky Way, and the same systematic variation of Δm apparently holds good, being represented by the formula

$$\Delta m = a + \kappa\beta$$

representing the galalactic latitude and $\kappa = -0^m \cdot 0099 \pm 0^m \cdot 0010$.

In seeking for an explanation of the difference, Prof Kapteyn investigates each possible cause singly. His conclusion, to state briefly, amounts to this, that, if one considers the stellar magnitudes given in the "Uranometrique" and in Gould's "Catalogue of Zones" (it is from these two sources that he has obtained the visual magnitudes) to be correct and not subject to systematic errors amounting sometimes to as much as half a magnitude, then it must be concluded that the light of the stars situated in the Milky Way or in its vicinity is much richer in actinic rays than those at considerable galalactic latitudes. We may remark that the publication of this paper has been purposely hurried owing to the importance of the matter therein, but although sufficient observations have not been taken in account for a very rigid investigation, Prof Kapteyn hopes to eliminate many of the difficulties and accidental errors by the discussion of clichés of different regions of the sky, differing in galalactic latitudes, made at equal altitudes, on similar plates, with equal lengths of exposure

THE CANALS OF MARS —The late opposition of Mars, and the re observation of the doubling of the canals has brought forward many theories relative to this very curious phenomenon. There seems to be no doubt now that this doubling is not due to instrumental deficiencies, or even to an optical delusion caused by the fatigue of the eyes, but that it is a real observed fact and therefore requires a rigid explanation Omitting the now well known hypotheses suggested up till quite lately, the most recent is that put forward by M Norman Lockyer and which is recorded in NATURE, vol xlvi p 448 Mr Lebour also (NATURE, vol xlvi, p 611) points out the likeness of these markings to the cracks produced in glass broken by torsion, adding that the chief characteristic features in the Mars' lines are there produced In *Comptes rendus* (No 18) for October 31 M Stanislas Meunier relates another possible cause, and illustrates the phenomenon experimentally The experiment is as follows —He takes a polished metallic surface and on it traces a series of lines and spots, representing as nearly as possible the Martial surface as seen by us, and illuminates it all by sunlight He then stretches at some distance (a few millimetres) from it a fine transparent piece of muslin Looking at the surface through this medium he finds that all the lines and spots are doubled, and, "se germiner par suite de l'apparition, à côté de chacune d'elles de son ombre, dessinée sur la mousseline par la lumière que le métal a réfléchie" A fact observed by M Schiaparelli is that the canals when doubled are not always exactly parallel, and that sometimes there is an "aspect de nébulosité" These and other peculiarities are, according to M Meunier, reproduced by simply undulating the muslin His explanation is that the solar light is reflected from the planet's surface very unequally, that from the continents exceeding that emitted by the deeper parts, seas and canals Although the atmosphere is a limpid one, we are unable to see its motions, but if, as he says, the aerial envelope includes a transparent veil of fog at a suitable height, a contrast would be produced, as was the case with the muslin, by the production of shadows "qui pour une œil placé ailleurs que sur le prolongement des rayons réflechis, à côté de chacune des surfaces peu réfléchissantes, une image pareille à elle" This explanation of the phenomena of shades by reflection if valid should of course hold good for the planet Venus when properly situated, and that it is not observed on the Moon is only another proof that our satellite has no atmosphere

GEOGRAPHICAL NOTES

THE *Revue Française* states that a subterranean town, laid out with regular streets in a series of great caverns, near Karki, on the right bank of the Amu daria, has recently been explored Pottery and metal work were found amongst the ruins, and from the coins and inscriptions seen the town must have been occupied at least as early as the second century B C.

BY the new constitution of the United States of Brazil the seat of government is to be transferred from Rio de Janeiro to a site upon the central plateau where an area is to be marked off as a federal district A scientific mission under Senor Cruls has been appointed to examine the region where the three rivers, Sao Francisco, Tocantins, and Parana, take their rise at an elevation of over 3,000 feet, with the view of finding a suitable site for the new capital.

MR. D J RANKIN communicates to the *Scottish Geographical Magazine* an account of his journey up the Zambesi in 1890-91, with a map of the country between the Zambesi and Shire He found the Zambesi freely navigable for light-draught steamers as far as the Acababassa Falls, more than 300 miles from the sea, the Lupata narrows presenting no difficulty Between Lupata and Acababassa extensive coal deposits occur, and these are sure to become valuable. Beyond the falls after a portage of about thirty miles, the Zambesi is again navigable

to Zumbo, and thence for a distance of 300 miles up the Loangwe river

A NOMINATION to the geographical studentship of £100 in the University of Oxford will be made at the end of Hilary term, 1893 Particulars of the appointment may be obtained from Mr Mackinder, the Reader in Geography

TWO sudden deaths of men known in connection with minor exploration and geographical writing are announced Mr Theodore Child, author of "South American Republics" and other works, died of cholera at Ispahan, and Lieutenant Frederick Schwatka, who has travelled extensively in Alaska, committed suicide in Portland, Oregon

MR PRATT, whose departure for the head waters of the Amazon was announced in this column at the time, has been compelled to relinquish the expedition on account of ill-health, and is now in this country

AT the first meeting of the Royal Geographical Society the certificates of 106 new members, including 15 ladies, were read This is the largest number seeking admission into the society which has yet been proposed at one time

DR NANSEN'S ARCTIC EXPEDITION

DR FRIDTJOF NANSEN opened the session of the Royal Geographical Society on Monday night by a description of his plans for crossing the north polar region, and received a most enthusiastic reception from a crowded audience His scheme involves two separate considerations (1) the direction of the prevailing polar currents, and (2) the means by which these currents can be utilized for transporting an expedition All attempts to reach the pole by Smith Sound, by the east coast of Greenland, and by the north of Spitzbergen have been complicated by contrary currents, the few expeditions by way of Bering Sea, although equally unsuccessful, have had the currents in their favour

Taking into account all the available data, it appears that the polar current between Greenland and Spitzbergen carries southward between 80 and 120 cubic miles of water every twenty-four hours. The Gulf Stream drift may carry 60 or 70 cubic miles of water a day into the polar basin north of Nova Zembla, about 10 or 14 cubic miles daily probably flow in through Bering Strait, and possibly about one cubic mile a day of fresh water pours in on the average from the great Siberian rivers. This comparatively small addition of fresh water must account for the salinity of the Greenland outflowing current being somewhat less than the average salinity of the North Atlantic Theoretically there would thus appear to be a current running from near the New Siberian Islands towards the north of Greenland

The existence of such a current is strongly indicated by the drift of the *Jeannette* from 71° 30′ to 77° 15′ N after being caught in the ice, this drift being northwestward from Bering Strait Again, articles lost on the sinking of the *Jeannette* in the latter position off the New Siberian Islands were found on an ice-floe near Julianehaab, in the south of Greenland. A throwing stick, of a kind made only by the Eskimo of Alaska, was found a few years ago near Godthaab, on the west of Greenland Siberian driftwood is stranded regularly on the coasts of Greenland, and even on the north coast of Spitzbergen These facts can only be accounted for by the theory of an ocean current across the polar basin The evidence of the relative thickness of ice in different parts of the Arctic Sea, and of the occurrence of Siberian diatoms in the mud of ice floes between Greenland and Iceland is strongly confirmatory

Dr. Nansen intends to make the northwesterly current transport him across the middle of the polar basin, and so give him an opportunity for making scientific observations nearer the pole than has ever previously been done. He will sail next June *via* the Kara Sea for the New Siberian Islands, thence work a way as far north as possible, when stopped, he will run into the ice, and await the time when he will be drifted into the open sea again between Greenland and Spitzbergen He has had a ship built in Norway expressly for the voyage. Her form is such as to cause the ice, on closing round, to lift her out of the water, and she will rest upright on its surface. This vessel, named the *Fram* (*i.e.* Forward), is built of very long-seasoned timber, and is more strongly put together than any other vessel of her size The frame timbers are of great thickness, and set close together, so that if all the planking were stripped off the vessel would remain water tight The planking is first a ceiling of pitch pine, alternately 4 and 8 inches thick, then outside two layers of oak, 3 and 4 inches thick respectively, and over all is an "ice sheathing" of from 3 to 6 inches of the hard and slippery greenheart The sides are thus from 28 to 32 inches thick of solid wood The decks are equally strong, and the cabins are planned so as to be isolated by store rooms and coal-bunkers from the sides, while non conducting materials such as cork, felt, and reindeer hair are introduced between the walls or decks and the rooms to guard the crew from cold

The vessel is sharp fore and aft, and both propeller and rudder may be lifted in wells so as to avoid risk of fouling the ice The rudder is deeply immersed when in action, so that floating ice will not touch it Both stem and stern overhang greatly, and are heavily plated with iron to crush and cut through thin ice The length of keel is 101 feet, and the length of deck over all is 128, while the greatest beam (exclusive of ice sheathing) is 36 feet, and the depth 17 feet These proportions are very unusual, but were adopted as the result of experience in other ships With light cargo she will draw 12 feet, and fully loaded 15½, the displacement being about 800 tons She is rigged as a three masted schooner, with square sails on the foremast, and has an engine of 160 indicated horse-power The crow's nest on the maintopmast is 105 feet above the water line, so as to give a wide horizon for the look out Two large decked boats are carried, in either of which the whole crew of twelve men could live if the ship were lost Dogs, sledges, ski, several small boats, canvas for building extra boats on an emergency, and provisions for five or six years are taken A pendulum apparatus is included in the scientific outfit, which is otherwise very complete The ship is fitted with electric light the dynamo may be worked by a windmill when coal can no longer be spared, or as a last resort it can be driven by a capstan arrangement adapted for four men, thus supplying healthy exercise and useful work to one third of the crew, and abundant light to the remaining two-thirds

The duration of the voyage cannot be estimated, as it will entirely depend on the rate of drifting, which must vary considerably from year to year, but judging from the movement of the *Jeannette* relics, two years ought to suffice.

A REMARKABLE CASE OF GEOMETRICAL ISOMERISM

AN exceptionally interesting memoir is contributed to the current number of *Liebig's Annalen* by Prof. Wislicenus of Leipzig, who has latterly identified himself so earnestly with the subject of molecular configuration It has been suspected for some years that there are two isomeric unsaturated acids of the composition C_4H_7 COOH One of these substances exists in the free state in the roots of *Angelica archangelica* and has therefore received the name of *angelic acid* The other compound is found along with angelic acid in Roman oil of cumin and has been termed *tiglic acid* These two acids, moreover, behave so similarly in almost all their reactions with other substances that the conclusion has been rendered inevitable that they must be represented not only by the above formula, but by the same constitutional formula, $CH_3\,CH : C \begin{cases} CH_3 \\ COOH \end{cases}$ That the two acids are not identical, however, was indicated by certain slight differences of behaviour, and Prof. Wislicenus felt convinced that the two were in fact geometrical- or stereo isomers, the difference consisting in a different arrangement of their various radicle groups in space He considers it probable that the nature of the difference may be represented in one plane by the following formulæ.

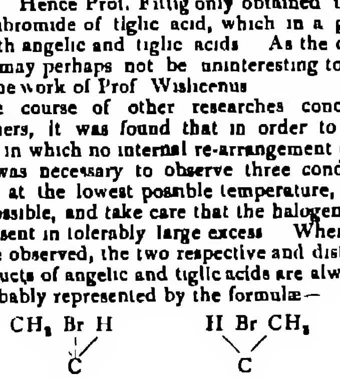
$$\begin{array}{c} CH_3-C-H \\ \| \\ CH_3-C-COOH \\ \text{Angelic acid} \end{array} \quad \text{and} \quad \begin{array}{c} H-C-CH_3 \\ \| \\ CH_3-C-COOH \\ \text{Tiglic acid} \end{array}$$

Judging from previous experience of the behaviour of other geometrical isomers of a similar nature, it appeared probable that the halogen addition products of the two acids would exhibit differences so marked as to determine definitively the separate nature of the two acids. Under the direction of Prof Wislicenus, therefore, one of his pupils, Herr Pückert, undertook the investi-

gation of the bromine addition products of angelic and tiglic acids, and was successful in showing that the two products were essentially different, exhibiting properties indeed so dissimilar that their identity was entirely out of the question. Although their similar constitution was indicated by melting-points differing by only one or two degrees, yet it was found that the crystals of the dibromide of angelic acid immediately reacted with water with production of a colourless oil, whilst the dibromide of tiglic acid remained unchanged in contact with water; moreover, the two compounds upon decomposition of their sodium salts, yielded two mono brom-pseudo-butylenes, which differed essentially in their capability of reacting with alcoholic potash.

In the year 1890, however, Prof. Fittig, of Strassburg, who had previously investigated the subject in conjunction with Herr Pagenstecher, and had obtained *identical* bromine addition products from the two acids, published a paper in the *Annalen* in which he sought to show that the results of Herr Puckert were incorrect, and that the two substances were identical. Prof. Fittig has since requested Prof. Wislicenus to withdraw the work or substantiate it, and further charges Prof. Wislicenus with seeing facts through the veil of his theory. Unfortunately Prof. Wislicenus has been unable hitherto to meet the attack owing to domestic loss and serious illness, but at last he is able to publish the results of a really classical piece of work which he has carried through himself, and which not only demonstrates the truth of Herr Puckert's conclusions, but places the results beyond all criticism, and shows the singular cause of Prof. Fittig's inability to repeat them. It is indeed remarkable, but nevertheless true, that the fate of the theory of geometrical isomerism has actually been trembling in the balance owing to the different situation of the draught cupboards in the Leipzig and Strassburg laboratories. In the former laboratory they are placed *between* the windows, and in deep shadow; in the Strassburg laboratory they are *against* the windows, and are consequently brightly illuminated in daylight. Now Prof. Wislicenus shows that the dibromide of angelic acid is only formed in the absence of bright light, *rays of daylight intensity being absolutely fatal to its formation*. Hence Prof. Fittig only obtained the relatively more stable dibromide of tiglic acid, which in a good light is yielded by both angelic and tiglic acids. As the case is so remarkable, it may perhaps not be uninteresting to give a brief summary of the work of Prof. Wislicenus.

During the course of other researches concerning geometrical isomers, it was found that in order to obtain addition-products in which no internal re-arrangement of atoms had occurred, it was necessary to observe three conditions. One must operate at the lowest possible temperature, exclude light as much as possible, and take care that the halogen to be added is always present in tolerably large excess. When these three conditions are observed, the two respective and distinct bromine addition-products of angelic and tiglic acids are always obtained. They are probably represented by the formulæ:—



Dibromide of angelic acid   Dibromide of tiglic acid

The operation of preparation is best conducted as follows:—A quantity of bromine, at least half as much again as is required by theory, and dissolved in three times its weight of carbon bisulphide, is placed in a flask surrounded by iced water. The flask is fitted with a triply bored caoutchouc stopper, through one hole of which is inserted a thermometer, through a second an exit tube furnished with a calcium chloride drying tube, and through the third the end of a burette containing a solution of pure angelic or tiglic acid in five times its weight of carbon bisulphide. The draught cupboard is darkened as much as possible and then the acid solution is slowly allowed to run into the flask. After the expiration of a few hours the formation of the brominated compound is complete, and the carbon bisulphide may be evaporated away in a rapid stream of dry air.

The difference between the two compounds is apparent even at this early stage, for the tiglic compound commences to crystallize long before the removal of all the carbon bisulphide, and soon forms a snow-white mass of crystals. On the contrary, the angelic dibromide shows no sign of crystallization, remaining as an oil for some time after the removal of all the carbon bisulphide. Eventually it crystallizes to a hard yellowish mass. The only solvent from which it was found practicable to recrystallize the angelic dibromide was the pentane fraction of petroleum ether boiling at 33°–39°.

The melting-point of pure angelic dibromide is 86.5–87°. That of tiglic dibromide is 87.5–88°. The two substances behave quite differently upon resolidification. The former congeals to a transparent resinous mass, whilst the latter forms an opaque solid.

The most striking difference is apparent in their respective behaviour towards water. The dibromide of tiglic acid is only slightly soluble in water, and dissolves unchanged, crystallizing out again upon evaporation. The dibromide of angelic acid, however, instantly combines with the equivalent of one molecule of water, to form a curious unstable liquid, an oil of high refractive power, which is somewhat soluble in excess of water, and is again deposited upon evaporation. This liquid compound is also formed when the dibromide is exposed to moist air, while the dibromide of tiglic acid is not changed in a moist atmosphere. In dry air the angelic liquid compound again dissociates into the dibromide and water vapour. In fact the dibromide of angelic acid would appear to act as an excellent indicator of the hygroscopic state of the atmosphere.

The two dibromides show a further difference in solubility, the angelic compound being far more readily soluble in all the solvents experimented with.

Finally the crystals of the two compounds, although both belonging to the triclinic system, are absolutely unlike. From measurements made by Dr. Fock, they are shown to exhibit different forms, entirely different angles, and different disposition of optic axes.

From the above description it will be quite evident that the two compounds are certainly not identical.

In conclusion, Prof. Wislicenus gives the results of attempts to obtain the dibromide of angelic acid in bright sunshine in the open air, then when working in front of a window, and again when the experiment was performed upon a table in the centre of the laboratory. In the first case, instead of the angelic compound, 92.8 per cent. of the dibromide of tiglic acid was obtained, in the second case 89.6, and in the third case 88.7 per cent. These results render it perfectly clear why Prof. Fittig could not obtain the angelic compound in his experiments, and they also show how it is possible for two chemists, both working with a desire to ascertain the truth, occasionally to obtain results apparently at complete variance with each other.

A. E. TUTTON.

MARINE LABORATORIES IN THE UNITED STATES.[1]

ONLY in comparatively recent times has the tremendous importance of the bearing of the invertebrates upon the general questions of biology been appreciated. We have seen that some work was done upon these animals at an early date, when the minds of workers were not much troubled by theoretical considerations, but the study of the adult forms is so small a part of a real understanding of these animals that it was unsatisfactory work, and never became popular among investigators until embryological methods had been introduced.

Dr. Brooks has remarked that "nearly every one of the great generalizations of morphology is based upon the study of marine animals, and most of the problems which are now awaiting a solution must be answered in the same way."[2] We find the reason for this in the fact that the biology of the present day is a study of vital phenomena and of natural laws governing living things. The importance of the invertebrates depends, therefore, upon the fact that in them life exists under simplified conditions, affording opportunities for the study of questions for which higher forms are, with our present knowledge, too complex.

As the study of invertebrates has extended, it has become more and more desirable to have more favourable conditions for this work, more abundant facilities for collecting and oppor-

[1] Reprinted from "Biological Teaching in the Colleges of the United States," by John P. Campbell, Professor of Biology in the University of Georgia, issued by the U. S. Bureau of Education.

[2] Johns Hopkins University Circulars, vol. vi., p. 37.

unities for studying animals alive Much of the early work was done upon specimens collected and stored in museums, but workers, both in this country and Europe, had frequently made excursions to the seacoast for the purpose of studying the invertebrate forms constituting so large a part of the marine fauna.

The unsatisfactory nature of this work was of course evident Suitable accommodations and working appliances could not be provided under these circumstances, and desirableness of establishing permanent seaside laboratories was early felt Nothing was done, however, in this country until 1871, when John Anderson, a wealthy citizen of New York, presented to Prof Agassiz the island of Penikese in Buzzard's Bay, together with the sum of $50,000 with which to found a seaside station for the study of marine life Another friend gave him a yacht of 80 tons burden for use in collecting Agassiz had long wished for such a laboratory, and no one but himself could have aroused the necessary enthusiasm for carrying out the project He soon set to work and built large laboratories, with suitable accommodations for a large number of workers In 1873 they were opened for work This constituted the first opportunity enjoyed by American students of studying marine animals in their native waters, with proper appliances for work It inaugurated a new era in scientific research, being the first outward expression of an idea which has since taken a firm hold upon the investigators of the country The death of Agassiz in December, 1873, put an end to the project. The buildings were used but two seasons and then abandoned

Of this laboratory Prof Whitman says —

"At the close of the second and last season at Penikese, in 1874, Alexander Agassiz appealed to the colleges and all interested boards of education for support, but all in vain, for not a single favourable reply was received, and so his intention to remove the laboratory to Wood's Holl was never carried out Thus that great and memorable undertaking, after absorbing money enough to build and equip a most magnificent laboratory, was abandoned from lack of interest on the part of educational institutions rather than of means Such a failure, it must be frankly confessed, is not one to inspire confidence, but its explanation removes the apparent grounds for discouragement It was the marvellous personality of Prof Agassiz that made Penikese a possibility It was his magic influence that created that school, his commanding individuality that organized and vitalized it All interests centred in him so completely that with his sudden removal the enterprise was left without a soul The school had no coherency except in his magnetic power and intellectual strength, and the moment these elements of stability were withdrawn, collapse followed as a natural and inevitable consequence. Then, too, it should be remembered that Prof Agassiz lived just long enough to demonstrate the impracticability of maintaining such a school in such a locality, but unfortunately not long enough to convince the scientific world of its utility The school was an experiment, its master was stricken down before it could be fairly tested, and the times were not ripe for it"

The establishment of this laboratory was an event of the greatest significance because of its bearings upon the history of education Not only was Penikese the first biological station established in this country, and, indeed, in the world, but it was the beginning of the summer-school movement which has spread so generally over the country, and which, it should be noted, began with original research and finally extended to include the work of elementary instruction.

The movement met with the cordial support of naturalists everywhere, and was almost immediately followed by the establishment of Dohrn's magnificent station at Naples Soon after, in 1875, a seaside station was established at Helder by the Netherlands Zoological Society, and other smaller ventures followed in Europe.

The need of opportunities for seaside study in the United States was too generally felt by those who had come under Agassiz's influence for the project to be allowed to stop The advantages of this method of work over museum study had impressed themselves at least upon a few workers, and accordingly we find several attempts made to found new laboratories They differed in character and aims, but all agreed in being founded upon the one idea of studying marine animals in their native waters.

The most direct successor of the Penikese laboratory is the private laboratory of Prof Alexander Agassiz at Newport While this building is constructed on a much smaller scale than that at Penikese and is open only to a limited number of workers, yet it is prominent for the elegance of its appointments and its conveniences for work

The first laboratory for seaside study established in this country after the abandonment of Penikese was maintained by the Peabody Academy of Sciences, under the guidance of Prof Packard, with the co-operation of Prof Kingsley and others This laboratory was for elementary instruction rather than research, and remained in existence only from 1876 to 1881

In 1878 the trustees of the Johns Hopkins University made an appropriation to allow a party of workers to spend some time in seaside study The party was under the guidance of Dr W K Brooks, who had himself been a pupil of Agassiz and a member of the Penikese laboratory The location selected was at the lower part of the Chesapeake Bay, from which the name of Chesapeake Zoological Laboratory was chosen No permanent buildings were erected, as it was intended, if possible, to change the location from year to year, but an outfit of boats and collecting apparatus was provided The summers of 1878 and 1879 were spent about the lower part of Chesapeake Bay at Crisfield, Md, and Fort Wool, Va., at which places special attention was given to the development of the oyster

At the opening of the third season, in 1880, the need was felt of a locality that would offer a greater variety of objects for study, and accordingly the summers of 1880–82 were spent at Beaufort, N C This locality proved especially favourable, since sand bars, mud flats, salt marshes, and land-locked salt water, within easy reach, gave a large variety of different rare forms, and there was also abundant ocean dredging A sufficient appropriation was made in 1880 to purchase a steam launch and a sloop, which put the workers in a position to take every advantage of their opportunities

In 1883 a special study of oyster beds made a return to the mouth of the Chesapeake Bay necessary, and that season was spent at Hampton, Va, but the following two seasons were again spent at Beaufort

In 1886 the need of a more southern location was felt, and the Bahama Islands seemed to offer an inviting field The summer of 1886 was therefore spent at Green Turtle Cay, and the following summer at Nassau, New Providence

Financial difficulties temporarily stopped the work of the laboratory, but it is announced that it will be reopened in the summer of 1891 [1]

It is difficult to summarize the work of this laboratory, and none the less so to over estimate its importance. It enjoys the distinction of being the first marine laboratory ever carried successfully into operation in the United States, and its work was entirely original research The character of work done differed from year to year, according to the facilities which the different localities offered, but in general it may be said that embryology received most attention, while considerably less was devoted to the discovery and description of new species. The methods employed, as well as the new facilities enjoyed, made it possible to apply effective means of solution to many problems previously obscure, as well as opening many questions in regard to which nothing had been done

Of the lasting value of the work it is perhaps too early to speak, but the fact that over one hundred papers, based upon work there performed, have readily found publication in the best journals of this country and Europe, as well as the fact that much of the work has already found its way into standard text-books, gives strong testimony to its value.

The Chesapeake Zoological Laboratory may be regarded as the successor of the Penikese laboratory to the extent that its aims are the same, but it differed in not being generally open to the workers of the country. Arrangements were not made for large numbers, and those who were present were mainly students of the Johns Hopkins University. During the nine years that this laboratory remained in existence, there were in all fifty investigators present, and the average length of each session was nearly two months.

The need was felt, especially in that portion of the country where Agassiz's influence was more directly exerted, of establishing a laboratory on a larger scale, and open to a larger

[1] Shortly after the above was written, Kingston, Jamaica was chosen as a suitable locality, and a party of advanced workers, numbering about fourteen in all, were present from May until September — September 21, 1891

number of workers, and the first step taken in this direction was the founding of a laboratory by the Boston Society of Natural History. In their report for 1881 these words occur:

"It has been considered desirable to found a summer laboratory sufficient to supply the needs of a class of persons who have begun to work practically under our direction, but have hitherto had no convenient means for pursuing their studies on the seashore . . . We are sure that such a laboratory is needed for a limited number of persons, such as our own pupils in natural history, and some of the teachers of the Boston public schools, about a dozen in all, but we are not sure of any real demand outside of these."

Arrangements for laboratory work were speedily made at Annisquam, Mass. Boats and appliances for collecting were at once provided, and in the spring of 1881 a circular was issued announcing the opening of the new laboratory. From this the following extracts are taken:—

"The liberality and co-operation of the Woman's Educational Association enable the Boston Society of Natural History to announce that a seaside laboratory, under the direction of the curator (Prof. Alpheus Hyatt), and capable of accommodating a limited number of students, will be open at Annisquam, Mass., from June 5 to September 15.

"The purpose of this laboratory is to afford opportunities for the study and observation of the development, anatomy, and habits of common types of marine animals, under suitable direction and advice. There will, therefore, be no attempt during the coming summer to give any stated course of instruction or lectures.

"It is believed that such a laboratory will meet the wants of a number of students, teachers, and others who have already made a beginning in the study of natural history."

Twenty-two persons were attracted to the Annisquam laboratory during its first season. Prof. Hyatt, in his report for 1882, remarks as follows:—

"The great need of an institution for teaching field work cannot be properly estimated by the number of those who are attracted by the opening of such opportunities for study. The mental condition of those who attend, and what it has done for them, and the sphere of influence which it reaches through them, are the only true standards by which its present and future usefulness can be properly measured. Nearly all the pupils were persons who could be termed 'well educated,' nevertheless they were, with the exception of some who had already worked in the laboratory or field, entirely unable to obtain knowledge with their own eyes and hands, and had even acquired a notion that this was not possible for anybody except the trained man of science. Several of these teachers, after their work was finished, expressed their gratefulness for the new powers the course had developed in themselves, and the fascinating pleasure they had experienced in learning to use their own eyes and hands in the study of things hitherto unapproachable for their uncultivated senses except through the deceptive mediation of books. When it is remembered that these teachers influence and mould the minds of thousands of young persons it is at the same time proved that what this laboratory has done and can do is not to be estimated by the number of its own pupils."

The success of the undertaking seemed assured, and arrangements were made for its continuance during the five years following. The number of students fluctuated greatly, falling to ten in the third year, and running up in the sixth year to twenty-six.

During these six years the laboratory was carried on jointly by the Boston Society of Natural History and the Woman's Educational Association of Boston. It has been the policy of both of these associations to originate new enterprises, but to turn them over when well started into other hands. It seemed in 1887 that the time had come when the maintenance of the laboratory should be put on a firmer basis. It had been supported long enough to demonstrate its practicability and usefulness. The demands upon it had increased. It was no longer an experiment. The associations believed that a permanent organization should be effected, the working facilities increased, and the whole established on a larger scale. Moreover, it seemed that something more might be done to give the laboratory a wider sphere of usefulness in advancing knowledge of marine life. Great as was its work in teaching, it seemed to depend for its support upon a circle of people too small for the extent of its benefits. It seemed desirable that a change should come which would lead to a more widespread interest in the laboratory, and bring together more investigators. The Marine Biological Laboratory was the result of this movement.

While space will permit but a brief account of this laboratory, its history, development, aims, &c., it may be said that the one point which distinguished it from the Annisquam laboratory was the prominence given to research. Students are received, but from the outset there has been a settled determination to so adjust the claims of each as to secure the greatest amount of efficiency and do most to advance science. The organization was therefore effected so as to secure a permanent staff of investigators, who would always be present, increasing knowledge by their own work, and by their example stimulating others to follow. Moreover, the principle was thoroughly recognized that the best investigation is prompted by the work of teaching. The best investigator is often the best teacher, but the work of teaching reacts upon the work of investigation, influencing it for the better.

The experience of the laboratory shows that these points, which had previously been carefully considered, were well taken. Various means were resorted to for providing funds, and in March, 1888, the laboratory was incorporated.

Wood's Holl was chosen as a locality because of its convenience, accessibility, and the variety of its land and marine flora and fauna. The building was at once begun, and finished in time for work during the summer. Circulars could not be issued until after most of the colleges had disbanded for the summer, and yet during the first season seven investigators and eight students were attracted to the laboratory.

In subsequent years the growth has been a steady one. The number of workers has greatly increased, and even now, when only its third season has been passed, it is stated that the space is insufficient to meet the demands upon it; the facilities for collecting are too small, and the staff of instructors is not large enough for their classes. Its usefulness is now established, and the time is ripe for it. To it in great measure the United States must look for the advancement of biology. Let us hope that its trustees, all of whom are working biologists, may be successful in placing the laboratory upon such a financial basis that its full possibilities for usefulness may be realized.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Cambridge.—Dr. Hill, Master of Downing College, has been appointed Chairman of the Natural Science Tripos Examiners for 1893. An election to an Isaac Newton Studentship in Astronomy, Astronomical Physics, and Physical Optics, will be held in the Lent term 1893. Candidates must be B.A.'s, and under twenty-five years of age on January 1. The emoluments are £200 per annum for three years. Applications are to be addressed to the Vice-Chancellor between January 17 and 27, with testimonials or other evidence of competency.

Dr. Lorrain Smith, M.D. Edin., Demonstrator of Physiology at Oxford, and Dr. F. F. Wesbrook, M.D., Manitoba, Professor of Pathology at Winnipeg, have been elected John Lucas Walker Students in Pathology. The Managers express their high approval of the valuable researches conducted by the late student, Dr. A. A. Kanthack, of St. John's College. The State Medicine Syndicate state that, at the two examinations held in April and October, 1892, there were in all sixty-four candidates, of whom thirty-five received Diplomas in Public Health. The fee in future will be five guineas for each of the two parts of the examination in State Medicine.

Examinations for open scholarships and exhibitions in Natural Science will be held in twelve of the Colleges in December and January next. A list giving the conditions and value of the scholarships is published in the *University Reporter* of November 12, pp. 198, 199.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 10.—Refraction and dispersion of light in metal prisms, by D. Shea. Thin prisms of gold, silver, nickel, and cobalt were prepared by the electrolysis of cyanide solutions by Kundt's method. Prisms of platinum were also prepared by the disintegration of platinum foil. A piece of foil 4 mm. broad and 0·02 mm. thick placed perpendicularly to a piece of plate glass at a distance of 0·5 mm. produced under the action of a current of 20 amperes a double wedge-shaped layer of oxide in half an hour.

This was easily reduced by a Bunsen flame, so as to represent a metallic prism with an angle of some 20 seconds. Only one in twenty of the prisms could be used, and only one in 200 silver or gold prisms. The source of light was a zirconium burner with a red shade transmitting light of the mean wave-length $64 \times 10^{-}$ cm. The index of refraction was found to vary with the incidence. For perpendicular incidence the following values were found: Au 0·26, Ag 0·35, Cu 0·48, Pt 1·99, Ni 2·01, Iron 3·02, Co 3·16. For silver the index was 0·39 at an incidence of 10°, 0·60 at 30°, 0·80 at 50°, 1·01 at 80°, and 1·03 at 90°. The following refractive indices for various wave-lengths illustrate the dispersion:

	Li, α	D	F	G
Au	0·29	0·66	0·82	0·93
Ag	0·25	0·27	0·20	0·27
Cu	0·35	0·60	1·12	1·13
Pt	2·02	1·76	1·63	1·41

—On a law of refraction for the entrance of light into absorptive media, by H. E. J. G. du Bois and H. Rubens.—On the infra-red emission spectra of the alkalies, by Benjamin W. Snow.—Absolute change of phase in light by reflection, by Paul Glan.—Inductive representation of the theory of double refraction, by Franz Koláček.—Studies in the electric theory of light, by D. A. Goldhammer.—On the passage of feeble currents through electrolyte cells, by Rud. Lohnstein.—On the motion of the lines of force in the electro-magnetic field, by Willy Wien.—On the electric theory of magneto optic phenomena, by D. A. Goldhammer.—An automatic interruptor for accumulators, by H. Ebert. This is to prevent the current from the accumulator exceeding the supply for which it is constructed. Two mercury cups are inserted in the circuit, connected by a piece of stout copper wire. The current next passes through an electro magnet. As soon as the current reaches a certain strength the electro magnet overpowers an adjustable spring, and lifts the copper connecting-piece out of the cups.—Contribution to the history of the spheroidal phenomena, by G. Berthold.

SOCIETIES AND ACADEMIES

LONDON

Physical Society, October 28.—Dr. J. H. Gladstone, F.R.S., past president, in the chair.—The discussion on Mr. Williams's paper, "On the relation of the Dimensions of Physical Quantities to Directions in Space," was opened by Prof. Perry reading a communication from Prof. Fitzgerald, president. The writer said Mr. Williams disagreed with the suggestion that electric and magnetic inductive capacity are quantities of the same kind principally because he had not got over the curious prejudice that potential and kinetic energy are different. No theory of the ether could be complete unless it reduced its energy to the kinetic form. Electric and magnetic inductive capacity would probably be found to be similar in the ether, and ultimately have the same dimensions. The analogies were not yet complete, but only in respect of *matter* was it probable that any difference existed between them. Diamagnetism corresponded to electrostatic induction, but paramagnetism had no definite electrical analogue. He was inclined to regard the phenomena of paramagnetism as connected with the arrangement of the material molecules, whilst diamagnetism depended on the electric charges on those molecules. So far no matter had been found which conducts magnetism, and such may not exist in our universe, but it may be gravitationally repelled by matter as we know it.—Mr. Madan remarked that in the first part of his paper Mr. Williams recognized that dimensional formulæ were originally change-ratios, but puts this aside for the higher conception which regards these formulæ as expressing the nature of the quantity. Fourier showed how to find the dimensions of units by making the size of the fundamental units vary. But k (specific inductive capacity) did not vary with the fundamental units, for it was merely the ratio of the capacities of two condensers, and therefore, by Mr. Williams's definition, a pure number. It was difficult, he said, to see how k could have dimensions, but Mr. Williams regarded it as a physical quantity, and therefore possessing dimensions. The object in giving dimensions to k and μ seemed to be to get over the double system of units. Mr. Madan did not think that dimensions could express the nature of physical quantities, and said differences of opinion existed amongst authorities on this point. For example, Dr. J. Hopkinson, at the last B.A. meeting, said that because a co-efficient of self-induction had the dimensions of length it must be a length, whilst other learned professors objected to this view. Even if one admitted that dimensions are a test of the nature of physical quantities it was not necessary that the two systems of units should be identical. The connecting link between the two systems was $Q = C\,t$, and the validity of this equation had been questioned. If this objection be confirmed, then there would be no current in electrostatics and no Q in the electromagnetic system, and the units would not clash. Referring to dynamical units, Mr. Madan pointed out that two units of mass were used in astronomy, but astronomers got over the difficulty by using a co-efficient. Dimensional formulæ, he said, are the result of a convention that certain definitions should hold true generally, but they contain no further information respecting the nature of the quantities beyond that involved in those definitions. As an example of the inability of such formulæ to express the nature of quantities, he pointed out that whilst physical differences were known to exist between + and − electricity the dimensional formulæ showed no signs of such differences.—Prof. Rucker said every correct physical equation consisted of a numerical relation between physical quantities of the same kind, and might be written either as a mere numerical equation or as a relation between the physical quantities themselves. The equation $2 + 1 = 3$ may correspond to 2 feet + 1 foot = 3 feet, and the latter may be written 2[L] + 1[L] = 3[L], where [L] represents the unit of length. So far as he was aware, nobody but a recent writer in the *Electrician* had denied that in such an equation [L] represented a concrete quantity. Maxwell explicitly stated that it does in his article on "Dimensions" ("Encycl. Britt.") and elsewhere, and Prof. J. J. Thomson, in his paper on the same subject, makes no statement contrary to this. The above equation might also be written 2[feet] + 1[foot] = 1[yard]. Another equation involving time is 60[sec.] = 1[minute], and dividing one by the other one gets

$$\tfrac{2}{60}\left[\frac{\text{feet}}{\text{sec.}}\right] + \tfrac{1}{60}\left[\frac{\text{foot}}{\text{sec.}}\right] = 1\left[\frac{\text{yard}}{\text{min.}}\right]$$

A difficulty was felt here in understanding what dividing a foot by a second meant, but this difficulty Prof. Rucker considered was not greater than that involved in dividing an impossible by a real quantity, a very familiar analytical device. Reasons for regarding the symbols $\left[\frac{\text{foot}}{\text{sec.}}\right]$ as legitimate were then given. Prof. Henrici said the communication under discussion was one of the most important contributions to physical science which he had come across for a long time. Such difficulties as presented themselves in the paper arose from its fundamental character. The author had attempted to express all physical quantities in terms of three, but quantities may exist which cannot be completely represented in terms of L, M and T. The tendency of modern mathematics was to express everything dynamically. Mathematicians had long been in the habit of using quantities which were neither numbers nor concretes in the ordinary sense, and different kinds of algebra with units not understandable had been developed. If a quantity, a times a unit u, be multiplied by b times another unit v, the result is expressed by $ab\,uv$, where ab is a number and uv a new unit which may or may not be physically interpretable. The interpretation of a product depended on the meaning attached to "multiplication," and if this be restricted to "repeated addition" the range is very limited. The narrow conceptions concerning multiplication acquired at school could only be removed by a careful study of vectors. Mr. Williams had treated his subject by vector methods, but a few traces of quaternions remained which might be omitted. To truly understand the subject, vectors must be treated vectorially. Dimensions might then show the nature of the quantities involved. The system adopted in Mr. Williams's paper was probably the best attainable at present, but he (Prof. Henrici) looked forward to the use of a more fundamental quantity than the vector—viz. "the point"—as the ultimate basis. Grassmann had worked out a "point calculus" in 1844, which was republished in 1880. Quantities more complex than vectors, viz. rotors, screws, motors, &c., had been used with advantage by Clifford, Ball, and others. Dr. Sumpner thought the first ideas of students on the subject of dimensions were that they represented the nature of the quantities, but could not see why every quantity should be expressed in terms of L, M and T. Prof. Rücker's paper on "Suppressed Dimensions" had cleared up several important points, and he (Dr. Sumpner) now considered that every quantity

must be expressed in terms of a unit of the same kind as itself He viewed Mr. Williams's attempt to express everything in terms of L, M and T, as rather a retrograde step The discussion on Mr Williams's paper was adjourned, and Dr Young made some remarks on Mr Sutherland's communication "On the Laws of Molecular Force" Mr Sutherland, he said, thought that Ramsay and Young's law $\partial p/\partial T = f(v)$ is not correct for compounds in the liquid state. Barus, however, had proved that several liquids, including ether, only showed variations from the law at extremely high pressures After writing the equation of the virial in the form $pv = RTvf(v) + v\phi(v)$, where $v\phi(v)$ stands for the internal virial term, the author of the paper had shown that $v^2\phi(v)$ ought to be constant, but, finding it not constant in the case of ether, &c, he attempted to explain the discrepancies by the formation of pairs of molecules at small volumes Other substances, such as nitrogen and methane, were supposed to follow the law This, Dr Young said, could not be accepted as proved, for the range of volumes over which the experiments had been made was only small, and methane was difficult to prepare pure After criticizing the use of two and sometimes three "characteristic equations" for the same substance, he went on to show that the formulæ given in the paper by which the critical temperatures, pressures and volumes might be calculated, lead to results differing from experimental numbers by quantities greatly in excess of experimental errors Experiment also showed that capillarity had little or no effect on the determination of critical constants Speaking of critical volumes he pointed out that MM Cailletet and Mathias had published a method of finding critical densities which gave very accurate results Mr Sutherland's conclusions respecting Van der Waals's generalizations were practically identical with those expressed by Dr Young in his paper on the subject, read before the Society last year The views as to the nature of the various kinds of "pairing" mentioned in Mr Sutherland's paper were open to serious objections, for his "physical pairing" is supposed to produce more effect on the "characteristic equation" than true chemical pairing In his (Dr. Young's) opinion the idea of physical pairing appears somewhat speculative and requires further elucidation —A paper on the determination of the critical density, by Dr Young and Mr. A L Thomas, and two papers, on the determination of the critical volume, and on the boiling points of different liquids at equal pressures, by Dr Young, were taken as read The first paper gives an account of results obtained by Cailletet and Mathias's method, based on the fact that the means of the densities of a substance in the states of liquid and saturated vapour when plotted with temperature, lie on a straight line which passes through the critical point In the paper on critical volumes the above-mentioned method is again referred to and results obtained thereby accepted in preference to those given by the author in his paper on Generalizations of Van der Waals, &c, read before the Society about a year ago The alcohols do not strictly follow the straight-line law Revised tables of critical volumes, densities, pressures, and temperatures are given, and it is pointed out that for many substances the ratio of the actual critical density to the theoretical density (for a perfect gas) is about 3 8 The paper on boiling-points of different liquids at equal pressures contains a comparison of the accuracies with which a formula for the relation between the boiling-points given by M Colot (*Compt Rend*, cxiv p 653), and one by Ramsay and Young (*Phil Mag.*, January 1886), accord with experimental results The author concludes that the latter formula shows the best agreement, but that of M Colot is satisfactory under certain conditions. The further discussions of Mr Williams's and Mr Sutherland's papers were adjourned till the next meeting

Mineralogical Society, October 25.—At the Anniversary Meeting the following were elected Officers and Members of Council —President, Prof N S. Maskelyne, F R.S ; Vice-Presidents, Rev Prof S Haughton and Dr Hugo Müller, F R.S., Treasurer, Mr F. W Rudler, F G S., General Secretary, L. Fletcher, F R S , Foreign Secretary, Mr. T. Davies; Ordinary Members of Council, Prof. A H Church, F R.S., Prof. Grenville A. J. Cole, Mr T W. Danby, Dr C Le Neve Foster, F.R.S , the Rev. H. P. Gurney, Mr. J. Horne, Prof J W Judd, F.R.S., Prof G. D Liveing, F R.S , Lieut General C. A. McMahon, Mr. H A. Miers, Mr F. Rutley, and Mr J. J H Teall, F.R.S.—Dr C. O. Trechmann detailed the results of the goniometrical measurement of two very perfect crystals of Binnite collected by himself in the Binnenthal. The measurements, besides adding a large number of forms to those previously recorded for this species, serve to establish the tetrahedral hemisymmetry of the mineral which has been left as a very doubtful feature by previous observers, and was denied by Hessenberg —Mr H A Miers and Mr G T Prior announced the results of further researches on the rare silver minerals known as Xanthoconite and Rittingerite According to their physical measurements and chemical analyses these two substances are identical, both having the same composition as Proustite, and crystallizing in rhombic shaped tables belonging to the mono-symmetric system The name Xanthoconite, given by Breithaupt, has the priority; the red silver ores are now to be regarded as an isodimorphous (?) group consisting of the two sulph arsenites Proustite and Xanthoconite, and the two sulph-antimonites Pyrargyrite and Fire-blende Previous determinations of the composition of Rittingerite and the crystalline form of Xanthoconite have been erroneous —Mr Fletcher gave a description of a new habit of Descloizite from the Argentine, and also an account of the new mineral Baddeleyite (native zirconia) the only fragment as yet found is part of a twinned crystal showing forms which belong to the mono-symmetric system pleochroic optically negative and biaxal with inclined dispersion specific gravity 6·025 hardness 6 5 —Mr Allan Dick contributed further remarks on Geikielite, supplementing his paper read at the previous meeting —Prof Judd exhibited photographs in illustration of his previous paper on the lamellar structure of quartz crystals and the method by which it is developed.—Mr Rutley exhibited a large series of beautiful cardboard models illustrative of the symmetry and optical characters of the crystalline systems — Mr Miers exhibited specimens, including the rare mineral Turnerite from the Tintagel Slate quarries which he had visited in search of that mineral

Zoological Society, November 1—Sir W H. Flower, F.R S , President, in the chair —The Secretary read a report on the additions that had been made to the Society's Menagerie during the months of June, July, August, and September, 1892, and called special attention to a young Gibbon from Hainan, South China, of a uniform black colour, belonging to the species recently described by Mr Oldfield Thomas as *Hylobates hainanus*, presented by Mr Julius Neumann, and to a young male Malayan Tapir (*Tapirus indicus*) from Tavoy, Burmah, presented by Col. F M Jenkins —Mr E Hartert exhibited (on behalf of the Hon Walter Rothschild) examples of two new Mammals from New Guinea (*Proechidna nigro aculeata* and *Acrobates pulchellus*), and a stuffed specimen of *Apteryx maxima* from Stewart Island —A communication was read from Lord Lilford, giving an account of the breeding of a pair of Demidoff's Galagos in his possession —Prof Bell read a note on the occurrence of *Bipalium kewense* in Ireland — Mr Finn gave an account of his recent zoological excursion to Zanzibar —Prof. Newton, F R S , exhibited and made remarks on a specimen of *Sylvia nisoria* lately killed in England —Prof F Jeffrey Bell read a description of a remarkable new species of Echinoderm of the genus *Cidaris* from Mauritius, proposed to be called *C curvatispinis* —A communication was read from Sir Edward Newton, and Dr Gadow, F.R S., describing a collection of bones of the Dodo, and other extinct birds of Mauritius, which, having been recovered from the Mare aux Songes in that island by the exertions of Mr Theodore Sauzier, had been by him entrusted to them for determination. The collection contained examples of the atlas, metacarpals, pre-pelvic vertebra, and complete pubic bones of the Dodo, which had before been wanting, as well as additional remains of *Lophopsittacus*, *Aphanapteryx*, and other forms already known to have inhabited Mauritius. Besides these there were bones of other birds, the existence of which had not been suspected, and among them of the following, now described as new — *Strix* (?) *sauzieri*, *Astur alphonsi*, *Butorides mauritianus*, *Plotus nanus*, *Sarcidiornis mauritianus* and *Anas theodori*, the whole adding materially to the knowledge of the original fauna of Mauritius —Mr. Oldfield Thomas gave an account of a collection of Mammals from Nyassa-land, transmitted by Mr H H Johnston, under whose directions they had been obtained by Mr Alexander Whyte.—Dr Günther, F.R.S., read a paper descriptive of a collection of reptiles and Batrachians from Nyassa-land, likewise transmitted by Mr. Johnston, and containing examples of several remarkable new species, amongst which were three new Chameleons, proposed to be called

Chamæleon isabellinus, *Rhampholeon platyceps*, and *R. brachyurus*.—Mr. R. Lydekker read a memoir on some Zeuglodont, and other Cetacean remains from the Tertiaries of the Caucasus.—Mr. Martin Jacoby read the descriptions of some new genera and new species of Phytophagous Coleoptera from Madagascar.

Linnean Society, November 3.—Prof. Stewart, President, in the chair.—The Rev. Prof. Henslow exhibited an instrument used in Egypt for removing the end of the sycamore fig, and gave some account of the mode of cultivation.—Mr. A. Smith Woodward exhibited and made remarks on some supposed fossil lampreys (*Palæospondylus gunni*) from the old red sandstone of Caithness.—The Rev. E. S. Marshall exhibited some hybrid willows from Central Scotland, believed to be rare or new to Britain.—Mr. G. N. Douglass exhibited the train of a peahen which had assumed the male plumage. The bird, which was reared at the Castle Farm, Tilquhillie, near Banchory, N.B., was believed to be about thirty years old at the time of its death, and for some years previously had not laid any eggs. In the opinion of the exhibitor and others present the phenomenon was correlated with disease of the ovaries. Similar cases had occurred with fowls, pheasants, and black game, but not, so far as was known, with peafowl.—Mr. C. T. Druery exhibited some new examples of apospory in ferns, namely a specimen of *Athyrium filix fœmina var. clarissima* with pinnæ showing development of prothalli by soral apospory, and a seedling *Lastrea pseudomas cristata*, showing prothalli developed aposporously over general surface of frond (pan-apospory).—Mr. J. E. Harting exhibited some live specimens of the short tailed fieldvole (*Arvicola agrestis*), and gave an account, from personal inspection of the serious damage done by this little rodent upon the sheep-pastures in the lowlands of Scotland.—Mr. A. B. Rendle exhibited some seedling plants of the sugar cane which had been raised in this country by Mr. Veitch.—The discussion on several of these exhibitions having continued until a late hour, a paper by Prof. Henslow, on a theoretical origin of endogens through an aquatic habit, was by consent adjourned to the next meeting of the Society, which will be held to-day.

Mathematical Society, November 10.—Prof. Greenhill, F.R.S., President, in the chair.—This was the annual general meeting and after the election of the gentlemen whose names are given on p. 616 (NATURE, vol. xlvi.) to serve on the council for the session 1892–93, the new President, Mr. A. B. Kempe, F.R.S., took the chair and at once called upon the retiring president to read his valedictory address. Prof. Greenhill took as his subject collaboration in mathematics.—The following further communications were made: Some properties of homogeneous isobaric functions, by E. B. Elliott, F.R.S. This paper is a sequel to one which the writer communicated at the June meeting entitled a proof of the exactness of Cayley's number of seminvariants of a given type. The earlier part of the present paper supplies omissions in the preceding one and in the remainder the theorem on which Mr. Elliott's argument was based is transformed, and the result examined for its own sake without reference to the particular application.—On certain general limitations affecting hyper-magic squares, by S. Roberts, F.R.S. The paper does not aim at making any addition to the known ways of constructing magic squares. Hyper-magic squares, as the writer regards them, include those called by M. E. Lucas "carrées diaboliques," and also treated by Mr. A. H. Frost under the designation of "Nasik squares." The special form is of ancient origin. The second method given by Moschopulus (thirteenth century) is a general one for forming such squares and they have been discussed by various modern authors. The writer's object is to show some limitations to which they are subject when the elements are positive or negative integers. Incidentally it appears that hyper-magic squares of oddly even orders cannot be formed of series of consecutive natural numbers. There is some reason for believing that much ingenuity has been fruitlessly employed in trying to form such squares. We may here mention that a very interesting historical essay on the subject of magic squares has been published by Dr. Siegemund Günther, in his work entitled "Vermischte Untersuchungen zur Geschichte der Mathematischen Wissenschaften" (Leipsic 1876). The subject has also been brought into connection with the "Geometry of Tissues," by M. Lucas and others (see the "Principii Fundamentali della Geometria dei Tessuti," par Edoardo Lucas, Torino, 1880).—Note on the equation $y^2 = x(x^4 - 1)$ by Prof. W. Burnside.—Note on secondary Tucker circles by Mr. J. Griffiths. The idea of this note sprang from the fact that if G, g, are two inverse points with respect to the circumcircle (ABC) whose centre is O, i.e. such that $OG \times Og = R^2$, then the pedal triangles DEF, *def* of G, g, with regard to ABC are similar. Taking G to be one of the Brocard points, then (DEF) is a Tucker circle and (*def*) a secondary circle.—On a group of triangles inscribed in a given triangle ABC whose sides are parallel to connectors of any point P with A, B, C, by Mr. Tucker. If DEF, D'E'F', are a pair of such triangles they are readily seen to be in perspective. Their properties are considered with reference to the principal points and lines of the modern geometry of the triangle.—A note on triangular numbers by Mr. R. W. D. Christie.

PARIS

Academy of Sciences, November 7.—M. de Lacaze Duthiers in the chair.—Letter addressed to the President by the committee formed to celebrate the seventieth birthday of M. Pasteur.—Influence of the distribution of manures in the soil upon their utilization, by M. H. Schlœsing.—Note on the reply of M. Berthelot to my note of October 24, by M. Th. Schlœsing.—Comparison of the magnetic observations of General Pevzoff in Central Asia with the data of the English magnetic charts, by M. Alexis de Tillo. General Michael Pevzoff, in his last exploring tour in Eastern Turkestan, made some careful determinations of magnetic declinations and inclinations. If these are compared with those published by M. Creack in the report of the *Challenger* expedition, it appears that in declination an average correction of + 1°.7 has to be applied to the latter, while the inclinations are practically identical.—On the new triangulation of France, by M. L. Bassot. This work was commenced in 1870. It comprised the establishment of a continuous chain between the Spanish frontier and Dunkerque, supporting the net on three base lines, and attaching it as far as possible to each of the parallel chains of the old triangulation. Also a new determination of the co-ordinates of the Panthéon, the fundamental point of the triangulation, the measurements of base lines in terms of the international metrical standard, and the calculation of the new arc of meridian. It was found that, starting from the Paris base-line, the network was verified at Perpignan, at a distance of 6°, to within 1 in 250,000. Where the French system meets the English, Belgian, and Italian systems, the correspondence is found practically perfect, but on the Spanish frontier there exists a difference of 1 in 65,000 at present unexplained. The arc between Dunkerque and Carcassonne, as now calculated, exceeds that of Delambre by 44.7m., or 1 in 20,000.—Essay on a general method of chemical synthesis, by M. Raoul Pictet.—On the fifth satellite of Jupiter, by M. E. Roger. From the empirical formula for the distances of Jupiter's satellites

$$\log \text{hyp}\, a = 8 - \frac{3m}{2\pi} - 0.03 \cos \frac{m\pi}{5} + \epsilon$$

the probable distances of any satellites yet undiscovered can be calculated. It appears that there may be one at distance 1.97, two others at 1.61 and 1.27, or a single one at 1.425, and others beyond the outermost satellite. The distances of those already known are 2.50, 6.05, 9.62, 15.35, and 27.00.—On the transformations of dynamical equations, by M. Paul Painlevé.—Lenticular liquid microglobules and their conditions of equilibrium, by M. C. Maltézos. The smallest drops of a liquid jet falling upon another liquid often assume a lenticular shape, one surface of which is more curved than the other. These are called microglobules. Their diameters were measured, and their volumes and masses calculated. The production of microglobules in all the liquids in Quincke's table was experimented upon.—Effects of weight on fluids at the critical point, by M. Gouy.—Dilatation of iron in a magnetic field, by M. Berget. An elegant experiment to exhibit the lengthening of an iron bar on magnetization, on the principle of Newton's rings. The bar in question, provided with a cap of black glass, presses against the flat side of a plano-convex lens screwed to the same stand. The bar is surrounded by a coil, which can be excited by a battery of accumulators. Magnetization is at once indicated by the expansion of the rings.—On the dissipation of the electric energy of the Hertz resonator, by M. V. Bjerknes (see *Wiedemann's Annalen*, No. 9).—On the equality of potential at the contact of two electrolytic deposits of the same metal, by M. G. Gouré de Villemontée.—On the rotating power of the diamine salts, by M. Albert Colson.—Volumetric determination of the alkaloids, by M. E. Léger.—On the fixation of free nitrogen by

plants, by MM Th Schlœsing, jun, and Em Laurent — Observations on the preceding note, by M. Duclaux — Observations on the preceding communications, by M Berthelot — On γ-achroglobine, a new respiratory globuline, by M A B Griffiths — On the axinite of the Pyrenees, its forms and its conditions of occurrence, by M A Lacroix — On the subterranean river of the Tindoul de la Vayssière and the springs of Salles la-Source (Aveyron), by MM E A Martel and G Gaupillat — On the comparative anatomy of the stomach in Ruminants, by M J A Cordier — Remarks on some means of defence in the æolidians, by M E Hecht. — On the evolution of the brachial apparatus of some brachiopods, by MM P Fischer and D P Œhlert — On the mechanism of solution of starch in plants, by M A Prunet — On the diuretic and ureopoietic action of the alkaloids of cod liver oil on man, by M J Bouillot — Results obtained at the crystal works of Baccarat by the introduction of metastannic acid into putty powder, by M L Guéroult

BERLIN

Physiological Society, October 14. — Prof Munk, president, in the chair — Prof Kossel gave an account of further researches on nucleinic acid, a compound which, in union with albumin, composes the proteids of the cell-substance In earlier researches he had studied the acid as derived from yeast cells and salmon-milt, and found that while the substances obtained from these two sources differed in many respects, they resembled each other in that the ratio of phosphorus to nitrogen was in both as 1 to 3, and that they both yielded nuclein-bases during their decomposition More recent researches on the nuclein derived from the leucocytes of the thymus gland have shown that the nucleinic acid it yields is more like that from milt, and resembles the product obtained from yeast even less than does the product from milt The relationships of nucleinic acid to the chromatin bodies of the histologists were minutely considered — Prof. Gad brought forward a theory of the excitatory process in muscles, based upon the theory of Fick, but further developed and supported by experiments on tetanized muscles.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, NOVEMBER 17

ROYAL SOCIETY, at 4.30 — On the Characters and Behaviour of the Wandering (Migrating) Cells of the Frog, especially in Relation to Micro-organisms Dr Kanthack and W B Hardy — On the Colour of the Leaves of Plants and their Autumnal Changes Dr Hassall — Stability and Instability of Viscous Liquids A B Basset, F R S — Observations on the Earthquake Shocks which occurred in the British Isles and France during the Month of August, 1892 Prof Hull, F R S

LINNEAN SOCIETY at 8 — A Theoretical Origin of Endogens through an Aquatic Habit Rev Prof Henslow — On the Buprestidæ of Japan and their Coloration G. Lewis

CHEMICAL SOCIETY at 8 — Fluo-sulphonic Acid T E Thorpe, F R S and William Kirman. — The Interaction of Iodine and Potassium Chlorate T E Thorpe, F R S, and George H Perry — The Magnetic Rotation of Sulphuric and Nitric Acids and their Solutions also of Solutions of Sodium Sulphate and Lithium Nitrate W H Perkin, F R.S — Note on the Refractive Indices and Magnetic Rotation of Sulphuric Acid Solutions S U Pickering, F R S — Hydrates of Alkylamines S. U Pickering, F R S — On the Atomic Weight of Boron W Ramsay, F R S, and Miss Emily Aston — And other papers

INSTITUTION OF ELECTRICAL ENGINEERS, at 8 — The Problems of Commercial Electrolysis James Swinburne (Discussion.)

LONDON INSTITUTION, at 6. — Lincoln Cathedral (Illustrated) Rev Canon Edmund Venables

SUNDAY, NOVEMBER 20

SUNDAY LECTURE SOCIETY at 4 — How Weather Forecasts are arrived at, and how we should use them (with Oxy hydrogen Lantern Illustrations) Arthur W Clayden

MONDAY NOVEMBER 21

SOCIETY OF ARTS, at 8 — The Generation of Light from Coal Gas Prof Vivian B. Lewes.

ARISTOTELIAN SOCIETY, at 8 — The Nature of Physical Force and Matter R J Ryle

LONDON INSTITUTION, at 5. — Respiration in Man and Animals (Illustrated). Hy Power

TUESDAY, NOVEMBER 22.

INSTITUTION OF CIVIL ENGINEERS, at 8 - Halifax Graving Dock, Nova Scotia Hon. R C Parsons. — Cockatoo Island Graving-Dock, New South Wales E. W Young — The Alexandra Graving-Dock, Belfast W Redfern Kelly — Construction of a Concrete Graving-Dock at Newport, Monmouthshire Robert Pickwell. (Discussion.)

WEDNESDAY, NOVEMBER 23.

GEOLOGICAL SOCIETY, at 8 — Outline of the Geological Features of Arabia Petræa and Palestine Prof. Edward Hull, F.R.S. — The Marls and Clays of the Maltese Islands J H. Cooke. — The Base of the Keuper Formation in Devon: Rev A Irving

SOCIETY OF ARTS, at 8. — Cremation as an Incentive to Crime: F Seymour Haden.

THURSDAY, NOVEMBER 24

INSTITUTION OF CIVIL ENGINEERS, at 2 30. — Students' Visits to the Gas Light and Coke Company's Chief Office, Horseferry Road, Westminster.

LONDON INSTITUTION, at 6. — The Ruined Cities of Mashonaland (Illustrated) J Theodore Bent

FRIDAY, NOVEMBER 25

PHYSICAL SOCIETY at 5 Experiments in Electric and Magnetic Fields, Constant and Varying E C Rimington and E Wythe Smith

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS — The Value of Hypnotism in Chronic Alcoholism Dr. C L. Tuckey (Churchill) — Guide to the Science of Photo Micrography, 2nd edition E C. Bousfield (Churchill). — Das Centralnervensystem von Protopterus Annectens Dr R Burckhart (Berlin, Friedländer). — Aids to Experimental Science A Gray (Auckland, Upton) — The Outlines of Organic Chemistry C J Leaper (Iliffe) — Théorie Mathématique de la Lumière H Poincaré (Paris G Carré). — A Sequel to the First Six Books of the Elements of Euclid, 6th edition Dr J Casey, edited by P A. E. Dowling (Longmans). — The Jurassic Rocks of the Neighbourhood of Cambridge: T Roberts (C J Clay). — Fossil Plants as Tests of Climate: A C Seward (C J Clay) — The Collected Papers of Sir Wm Bowman, Bart., F R S vol 1, Researches in Physiological Anatomy, edited by Prof J. Burdon Sanderson, vol 2, Surgical and Ophthalmological Papers, edited by J W Hulke (Harrison) — The Fayûm and Lake Mœris: Major R H Brown (Stanford) — Text book of the Embryology of Man and Mammals Dr O Hertwig, translated by Dr E L Mark (Sonnenschein).

PAMPHLETS — A Sanitary Crusade through the East and Australia (Glasgow, Boyle) — Geologische und Geographische Experimente, ii Heft, Vulkanische und Massen Eruptionen E. Reyer (Leipzig, Engelmann) — The Gods of Greece, and other Translations Dr J F Whitty (Greenock). — First Series of Field-path Rambles round Bromley, &c. W Miles (Taylor) — Un Avance á la Antropologia de España L. de Hoyos Sáinz and T de Aranzadi (Madrid) — Appunti in Conferma delle Osservazioni Tromometriche P T Bertelli (Torino, Giuseppe).

SERIALS. — Journal of the Royal Horticultural Society, vol xiv, Report of the Conifer Conference (London). — Himmel und Erde, November (Berlin, Paetel) — Bulletin de la Société Impériale des Naturalistes de Moscou, 1892, No 2 (Moscou) — Quarterly Journal of Microscopical Science, November (Churchill) — The Kansas University Quarterly, October (Lawrence, Kansas).

CONTENTS.

THURSDAY, NOVEMBER 24, 1892

ANIMALS' RIGHTS

Animals' Rights By H. S Salt. (London Bell, 1892)

THIS little volume is divided into three main parts, the principle upon which the rights of animals are founded, the various ways in which they have been infringed, and the reforms necessary to secure their full recognition Notwithstanding, however, the logical form in which the subject is thus set forth, the book is absolutely useless both from the ethical and the practical points of view In the first place the author nowhere attempts to define the relative value of the lower animals as compared with the human race, and although he certainly allows that they possess less "distinctive individuality," he condemns the use of the terms by which they are commonly designated (such as dumb beast, live stock, or even animal), on account of the imputation of inferiority which is involved in them

He seems to be totally unaware that not only is the natural affection of animals far less enduring, and their intellect immeasurably weaker, but that of morality, *i e* the doing of right for right's sake alone, unswayed by personal feeling or the influence of others, they have absolutely no conception whatever

Ignoring, however, these fundamental distinctions from which the subjection of animals inevitably follows, Mr Salt at once proceeds to enunciate his theory of their rights.

This whole question, however, is thrown into absolute chaos by the fact that, for subsequent dealing with the practical aspects of his subject, the author has equipped himself with not merely one but two definitions of animals' rights, differing from each other so widely that while the one involves the unconditional prohibition to kill, eat, or use any harmless animal, the other would admit of all these things being done for good cause shown. Thus on page 9 we find that they have the right to live their own lives with a due measure of that restricted freedom of which Herbert Spencer speaks, *i e* the freedom to do that which they will, provided they infringe not the equal liberty of any other. Except, therefore, in the case of the beasts of prey, who no doubt would "will" to eat man if a convenient opportunity offered, the liberty to sacrifice the lives of animals for human food or indeed to employ them in any way is cut off without reserve Turn, however, to page 28 and we find that this freedom of animals is no longer restricted merely by the equal freedom of others, but is also "subject to the limitations imposed by the permanent needs and interests of the whole community" A life of idleness and a death from disease or old age and starvation are no longer secured to them, and the whole principle of the subordination of the interests of the lower race to those of the higher is conceded

From the confusion of mind thus exhibited suggestions of practical value can scarcely be expected, nor indeed do we find them in the succeeding parts of the work Thus we are told that "the contention that man is not morally justified in imposing any sort of subjection on the lower animals" is one which the author "desires to keep clear of," and pronounces to be "an abstract question beyond the scope of the present enquiry," yet, as he also states "that no human being is justified in considering any animal as a meaningless automaton to be worked, tortured, or eaten for the mere object of satisfying the wants or whims of mankind," we would submit that he has not kept clear of the matter at all, as we cannot call to mind any forms of subjection which are not included in these three

In his discussion of the treatment of domestic animals we would only draw attention to that passage wherein the degrading practice of pampering lap-dogs is rebuked as unworthy of their moral dignity ! In the succeeding chapters the employment of animals in personal decoration, sport, and scientific experiment is dilated upon and condemned, and it then only remains to consider the question of the reforms which ought to be instituted

The first remedy proposed is that of education We are all to be taught to be humane, but seeing that this has been, for countless generations, carried into effect by almost every mother with almost every child, the suggestion can hardly be accounted novel nor need any great changes in the present condition of affairs be expected from it Further, there must be a crusade preached against the disregard of the kinship of animals to ourselves, and the laugh must be turned from the so-called sentimentalists (*i e* those agreeing with the author's views) against certain flesh eaters, sportsmen, and scientific experimentalists whom he seems to have in his mind's eye, and who, seeing that he represents them as advancing absolutely foolish reasons for practices which they could easily defend on common-sense grounds, are very properly described by him as "cranks"

The second reform is to be found in legislation, and it might naturally be supposed that this should first be applied in that case which Mr Salt considers to be productive of the greatest bulk of suffering, namely in that of flesh eating But this is not so, he has already said that it is no part of his present purpose to advocate vegetarianism, and he discreetly leaves it to look after itself Then after suggesting that the worrying of tame animals might be classed as baiting, and that improvements (though what and how he does not say) might be made in the transport of animals, and by substituting public for private slaughter-houses, he demands that the full fury of the law should be turned on to scientific experiment, which must be totally abolished

The demand thus made he bases on two grounds — (1) That nothing is necessary which is abhorrent to the general conscience of humanity, and (2) That it involves hideous injustice to innocent animals, quoting with approval Miss Cobbe's, in this case, specious axiom, that the minimum of all possible rights is to be spared the worst of all possible wrongs

How far either of these arguments is applicable here we propose to briefly touch upon.

In the first place no proof whatever exists that scientific experiment *is* abhorrent to the general conscience, seeing that England is the only country where it is even under legislative supervision, that there, after the most careful deliberation, it is freely allowed on good cause shown, and that the whole body of those qualified to

judge strongly advocate it Supported, therefore, as we have shown it to be, by the legal and moral sanction of the civilized and scientific world, it follows that the "general conscience" of which Mr Salt speaks must find its local habitation in the minds of a class of persons about as enlightened as those who fomented the riots against the study of anatomy, a noisy and violent agitation, which has died the natural death of ignorant prejudice

For the refutation of the second proposition, viz that of the cruel *wrong* done to an innocent animal by sacrificing it for the good of others, we must refer Mr Salt to his own principle of animals' rights, in which the freedom conceded to them to live their own lives is very properly made "subject to the limitations imposed by the permanent needs and interests of the community," and we fail to see how the logical application of an acknowledged right can be supposed to involve the infliction of a "cruel wrong"

The contention of the scientific experimentalist is exactly that which is here conceded by Mr Salt, viz that the interests of individuals of the lower race must morally be treated as subordinate to those of the higher, and that while men are bound to benevolently regard all harmless animals, and never to inflict pain upon them wantonly, they not only may but ought to do so when the suffering thus caused is but one-tenth in intensity and one-millionth in quantity of that which it is designed to avert from both mankind and the lower animals The whole matter is in truth a rule of three sum, and unless the anti-vivisectionist can successfully demonstrate that the scientific statement of accounts is false, his outcry is but the confession of the immoral fact that, rather than inflict an infinitely less amount of physical suffering upon some individuals of a lower race, he wilfully prefers to perpetuate a far greater amount of both physical and psychical agony among the whole community of animals and men When such an avowal of callousness can be seriously advanced in the name of humanity we are tempted to believe that chaos is come again

We should not omit to mention that Mr Salt appears to be an ardent republican, and that he looks for the advent of his animal millenniun upon the establishment of an "enlightened sense of equality," but whether of men with animals, of both with insects, or all three with bacteria, he does not say, nor are we concerned to enquire

ELEMENTARY PHYSIOGRAPHY

A Description of the Laws and Wonders of Nature By Richard A. Gregory, F.R A S. (London. Jos. Hughes and Co)

NOTWITHSTANDING the numerous text-books that have been issued from time to time on this subject, it seems to Mr. Gregory that there is still room for another, for whose appearance, however, he apologizes and offers an explanation.

A work on physiography is not, as some people, who ought to know better, seem to think, limited to the study of physical geography. At least that is not the view, the author emphatically asserts, of Profs. Judd and Lockyer, whose opinion in this matter is final for the students interested Neither is it a work on astronomy, nor chemistry, nor geology, nor any specialized science, whose aim and scope are recognized and defined, though doubtless it is allied to all As soon as an author treats of any of these subjects in detail, he is travelling beyond the record To this fact Mr Gregory is fully alive His object, if we have understood him correctly, consists rather in showing that some knowledge of all branches of physical science is necessary for the pursuit of one, and this kind of general knowledge he considers comprised under the generic term, physiography It is the kind of information which every so-called educated person ought to possess, and without which he is not educated

It may not seem a very ambitious task to write a book to meet the requirements of a syllabus, and our author thinks it necessary to defend himself against the charge of producing a cram book, addressed to the few ambitious of possessing a South Kensington certificate But the task need not be the less useful or the less necessary on that account Indeed, there is one circumstance connected with the appearance of this book which is very satisfactory, and should be a subject for congratulation. The author asserts that the book is rendered essential from the fact that the examiners have found it necessary or desirable to raise their standard for examination This means that the Department has proved, that the general character of the education given to those classes from which the candidates for examination are drawn has so improved that a greater amount of information can be demanded than was formerly the case

But independently of the fact that the author addresses himself principally to those preparing for the ordeal of examination, he has produced a very readable book, a little too much like an encyclopædia perhaps for ordinary tastes, but replete with a vast deal of information, by no means ill-arranged and generally expressed with exactness, but the effort to impart and to treat lightly and discursively of many branches of information is apt to give to the book a disconnected and incoherent aspect, and this is the principal defect that can be urged against the work As soon as a subject is introduced it is necessary to drop it, because to pursue it in detail would be to enter into the domain of some science whose limits are fixed, and to which further discussion properly belongs—for instance, we have a chapter on water (its composition and different states), which it might seem very desirable to pursue at greater length, but as soon as the student gets interested, without a word of warning the subject is dropped, and he finds himself introduced to the method of measuring angular space and time. This naturally leads on to some preliminary account of astronomy and astronomical methods, ending with the measurement of the day and year, and then, on turning the page, the reader is not allowed to continue the subject, but is invited to consider the composition and characteristics of common rocks This incoherency is perhaps inseparable from the subject; but we think the author might have developed his introductory chapter at greater length and put his scheme and sequence of thought more fully before his reader, so as to prepare him for these sudden deviations from continuity.

It is instructive to notice that as educational treatises are improved in character and prepared by those qualified for the task, the reverent superstition which has for ages surrounded certain errors and fallacies, that have done duty for scientific reasoning, is being remorselessly swept away The so called proof of the sphericity of the earth, based upon the fact that ships have sailed round it, is not quoted now, even by incompetent teachers, with the same satisfactory conviction that was formerly accorded to it Mr Gregory gives a diagram which ought to convince the most antiquated schoolmistress, but such myths die hard Similarly with our friend "the burning mountain," which has frequently been regarded as an adequate definition of a volcano—that too is meeting with its deserts, but this will take a still longer time to kill, let Prof Judd and others insist as they will Many instances will occur to every one who has compared the carefully compiled text-books of to-day with those that were popular only a few years back, and no fact marks more emphatically the improvement, or the necessity for improvement, in educational treatises Definitions, to be accurate and adequate, will always be a source of trouble to the writers of elementary books, and the author of the present work has no doubt been exercised to combine the necessary accuracy and simplicity We cannot think that he has always been happy, but where so much is admirable it would be ungrateful to dwell upon small blemishes, and can only be permitted with the view of securing their improvement or removal in a future edition

The definition of meridian as given on page 105 and again at page 151 is susceptible of improvement, and it is certainly incorrect to describe a sidereal day as the interval of time that elapses between two successive transits of the same star Such little slips must be due to the hurry of production, as that on page 382, where we are told to determine the position of the north point by observing the "shadow of the sun" We should have thought the shadow of the object would have been more convenient And again, on page 407, what is meant by the sun's "regular diameter"? But such little slips as these do not materially detract from the merit of the book, which we heartily commend to the thoughtful study of those for whom it has been written

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SCIENCE AND BREWING

A Handy Book for Brewers By Herbert Edwards Wright, M A (London. Crosby Lockwood and Son, 1892)

THE author claims that the principal aim of this book is to give the conclusions of modern research in so far as they bear upon the practice of brewing. We gathered a different opinion on first opening the volume, for facing the title-page there stands conspicuously a trade advertisement of a firm manufacturing a patented article used by brewers, stating that this article is "referred to in the work," and "for further particulars see advertisement at end of book" To any one at all familiar with the way in which quasi-scientific articles are so frequently to be met with in the literature of brewing written for the purpose of advertizing their author or some other thing, it would be only natural to conclude that the advertisement quoted was the real clue to the origin of this volume, and wonder at the unusual clumsiness with which it was made so evident However, we afterwards meet with the following statement in the author's preface "Having found after the sheets had been finally passed to the printer, that the publishers considered it would be a useful feature in the book to insert a few advertisements of matters interesting to brewers, he wishes it to be clearly understood that he has no personal interest in the matter" A little prejudice perhaps remained in our mind even after reading this disclaimer, but in justice to the author we may say at once that a perusal of the book has removed it We sympathize with him in having a publisher whose disinterested over-zeal for the convenience of his readers has given his book such an unpleasant first impression

From a scientific point of view, in one respect the practice of brewing compares with the practice of medicine, in that the complexity of vital processes has to be encountered in both, and through our present imperfect state of knowledge of these questions, the practice of both is based very largely on empiricism Fortunately for the brewer, the life functions with which he has to deal so largely belong to the more simple forms of life, and the vast strides which have been made the last few years in our knowledge of the microphytes, and the physiological processes of the higher plants, have probably placed him much nearer to a sound scientific basis on which to rest his practice, than is the physician who has to deal with the vital functions of the most highly developed organism But even yet empiricism rules many details of the brewer's practice, although research is gradually throwing true light upon them, therefore any writer who, in the present state of things, attempts to bring scientific knowledge and the practice of brewing together, has a very hard task before him in order to clearly make his readers understand the relative position in which the two stand at present Mr Wright has with much diligence gathered together the results of a large amount of research work bearing upon the different stages of the brewing process, but we do not think that he has been always happy in selecting only the most trustworthy of these, neither are we pleased with the way in which he sets them before his readers to explain, or at any rate throw light upon, the different stages of the manufacturing process It is a very difficult task, as we have just intimated, and we believe that the author, who is evidently a scientific man as well as a practical brewer, could have improved upon these parts of his work; at any rate we are quite sure that with due consideration he could easily have improved upon the general arrangement of his subjects, which is badly considered, and must be very confusing to a student not well acquainted with his subject

We also regret that space is wasted in devoting a chapter to an attempt to teach the science of chemistry to the reader Some such mistaken attempt is frequently made in technical works treated scientifically, but a greater waste of paper can hardly be imagined For instance, in the present case we have a chapter starting with a description of the elements and the atomic theory, which positively, in less than thirty-five pages, professes to lead the reader up to the consideration of the con-

stitution of the carbo-hydrates and the amido-compounds What can be the use of this sort of writing, however well done? No student not already well grounded in science generally can hope to get any real advantage from those parts of this book that are devoted to the scientific consideration of the details of the brewing process, and we wish the author had boldly recognized this very evident fact

Apart, in a manner, from the more scientific portions of his book, the author gives us his views on the empirical questions of brewing, and also on the arrangement of a brewery and its plant, with the authority of much experience Here is common ground on which all interested in brewing meet, and we recommend the author's conclusions as worth their attention At the end of the volume we find a novel feature in a synoptic table of the malting and brewing processes, giving side by side the time, working memoranda, physical changes, and chemical changes of each process, an epitome which is likely to be useful to many readers A good index also adds value to the book

Although we do not think that the author in writing this book has been very successful in meeting the requirements of young students of brewing, yet there is a large amount of information contained in the 516 pages of the volume which will repay a careful perusal by those more advanced in the study of the scientific aspect and practice of brewing

OUR BOOK SHELF

A Manual of Veterinary Physiology By Vety-Captain F Smith, M R C V S (London Baillière, Tindall, and Cox, 1892)

THE publication of this work ought to delight the heart of the veterinary student, for hitherto in his pursuit of physiological knowledge he has been compelled to rely upon works which deal exclusively with the human subject However excellent such works may be and well adapted to the requirements of the human physiologist, they must necessarily contain much which is only of secondary importance to the veterinary student, and absolutely nothing concerning many questions which to him are of vital interest For example, how needful to him is a thorough knowledge of the physiology of the horse's foot—the seat, as he is afterwards to learn, of manifold diseases Yet clearly the consideration of this subject is outside the range of human physiology Similarly the composition, digestibility, and feeding properties of the foods supplied to the various domestic animals are to him matters of paramount importance Yet here again he finds himself left in the lurch by the standard works on human physiology Such considerations amply indicate the necessity for a work of the kind now before us, and cause us to wonder that the veterinary profession should have had to wait so long for its publication Though several first rate treatises on veterinary physiology exist in French and German literature, Captain Smith's is the first attempt, we believe, to deal with the subject in its entirety in this country

We can heartily congratulate the author on the manner in which he has performed his task He writes in a concise but precise style Bearing in mind how many subjects the student is supposed to take up and master in a comparatively short time, the author has omitted, and we think wisely so, the details of physiological experimental methods and descriptions of elaborate mechanical appliances employed in the laboratory

The value or usefulness of the horse depends so largely upon its powers of speed or draught that a knowledge of its locomotory apparatus is obviously imperative to the veterinarians During recent years much light has been thrown upon the subject of animal locomotion by the elaborately devised experiments of Stillman and Muybridge, carried out, as is well known, by means of instantaneous photography Captain Smith furnishes a capital *résumé* of the conclusions derived from these experiments and a number of plain, simple diagrams aid the reader considerably in comprehending the subject

The physiology of the horse's foot is dealt with in a somewhat short chapter The author adheres to the theory of the expansion of the foot at its posterior part when the weight of the body is imposed thereon It is a subject which has often been hotly debated, and its discussion will probably be again reopened in the columns of the veterinary periodicals. The chapter concludes with some half-dozen rules on physiological shoeing, a copy of which might well be suspended and acted upon in every place where the shoeing of the horse is carried on

The book is well printed, neatly bound, and published at a very reasonable price (10s 6d.) Horse-owners as well as veterinarians will find its perusal attended with profit as well as interest W F G

The Principal Starches used as Food By W Griffiths (Cirencester Baily and Son, 1892)

THIS little book of 62 pages will be found useful by analysts and others who are interested in the examination of foods The author has collected together short descriptions dealing with the origin and microscopical characters of the different starches met with in commerce—the arrowroots, tapioca, sago, the starches of our common cereals, and of millet, maize, rice, the bean, the pea, the lentil, the potato, and so forth These are classified according to the natural orders of the plants from which they are derived, and the descriptions are accompanied by remarkably good photo micrographs, which indicate at a glance the peculiarities of the different varieties The mode of classification serves to bring out the resemblances which often exist in starches obtained from plants of the same natural order Since the microscope alone can be employed in attempting to trace the origin of a starch, and bearing in mind the extent to which it is now used as an adulterant, this handy little book will no doubt supply a want

Three clerical errors were noted On p 47 "feint" should be "faint," and "not" is evidently omitted in line three from the bottom On p 48 "character" should be "characters"

Les Alpes Françaises Par Albert Falsan (Bibliothèque Scientifique Contemporaine (Paris J B Baillière et Fils, 1893)

WE cannot call this a successful book A mixture of condensed statistical information and of popular descriptive writing is not much better than a stirabout of Liebig's extract and of trifle-whip Fixity of purpose on the author's part is also wanting. Doubtless the French Alps cannot be separated from the rest of the chain, but for a book of only 286 pages all told, this contains too much about the Central, Pennine, and Eastern Alps The geological part is sketchy, and not always very accurate The author repeats the old mistake about the "variolite of the Durance forming a fringe to the euphotide," though the question was settled by the elaborate paper of Messrs Cole and Gregory, published in the *Quarterly Journal* of the Geological Society for 1890. The illustrations are numerous, few, however, of them are good, and several very bad There is no index. The work, in short, is a piece of book-making, characteristically French in style, and is not a valuable addition to the library either of the mountain-climber or of the man of science.

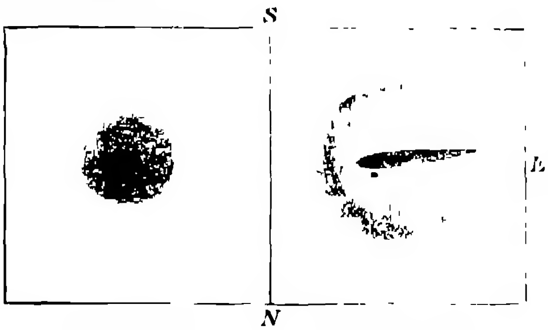
LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The New Comet

THE comet discovered by Mr. Holmes on November 6 was observed here on November 9 at 5h. 50m., and found to consist of a very bright circular nebulosity with central condensation. The diameter of the comet was 5′ 41″.

It was re-observed on November 16 at 10h. 45m., and its physical appearance seemed to have undergone a complete transformation. The diameter had increased to 10′ 33″, and the cometary material had become much fainter and more irregular. The nucleus was now in the form of a bright streak, and this was enveloped in a large faint coma. A small star was seen just N. of the W. extremity of the nucleus, and the latter seemed composed of knots of nebulosity.



Nov. 9, 5h. 50m. Nov. 16, 10h. 45m.

On November 19, 14h. 15m., the comet was seen again. Its general aspect was much fainter, and it exhibited a further increase in dimensions. I carefully determined its diameter as 14′ 30″, but the outlying portions were very tenuous and indefinite.

From Berberich's elements given in Edinburgh circular No. 33, it appears that the comet is moving rapidly away from the earth. The great increase in its apparent diameter is therefore not a little remarkable. On November 9 the comet was about 203 millions of miles distant from the earth, and its real diameter must have been 333,000 miles. On the 16th this had increased to 652,000 miles. By the 19th the comet's distance had become 217 millions of miles, and its real diameter 925,000. In ten days, therefore, the cometary material expanded nearly threefold.

Bristol, November 20. W. F. DENNING.

The Light of Planets

A FEW facts relative to this subject may be interesting. At Plymouth on August 12, about 9 o'clock, favoured with a beautifully clear horizon, the brilliancy of Mars was so great that it cast a distinctly black shadow on a piece of white paper from an ordinary walking stick held at a distance of 4½ inches; the outline of the hand, under the same conditions, was also easily perceptible. A faint, yet decided, darkening of the white cliffs of the shore was caused by a person standing upright—the slope being about 45°. The point of observation was at the extreme north-west of the Sound, and the splendour of the planet's light reflected from three or four miles of water is perhaps unrivalled.

The light of Jupiter has often enabled me, when using the telescope at a southern window, to make drawings and such references to books, &c., as were found necessary, without any other illumination. JOHN GARSTANG.

Springwell House, Blackburn, November 21.

Rutherfurd Measures of Stars about β Cygni

IN order to prevent any possible misapprehension in connection with your notice (NATURE, vol. xlvi. p. 619) of Mr. Rutherfurd's measures of the stars surrounding β Cygni, may I call attention to the following?—The two stars of Argelander, 27° 3435 and 28° 3341, concerning which a doubt is expressed in my paper, are certainly lacking on the Rutherfurd plates. If they were present they would be very near the edges of the plates, and it is for this reason that I doubted whether we should expect to find them at all. The star numbered 28 in the Rutherfurd list, which appeared only as a sort of elongation of No. 27 on a plate taken at this Observatory, April 19, 1892, is one of the components of Σ2539, as was pointed out by Mr. Burnham in the *Astronomical Journal*, No. 268, and by myself in the same journal, No. 266. HAROLD JACOBY.

Columbia College Observatory, New York, November 11.

The Alleged "Aggressive Mimicry" of *Volucellæ*

MR. POULTON'S letter calls for few words in reply. I invited Mr. Poulton to produce observations in support of his statement that the two varieties of *Volucella bombylans* lay in the nests of the bees which they respectively resemble. To this invitation Mr. Poulton has not responded. He tells us that his account represented "a very general impression", that the same impression has been set forth in a showcase at the Museum of the Royal College of Surgeons, that even if he were mistaken it was well, if through his mistake the truth shall the more abound. It is thus admitted that in making that statement Mr. Poulton relied not on original authorities, but on the general impressions of others. That these impressions are in any sense correct there is as yet no evidence to show.

Compared with this, Mr. Poulton's error as to *Bombus muscorum* is of course comparatively trifling and it would be useless to pursue the matter, were it not for discoveries made in the process of unravelling it.

I pointed out that *V. bombylans* is common in nests of *B. muscorum*, a bee which it does not resemble. Mr. Poulton in reply maintains the opinion that *V. bombylans* var. *mystacea* does resemble *B. muscorum*. In defence of this statement he refers to (1) the showcase at the Royal College of Surgeons, where the resemblance is set forth; (2) a recent book, "Animal Intelligence," by Mr. Lloyd Morgan, where the resemblance is again asserted and illustrated by figures of insects in the similar showcase at the Natural History Museum.

In following up these clues I came to unexpected results. (1) There is at the College of Surgeons a showcase, as stated, illustrating the likeness of *Volucellæ* to humble bees. The label states that "the resemblance enables them [the flies] to escape detection." Two bees are exhibited bearing a good likeness to the var. *mystacea*, and, as Mr. Poulton says, they are labelled "*B. muscorum*." The one, however, is a worker of *B. sylvarum L.*, and the other is probably a male of the same species. Neither can be mistaken for *B. muscorum*, which they do not resemble.

(2) At the Natural History Museum bees of several species are shown beside the *Volucellæ*, with a similar statement that the resemblance enables the flies "to enter the nest of the bee without molestation." Not one of these bees is *B. muscorum*, nor are any of them said to belong to this species, for no names are given. Nevertheless, on turning to Mr. Lloyd Morgan's book, which I had not before seen, I find the statement (p. 90) that *V. bombylans* "closely resembles" *B. muscorum*, the passage continuing in the words of the Natural History Museum label. Figures are added showing the two forms of *V. bombylans* and two very different bees, *both* marked "*B. muscorum*." Now the figures are from *photographs* of certain specimens in the showcase, and on reference to the specimens in question, it appears that one of them is a yellow-banded humble bee (perhaps *B. hortorum*), while the other is one of the red-tailed humble-bees! These two are put out to match *V. bombylans* and the var. *mystacea* respectively, and of course have no likeness either to each other, or to *B. muscorum*, though both are referred to this species by Mr. Lloyd Morgan.

Mr. Poulton's choice of *B. muscorum* as a form resembled by the var. *mystacea* probably therefore arose from the wrong naming at the Royal College of Surgeons. How Mr. Lloyd Morgan came to call the two different bees by the name *B. muscorum*, which belongs to neither, I cannot tell. Perhaps this is in part an echo of Mr. Poulton's previous mistake.

Any one by reference to a collection of bees may easily satisfy himself that the common and ordinary *B. muscorum*, with its bright brown thorax, does not resemble *V. bombylans*, though this fly is common in its nests, just as *V. pellucens* lives in wasps' nests, though it does not resemble a wasp.

In the absence of direct evidence in its favour, and inasmuch

as it is inconsistent with many ascertained facts which were specified in my first letter, the hypothesis of "Aggressive Mimicry" should surely be withdrawn

No speculation is needed to enhance the exceptionally interesting facts of the Variation and the resemblances of the *Volucellæ* If a number of people will set to work on this problem in the way suggested, there is, I think, a fair chance of considerable results It was in the hope that such effort may be made that I drew attention to the matter, and I am really sorry that Mr Poulton should be hurt thereby. Nevertheless, I cannot but regard his account of the matter as an example of the way in which statements pass on from one writer to another, but prove on inquiry to be baseless WILLIAM BATESON

St John's College, Cambridge, November 14

Parasitism of *Volucella*

MR BATESON's interesting discussion of the relations between *Volucella* and the species of *Bombus* (NATURE, vol. xlvi p 585) suggests the following observations —The nest of *B muscorum* is made without much effort at concealment on the surface of the ground If accidentally disturbed the inmates set up a peevish buzzing, which, no doubt, answers the purpose of warning off ordinary intruders Yet *B muscorum* is of a patient and gentle disposition, and will put up with a good deal of maltreatment before using its sting Its sting, moreover, is less venomous than that of either of our other common humble bees. It apparently trusts to the reputation of its genus for protection from annoyance Such a creature would seem marked out by Nature as the very host to be imposed on by a parasite like *Volucella*, which, on the other hand, may need all its cunning to come round an irascible being like *B lapidarius*, or even like *B hortorum* And, in fact, as Mr Bateson points out, we find it multiplying abundantly at the expense of the first named bee, and less frequent in the nests of the other two Notwithstanding this, *B muscorum* appears to be certainly no less successful than either of the others in the struggle for existence W E HART

Falmore, Carrowmena, co Donegal

Optical Illusions

THE illusion of the Gothic arch in NATURE (vol xlvii p 31) is too good to have a rival, but simple Norman arches occasionally practise a deception of some subtlety In certain cases they seem to be of the Moorish horse-shoe form, this happens when the semicircle does not spring at once from the capitals of the Norman columns, but has a short intervening vertical space of masonry Architects are familiar with the effect, and call these arches stilted, they say the stilts are commonly vertical, although Norman walls have no doubt sometimes fallen away from the upright course I suppose the eye is quick enough to perceive that there is more than a semicircle, while the mind is gullible enough to infer that the curvature is continued In Winchester Cathedral there are some good illustrations of this appearance

Winchester College, November 12 W B CROFT

A Strange Commensalism—Sponge and Annelid.

A CURIOUS case of what I believe to be definite commensalism between members of these two classes came under my notice the other day when collecting, and, as it is, so far as I know, a new instance in this interesting inter-relationship between animals, I venture to record it

Several large patches of crusting orange red sponge attracted my attention because of the peculiarly emphatic markings of what appeared to be the oscula They were suspiciously unlike anything spongiform, so I secured some good pieces of the sponge for further investigation Sections proved them to belong to the *Microciona plumosa* of Bowerbank, but the supposed oscula—which to the naked eye appeared as innumerable tiny black specks, each surrounded by a grey ring—proved to be, when the mass was teased out in water, in reality the ends of tubes inhabited by an eyeless *Leucodore* (*L cæca*, Œrsted). Fully forty could frequently be counted in a square inch.

The conclusion I come to after examination of a large number of specimens is that actual benefit is mutually given and received by each of the two messmates, the sponge gaining considerable support and extra consistency from the numerous comparatively wiry upright tubes There is also the question whether the excreta of the worms is of any food value to the sponge On the part of the worm, there is little doubt that it finds a valuable protector in the sponge which by the way is characterized by an intensely rank smell of garlic (warning odour?) I have seen no signs of this sponge being preyed upon by any animal, so we may conclude its protective devices of spicules, odour or taste are fairly successful A worm whose tube is sunk completely in its substance will naturally be very safely housed, and besides, the friendly water currents set in motion by the sponge cilia will bring much food matter to its very mouth

Bowerbank in his description (" Br Spongiadæ," vol ii p. 134) writes of a specimen as "permeated by some small tubular zoophyte which it has coated with its own tissues, and from these adopted columns defensive spicula are projected"—evidently the same as I describe above, though he makes the mistake of considering the tubes as those of zoophytes instead of those of annelids From this quotation, however, it is evident that the habit is widely spread, and not merely local. Here at extreme low-water the sponge grows exceedingly abundant, and the commensal worm seems always present

JAMES HORNELL

Jersey Biological Laboratory, November 10.

Induction and Deduction

MR DIXON says that there are "at least three different kinds of interpretation which may be put upon the proposition, [An isosceles triangle has equal angles at the base] It may mean (1) the triangle used to illustrate this proposition has equal sides, therefore it has equal angles, or (2) I have conceived a triangle which has equal sides, therefore I have conceived one which has equal angles, or (3) the connotation ascribed by the adjective isosceles implies the connotation 'having equal sides' [? angles]"

He goes on to observe that the difference between either (1) or (2), and (3) is "that this latter gives us no information about any real thing or concept, but only about what is implied by using certain terms," that is, about the connotations of "isosceles" and "having equal angles" ("equal sides" is of course a slip) But if connotation refers neither to the attributes of "real things" nor to "concepts" (which I suppose means ideas or notions) what can it be that we "imply" by using the terms *isosceles*, &c? If we do not mean things, nor attributes of things, nor ideas, do we mean anything which can convey or contain information?

In Mr Dixon's view the terms do convey information, but information which "clearly does not require to be based upon any real knowledge of things, but may be based solely on definitions of words" But must not definitions of words be based, in the last resort, upon knowledge either of things or of concepts—definitions of current words in some current sense, or even of strange words in strange senses—as *e.g* if I say Abracadabra means ixtra mixtra, and Triangle means abracadabra, and all abracadabras are four sided, and so on? With such propositions I may certainly frame syllogisms and arrive at "symbolical" conclusions, though I cannot see that I shall be doing anything to convey information or to advance thought

And when Mr Dixon says that the proposition "an isosceles triangle has two equal sides" has "wide applicability and usefulness" because we "often find things which can fairly be called isosceles triangles," it seems clear that he himself cannot have taken the proposition at starting in a sense purely "symbolic" (in his meaning of that word). If he did, it would be little less than miraculous that an entirely arbitrary definition should happen so to fit actual experience, especially when we consider that other equally symbolical mathematical propositions have an equal applicability.

I think it is probably true that we often do not depend, for our assent to complicated reasonings, on anything like full "realization in succession of the actuality of the relations and operations discussed", but I cannot admit that such reasonings do not refer to objects of experience or of thought Unless the terms did refer to something other than themselves, we could never assert S is P, or $x = y$

I unfortunately know nothing either of Pascal's theorem or of the intersections of two conics, but I think that in the case of the individual isosceles triangle, my intuition that the equality of angles at the base is inseparably connected with equality of sides, gives me ample ground for believing it to be "mathematically certain" that every isosceles triangle has equal angles at the base; it is self-evident that the one characteristic cannot exist without the other. That the isosceles triangle in question, if put under a microscope or tested by some micrometer, might turn out to be not "really" isosceles, seems to be a perfectly

irrelevant consideration, and I have never been able to understand the stress laid upon it by acute thinkers It is because the triangle is *as far as I can perceive* isosceles, that I intuit it to be *as far as I can perceive* equal angled

It has, I believe, been already explicitly recognized by certain logicians that a "symbolically" proved conclusion need not give any actual information about "real things" Indeed some go further, but I do not know that any have gone so far as to say that it would not give any information about ideas—although perhaps this may be the logical conclusion

Cambridge, November 10 E E CONSTANCE JONES

Ice Crystals

YOUR correspondent, C M Irvine (vol xlvii p 31) will find letters on this subject in NATURE, vol xxxi pp 5, 81, 193, 264, 480, and in vol. xxxiii pp 461, 486

Prof (?) McGee's letter at p 480, of vol xxxi, gives a list of communications on the same subject in earlier volumes

B WOODD SMITH

The Late Prof Tennant on Magic Mirrors

SEVERAL scientific friends tell me that the late Prof Tennant, the well-known mineralogist, published some twenty or twenty five years ago a small pamphlet on Magic Mirrors Failing to find a copy even in the library of King's College, I invite the readers of NATURE to assist me to discover one

SILVANUS P THOMPSON

City and Guilds Technical College, Finsbury, November 15

On a Supposed Law of Metazoan Development

UNDER the title of "The Relations of *Larvæ* to Adult Forms," I recently read a paper before Section D at the Edinburgh meeting of the British Association The subject dealt with was of so extensive a nature, and the time available was so limited, that I fear much that was said must have appeared vague and ill-founded, if not entirely incomprehensible The material of the essay had, indeed, been prepared with the intention of devoting at least an hour to its delivery as it happened, I found myself under the necessity of cutting out whole passages of my notes whilst speaking

The few lines of the report in NATURE (vol xlvi p 404), convey a very inadequate idea of what I aimed at proving in the paper, and hence I am tempted to offer a fuller account to the readers of this journal

The subject of the essay furnishes a problem which must interest every embryologist, even though he should reject the conclusions to which observation and reflection have led me

In working out the complete paper so many novel and confirmatory points have been met with, so much of importance in the writings of the older embryologists, and more especially in the memoirs of Johannes Muller on the Echinoderm larvæ, has been unearthed, that an extension of the original plan of the work has been rendered necessary

My conclusions, moreover, are so much in conflict with prevailing doctrines that any haste in producing the full argument would be unpardonable, although a preliminary sketch by way of clearing the ground may be justifiable On a subsequent occasion an attempt would be made to show how the researches of recent years had, with a few notable exceptions (such as the work of R S. Bergh, J Kennel, and N Kleinenberg), tended away from rather than in the direction] of a recognition of the fundamental fact of an alternation of generations as underlying Metazoan development, in that they had been concerned, for example, with unnecessary attempts at homologizing the "mesoderm" and its mode of formation throughout the animal kingdom.

If the facts in support of my case should not be as complete as the published researches of the last thirty years on the ontogeny of very many animals might lead one to anticipate, the circumstance would have an obvious explanation.

With the death of Johannes Müller—a man whose brilliance as an embryologist was only surpassed by his greatness as an anatomist—there closed one chapter, and that one of the finest, in the history of comparative embryology What influence the publication of "The Origin of Species" had upon the subsequent progress of the science is too well known to need further expatiation here The pernicious search after pedigrees, initiated by Hæckel, led to an era of activity during which every fact with no apparent bearings on phylogeny was ignored As a consequence the work of Muller on the Echinoderm larvæ and the essay of Steenstrup on "Alternation of Generations" became more or less mere curiosities in the history of the science With little exception embryological speculation of the past thirty years has been naught else than a pursuit of will-o'-the wisps

It behoves us now to revert to the path along which Johannes Muller laboured

My own embryological conclusions, like those of contemporaries, have not hitherto been influenced by the *embryological* works of Muller, for it was not until after my paper had been read that a first study of the Echinoderm memoirs convinced me how nearly he had anticipated what follows

Before passing to the subject, one further remark may be permissible Owing to lack of time when reading the paper no opportunity offered itself for pointing out the analogy which obtains between the suggested mode of Metazoan development and the accepted fact of an alternation of generations in the life histories of all plants above the lowest Thallophytes Furthermore nothing was said about the mode of formation of the "mesoderm" in certain cases as one or more outgrowths of the endoderm, although the writer was fully alive to the explanation which from his standpoint could be offered This and other questions of a like character would receive consideration in the complete paper, in which it would be demonstrated that such things and processes need be neither "palingenetic" nor "cœnogenetic," but that the analogy of the formation of imaginal discs in *Insecta*, or in the *Pilidium* of the Nemertine, ought to suffice to account for them. As an instance, the formation of the mesoblastic somites in Amphioxus as evaginations of the endoderm may be only a mode in which certain parts of the adult are in that particular case laid down upon the larva

And now, after this digression, to return to the question under consideration Two modes of development have long been distinguished, viz, *larval with metamorphosis* and *fœtal and direct* Cases are known in which there subsists no homology between the larva and the adult, and even such in which the larva (*Bipinnaria asterigera*) is said to exist apart for a time after it has given rise to the Echinoderm In many such, moreover, the sole larval organ carried over to the adult is the alimentary tract, all other organs of the larva, such as nervous system, sense organs, locomotor and excretory organs, mouth and anus, &c, being replaced by new formations in the adult The new organs are thus not homologous with those of the larva, indeed, neither as a whole nor in its parts is the larva the homologue of the adult form, but the latter arises upon the former by a mode of asexual generation

The birth of the Nemertine on the *Pilidium*, and that of the Echinoderm upon the *Pluteus*, or upon the *Bipinnaria asterigera*, may be cited as examples, and the question may now be asked, What becomes of the larva when (*a*) food yolk is more or less abundantly acquired, and (*β*) when uterine development is initiated? Does the larva really disappear? Anticipating the sequel, it is asserted that the larva never vanishes from the development, but is always present in more or less disguised form In all cases the adult or imago would appear to arise upon it just as is so obviously the case in the examples previously cited

In the complete paper the modifications of the process throughout the Metazoa would be considered, in this place generalities alone can be dealt with If the larva be laded with food yolk it becomes transformed into a more or less obvious *blastoderm*, upon which the *imago* or mature form takes its origin Certain of the larval organs—such as those of locomotion—may then disappear, but others, such as the larval excretory and nervous mechanisms (*e g*, *Hirudinea*, according to Bergh's researches, *Ichthyopsida* from my own work) would persist Considerations of space do not permit me to enter fully into details regarding Molluscan development The published work on this group furnishes one with useful material in support of my case; and the group is an interesting one in connection with this question of the relation of the larva to a blastoderm In the *Mollusca* one can readily find all gradations from cases in which the adult is gradually substituted for a pelagic larva (*Patella*), through those in which the larva is somewhat burdened with food yolk (*Buccinum*), to others, finally, in which there is a large yolk sac and a blastoderm, on which the adult form arises (*Cephalopoda*) Incidentally I may remark that it was the study of some *Buccinum*

larvæ (*Veligers* with large yolk-sac) three years ago, which first afforded me a key to the solution of the problem of the relation of the larva to food yolk.

The *Arthropoda* are an important group, for larval forms widely prevail, especially, as is generally admitted, in the lower forms

The nature of the *Nauplius* is too big a question for discussion here, but Dohrn's conclusion that it is a transformed worm larva (*i e* one with *Arthropod* characters) appears to me to represent the truth. Two of the laws governing developmental processes appear to be that larval organs may be transferred to the service of the adult, and (more usually) that adult organs may become larval, or, as thay may be termed, *adaptational larval organs* Numerous instances of both these could be cited, and the three pairs of appendages in the Nauplius furnish us with a case in point

In the development of *Mysis* there is an example of the con version of the *Nauplius* larva, typically represented in the allied *Euphausia*, into a blastoderm upon a yolk-sac

I venture to attach most weight to the application of the prin ciple to the *Vertebrata*, for it is there that my own work has chiefly lain, and it is undoubtedly the obstacles offered by the phenomena of Vertebrate development which have hitherto prevented the enunciation of the "law of development as an alternation of generations" Larvæ are so commonly encountered among the Invertebrata that the wonder is that no one has inquired why they are so rare, in any guise, in the *Vertebrata*

In this latter division of the animal kingdom it becomes necessary to approach the problem previously stated as to the fate of the larva when uterine development is initiated

It may firstly be noted that larval forms, equipped with many adaptational larval organs, are to be encountered in cases with complete segmentation and but little food-yolk, *e g Marsipobranchii, Ganoidei*, and most *Amphibia*, while a blastoderm on a yolk sac is characteristic of *Elasmobranchii*, *Teleostii*, and *Sauropsida*, in which a larva, according to the common accepta tion, would not be very obvious

In all these cases, however, larval organs can be proved to exist, and, most important of all, there is a well-marked larval nervous system, which, while not certainly known to persist in any adult form, has been proved to degenerate during the ontogeny of all the oviparous *Ichthyopsida* as yet studied This apparatus is certainly neither a part of the adult nervous system nor homologous with the latter For an account of this mechanism the reader may be referred to the papers cited below [1]

Among other larval structures referred to when reading the paper, the curious degenerating cells on the blastoderm of *Pristiurus*, to which Prof Van Wijhe once drew my attention, and the knob on the blastoderm of *Torpedo*, as shown in Ziegler's beautiful models of the embryos of this form, and as described by H E and F Ziegler in the *Archiv fur Mikroscopische Anatomie*, Bd xxxix p 85, deserve mention

The yolk sac viewed as part of the larva would require detailed and extended consideration

It is gradually broken down by some ferment action on the part of the so-called merocytes,[2] which may possibly represent degenerating cells of the larva Only towards the close of life in the egg-capsule does the yolk appear to be digested by the alimentary tract of the Elasmobranch In some reptiles, according to Hans Virchow, the remains of the yolk-sac would appear to be cast off

In the discussion on my paper, one speaker, a personal friend, hinted that I had been led to look upon the yolk-sac as part of the larva from having followed some stray ends of "larval nerve fibres" on to that structure I had to confess my regrets that at that time I was unable to lay claim to any such observation, indeed, that having cut my embryos of *Raja batis* without any part of the yolk-sac appended, it had never occurred to me that the fibres described might pass to the yolk-sac Quite recently it has been seen that at any rate some of the larval "subepiblastic nerves" of the *Anat Anz* paper *do undoubtedly make their way to the surface of the yolk sac, lying just beneath its epiblastic covering* That a further confirmation of my conclusions is to be found in this observation goes without saying

[1] J Beard "The Transient Ganglion Cells and their Nerves in *Raja batis Anat Anz*, 1892, pp 191–206, and also, "The Early Development of *Lepidosteus osseus*," Proc Roy. Soc London, vol. xlvi. 1889, pp 115–118

[2] It is to H E Ziegler that we owe most of our knowledge of the way in which these merocytes, in their own degeneration and death, cause the elements of the yolk to become fit for absorption and assimilation

Some three years ago, when considering the "Inter-relationships of the Ichthyopsida," at a time when this larval question was prominently before me as a fascinating puzzle, I thought that the larva disappeared above the *Ichthyopsida* I was led to this conclusion by reliance on the accepted belief that larvæ are only met with in aquatic animals, more particularly in marine forms, and by the apparent absence of a larval nervous system above the *Ichthyopsida* My recent studies and the work of Froriep and Robinson have taught me that this was erroneous

The larva never disappears, however much it may undergo degeneration

It may even be doubted if there are not traces of the nervous system of the larva in the ontogeny of the *Amniota*, for there appear to be certain observations of Froriep on reptiles which may admit of interpretation in this sense, and my friend, Dr Arthur Robinson, tells me that he believes he has found traces of it in certain Mammalian embryos In mammals, as will be seen, the larva must be regarded as an internal parasite, and like such it would yield up its chief organs Some remains of its nervous system may, however, persist, as I have proved to be the case in *Mustelus vulgaris*, where the larva is almost as parasitic as in the Mammal The *Amnion* of the higher Vertebrata is probably also a larval structure with analogies to the organ of the same name in *Insecta*, in the *Pilidium* development, &c , as Kennel had previously insisted It would appear to me to be a membrane conditioned by the way in which the adult is formed upon the larva

Another important larval structure is the yolk-sac placenta of *Mustelus lævis* and of many mammals

In the latter the importance of this organ during a long period of fœtal life has been proved by Hubrecht and Robinson

The yolk-sac placenta may be explained as due to the fixation of a parasitic larva ; indeed, in mammals the larva has become a fixed internal parasite in the uterus, and its mode of life, like that of all internal parasites, leads to great degeneration

In this connection it may be insisted that it would be con trary to all that we know concerning the effects of the parasitic mode of life to suppose that a form might become a fixed internal parasite, and subsequently becoming freed from its host, attain to a higher grade of organization Yet this is what we must believe to hold good, if the current views of mammalian development be accepted as correct From my standpoint, on the contrary, the larva may become a fixed internal parasite, and none the less there may arise upon it a more highly organized and, when fully developed, free living form, the Mammal

Witness must be borne to the circumstance that Muller, Kleinenberg, and Kennel have already recognized that in some few divisions of the Invertebrata the mature form always arises upon a larva

In such groups as the Echinoderms an alternation of generations is now an obvious explanation of the facts, and when so magnificent an investigator as Johannes Muller proved this nearly fifty years ago, one asks, in vain perhaps, why modern embryologists, like Korschelt and Heider in their otherwise admirable "Entwickelungsgeschichte," ignore it The "recapitulation theory," and the question concerning the nature of the mesoderm have overshadowed the fact and concealed the recognition of an alternation of generations. But the so-called "law of ontogeny" itself is no explanation of the riddles of embryology, at most the recapitulation hypothesis holds for the development of organs, not of organisms

So far as the facts are available, Metazoan development appears to me to be by means of an alternation of generations, in that from the fertilized egg there arises an organism, the larva, upon which, in one way or another according to the circumstances of each case, a new form, the adult or imago, takes its origin

In 1855 the veteran zoologist, P. J. Van Beneden, wrote — "*La génération alternante est un phénomène qu'il faut chercher à faire rentrer dans la loi commune de la reproduction et non pas laisser comme une exception dans la science*"

In this essay an attempt has been made for the first time to prove that it is "la loi commune de la reproduction" in Metazoa,[1] and in concluding I cannot do better than echo the beautiful aphorism of Gœthe, which in a similar connection has already been commented upon by Steenstrup and Von Baer :—

"*Die Natur geht ihren Gang, und was uns als Ausnahme erscheint ist in der Regel.*" J BEARD

[1] It is not assumed that all the phenomena classified as "alternations of generations" are alike in their nature.

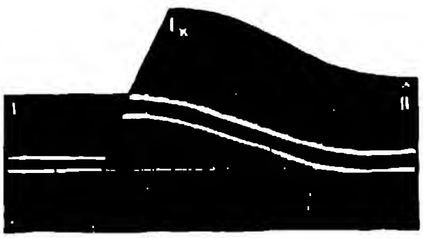
EXPERIMENTS ON FOLDING AND ON THE GENESIS OF MOUNTAIN RANGES[1]

Method of Investigation, Folding at Different Levels

DEFORMATION is represented in an exact manner, if we note the movements executed by certain points, and the position of these points before and after deformation. I divide the surface of sediments into squares (scale = 0 1m), and this division passes in vertical direction through the whole system, so that every stratum is divided into prisms or cubes of known dimensions and positions At every moment of deformation we may note the movements of any point or line, and the deformation of any square or prism Especially the deformations of the surface and of normal-profiles is important The position (orientation) of prisms must agree with the direction of pressure

FIG 1

FIG 2



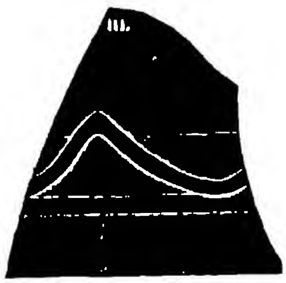


FIG 3 FIG 4

FIG 5 FIG 6

FIG 7 FIG 8

I employed in every case muddy material (clay, plaster of Paris) Example We note the position of prism I in Fig 1, and its position and deformation are noted in Fig 2, I is pushed forward and deformed into I x B = the "Basal plane," is parallel to the base or surface No = Normal plane, is situated vertical and in the direction of pressure L = Longitudinal plane, vertical and at right angles with No, agrees with extension of strata

N = normals, *i e*, perpendicular scale-lines

Explaining experiments The sediments I, II, Fig 3 (exp 203, clay with a layer of plaster) are subjected to lateral thrust The higher parts are more moveable and get deformed more than the lower strata

I goes to I x, it is compressed and elevated, II in contact with the wall is elevated a little (to x) The dark middle stratum I produces a flat fold In Fig 4 compression and elevation is more intensive The normals N (originally vertical lines) are deformed into curves

When at the surface very plastic material dominates (mud), the surface after deformation remains flat, whereas in the deeper parts intense folding may have taken place If we push a muddy mass, covered by plastic layers, the latter get folded, whereas the deep parts are only thickened

The movements and deformations of N (normal profile) are of especial importance

Fig 5 (exp. 292), paper between muddy strata The direction and deformation of normals show the typical movement of strata in each case

In Fig 6 a plastic layer (white) lies between muddy sediments After the deformation only the white layer is folded

In Fig 7 folding towards the deeper parts is more intense, but the muddy surface remains flat In all these cases strata get thickened The thickness measured in a fold-chain does not correspond to the original thickness The strata of the Appalachian Mts, having to day a thickness of 10 km in a certain section, originally had different dimensions If measured along the fold-limbs the number is by far too small, as here the strata are rolled out, in the synclines, on the contrary, strata appear much thicker than they were at the beginning

If plastic sediments are driven by their own weight, *i e* if they *glide* over an inclined plane against an obstacle.

[1] Extracted from *Geologische und Geographische Experimente*, by Dr E Reyer 1 Heft Deformation und Gebirgsbildung Leipzig, 1892 See also "On the Causes of the Deformation of the Earth's Crust," by the same Author. (NATURE, vol. xlvi. p. 224)

there occurs a deformation, as in the case of lateral pressure Deformation in the first case is greatest near the obstacle

Anticlinal Rupture, Pinch-folds, Squeezing, Pseudo-eruptive Processes

Pushing produces compression In the anticlines tension effects rupture In the fold-limbs plastic material is squeezed, rolled out, and pushed towards the clines (synclines or anticlines)

In the synclines of great dimension plastic material is pushed together and pinch-folds result

Passing over some of the experiments which illustrate the dislocations described by Heim and Margerie we come to more complicated examples

Figs 5-8 show "pinch folds" in very plastic material, which are spread and thrust over, so that they form a flat bottom in the syncline

Other experiments illustrate a pinch-fold with ruptural deformation Usually the intense deformation is confined to the district of the pinch-fold, in very plastic material and under variable pressure the stratum in every part gets greatly altered If we divide the strata into differently coloured prisms we see in each profile at once the deformation at every point Often deformation is so intense that we may denote it as kneading

The deformation shows how a vertical dyke gets influenced by folding

If a plastic stratum is inserted between rigid strata, the former often gets injected into ruptures of the rigid sediments, mud-dykes, pseudo eruptive processes (Reyer, "Theoret Geol" p 330)

Movements of Normals and of Waves Overthrust, Thrustplanes [1]

In a fold-chain the higher masses are pushed over the lowland, which does not yield sufficiently The result is an overthrust, often combined with pinch-folds, Fig 11 (exp 207) The inverted strata dip against the direction of the push

Fig 9 = original thickness of strata In Fig 10 folding begins Fig 16 last stage Normal measure at the base = 1 dm

In most cases shifting occurs between the strata, especially in upheaved strata, and we see gaping fractures, which cross a stratum and then follow again the planes of stratification (intrusive sheets)

The gliding movement may sometimes cause an extrusion

Fig 12 plan, and section Fig 13 (exp 278)

An overthrust-fold is nearly squeezed off (compare position of normals) An intense thrust generates ruptures, and the strata glide in the form of scales over the lowland

Fig 14 (exp 242) a fault in the base, over which a complex of sediments glides, the lowland sinks and the higher masses now push with increased force towards the plain ("Vorfaltung" *Suess*)

Squeezing and Tearing, Deformation of Included Masses.

Squeezing and tearing often occur in regions of great difference of tension or pressure. In the anticlines strata are torn, the direction of ruptures is converging towards the axes (axipetal direction), in the limbs there occur squeezing and tearing

[In the latter part of his memoir, Dr Reyer shows how his experimental methods may be applied to the explanation of such complicated questions as very complicated overthrust faults, the appearances presented when much folded and faulted strata are subjected to erosion, the occurrence of undisturbed tracts associated with much folded ones, and the formation of lake-basins]

E REYER

FIG 9

FIG 10

FIG 11

FIG 12

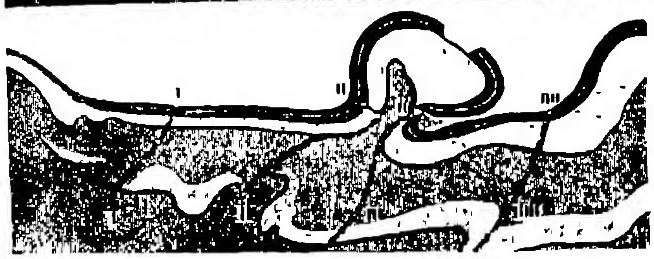


FIG 13

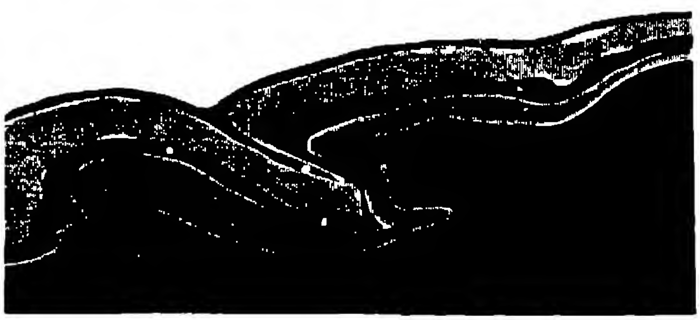


FIG 14

[1] Compare the excellent experiments of Forchhammer (Sanddruck, 1883), Cadell (NATURE, vol xxxvii, p 489). Those authors experimented with powder material, whereas I operate upon plastic materials.

GALILEO GALILEI AND THE APPROACHING CELEBRATION AT PADUA.

ALTHOUGH Galileo began his career as a teacher in Pisa, and occupied for three years the Chair of Mathematics there, and was inscribed until his death in the list of the teachers of that University, nevertheless the University of Padua was the one to which from the beginning he had aspired, and in which he exercised with the greatest efficiency his powers as a man of science and

a lecturer Now the University and citizens of Padua desire to celebrate the tercentenary of the day on which he delivered his first lecture

When elected by the Venetian Republic to the Chair of Mathematics on September 26, 1592, he asked to be permitted to delay the beginning of his lectures in order to prepare his inaugural oration, and to attend to some domestic duties which required his presence in the country, thus it was December 7 when he first occupied the professorial chair This date is confirmed by a letter, written from Padua to Tycho Brahe, and published by the latter in his celebrated "Astronomiæ Instauratæ Mechanica," and Galileo's chair is amongst the most precious relics preserved by the ancient and famous University A week later he began regular lectures, which he continued to give for eighteen years

In the ancient archives of the University the rolls of the time when Galileo taught are in a great measure preserved, and from these we learn that, in accordance with what was prescribed by the statutes, he alternated astronomical teaching with that of Euclid and the mechanical questions of Aristotle

The didactic activity of Galileo was not altogether confined to public teaching, it was extended, in conformity with the prescriptions of the statutes, to private teaching How much influence he exercised in this manner is easily seen from his autographic records which have come down to us The importance of these private lessons will appear all the greater when we reflect that they dealt not only with the subjects discussed in public, but with matters connected therewith From contemporary documents we perceive with what precision all such subjects were taught by Galileo the use of the geometrical and military compass, fortifications, Euclid, perspective, mechanics, geography, arithmetic, geodesy, and cosmography As to the students, they were for the most part foreigners, namely, Poles, Germans, Danes, French, and Flemings In the lists of private scholars we find an "illustrious Englishman"—very probably Richard Willoughby, who was vicar of the University of Law and Councillor of the English nation In his honour a stone on the wall of the University is still preserved, and, a still greater honour, a copy of the famous "Difesa" is dedicated to him with Galileo's autograph Two Scots should also be particularly mentioned as amongst Galileo's pupils, these were John Wodderborn, who wrote a confutation of the libel of Horky against Galileo, and dedicated it to Henry Wotton, the English ambassador at Venice, also Thomas Segget, Councillor of the Scots nation, in whose "Album Amicorum," now in the Vatican library, there is also an autograph of the great philosopher It was Seggett who received from Kepler a copy of Galileo's "Sidereus Nuncius," and who in the appendix to the "Narratio" of the same Kepler published the epigrams containing the famous "Vicisti Galilaee."

Besides the ordinary public and private lectures, Galileo held in the University some special public lectures, of which we may mention those upon the new star of October, 1604, and those in which he announced his astronomical discoveries.

Every one tried to render Galileo's stay in Padua as pleasant to him as possible His freedom in teaching was absolutely complete, and the strong arm of the Venetian Republic defended the professors of the University from the power of Rome In Padua, from the first, Galileo was received with the greatest kindness, he found many faithful friends both in Paduan society and among the Venetian patricians. His salary was repeatedly increased, so that, after the presentation of the telescope, it rose to thrice the amount conceded to his predecessors Galileo came to Padua at the age of twenty-eight and remained there during the eighteen years which were the best of his life, those in which he showed the greatest scientific fertility, and in which he prepared the way for all his future labours We have now reached the completion of the three centuries since Galileo began his teaching in Padua, and the University naturally considers that the anniversary should not be allowed to pass without honourable notice

It is fitting that a celebration relating to the work of a man of science of the highest rank should have a truly national character The King of Italy has therefore associated himself with the movement, and the Universities, the polytechnic institutions, and the most celebrated academies of the world have been invited to send delegates Already the Universities have in great number responded to the appeal Mr J Norman Lockyer will represent the Royal Society of London, and Mr George Howard Darwin the University of Cambridge

As once scholars from every part of Europe came to Padua to hear the celebrated master, so now from every part of Europe the most celebrated come to honour his memory

ANTONIO FAVARO
(Director of the National Edition of Galileo's Works)

A NEW METHOD OF TREATMENT FOR CHOLERA

IN the *Times* of the 18th inst there appears an account of a new method of treatment for cholera which, should it ultimately be proved to be founded on accurate observation and well-authenticated cases, gives results seldom, if ever, obtained by any other method during the height of a cholera epidemic Before criticizing this new method let us see what are its essential features

In cholera there are two main, and evidently different, indications for treatment it is usually maintained that the primary etiological factor in the disease is the "Comma" bacillus, which under certain conditions is enabled to live and multiply in the human intestine There, living as an anærobic organism, it thrives especially well if, through inflammatory reaction, certain of the albuminous constituents of the blood and lymph are thrown into the intestinal tract From or in this favourable culture medium it is enabled to produce a most virulent and readily diffusible poison, which has not only a powerful local action, but also a power common to these micro-organismal poisonous products, of acting on the nerve centres In this way, so long as the bacillus remains alive, the supply of exudation into the intestine is kept up by the local irritant action of the poison, this being accompanied by a rapid abstraction from the blood of its watery elements, and at the same time a supply of the powerful "toxine" is maintained and diffused throughout the body Except in very severe cases, where the paralyzing effect of the toxine on the individual cells of the tissues is extremely rapid and well marked, an effort is made by these cells to destroy the bacilli and by the special secretory cells of the intestine, kidney, and other excretory organs to eject this poison from the body Not only so, but if the poison can, like the bacillus, be confined to, and eliminated directly from the intestine, the bacillus soon becomes unable to live, and as it multiplies and produces its toxines it is killed off by the various agencies that are conspiring to destroy it.

Up to the present all conceivable methods of treatment have been tried, and almost every drug has been pressed into the attack on cholera, but the most successful and rational attempts have been those in which the destruction of the bacillus and its poison have been aimed at, especially if this has been accompanied by the use of means for promoting the rapid secretion

and excretion of the poison from the body Here as in the specific infective diseases generally our want is an antiseptic that will help to kill bacteria, directly or indirectly, and that will not damage, but will even give healthy stimulation to the tissue cells

In this new method of treatment it appears to be claimed that in certain periodate salts we have substances which act not only on the bacillus (as bactericides) in the alimentary canal, but also directly on the "toxines," bringing about their oxidation into less complex and more stable non-poisonous substances, which can be readily excreted by the kidneys, or may be got rid of directly from the intestineal tract It is also claimed, but apparently with very little reason, that the periodate salts have some direct action on the nerves, this, however, is mere conjecture, and the arguments offered in support of this hypothesis are far from convincing In the *Times* article it is stated that "there are two principal drugs employed—the crystals of periodate" (of what?) "which are powdered, and a periodate of iron The last-named is used in such cases as demand an extra strong nerve or cardiac stimulant treatment, and where there are severe neuralgic symptoms The first is used in several ways first as a powder to disinfect the alimentary tract, second as a plain water solution, prepared by boiling copiously, and used as a beverage by patients to wash out the stomach in severe vomiting, which abates as soon as the walls of the stomach begin to absorb the fluid, whereby the nervous energy is stimulated, in from two minutes to an hour or two, for transfusion under the skin, and, in cases of collapse, into a vein, for restoration of the suspended circulation of the blood, third, an acid solution of the powdered crystals of much greater strength than the plain watery preparation is found to stimulate the liver and kidney and gall bladder, promoting a free secretion of bile"

It is supposed that by this treatment the body is flushed and sweetened as it were, and so far the treatment would be rational enough could it be thoroughly carried out Far greater reliance might have been placed on the evidence put forward had the initiator of this treatment been content to place on record facts, instead of attempting to formulate a theory for everything, as his theories whilst giving evidence of his undoubted enthusiasm, indicate only too plainly that where he gets beyond the use of the test tube he is compelled to draw largely on his imagination for many of his facts and most of his explanations

As regards the percentage of recoveries mentioned, it must be remembered that towards the end of an epidemic the fatal cases always form a much smaller proportion of the total cases than during the earlier stages of the outbreak. The people most susceptible to the attack of the disease, *i e* those with damaged hearts, kidneys, and lungs, have already succumbed, the weaklings have been cleared out of the way, and but the fittest and comparatively well-nourished remain Attempts have been made to ameliorate the wretched surroundings of those most prone to take the disease, the poor are better fed and better able to withstand the ravages of the cholera organism, the "cholera fright," at first a most potent factor in the preparation of patients for cholera, has to some extent subsided, the cases are not only much less numerous, but they are of a milder type and a less fatal character Then, too, after the first few batches of patients come in (amongst which the mortality is always extremely high) there ensues a kind of panic amongst the authorities, and the treatment consists of little more than placing the patient in a ward along with others suffering from the same disease, in order to get them away from their healthy companions; other treatment is for long of the most meagre description, and it is only when hygienic conditions have been improved, mode of transport organized, and hospital accommodation arranged that the medical authorities have time to devote to the treatment of individual patients As soon as patients do obtain such individual treatment and attention the percentage of fatal cases rapidly declines

These periodates, analogous salts to the chlorates, are apparently the direct heirs to the qualities that at one time were ascribed to the chlorates, for which it was claimed that they had great power of supplying oxygen for the transformation of poisonous products in the body It was found, however, that these chlorates when administered in large doses made their appearance in the secretions in a very slightly altered condition, not only so, but they exerted an exceedingly deleterious effect on the blood, reducing the hæmoglobin to methæmoglobin, and stopping the respiration and bringing about a fall of the blood pressure to zero This periodate, which is apparently extremely insoluble except in acids, may be tolerated in small doses, but its physiological action, especially when administered in large doses, can scarcely yet have been studied

As to the action on the kidneys through the nervous system, we have as yet little or no evidence that there is any direct action of the nerves on the secretion by the kidneys except through the vaso-motor system It is usually maintained that the suppression of urine in cholera is due primarily to the extremely low general blood-pressure owing to the rapid abstraction of the fluid elements of the blood brought about by the passage of watery stools, but also in part to the irritative action on the secreting cells of the kidney of the cholera toxines, as a result of which secretion is more or less paralyzed In order to overcome this stoppage of excretion by the kidneys, the practice of injecting warm normal saline solution has in recent epidemics been practised with some success, especially when boldly and repeatedly carried out This treatment has the additional advantage that it not only supplies fluid to the parched tissues, but also increases the volume of blood on which the heart may contract and helps to wash away the specific poison It is utilized to a very great extent in the new method described in the *Times*, but whether the periodates are better than common salt as a substance with which to raise the specific gravity of the warm water, yet remains to be determined As yet the details supplied are far too meagre to allow of any definite opinion as to the value of this periodate treatment being arrived at

It is fortunate that we have no cholera epidemic with us at present, otherwise we should have a right to complain that the *Times* has been made the medium through which what must be a very imperfect—and certainly from a physiological point of view—incorrect theory, has been presented to the public, and it will be well to await the exact accounts of those who have been entrusted with the carrying out of the treatment in the wards of the Seamen's Hospital, and the results of fuller chemical physiological, and therapeutic experiments, minutely detailed and recorded, before we allow ourselves to be buoyed up by hopes which, previous experience has taught us to fear, may be very summarily and completely dashed We hope that we may have no opportunity of testing the value of this new treatment in England, but there is too much reason to fear that, abroad, opportunities in abundance will be afforded during next spring and summer.

How much of the success obtained in Hamburg is to be ascribed to the factors above mentioned, and how much to the careful treatment and nursing of confident medical men, inspired by the enthusiasm of the "inventor" or promoter of the "periodates," it is difficult to say, and we shall await with interest, but with well disciplined and chastened expectation, the report of the German doctors mentioned in the *Times* on the results of their observations

NOTES

MR W H PREECE, F R S, has been appointed engineer-in-chief and electrician to the Post Office

A CIVIL LIST pension of £75 per annum has been granted to Mrs Dittmar, widow of Dr William Dittmar, F R S, Professor of Chemistry in Anderson's College, Glasgow, in consideration of her husband's distinguished services

THE Linnean Society, at its ordinary meeting on the 17th inst, adopted an address of congratulation to the Rev Leonard Blomefield on the completion of the seventieth year of his Fellowship of the Society, he being the father of the Society, having joined it on November 19, 1822, and being now in the ninety-third year of his age At the time when Mr Blomefield (then Jenyns) became a Fellow of the Linnean Society, it was still under the presidency of its first President, Sir J E Smith, he was also an original Fellow of the Zoological Society, and is one of four survivors of the founders of the Entomological Society He joined the British Association in the second year of its existence Mr Blomefield was Mr Darwin's senior at Cambridge, was closely associated with him in his zoological researches until Mr Darwin's death, and was one of his most frequent correspondents His early bias towards the study of nature was due to his reading White's "Natural History of Selborne" while at Eton This was then a very scarce book Having borrowed a copy of it from a friend, being uncertain whether he should ever see it again, he copied the whole of it in manuscript with his own hand The address of congratulation was moved by Sir William H Flower, seconded by Mr St George Mivart, and acknowledged by the Rev Geo Henslow, a nephew of Mr Blomefield

THE following gentlemen have been appointed to form the Fishery Board for Scotland —Mr Peter Esslemont is Chairman, the other members being Mr John Guthrie Smith, Sheriff of Aberdeen, Kincardine, and Banff, Mr George H Thoms, Sheriff of Caithness, Orkney, and Shetland, Mr Dugald M'Kechnie, Sheriff of Argyle, Mr William Boyd, solicitor, Peterhead, Mr James Johnston, fish curer, Montrose, Mr William Anderson Smith, Ledaig, Professor Mackintosh, St Andrews, and Mr J Ritchie Welch, St Andrews

THE Royal Microscopical Society will hold a *conversazione* in the Banqueting Saloon, St James's Hall Restaurant, on Wednesday, November 30, at 8 p m

THE annual dinner of the Institution of Electrical Engineers was held on Friday evening at the Criterion The president, Prof W E Ayrton, F R S, was in the chair Responding to the toast of the Learned Societies (proposed by the chairman in a humorous speech), Prof G F Fitzgerald said that learned societies were never more flourishing than they were now The co-operation of theory and practice had been the fruitful parent of nearly all the advances of the present generation We had such enormous stores of energy at our service that almost immeasurable prospects were open for the material improvement of man's estate Mr Latimer Clark (past president) proposed "The Engineering Societies." He said these societies were in danger of being overlooked They first perfected the steam-engine, then improved manufacturing implements, then the steam-boat. The engineering societies had done much more to promote the great prosperity of this country than the politicians who had so wickedly usurped the greater part of the credit Dr. W Anderson responded The Chairman then proposed "Our Guests," with which he joined the name of Mr Mundella, President of the Board of Trade, who exercised a sort of parental supervision over them all No doubt sometimes there was a little disposition to grumble, as children did occasionally, at the form in which that fatherly affection displayed itself But, whatever their feelings about the Board of Trade, there was no doubt about their feelings with respect to its president Mr Mundella, in response, said that, whatever grievances the engineers might have against the politicians, his withers were unwrung The Board of Trade might have given the electrical engineers some trouble if so, it was not due to him Mr Latimer Clark had complained of the appropriation of all the credit of material progress by the politicians Let them halve the difference The politicians had, at all events, appointed Dr Anderson He was speaking to a comparatively young institution, but it was to one which was growing more and more and would advance to still greater degrees of greatness The Board of Trade owed much to the electrical engineers, who had devised systems and methods of the utmost value He believed we were now at the outset of a great advance in the science of electric lighting Progress would be assured when they could assure shareholders of a reasonable dividend Two millions had already been expended in the metropolis, and we might soon hope to overtake the United States and Continental countries, which were, he feared, still to some extent in advance of ourselves The Board of Trade had no desire to hamper the progress of electricity by needless rules, and hoped that in this, as in all other branches, science would go on its beneficent course untrammelled by any unnecessary regulations Sir James Sivewright, Commissioner of Public Works, Cape Colony, proposed "The Institution of Electrical Engineers," to which the president briefly responded

WE print elsewhere an abstract of a most interesting paper on stability and instability of viscous liquids, read before the Royal Society, by Mr A B Basset It presents in a new way the various problems involved in the calming effect of oil poured on troubled waters

PROF J E HUMPHREY, of the Massachusetts Agricultural Experiment Station, is about to visit Jamaica for the purpose of making a study of the algæ and fungi of that island

THE weather during the past week has, upon the whole, considerably improved, it has been mostly fine in the southern and eastern parts of the kingdom, but less settled in the west and north Temperature has been decidedly lower, and over the central and eastern parts of England sharp frosts have been experienced The distribution of pressure has been generally cyclonic over these islands, but over the west of Europe the anticyclonic has still held its ground The eastern portion of England has been brought under the influence of both high and low pressure systems, being situated about mid-way between the cyclones which have skirted our western coast, and the anticyclone over western Europe. These conditions were accompanied by very quiet weather, with a good deal of local fog On Sunday a depression, which passed along the Irish coast, caused southerly gales on that and following days in the south of Ireland and the English Channel, with very heavy rainfall in Ireland, the amount measured at Roche's Point on Monday and Tuesday mornings was nearly 2 5 inches Towards the close of the period the European anticyclone was spreading westwards, and the barometer was high and uniform over Great Britain For the week ended the 19th instant the official reports show that the rainfall was considerably in excess of the average over Ireland and the south of England From the beginning of the year the deficiency in the latter district is 2 3 inches, and in the south-west of England 8 4 inches, or more than 23 per cent of the average amount Bright sunshine was

again very deficient over the whole of England and Scotland, in the south-west of England the duration only reached about 2 per cent of the possible amount

THE *Pilot Chart* of the North Atlantic Ocean for November contains some interesting reports of the drift from some portion of the coast of the American continent to mid-ocean of a mass of forest growth resembling a floating island It was first seen on July 28 in lat 39° 42′ N, long 64° 20′ W On September 19 the *Roman Prince* reported it in lat 45° 29′, long 42° 39′ as "a clump of bamboos about 30 feet in diameter and 20 feet high" Between these two dates the little island drifted more than 1000 miles in an E N E direction The month of October was very stormy in the North Atlantic, from the tracks laid down on the chart several of the storms seem to have moved along very abnormal tracks, and this fact has probably some connection with the very severe weather experienced in this country In the early part of the month a hurricane formed in very low latitudes, and passed over Trinidad on October 6 into the Gulf of Honduras, and possibly into the Gulf of Mexico It is unusual for a hurricane to occur in such low latitudes in the North Atlantic Very little fog was reported, and no ice south of the 50th parallel

SEVERAL shocks of earthquake have been felt lately in the island of Ponza On the evening of November 16, according to a Reuter's telegram, the walls of several houses were slightly cracked by one of these shocks, which was accompanied by subterranean rumblings No one was hurt, but alarm spread rapidly among the inhabitants, half of whom took refuge on small vessels lying along the coast, while the remainder encamped on the beach

THE *Age Herald* of Birmingham, Alabama, gave on October 28 an account of a great meteor which had been seen on the previous day to pass over that city and disappear in a south-westerly direction. We learn from the Mobile *Daily Register* of October 29 that at Gadsden a brilliant meteor was seen at the same time, that is, between five and six o'clock on the afternoon of October 27 It passed near the zenith Two young men employed in the *Daily Register* office at Mobile saw at the same hour in the afternoon a bright meteor in the north-west It was about 45° above the horizon When it neared the western horizon it explòded like a sky rocket

A MALE gorilla (*Gorilla gina*) has lately been acquired by the Berlin Aquarium He is larger than any gorilla that has yet been brought to Europe. He is supposed to be eight or nine years old, and was for six years in the possession of a chieftain on the Gaboon Captain Clarke brought him to England. The *Naturwissenschaftliche Wochenschrift*—which estimates the value of this "splendid animal" as not less than 10,000 marks—says he has not yet shown any very friendly feeling for man.

IT appears from a report issued by the Board of Trade that the examinations and comparisons of the Parliamentary copies of the Imperial standards show that no measurable change has taken place in the length of the Imperial standard of measure The Imperial standard pound weight appears, however, by comparison with the Parliamentary copies of the Imperial standard pound, to have decreased in weight since it was restored and legalized by the Standards Act of 1855. The amount of diminution in the weight of the Imperial standard pound would not be appreciable in trade, and had probably arisen before the year 1872, but the Board of Trade are taking into consideration the question of restoring this standard in the manner provided by Section 6 of the Act of 1878.

THE South Australian Government has issued a full report of the proceedings of the Rust in Wheat Conference during its third session, held in March of the present year Among the resolutions adopted by the Conference was one to the effect that a practical system for the production and distribution of rust resisting wheats suitable to different districts should be immediately established, and that this system—subject to modifications needed by each colony—should be conducted on the following lines —A central station for each colony for the preliminary testing of new wheats introduced into the colony, for the production of new varieties by cross fertilization and by selection, and for the distribution of suitable wheats thus obtained to representative districts of the colony, to be there subjected to a sufficient test, and, if necessary, fixed in their characters by farmers and others competent for the work, and that such wheats as pass satisfactorily this test should then be distributed to the farmers around in such a manner and by such agency as would be most suitable to the conditions of each colony The Conference will meet at Brisbane in 1894 It is hoped that in the meantime the various colonies will publish the results of the experiments which are to be carried on during the coming year.

MR XANTHUS SMITH, a well-known American photographer, has formed a high opinion of some of the work done in photography in England "There is no doubt," he has lately said, "that the English photographers excel us Americans in landscape photography, and mainly for two reasons, the first being their appreciation of atmospheric effects, which is no doubt a result of their moist climate, and second, the extreme pains which they are willing to take in order to secure an effective picture" The *Photographic News* considers it 'quite a comfort to record a statement like this, not because it praises English work, but because it acknowledges the pictorial effect often obtainable from a misty atmosphere" "Those who are ignorant of the subject," adds our contemporary, "invariably credit the alleged superiority of foreign photographs to the greater clearness of the atmosphere which is supposed to prevail outside the confines of Great Britain"

AN interesting case of a wild rabbit living in an almost tame condition is recorded by Helen J. Murray in the current number of *Nature Notes*, the Selborne Society's magazine Mrs. Paul, a fisherman's wife, living in a hut between Ardnahein Farm and the mouth of Loch Goil, deserves the credit of having achieved this result. The rabbit was brought in when very young by a cat, and reared by Mrs Paul, from whose hand it still feeds It now spends part of its time in the woods, and part on the low sloping roof of the hut among the pigeons, or at the door among the fowls It is shy in the presence of strangers, but quite friendly to the fisherman's wife

IT seems that since the appearance of the Russians at Tashkend a beginning has been made there in the cultivation of the better kinds of tobacco According to the *Journal of the Constantinople Chamber of Commerce*, quoted in the Board of Trade Journal, first trials were made by a commercial firm trading between Persia and China. The satisfactory result of this cultivation, due to the favourable atmospheric conditions and to the fruitful qualities of the soil, attracted many Russian imitators, and very soon the native population followed their example, so that the area of land devoted to the cultivation of tobacco now comprises sixty-three deciatines, and it is expected that it will not stop at that point

THE new number of *L'Anthropologie* contains an interesting article by M. Emile Cartailhac, on the Stone Age in Egypt. It is the first of a series of papers on the stone age in Africa. English readers will be glad to see that in this instalment M Cartailhac does ample justice to some of the discoveries of Mr Flinders Petrie, the value of whose work has also been fully

recognized lately in the German periodical *Globus*. Another good paper in *L'Anthropologie*, by M Louis Siret, deals with the end of the Neolithic epoch in Spain.

PROF McINTOSH's paper on the Scottish Fisheries, to which we referred at the time it was read at the Edinburgh meeting of the British Association, has now been issued as a pamphlet by Messrs John Leng and Co, Dundee The paper presents a clear and interesting account of the Scottish Fisheries, chiefly in their scientific aspects, during the decade 1882 92

THE Cartwright Lectures, 1892, delivered by Dr Henry F. Osborn, Professor of Biology in Columbia College, have been reprinted from the *American Medical Record* They deal with "present problems in evolution and heredity" In the first lecture Prof Osborn discusses the contemporary evolution of man, in the second, difficulties in the heredity theory, in the third, heredity and the germ cells

THE Kansas University has started a "Quarterly," which is to be maintained as a medium for the publication of the results of original research by members of the University In the second number, which we have just received, Mr E H S Bailey has an interesting paper on the Great Spirit Spring Mound The Great Spirit Spring is in Mitchell county, Kansas, on a conical limestone mound 42 feet high, and 150 feet in diameter at the top The pool itself is a nearly circular lake about 50 feet in diameter, 35 feet deep, and the water rises to within a few inches of the top of the basin There is a level space on all sides of the spring so wide that a carriage can be readily driven round it Within about 200 feet of the mound is a limestone bluff, which rises perhaps 20 feet above the level of the spring Mr Bailey suggests that the mound may have been made by successive deposits from the spring Although the mound is plainly stratified, this need not, he thinks, interfere with his theory, as the water may have been intermittent in its flow The rock is very porous, and on being ground to a thin section is shown to be concretionary in structure. It is of just such a character as might have been built up by deposition from the water, as it contains the least soluble constituents of the water The process of solidification would be assisted by the silica in the water, forming insoluble cementing silicates An analysis given by Mr Bailey shows that there is abundant silica in the water for this purpose

A PAPER presenting a revision of the species of Coryphodon, by Charles Earle, printed originally in a Bulletin of the American Museum of Natural History (vol iv, No. 1), has now been issued separately The recent expedition sent out by the American Museum of Natural History to the Bad Lands of the Wahsatch formation of Wyoming was successful in procuring some valuable Coryphodon material The entire collection was placed in Mr Earle's hands for identification and study He has been surprised by the large number of species which have been proposed, and finds upon studying and comparing the types that a great reduction in the number of species should be made.

WITH a view to determining the phylogenetic position of mammalian hair, Herr Maurer has recently been studying the sense organs of the skin, feathers, and hairs, and their mutual relations (*Morph Jahrb*) His researches render more evident the profound difference that exists, both in early development and in later behaviour, between mammalian hair and feathers Morphologically, they are to be regarded as quite different organs. Are the hairs, then, *sui generis*, or may they be brought into relation with other epidermis-forms? From studying the lower vertebrates, Herr Maurer considers that the skin sense organs of amphibia afford the ground on which hairs are developed. The complex relations of the root sheath of the hair allow thus of an easy explanation Further, as to the relation of mammalia to other vertebrate groups, as indicated by forms of integument, Herr Maurer is of opinion that mammals become separated from Sauropsida and draw closer to amphibians, thus confirming a view based on other points of organization

FLUORSULPHONIC ACID, $SO_2(OH)F$, has been isolated by Prof Thorpe and Mr Walter Kirman in the laboratory of the Royal College of Science, South Kensington, and an account of their experiments was given at the opening meeting of the Chemical Society, held last Thursday evening When liquid hydrogen fluoride is brought into contact with sulphur trioxide a violent reaction occurs The product of this reaction, provided any great rise of temperature is prevented by extraneous cooling, is now shown to be fluorsulphonic acid, a liquid behaving in many respects like the chlorosulphonic acid, $SO_2(OH)Cl$, discovered by Prof Williamson The preparation of fluorsulphonic acid was effected in the following manner —A quantity of sulphur trioxide was first distilled from a glass apparatus into the receiver of a distillation apparatus constructed entirely of platinum A quantity of the anhydrous double fluoride of hydrogen and potassium, HF KF, more than sufficient to furnish enough hydrogen fluoride to combine with all the sulphur trioxide, was then placed in the retort of the latter apparatus, and the retort connected with a long condensing tube surrounded by a freezing mixture of ice and crystallized calcium chloride. The receiver containing the sulphur trioxide was finally adjusted to the condensing tube, and was likewise surrounded by a similar freezing mixture. Upon heating the retort the double fluoride of hydrogen and potassium was dissociated, and pure hydrogen fluoride (hydrofluoric acid) distilled over into the receiver and reacted with the sulphur trioxide The excess of hydrogen fluoride was subsequently removed by means of a current of dry carbon dioxide, the receiver and its contents being warmed to a temperature of about 30° during the process The fluorsulphonic acid thus prepared is a colourless mobile liquid, which possesses an extraordinary affinity for water, reacting, in fact, with that liquid with almost explosive violence It fumes when exposed to air, and possesses a specific mildly pungent odour quite different from that of hydrofluoric acid It may be distilled, with but slight decomposition, in a platinum apparatus, its boiling point (corrected) being 162°·6 The latter constant was determined by use of a specially constructed platinum distillation apparatus, in the neck of the retort of which was fitted a small platinum tube containing a little mercury, and in which the thermometer was immersed during the process of distillation, in order to protect it from the powerfully corrosive action of the vapour The error introduced by the use of this arrangement was very slight, and was determined by distilling liquids of known boiling points Considerable interest is attached to the relatively high boiling point of fluorsulphonic acid, inasmuch as it is several degrees higher than that of chlorosulphonic acid, which boils at 155°·3 It would appear as if this fact is in some way connected with the relatively high boiling point of hydrogen fluoride itself (19°), as compared with that of hydrogen chloride, which, as most people are aware, is gaseous down to comparatively low temperatures The main products of the decomposition which occurs to a slight extent during distillation, are most probably sulphuric acid and sulphuryl difluoride, SO_2F_2, which latter compound Prof. Thorpe and Mr. Kirman shortly hope to isolate by a method similar to that by which Behrend prepared the analogous sulphuryl dichloride, SO_2Cl_2.

THE additions to the Zoological Society's Gardens during the past week include two Maholi Galagos (*Galago maholi*) from South Africa, presented by Mr Luscombe Searelle, a Feline Genet (*Genetta felina*), a White-eared Scops Owl (*Scops leucotis*), a Tawny Eagle (*Aquila naevioides*) from Matabeland, South

Africa, presented by Mr. B B. Weil, two Jackdaws (*Corvus monedula*, white var) British, presented by Mr Harding Cox, F Z S, eighteen Deadly Snakes (*Trigonocephalus atrox*) from Demerara, presented by Mr J J Quelch, C M Z S; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr J Pettitt, a Blue and Yellow Macaw (*Ara ararauna*) from South America, deposited, four Lapland Buntings (*Calcarius lapponicus*), twelve Snow Buntings (*Plectrophanes nivalis*) European, six Cirl Buntings (*Emberiza cirlus*) British, purchased

OUR ASTRONOMICAL COLUMN

THE NEW COMET — The following observations of the "Comet Holmes" are communicated to the *Comptes rendus* by M Bigourdan, Paris Observatory —

Date	Paris Mean Time h m s	App R A h m s	App Decl ° ′ ″
Nov 9	7 59 25	0 45 55 51	+ 38 19 25 8
9	9 28 6	0 45 53 46	+ 38 19 4 5
13	10 20 1	0 44 3 76	+ 37 53 6 2
13	10 46 32	0 44 3 17	+ 37 52 58 7
13	10 55 43	0 44 3 01	+ 37 52 57 9
13	11 10 49	0 44 2 71	+ 37 52 50 6
13	11 25 6	0 44 2 33	+ 37 52 48 6

On November 9 the comet was a large and bright nebulosity, perfectly round, and 5′ 5 in diameter It showed a central diffused nucleus, 10″ in diameter A rather brighter portion of an approximately elliptic form appeared to extend from the nucleus in the direction $p = 127°$, its axes being 1′ 5 and 30″ respectively On November 13 the comet was only seen intermittently It was 8′ in diameter and nearly round The nucleus no longer occupied the centre, but had shifted towards the preceding portion The elliptical region was 2′ by 30″, and in the direction $p = 116° 8$ To the naked eye it was easily visible, being as bright as the Andromeda nebula near it, but less easily distinguished, owing to its smaller apparent size.

The most recent elements and ephemeris have been obtained from observations made on November 9 at Karlsruhe, November 10 at Rome, and November 11 at Gottingen, and are given in *Astronomische Nachrichten*, No 3128, from which we make the following extract —

Elements

T = 1892 August 15 779 M T Berlin

$$\left.\begin{array}{l}\omega = 300^\circ\ 2'\ 7 \\ \Omega = \ \ 11\ 25\ 9 \\ i = \ \ 27\ 34\ 0\end{array}\right\}\text{ M Aequator, 1892 0}$$

$\log q = 9\ 92222$

Ephemeris for 12h Berlin M Time

1892	α	δ	log r	log Δ
Nov 17	0h 43 5	+ 37 32	0 2562	9 9734
,, 21	43 7	11	0 2688	0 0071
,, 25	0 44 7	+ 36 50	0 2810	0 0387

The comet can be easily picked up with a small telescope by knowing that it lies in a line joining the stars β and θ Andromedæ, about one-third of the distance from β

MOTION IN THE LINE OF SIGHT — The transformation of the great reflector of the Paris Observatory for the purpose of adapting it to the spectroscopic determination of radial velocities is described by M H. Deslandres (*Comptes rendus* 20) Instead of having a flat mirror at 45°, a collimator was placed in the optic axis itself, and movable along it. The rest of the spectroscope, which contained three flint prisms and a camera, was enclosed in a rigid steel box attached to the upper ring of the telescope. In order to control the motion, the plates forming the slit were made of polished steel and slightly inclined, so as to throw an image of the sky down into an auxiliary telescope inside the tube, which was provided with a reflecting eye-piece. Thus the observer below, standing near the great mirror, was enabled to keep the star well on the slit. With this arrangement, spectra of stars down to the 4th magnitude could be obtained, 12 cm long, in two hours. In the blue portion a displacement of 0·005 mm. indicated a velocity of 3 6 km per second The lines whose displacements were measured were those of hydrogen, calcium, and iron. 250 stars are within reach of the instrument For α Aurigæ, with a comparison of 30 lines, the velocity was + 43 5 km β Aurigæ is a spectroscopic double with velocities, on February 5, of − 84 km and + 97 km. Venus, on April 12, had an actual velocity of 13 55 km That indicated by the negative was 15 km

"HIMMEL UND ERDE" FOR NOVEMBER — The current number of *Himmel und Erde* contains many astronomical articles of interest "The Heat in August, 1892" is the subject of an article by Prof W J van Bebber In this he brings together all the statistics of the temperature readings during the interval between August 11 and 25, and shows by weather charts the general state of the weather, such as wind, barometer, &c The following few values, showing the highest temperatures recorded and extracted from the table mentioned above, may be of interest —

Place	Aug	Temp Fahr	Place	Aug	Temp Fahr
London	23	80° 6	Cassel	17	96° 8
Oxford	23	77 0	Grunberg	19	102 2
York	23	73 4	Karlsruhe	17	96 8
St Petersburg	26	86 0	Bamberg	18	100 4
Stockholm	26	82 4	Constantinople	21	100 4
Paris	18	95 0	Madrid	16	107 6
Biarritz	16	107 6	,,	17	107 6
,,	17	104 0	Rome	17—21	93 2
Brussel	18	95 0	Lagouat	23	105 8

Dr J Scheiner, on "Astronomy of the Invisible," deals with the discovery of the dark companions of Sirius and Procyon. He commences with an historical sketch of the study of the proper motions of the fixed stars and leads up to the most modern observations describing the results obtained with regard to Sirius and Procyon Prof Barnard, with the help of two excellent woodcuts, explains the working of the great Lick refractor To prepare the instrument for micrometric work, he says five minutes is required, but for photographic work ten minutes is necessary, as a photographic correcting lens has to be adjusted to compensate for the difference between the photographic and optical focus, the large spectroscope absorbs nearly half an hour's work before it is ready for observation

OBSERVATIONS OF PERSEIDS — During the August display of the Perseids it has been noticed that in addition to the principal radiant point several minor ones have been observed, which although not very far distant from the primary one, are still far enough to suggest that they belong to another swarm of particles following a different track in space The orbit, which the particles in the main follow, corresponds, as is well known, to that of the comet of 1862 III, and M Bredikhine has suggested that the particles producing these minor radiant points belong really to the same swarm, only have either been acted on by external forces such as the perturbations of the major planets, or have been projected from the comet itself at different periods

With the intention of bringing some facts to bear upon this idea, M Puiseux, in the *Bulletin Astronomique* for October, gives the results of his observations made in August of last year, which seem to confirm those of M Bredikhine in several points of view.

His method of observation was simply to chart down on a large celestial globe the positions of the trails as observed A glance at this globe, after 199 positions had been so recorded, indicated that the area of radiation occupied a considerable surface, and extended principally in the directions of right ascensions, that several distinct centres of concentration were observable, and that the same radiant points, in general, manifested their activity at the same time, *i e*, on the evenings of August 10, 11, and 12, and some on August 7. In the table accompanying this paper M Puiseux shows that no less than fourteen different centres of radiation were observed. Table II, which we produce here, contains the essence of the whole work, and shows the positions of the radiant points in question, together with the corresponding elements of the orbits deduced. It must be remembered of course that their values cannot be very accurate, owing to the difficulty of observation, but the results are nevertheless interesting. The different radiant points are denoted by A, B, C, &c., while α and δ represent

their right ascension and declinations, the other nomenclature is that usually adopted in cometary computations

	α	δ	l	b	Ω	i	q	ω
A	44°.5	49°.1	57°.1	30°.7	138°.6	127°.3	0.9643	296°.2
B	41.3	46.7	53.8	29.1	138.0	130.3	0.9836	302.3
C	47.3	39.7	56.0	21.2	139.0	143.6	0.9674	297.8
D	62.7	60.6	73.2	38.7	138.5	107.1	0.8046	265.6
E	52.5	53.4	64.3	33.2	138.1	120.6	0.8839	277.9
F	35.3	65.8	60.0	47.9	138.7	99.1	0.9759	298.9
G	30.0	43.4	44.0	29.1	138.4	130.7	0.9982	330.3
H	105.3	60.9	99.4	38.0	138.7	79.1	0.5145	230.2
K	19.5	28.4	29.0	18.6	138.7	144.3	0.7495	19.2
L	5.3	67.0	45.8	56.1	138.6	87.9	1.0028	322.3
M	118.5	53.2	109.6	31.7	138.7	64.0	0.3811	215.0
N	314.7	67.4	23.4	72.9	137.9	62.4	0.9872	330.8
O	323.5	50.1	355.0	58.8	138.7	63.1	0.8402	5.7
P	14.0	37.4	28.5	28.7	138.5	126.3	0.8046	11.9

GEOGRAPHICAL NOTES

THE Royal Geographical Society has determined on a change in the form and alteration in the title of its *Proceedings*, which will materially enhance the value of the monthly publication The size of each part will be increased to ninety six pages, and two volumes will be published in the year instead of one as formerly Internally the arrangement will be slightly altered, and while the strictly geographical character of the publication will be maintained, the notes and record of geographical work from other countries will be made at once more systematic and more popular A special feature will be the record of the "Geographical Literature" of the month, summarizing all the accessions to the library, both books and memoirs This will form a subject-index to geographical literature, and serve as a continuous appendix to the exhaustive subject catalogue of the Society's library which is now being compiled The editorship of the new series remains in the hands of Mr J Scott Keltie, the assistant secretary

WITH reference to the note on the death of Lieutenant Schwatka, the Alaskan explorer, published last week, we are glad to observe that an official enquiry negatived the theory of suicide, and showed that the fatal result followed from an overdose of morphia taken medicinally.

THE German colonial authorities have recently come to a very important decision as to the official spelling of the place names of their various protectorates in Africa and New Guinea European names are to retain their ordinary form, but all native names are to be rendered phonetically according to a new set of rules These rules so closely resemble those put forward by the Royal Geographical Society, and now widely used, that it appears possible by some slight concessions on both sides to make one set serve both for English and German The letters *c*, *q*, *x*, and *z* are dispensed with as redundant, *c* and *z* being rendered by *ts*, *x* by *ks*, and *q* by *kw* The gutteral *ch* becomes *kh*, the English *ch* being given as *tsh*, and the sound of the English *j* as *dj* The German *j* sound will be represented by *y*, and the letter *j* used only for the French sound, which is represented in English as *zh* The German sound of *w* is rendered as *v*, the letter *w* being kept for the English sound Unfortunately the letter *s* is kept for its soft German sound, the sharp sound of the English letter being shown by *ß* The use of the English *z* would have overcome this difficulty, and removed the most serious obstacle to a common orthography

CAPTAIN MONTEIL, whose arrival at Kano on his way to Lake Chad was referred to in May last (vol xlvi p 110), has at last been heard of, and his mission, although involving two years of travel in the Sudan and Sahara, appears to be successfully completed The facts could not be put more concisely than in Monteil's official telegram to the French Foreign Office, which arrived on November 15 —"October 17 To-day I entered the territory of Fezzan by way of Tejerri coming from Kuka. Having set out from Kano on February 19, I reached Kuka on April 10, where the reception was excellent. I left Kuka on August 15 with a guide, sent by the Sheikh to accompany me to Murzuk . which I expect to reach on or about the 25th, and to stay there just long enough to arrange my departure for Tripoli. Badaire has borne the journey exceedingly well My men are all with me, except two left at Kuka" This is the most important journey through the Central Sudan and Sahara since the classical explorations of Barth and Rohlfs

STROMBOLI IN 1891 [1]

STROMBOLI is one of the most noted but least studied of volcanoes The regularity of the weak explosions which, succeeding each other at intervals of a few minutes, characterize its normal state, gives rise to the idea that its action is always thus uniform and monotonous, and the occasional paroxysms to which it is subject are apt to be overlooked In reality the so-called Strombolian phase of volcanic activity differs from the Plinian phase exhibited by Vesuvius and certain other volcanoes merely by the absence of intervals of perfect repose between the violent outbursts which are characteristic of the latter type It is in this difference that the explanation of the fact is to be found, that from time immemorial no explosion in any way comparable to the great explosions of Vesuvius have occurred at Stromboli, for the ceaseless activity of the latter prevents the accumulation of sufficient force to produce a powerful and destructive effect But from time to time the throat of the volcano does get more or less choked, and the efforts of the imprisoned vapour to escape result in an eruptive phase of some violence Such an event took place during the latter months of last year, and the following description of the phenomena is based on the observations of Profs Ricco and Mercalli, and of Ing Arcidiacono

The state of the volcano preceding this outburst had been one of relative calm for two years In October, 1888, an explosion had opened three new mouths on the upper edge of the Sciara del Fuoco, from one of which lava was emitted This was the commencement of a period of increased activity, with repeated issue of lava, lasting nine months till June, 1889 From this date to the eruption of last year, and particularly during the six months just preceding, the activity was less than normal It is to be noticed, however, that there were two short intervals of recrudescence, lasting only a few days, at the end of December, 1890, and January, 1891

On June 24, 1891, at 12 45 p m, two strong earthquake shocks were felt over the whole island at an interval of a few seconds Loud rumblings and a violent explosion followed each The shocks were not confined to the island of Stromboli, but were felt at Salina, a distance of 40 kilometres Even the subterranean rumblings were heard at the latter island The first shock and the first explosion were, as might be expected, more violent than any which succeeded Windows were broken at the semaphore station, and a great precipice of rock fell into the sea at the Filo del Cane, and other rocks in the same locality were so loosened that they fell on following days. Two powerful columns of ash, like thick smoke, arose from the crater and ascended far above the summit of the island Great masses of scoria were ejected and fell toward the northern part of the island, burning the grass and fig trees A boat passing to the north-east of the island at the time of the first explosion could not see the semaphore signals, owing to the quantity of ash in the atmosphere Lapilli fell around the eruptive mouths for a radius of a kilometre and a half, and a fine, dark grey ash rained over the whole island A stream of lava issued from a point on the Sciara del Fuoco near to the most western mouth, and a deep fissure formed its upper rim nearly in the same place as that of November, 1882. For two days the lava continued to flow, and loud explosions were frequent The rumblings were almost continuous On the 26th the emission of ash ceased, but moderately vigorous outbursts occurred with the ejection of incandescent scoria till the 27th, but on the 28th and 29th the volcano had resumed its wonted calm On the 30th, however, a fresh earthquake, accompanied by rumblings and a violent explosion, showed that the volcanic forces were not yet spent. An immense column of vapour and incandescent materials arose from a new breach on the edge of the Sciara, while an abundant current of lava flowed down the slope reaching the sea at its foot The whole of the powerful explosions o the 30th were repeated at short intervals, but the activity

[1] Sopra il Periodo eruttivo dello Stromboli cominciato il 24 giugno, 1891. Relazione dei Prof A. Riccò e G Mercalli col Appendice dell' Ingegnere Arcidiacono ("Annali dell Ufficio Centrale Meteorologico e Geodinamico" (2) XI Pt. 3, 1892)

gradually declined till July 4, when its normal state was reached. The eruptions were again violent, with emission of lava from the 16th to the 23rd of July.

The mouths on the edge of the Sciara, which were contemporaneously active during the above period, were four in number—two at the northern end and two at the western end. One of the former pair was opened by the explosion of June 30, and from it was ejected the greater part of the detrital material of the eruption, so that around it a cone has been built up, truncated by a crater, sub-elliptic in form, of about 60 metres in maximum diameter. The height of this new cone above the old edge of the Sciara is about 50 metres. The other crater is situated on the deep fissure mentioned above, and at night, from the sea the incandescent lava could be seen in free communication with the atmosphere—a circumstance which explains the fact that the explosions from this crater were rare and of feeble intensity. The two western ones were situated one below the other with an interval of about 30 metres. Near the lowest, three large fumaroles gave forth dense columns of steam, while other lesser fumaroles were plentifully scattered about. The majority of the explosions took place from these two mouths. During this same period, lava was emitted three times, (1) on June 24, soon after the first two explosions from the most western part of the Sciara, (2) on June 30, from the crater on the fissure, (3) on July 16, from the central part of the Sciara, between the first two. They all reached the sea, and since the second stream doubled itself round an obstacle about half way in its course, four new points were formed on the shore. The thickness of the lava at these points varied from 4 to 6 metres. Specimens of the lava collected from the most western stream showed that it consisted of an almost homogeneous blackish brown paste, compact in the interior, but becoming more and more porous and reddish in colour towards the exterior. Some of the larger cavities were internally covered with a shining brown patina. Externally it was covered with a rough crust, reddish-brown in colour, and of scoriaceous aspect. It was sensibly attracted by the magnet, and melted without effervescence to a brownish-green glass. Crystals of plagioclase, augite and olivine were apparent. In section, about two-thirds was rendered opaque and black by very minute microlitic granules of magnetite which were intimately mixed with a transparent glassy base, colourless or inclining to greenish. The remaining third consisted of a great number of colourless transparent microlites of plagioclase. Fluidal structure was only just apparent. In this microlitic paste were scattered crystals of plagioclase, augite, and olivine. The augites were greenish in section and possessed a feeble pleochroism. The olivines were corroded and irregularly fractured.

Analysis gave the following numbers —

	Stromboli	Etna Mean of analyses of 20 modern lavas
Silica	50.71	49.45
Alumina	13.99	19.30
Ferric oxide	5.13	11.82
Ferrous oxide	9.10	
Manganous oxide	.42	—
Lime	10.81	10.21
Magnesia	4.06	3.69
Potash	3.02	1.33
Soda	2.87	3.58
Loss on ignition	.24	—
Cl and SO_3	(traces)	—
	100.35	99.38

The lava is similar to other lavas of Stromboli, and to show the great similarity between the lavas of Stromboli and Etna, the mean of the numbers of twenty analyses of modern Etna lavas is appended for comparison.

The scoria, lapilli, and ash of the eruption present no special features, but are what might be expected from a lava of the above composition.

Although the volcano had reached a state of comparative calm at the end of July, this did not last for very long. Towards the end of August fresh signs of activity gave warning of an approaching explosion, which took place on August 31. It was preceded by an earthquake a few seconds before, and as a result a vast column of ash rose above the volcano, while scoria and other projectiles were shot out to a considerable distance. Soon after, a fine ash, dark red in colour (instead of black as in June–July), fell over the island, covering the ground in some places to a depth of several centimetres. On the evening of September 1 dense columns of ash were again emitted, and in the afternoon of September 3 the whole crater was enveloped in a thick mantle of steam, in the midst of which could be dimly seen a reddish-grey column of ash rising with extraordinary violence to a great height, when it spread out into a volcanic "pine." A fresh stream of lava was also observed. Eruptions succeeded each other at short intervals, accompanied by continuous rumblings, interrupted now and again by loud explosions, like heavy artillery. As far as could be observed, on the western side of the crater was a single mouth of almost circular form, 10 metres in diameter, which was most active in sending up vast columns of ash and projectiles of all kinds. To the east could be seen one or more little mouths, which tranquilly emitted large volumes of steam, while in the midst a large aperture, 30 metres in diameter, irregular in form and deeply fissured, was in powerful action. The activity, however, gradually quieted down, and towards the end of the year the volcano resumed its normal state.

In conclusion, it is useful to compare this eruptive phase of Stromboli with other contemporaneous seismo-volcanic phenomena of the Italian peninsula. It appears that earthquakes occurred in various districts in the early months of 1891, especially one on June 7 in the Verona district, rather severe, occasioning loss of life. Vesuvius was rather more active than usual during the whole of June, and in correspondence with this the great fumarole of the solfatara at Pozzuoli, increased in temperature. It is particularly interesting to note that Vulcano, the other active volcano of the Lipari Islands, remained in perfect calm during the whole period, emitting only vapour from the fumaroles. As, however, the character of the eruptions and the lithological composition of the material ejected from this volcano differ so greatly from those of Stromboli, it is tolerably certain that there is no free and direct communication between the reservoirs of these two volcanoes. In fact, Stromboli presents a much greater analogy with Etna. The similarity of the lithological composition of the lavas of these two volcanoes has already been referred to, and, further, Prof. Mercalli observes that the last four or five eruptions of Etna have all been immediately preceded or followed by a paroxysm at Stromboli. It is thus possible that there is a real relation between them.

L. W. FULCHER.

A LARGE METEORITE FROM WESTERN AUSTRALIA.

IN the *Mineralogical Magazine and Journal of the Mineralogical Society* of July, 1887 (vol. vii.) Mr. L. Fletcher, M.A., F.R.S., president of the Society, describes four specimens of a new meteoric iron found at Youndegin in Western Australia. They were discovered about three quarters of a mile to the north west from the top of Penkarring Rock, in the above district, about seventy miles from York. These fragments were found by Alfred Eaton, a mounted police constable, when on duty in the district of Youndegin, when he brought in one of the four pieces he found on January 5, 1884. Mr. Fletcher states that the late Mr. Edward T. Hardman, F.G.S., the then Government geologist, expressed his belief in the meteoric origin of these iron masses. Later the above-named Alfred Eaton was sent with a native assistant with instructions to bring in the other three pieces, and at the same time an unsuccessful search was made for additional fragments. In the above account it is stated that the four pieces were lying loose on the surface, three of them close together, and the fourth fifteen feet away. They weighed respectively 25¾ lbs., 24 lbs., 17½ lbs., and 6 lbs., the largest and smallest fragments are now in the British Museum collection, and the specimen of 24 lbs. is in the Geological Museum at Freemantle, and the fourth piece, weighing 17½ lbs., was presented to the Melbourne Museum in Victoria.

The new specimen now in my possession was discovered last year, and weighs 382½ lbs., and measures 22¾ inches high, 20½ inches wide, and 13¼ inches in its greatest thickness. In form it is roughly convex on one side and concave on the other, on both sides of which are large depressions or pittings similar to those usually observed on other large masses of meteoric iron. It is somewhat triangular in outline, but with irregular sides. It has one small hole quite through the mass near the top, and numerous deep holes, one near the bottom left hand corner

having a diameter of about 1½ inches and 4 inches deep, another at the opposite bottom corner 2 inches deep and 2 inches in diameter, also another of 3 inches deep, and several others On the upper edge especially, and at several other parts near, also on the edges, are fractured surfaces, as if in its fall a mass or masses were broken off, leaving a coarse crystalline structure, and which would indicate that several other large holes having existed before its fall on the earth, probably all or most of the pieces were connected together, and might have fallen in one mass It would be interesting to know if any of the pieces fitted together at the fractured surfaces as seems to me might be detach a fragment of which the cut face was not 2½ inche square

Mr Fletcher also states that on treating a specimen of this Youndegin iron to the action of bromine water, or of dilute nitric acid, the polished section gave no definite figures, but assumed a damascened appearance very like the Tucuman iron and of that of Brazos, being very similar to the latter in the proportion and distribution of the Schreibersite, some specimens of the Arva, the Sarepta, and the recently found Canon Diablo are similar as exhibiting these characters

One fifth natural size

possible. I observe that the two specimens of this iron in the British Museum collection exhibit similar fractures on the edges Before receiving this specimen I was informed that two masses were found, but have no information at present as to the size and weight of the other.

Mr. Fletcher in his paper minutely describes the size and form of the two British Museum specimens, and that the specific quantity was determined from three small pieces from the larger specimen, and gave 7·86, 7·85, and 7·72. He also states that a portion was cut off the larger piece by means of hack-saws, and was found to be so hard that three weeks were required to

The Youndegin Iron was also remarkable in containing the minute cubic and modified cubic crystals, having metallic lustre and of a greyish black colour, and which were determined to be graphitic in character, but of a diamond-like form, but were later found to be still distinct from the diamond, but having somewhat more the features of graphite. Mr Fletcher therefore decided to give the name of Cliftonite to this substance, as being a new form of a carbon mineral A most exhaustive description of this new mineral is given in his paper. Similar crystals of this substance are found in one or two other meteoric irons.

The composition of the Youndegin iron was found to be as follows —

Iron	92 67
Nickel	6 46
Cobalt	0 55
Copper	trace
Magnesium	0 42
Phosphorus	0 24
Sulphur	none
Insoluble cubes	0 04
	100 38

JAMES R GREGORY

THE CROSS-STRIPING OF MUSCLE

PROF RICHARD EWALD of Strassburg, has just communicated a paper to the fifty second volume of the *Archiv f. d ges Physiol*, in which he confirms Prof Haycraft's views concerning the structure of striped muscle The latter observer has held for many years that muscle fibrils are varicose threads, and that the cross striping is but an optical appearance due to this varicosity The varicosity is often difficult to demonstrate in the ordinary way, and most histologists were not prepared to admit that the stripings are all and entirely due to it Prof Haycraft, however, recently brought forward to the Royal Society of London, and to the Berlin International Medical Congress, fresh and striking proof of the strength of his position, by demonstrating films of moist collodion, on which pieces of muscle had been pressed and then withdrawn As a result of this pressure the collodion films were stamped as with a seal, and the impressions revealed in striking detail every stripe of the original fibre Prof Ewald confirms these experiments in the fullest manner, but suggests that the collodion impressions might be produced on the assumption that there are layers of hard and soft material alternating with each other in the course of the fibrils In this case the hard material would press into the collodion and make a series of furrows, which would appear as a series of stripes when examined with the microscope Prof Haycraft had previously demonstrated the varicosity of the fibrils, seen by transmitted light, and had published photographs of his preparations, but Prof Ewald was still sceptical upon this particular point, and sought to assure himself still more conclusively With this end in view he examined muscle, which had been rendered quite opaque, by means of reflected light, for under these circumstances the influence of the internal structure would be entirely set on one side, and the surface of the fibrils would alone receive and reflect the illuminating rays For purposes of illumination Prof. Ewald used the apparatus of W and H Seibert, of Wetzler, by means of which vertical rays can be projected upon an opaque object; and he rendered his preparations, both of fresh and of hardened muscle, quite opaque by a method of over-silvering Under these conditions Prof Ewald found that the cross-striping is most distinct, and he was able, with his admirable method of illumination, to examine the surface of a muscle just as one may observe the surface of the country at night by means of a search light from an observatory. With the light perfectly vertical the tops of the ridges of the muscle are bright, and the valleys on either side in half-light By shifting the light to one side or to another the slopes of the ridges can be thrown alternately into shadow or bright light. Prof Ewald concludes by admitting that his experiments fully prove that the striping is due to the shape of the fibrils alone, and that the internal structure of the muscle plays no part in its production

IRIDESCENT COLOURS [1]

ON taking a general survey of coloured objects, whether natural or artificial, we become aware of the fact that whilst the colours of some remain unchanged as regards tint, whatever their position in relation to the incident light, the tint of others varies with every alteration in their relationship to such light source We thus see that so far as their colours are concerned all bodies may be arranged in two groups according as their colours change or do not change in tint as their angular relationship to the light varies Nor is this classification entirely an artificial one, since, as will shortly be seen, though this change in tint with variation in the light source is an essential difference, it is not the only difference, even in the colour manifestations of the two groups, for it is also characteristic of the nature of the colour producing structure It is to the above mentioned varying colours that we apply the term iridescent, from the resemblance they have in the sequence or play of colours to the tints of the rainbow The unvarying group of colours, having no equivalent term to "iridescence" to express the nature of their colour production, are spoken of as "pigmentary," or absorption colours In naming examples of objects, natural and artificial, grouped as above in accordance with the nature of their colours, it is difficult to make a selection where all are so varied and characteristic I have preferred therefore to cite only such instances as I myself possess, and am therefore able to show you As examples of pigmentary colours, I need only name one or two for the sake of comparison, since the colours of most objects ordinarily met with are pigmentary Leaves, flowers, dyes, birds, fish, insects, minerals, &c, exhibit these colours, some almost entirely, and all, excepting fish, in far the majority of instances Of objects displaying iridescent colours we have also examples in the various divisions of the animal, vegetable, and mineral kingdoms Amongst birds the most striking examples are found amongst the humming birds, sun birds, birds of paradise, &c. Insects, again, furnish numerous examples, more especially amongst tropical species, though not, perhaps proportionally in greater numbers than amongst those belonging to our own more temperate regions The colours of fish are almost entirely iridescent, since their very whiteness, or silvery sheen, is due to the admixture of the iridescent colours of innumerable minute thin lamellæ, too small to be seen individually with the naked eye, but plainly perceptible under the microscope In the vegetable kingdom iridescent colours are far more numerous than is ordinarily recognized, since the surfaces of the cell walls produce interference colours which are more or less obscured by the pigmentary colours of leaves and coloured flowers, but may be readily seen in the case of white flowers by the aid of a lens and sunlight Under these conditions each cell may be seen to sparkle with its own iridescent colour, forming, by admixture of the interference tints of neighbouring cells, the varying shades of white seen in numerous flowers which are devoid of pigmentary colour Mineral bodies displaying iridescent colours are also numerous, opals, sunstone, fire marble, felspar, mica films, tarnish on various metallic crystals, certain crystals of chlorate of potash, &c., are examples

In describing the various natural objects for purposes of identification, or mere description, no account can be considered complete which omits all reference to their colours, and more especially is this the case where the colours constitute such a striking feature, as in the case of iridescent bodies. In innumerable instances, more especially amongst birds and insects, their specific names are taken from some conspicuous colour they possess. It thus becomes evident that a correct description of the colours of bodies is of importance, and where these colours are of the pigmentary, or unchanging kind, this is a matter of no difficulty How different, however, in the case of objects, the colours of which not only vary with every change of position, but disappear altogether, unless viewed with special relation to the light source Nor can it be wondered at that descriptions of these objects, even by observers of undoubted repute, vary according to the different angles from which they have been viewed, or are vague and profuse, owing to fruitless attempts to describe their changing tints produced by every movement The fact is, no words can convey an adequate impression of the gorgeous effects produced by most of such objects, whether birds, insects, or fish, when in motion in brilliant sunshine Some notion of the difficulties to contend with in describing the colours of humming birds, for example, may be gathered from the remarks of Wallace in his work on "Tropical Nature," when speaking of humming birds:—"In some species they must be looked at from above, in others from below, in some from the front, in others from behind, in order to catch the full glow of the metallic lustre, hence, when the birds are seen in their native haunts, the colours come and go and change with their motion, so as to produce a startling and

[1] By Alex. Hodgkinson, M.B., B Sc. Reprinted from the fifth volume of the fourth series of "Memoirs and Proceedings of the Manchester Literary and Philosophical Society" Session 1891-92.

beautiful effect." Most observers, in describing the colours of iridescent bodies, do so by attempting to depict the varied effects produced by casually changing the position of the object in relation to the light, omitting to mention the exact *sequence* of the play of colours, or the relation of these colours to the direction of the iridescent light, *i.e.*, whether produced by perpendicular or oblique illumination. Here is a description of the tufted neck humming bird, *Trochilus ornatus*, taken haphazard from a well known work:—"The throat is of a fine green colour, variable in different lights to a golden hue with a yellow or brown metallic lustre, and below that the whole of the belly is a rich brown, glossed with green, and golden." Such descriptions as the above, which happen to be the first I met with in seeking for an instance, are vague, and fail to give a definite idea of the appearance of the object. But vagueness in the description of these objects is not the only result of the changing character of their colours. As might be expected, where such variation in appearance exists, the descriptions of different authors are almost as variable as the colours. Few attempt descriptions without acknowledging the hopelessness of the task. Thus Jardine, after describing this humming bird, *Chryslampis mosquitus*, remarks:—"It is impossible to convey by words the idea of these tints, and having mentioned those substances to which they approach nearest, imagination must be left to conceive the rest." And I adduce this quotation as fairly expressing the feeling of naturalists in reference to the description of iridescent objects generally. Recognizing the admitted inability of observers to convey by description an idea of the appearance of these iridescent objects, and having myself, for many years, constantly experienced the same difficulty, I have been led to adopt a method for the examination of such objects, which, whilst extremely simple and available in its application, yields unvarying results with different observers, results, moreover, which admit of the simplest description.

Before describing this method, I may say that long experience in the examination of iridescent objects has proved to me that, almost without exception, the colours of natural iridescent objects are due to interference produced by thin plates. In order, therefore, to render clear the principles on which the method I propose is founded, I will briefly refer to certain fundamental facts in connection with colour production by thin plates, and for this purpose will select a thin film of mica, which with light at perpendicular incidence, appears red, iridescent red. If, now, this plate be inclined so that the light falls on it at a more oblique angle, it is, of course, reflected at the same angle, and now appears orange, and if the plate be still further inclined, the reflected light appears yellow, then yellowish green, green, and bluish green, and if the light were not too copiously reflected from the first surface to allow of perceptible interference by further inclination of the plate, all the colours of the spectrum in their proper sequence might be observed. The same results, but much more vividly, may be seen in these crystals of chlorate of potash. Thus, we see that by rendering the incident light more and more oblique, the reflected light changes from a lower to a higher tint, that is, from the red towards the violet end of the spectrum. And this is what occurs in the case of all iridescent bodies, as the incident light becomes more oblique the colour changes to the tint above it in the spectral order, so that, if we know what colour any such object appears when seen at a certain angle, we can infer what colour it will change to on varying the incidence. This beetle (*Sagra purpurea*), for instance, is red at perpendicular incidence, it will, therefore, appear orange yellow and green when examined by successively increased obliquity of light. And the same is true of all other iridescent red objects. If the object at perpendicular incidence be green, as in the case of this beetle (*Buprestis*), it will become blue and then violet as the incidence is increased. We thus see that an iridescent object varies in colour, simply because it is examined by light incident, and therefore reflected, at different angles. Thus, different observers see the same iridescent object of a different colour, when they view it illuminated by light at a different angle of incidence. If, however, the object is seen by all at the same angle of the incident light it will present the same colour, and this is, in fact, what the method I propose ensures, *i.e.*, that iridescent objects shall always be seen by light at one and the same angle of incidence. The angle I select is one of 90, so that the incidence and reflection are normal or perpendicular to the reflecting surface. By selecting this angle all trouble of measuring angles is avoided, since we know that the incidence is perpendicular when it coincides with reflection. Now, the reflected light may be made to coincide with the incident light by reflecting it on to the object by means of a mirror, and so adjusting the object that the light reflected from it passes to the eye through a perforation in the mirror. When examined in this way iridescent objects are marvellously altered in appearance, their changing colours are replaced by one fixed tint, visible only in one position, a fact which serves at once to distinguish them from bodies coloured by absorption, which remain coloured whatever the relation to the incident light. Such methods of examining bodies scarcely takes more time than by the eye alone. The mirror may be attached to a spectacle frame so as to leave both hands free, such as the one I show, or may be a simple hand mirror. For objects too small to be seen by the unaided eye, I have so arranged the microscope that light is made to pass down the tube of the instrument, through the object glass on to the objects, and by a special arrangement, so adjusted the position of the object that the light is reflected back again through the instrument to the eye. The method is thus available for macroscopic as well as microscopic objects.

To illustrate the practical value of this plan of examination, I have here a few objects exhibiting iridescent colours, which, by trial, will be found to give the following results:—

The crest of this humming bird, *Chrysolampis mosquitus*, which, to the unaided eye, appears resplendent with all shades of red, orange, yellow, or green, according to the angle of the incident light, appears, when examined by the mirror, of one unvarying red tint, disappearing when the object is moved but absolutely unchanging in tint. Such an object, therefore, I should describe as "iridescent red", all else regarding its colour may be inferred. Again, the breast, or gorget, of the same bird reflects all shades of orange, yellow, or green to the eye alone; with the mirror it is seen of a deep orange, which, as before, is unchanged in tints by any variation in position. Such an object I would describe as "iridescent orange." The gorget of another humming bird, *Calliphlox amethystina*, to the eye alone appears crimson, orange, yellow, or green; with the mirror it is iridescent crimson only, spectroscopically a red of the 2nd order. Amongst insects, instances of iridescent species are numberless, the results of examination are just the same as in other iridescent bodies. This butterfly, *Morpho*, to the eye alone appears either greenish blue, blue, or violet, as its inclination to the light varies; examined with the mirror it appears green, and should be described as iridescent green, or iridescent bluish-green. This beetle, *Poropleura bacca*, appears any shade of red, yellow, or green to the eye alone; with the mirror only iridescent red. In this extraordinary beetle, *Chrysochroa fulminans*, we have all the colours of the spectrum in their natural sequence, beginning with red at the tip of the wing case, and ending with violet higher up the elytron. These colours vary in an indescribable manner when attentively examined at different angles of incident light with the eye alone; with the mirror the wing cases are seen to be coloured successively from base to tip iridescent green, yellow, orange, and red, and these tints remain unaltered by change of position of the object. This piece of *Haliotis* shell exhibits indescribable changes of colour with every movement, but the difficulty of description, though by no means removed, is immeasurably lessened by the use of the mirror. And the same with this specimen of iridescent iron ore, its colours, which vary to the unaided eye, remain unchanged when examined by the mirror. To simplify the description of iridescent objects, therefore, I would advocate the above method, and would describe the result of such examination by recording the colour observed by aid of the mirror, and prefixing the term "iridescent" to express the changing properties of the colour. Bearing in mind the unvarying nature of these changes, a far clearer idea may be formed of the appearance of these objects than from any attempted description of what is admittedly indescribable. Time and space are also economized by the omission of lengthy descriptions. The accuracy, and, therefore, the value of any description of colour, is always enhanced by mapping its spectrum; more especially is this true in the case of iridescent colours. This is easily done, and by applying such map to a spectral chart, the order of the colour, and therefore its tint, is apparent. In examining many objects, chiefly birds or insects, by means of the mirror as above described, apparent exceptions are repeatedly met with to the fact stated above, that the colour

is invariable in tint and disappears by inclination of the body Such instances are no real exceptions, but are due to the reflecting plates being curved, or having pigmentary matter beneath them, or an opalescent medium above them In this way some of the most extraordinary and beautiful colour effects it seems possible to conceive are produced

In examining objects with the perforated mirror a single light is necessary The sun is of course the best, and the electric light probably almost as good I frequently employ the lime-light, but a good paraffin lamp may be used as a substitute Ordinary gas is unsuitable The light should be placed in front of the observer, its direct rays being prevented from falling on the objects by means of a book or partition of some kind resting on the table, and of such a height that the light can be seen above it , On placing the mirror to the eye the light may be reflected from the mirror on to the object, and the latter manipulated so as to reflect the ray back through the perforation in the mirror to the eye The incidence is thus known to be normal, and the colour observed is the one to be recorded

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE —The following letter has been addressed by the University of Cambridge to that of Padua, which is about to celebrate the tercentenary of Galileo s professorship —

Universitas Cantabrigiensis Universitati Patavinae S P D

Litteras vestras, viri doctissimi, GALILAEI GALILAEI Professoris vestri celeberrimi in laudem conscriptas vixdum nuper perlegeramus, cum statim in mentes nostras rediit non una Italiae regio viri tanti cum memoria in perpetuum consociata. Etenim nostro quoque e numero nonnulli urbem eius natalem plus quam semel invisimus, ubi Pisano in templo lucernam pensilem temporis intervallis aequis ultro citroque moveri adhuc iuvenis animadvertit , etiam Vallombrosae nemora pererravimus, ubi antea scholarum in umbra litteris antiquis animum puerilem imbuerat , ipsa in Roma ecclesiam illam Florentinam intravimus, ubi doctrinae suae de telluris motu veritatem fato iniquo abiurare est coactus , Florentiae denique clivos suburbanos praeterivimus, ubi provecta aetate caeli nocturni sidera solus contemplabatur, ubi extrema in senectute diei lumine orbatus cum MILTONO nostro collocutus est, ubi eodem demum in anno mortalitatem explevit, quo NEWTONUS noster lucem diei primum suspexit

Hodie vero ante omnia non sine singulari voluptate sedem quandam doctrinae insignem, intra colles Euganeos urbemque olim maris dominam positam recordamur, ubi trecentos abhinc annos saeculi ARCHIMEDES discipulorum ex omni Europae parte con[illegible]tium numero ingenti erudiendo vitam suam maturam maxima cum laude dedicavit , ubi, ut LIVII vestri verbis paulum mutatis utamur, ultra colles camposque et flumen et assuetam oculis vestris regionem late prospiciens, caelo in eodem, sub quo vosmet ipsi nati estis et educati, instrumento novo adhibito inter rerum naturae miracula primus omnium Lunae faciem accuratius exploravit, Iovis satellites quattuor primus detexit, Saturni speciem tergeminam primus observavit, ultraque mundi orbem ingentem a Saturno lustratum fore suspicatus est ut etiam alii planetae aliquando invenirentur

Ergo vatis tam veracis, auguris tam providi in honorem, nos certe, qui Professorum nostrorum in ordine planetae etiam Saturno magis remoti ex inventoribus alterum non sine superbia nuper numerabamus, hodie alterum ex Astronomiae Professoribus nostris, Georgium DARWIN, nominis magni heredem, nostrum omnium legatum, quasi Nuntium nostrum Sidereum, ad vosmet ipsos libenter mittimus Vobis autem omnibus idcirco gratulamur quod tum Italiae totius, tum vestrae praesertim tutelae tradita est viri tanti gloria, qui divino quodam ingenio praeditus rerum naturae in provincia non una ultra terminos prius notos scientiae humanae imperium propagavit quique caeli altitudines immensas perscrutatus mundi spatia ampliora gentibus patefecit Valete.

Datum Cantabrigiae
a. d viii *Kal Decembres*
A. S. MDCCCXCII.

Mr F. Darwin has been appointed Deputy Professor of Botany for the current academical year, Prof. Babington being unable to lecture on account of the state of his health

SCIENTIFIC SERIALS.

American Journal of Science, November —Unity of the glacial epoch, by G. Frederick Wright An examination of the evidence in favour of two successive glacial epochs separated by an inter-glacial epoch, during which the glaciated area was as free from ice as it is at the present time This evidence is shown to be inconclusive, at least as far as American observations go —A photographic method of mapping the magnetic field, by Charles B Thwing Iron filings are strewn upon the film side of a dry plate laid horizontally in a magnetic field, and the plate is exposed to light from above. The filings are then brushed off, and the plate developed From the negatives excellent lantern slides may be obtained —Contributions to mineralogy, No 54, by F A. Genth, with crystallographic notes by S L. Penfield Description and analysis of aguilarite, metacinnabarite, dollingite, rutile, danalite, yttrium-calcium fluoride, cyrtolite, lepidolite, and fuchsite —The effects of self-induction and distributed static capacity in a conductor, by Frederick Bedell, Ph D , and Albert C Crehore, Ph D —The quantitative determination of rubidium by the spectroscope, by F A Gooch and J I Phinney The method is that of comparing photometrically the intensity of a certain line in the spectrum of the metal under investigation with the intensity of that given by a standard solution containing a known amount of the metal. A definite amount of the salt solution—usually the chloride—is taken up by a hollow coil of platinum wire, which may be made to take up constant quantities of liquid by taking care to plunge the coil while hot into the liquid, and removing it with its axis inclined obliquely to the surface The coils were made of platinum wire 0 ,2 mm in diameter, wound in about thirty turns to a spiral 1 cm long by 2 mm across, and twisted together at the ends to form a long handle Each coil held 0 02 gr of water With such a coil, the blue rubidium lines were produced in a Muencke burner from 0 0002 mgr of the chloride Some test experiments showed that in the case of pure solutions of rubidium chloride the percentage could be found spectroscopically up to 1 part in 30,000 with an error as low as 1 25 per cent In presence of potassium or sodium, however, the error may be as great as 20 per cent —Notes on the meteorite of Farmington, Washington County, Kansas, by H. L Preston — A note on the cretaceous of North-western Montana, by H Wood —A deep artesian boring at Galveston, Texas, by R T Hill —Notice of a new Oriskany fauna in Columbia County, New York, by C E Beecher, with an annotated list of fossils, by J M Clarke —Description of the Mount Joy meteorite, by E E Howell —Influence of the concentration of the ions on the intensity of colour of solutions of salts in water, by C E Linebarger

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 17 —"Stability and Instability of Viscous Liquids," by A B. Basset, F.R.S (Abstract) —The principal object of this paper is to endeavour to obtain a theoretical explanation of the instability of viscous liquids, which was experimentally studied by Professor Osborne Reynolds[1]

The experiment, which perhaps most strikingly illustrates this branch of hydrodynamics, consisted in causing water to flow from a cistern through a long circular tube, and by means of suitable appliances a fine stream of coloured liquid was made to flow down the centre of the tube along with the water. When the velocity was sufficiently small, the coloured stream showed no tendency to mix with the water, but when the velocity was increased, it was found that as soon as it had attained a certain critical value, the coloured stream broke off at a certain point of the tube and began to mix with the water, thus showing that the motion was unstable It was also found that as the velocity was still further increased the point at which instability commenced gradually moved up the tube towards the end at which the water was flowing in

Professor Reynolds concluded that the critical velocity W was determined by the equation

$$Wa\rho/\mu < n,$$

where a is the radius of the tube, ρ the density, and μ the viscosity of the liquid, and n a number ; but the results of this

[1] *Phil. Trans.* 1883, p. 935.

paper show that this formula is incomplete, inasmuch as it does not take any account of the friction of the liquid against the sides of the tube

In the first place, if the surface friction is supposed to be zero, so that perfect slipping takes place, the motion is stable for all velocities If ϵ^{kt} be the time factor of a disturbance of wave-length λ, the value of k is

$$k = -\frac{2i\pi W}{\lambda} - \frac{\mu}{\rho a^2}\left(\frac{4\pi^2 a^2}{\lambda^2} + n^2\right) \qquad (1),$$

where n is a root of the equation $J_1(n) = 0$

Experiment shows that when the velocity is greater than about six inches per second, the frictional tangential stress of water in contact with a fixed or moving solid is approximately proportional to the square of the relative velocity This introduces a constant β, which may be called the coefficient of sliding friction, whose dimensions are $[ML^{-3}]$, and are therefore the same as those of a density This constant may have any positive real value, $\beta = 0$ corresponding to perfect slipping or zero tangential stress, whilst $\beta = \infty$ corresponds to no slipping, which requires that the velocity of the liquid should be the same as that of the surface with which it is in contact Owing to the intractable nature of the general equations of motion of a viscous liquid, I have been unable to obtain a complete solution, except on the hypothesis that β is an exceedingly small quantity This supposition, I fear, does not represent very accurately the actual state of fluids in contact with solid bodies, but at the same time the solution clearly shows that the instability observed by Prof Reynolds does not depend upon viscosity alone, but is due to the action of the boundary upon a *viscous* liquid

To a first approximation, the real part of k is proportional to

$$\frac{Wa\beta}{\mu} - \frac{(n^2 + m^2a^2)^2}{4n^2} \qquad (2),$$

where $2\pi/m$ is the wave-length of the disturbance, and n is a root of the equation $(J_1 n) = 0$ Since the second term is a number, this shows that the motion will be stable, provided

$$Wa\beta/\mu < \text{a number}$$

The experiments of Prof. Reynolds conclusively show that the critical velocity at which instability commences is proportional to μ/a, and the fact that the theoretical condition of stability turns out to be that Wa/μ, multiplied by a quantity of the same dimensions as a density, should be less than a certain number, appears to be in substantial agreement with his experimental results.

The results of the investigation may be summed up as follows —

(i) *The tendency to instability increases as the velocity of the liquid, the radius of the tube, and the coefficient of sliding friction increase, but diminishes as the viscosity increases*

(ii) *The tendency to instability increases as the wave-length ($2\pi/m$) of the disturbance increases*

The remainder of the paper is occupied with the discussion of a variety of problems relating to jets and wave motion.

I find that when a cylindrical jet is moving through the atmosphere, the tendency of the viscosity of the jet is always in the direction of stability. The velocity of the jet does not affect the stability unless the influence of the surrounding air is taken into account, if, however, this is done, it will be found that it gives rise to a term proportional to the product of the density of the air and the square of the velocity of the jet, whose tendency is to render the motion unstable. The tendency of surface-tension (as has been previously shown by Lord Rayleigh) is in the direction of stability or instability according as the wave-length of the disturbance is less or greater than the circumference of the jet.

If in addition, the jet is supposed to be electrified, the condition of stability contains a term proportional to the square of the charge multiplied by a certain number, n When the ratio of the circumference of the jet to the wave length is less than 0·6, n is positive, and the electrical term tends to produce stability; but when this ratio is greater than 0·6, n is negative, and the electrical term tends to produce instability. It must, however, be recollected that when the above ratio is greater than unity the tendency of surface tension is to produce stability, but if the influencing body is capable of inducing a sufficiently large charge, the electrical term (when $2\pi a > \lambda$) will neutralize the effect of surface tension and viscosity, and the motion will be unstable

The well-known calming effect of "pouring oil on troubled waters" has passed into a proverb The mathematical investigation of this phenomenon is as follows —The oil spreads over the water so as to form a very thin film, we may therefore suppose that the thickness l of the oil is so small compared with the wave-length hat powers of l higher than the first may be neglected Also, since the viscosity of olive oil in C G S units is about[1] 3 25, whilst that of water is about 0 014, the former may be treated as a highly viscous liquid, and the latter as a frictionless one

The result is as follows —

Let ρ_1, ρ be the densities of the water and oil, T_1 the surface tension between oil and water, T the surface tension between oil and air, μ the viscosity of the oil, and ϵ^{kt} the time factor, then, to a first approximation,

$$k = -\frac{\{g(\rho_1 - \rho) + T_1 m^2\}(g\rho - Tm^2)l}{4\mu\{g\rho_1 - (T - T_1)m^2\}}$$

For olive oil, $T_1 = 20{\cdot}56$, $T = 36\ 9$, so that $T > T_1$, and I find that the motion will be stable unless the wave length of the disturbance lies between about 9/11 and 6/5 of a centimetre This result satisfactorily explains the effect of oil in calming stormy water

OXFORD

University Junior Scientific Club, October 26 —Mr E I Collis, in the absence of Mr Bourne, gave an exhibit of *Codium tomentosum* —Mr F C Britten gave an exhibit of the nest of a trapdoor spider —Mr Hill read an interesting paper on the determination of sex, which was followed by a long discussion —Mr Fisher exhibited some specimens of crystallized anhydrous oxalic acid, and described their methods of preparation

CAMBRIDGE

Philosophical Society, October 31 —Prof G H Darwin, President, in the chair —The following officers were elected for the ensuing session —President. Prof Hughes Vice Presidents Dr Cayley, Prof G H Darwin, Dr Hill Treasurer Mr R T Glazebrook Secretaries. Dr Hobson, Mr J Larmor, Mr Bateson New Members of Council Prof Thomson, Mr F Darwin, Dr Shore, Mr Ruhemann.—The retiring President addressed the Society —The following communications were made —Note on the determination of low temperatures by platinum-thermometers, by Mr E. H Griffiths and Mr G M Clark The authors, following up the suggestion of Profs Dewar and Fleming, that the resistance of certain pure metals vanishes at absolute zero, have assumed the possibility of extrapolating the platinum thermometer formulæ, and have thus found the temperature at which $R = 0$ From the previously-published constants of seven different thermometers—including Callendar's original wire—the mean value deduced by them is $-273°\ 86$, which is in remarkable agreement with Joule and Thomson's thermodynamical value $-273°\ 7$. They further suggest that the simple method of determining the resistance in ice and steam and assuming $R = 0$ when $t = -273°\ 7$ is sufficient to graduate a thermometer constructed of fairly pure wire, as they show that the errors so introduced will only amount to a fraction of a degree over the range $-273°$ to $+150°$ —Carnot's principle applied to animal and vegetable life, by Mr J Parker. The author discusses the question whether the conditions of the growth of plants are limited by the law of entropy. The assumption is made that Carnot's principle takes account only of the exchange of heat, and the temperature of the material system at which the exchange takes places, that the differential effect of solar radiation of different kinds consists in variation of the activity but not of the mechanical type of the growth The increase of available energy due to the building up of inorganic materials into a plant can then only be explained, in conformity with the second law of thermodynamics, by the aid of differences of temperature during growth: the author gives calculations to prove that the difference between day and night is amply sufficient for this purpose.—Note on the geometrical interpretation of the quaternion analysis, by Mr J. Brill

[1] Osborne Reynolds, *Phil. Trans.* 1886, p 17

PARIS

Academy of Sciences, November 14.—M d'Abbadie in the chair —Heat of combustion of camphor, by M Berthelot —Remarks on a note by M A Colson on the rotating power of the diamine salts, by M C Friedel —Researches on the chemical constitution of the peptones, by M P Schutzenberger —Influence of the distribution of manures in the soil upon their utilization, by M H Schlœsing —On the laws of dilatation of gases under constant pressure, by M E H Amagat Tables are given of coefficients of expansion of carbon dioxide under pressures ranging from 50 to 1000 atm, and temperatures up to 258°, and for oxygen, hydrogen, nitrogen and air, under pressures up to 3000 atm For CO_2 the coefficient has a maximum at a certain pressure for each range of temperature This maximum corresponds to a higher pressure as the temperature rises For the other gases the coefficient decreases regularly as the pressure increases As regards temperature, the coefficient of expansion of CO_2 for each pressure reaches a maximum at a certain temperature and then decreases This temperature is the higher, the greater the pressure The more permanent gases behave as if they had already passed their maximum.—Study of the pathogenic power of fermented beet root pulp, by M Arloing —Observations of the new comet Holmes (*f* 1892), made at the Paris Observatory (west equatorial), by M G Bigourdan (see Astronomical Column) —Transformation of the great telescope of the Paris Observatory for the study of radial velocities of the stars, by M H Deslandres (see Astronomical Column) —Summary of solar observations made at the Royal Observatory of the Roman College during the third quarter of 1892, by M P Tacchini —On the inversion of Abelian integrals, by M E Goursat —On the summation of a certain class of series, by M d'Ocagne —On the equations of dynamics, by M R Liouville —Experimental researches on the deformations of metallic bridges, by M Rabut —Conditions of equilibrium and of formation of liquid microglobules, by M C Maltézos The following experimental results were arrived at When a liquid spreads over the free surface of a denser liquid, microglobules are produced on inverting the position of the two liquids If a liquid rests in drops on the surface of a denser liquid, then in the inverse position the denser will spread over the less dense liquid —Demonstration of the existence of interference of electric waves in a closed circuit, by means of the telephone, by M R Colson A Rhumkorff coil was kept vibrating at 130 per second by a thermopile To one of its terminals was attached a copper wire ending in a hook, to which a linen thread soaked in calcium chloride was attached by one end, the other hanging free One of the terminals of a telephone was placed in contact with the thread, the other terminal being isolated Under these conditions, the sound in the telephone was completely extinguished at a certain distance from the copper When both the ends of the thread (which was 3 m long) were connected up by fine copper wires, two points of extinction were reached, one from each end On shortening the thread these points approached each other and formed a zone of extinction between them This zone of extinction spread over the entire copper wires as the thread was shortened to zero The neutral zone is due to interference of two waves of the same period and of equal potential meeting in opposite directions.—On the co existence of dielectric power and electrolytic conductivity, by M E Cohn —Observations on the preceding communication, by M. Bouty —Magnetic properties of bodies at different temperatures, by M P Curie These were measured by bringing samples of the bodies between the ends of two electromagnets inclined to one another, and measuring the forces experienced by means of a torsion balance The bodies were heated in a porcelain crucible, the heat being supplied by platinum wires carrying a current, and measured by a Chatelier thermocouple —On the propagation of vibrations through absorptive isotropic media, by M. Marcel Brillouin.—On a new relation between variations of luminous intensity and the numerical order of the sensations, determined by means of a luminous paint, by M. Charles Henry —Essay of a general method of chemical synthesis experiments, by M Raoul Pictet.—On the fusion of carbonate of lime, by M H Le Chatelier —On the molecular weights of sodammonium and potassammonium, by M. A Joannis.—On some crystallized sodium titanates, by M. H Cormimbœuf —On a propylamidophenol derived from camphor, by M. P Cazeneuve.—On the colouring matter of the pollen, by MM G Bertrand and G Poirault —On the manufacture of melanite garnet and sphene, by M. L Michel —On the rotating power of solutions, by M Wyrouboff —Researches on the mode of elimination of carbonic oxide, by M L de Saint-Martin —Vital fermentations and chemical fermentations, MM Maurice Arthus and Adolphe Huber —Remarks on the preceding communication, by M A Gautier —Influence of the transfusion of blood from dogs vaccinated against tuberculosis upon tuberculous infection, by MM J Héricourt and Ch Richet —On a new species of chromogenic bacteria, the *Spirillum luteum*, by M Henri Jumelle —On two parasitic myzostomes of the *Antedon phalangium* (Muller), by M Henri Prouho

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS —Manners and Monuments of Prehistoric Peoples Marquis de Nardaillac, translated by N Bell (Putnam) —An Elementary Text book of Hygiene H R Wakefield (Blackie) —More about Wild Nature Mrs Brightwen (Unwin) —The Pharmacy and Poison Laws of the United Kingdom (office of the *Chemist and Druggist*).—Lessons in Elementary Algebra, 1st series L J Pope (Bell) —The Visible Universe J E Gore (Lockwood) —Man and the Glacial Period Dr G F Wright (K Paul) —Sinai from the Fourth Egyptian Dynasty to the Present Day late H S Palmer, new edition, revised by Prof Sayce (S P C K).—Time and Tide, 2nd edition Sir R S Ball (S P C K) —Les Races et les Langues Prof A Lefèvre (Paris, Alcan) —A Contribution to our Knowledge of Seedlings, 2 vols Sir John Lubbock (K Paul) —Australasian Newspaper Directory, 3rd edition, 1892 (Gordon and Gotch) —Sultan to Sultan M French Sheldon (Saxon).

PAMPHLETS —Recherches d'Optique Physiologique et Physique, Part 2 C Royer (Bruxelles, Monnoin).—Fauna Americana D T de Aranzadi (Madrid)

SERIAL —L'Anthropologie, tome iii No. 4 (Paris, Masson

CONTENTS.

THURSDAY, DECEMBER 1, 1892

CHEMICAL LECTURE EXPERIMENTS

Chemical Lecture Experiments By G S Newth (Longmans, 1892)

"ON revient toujours," &c and the very description of a good lecture experiment to one who had for thirty years always enjoyed performing an old one, and was overjoyed in bringing out a new one, is something akin to that of the old war-horse when he scents the battle from afar And both Mr Newth's experiments and his descriptions are good, so I think that not only the novices of the profession but the old hands will read this book—the first with profit with a view to what they will do, and the second with pleasure in recollecting what they have done I was dining some years ago with the great Dumas (I don't mean either of the novelists), and after dinner we sat together on the sofa smoking our cigars, when he said to me, "I have been in many positions—professor, minister of state, and investigator—and I have seen the world from many points of view If I had to live my life again I would not leave my laboratory The greatest pleasure in my life has been original work, the second greatest that of teaching a class who appreciated what I was telling them" We all know that Dumas was a master in the art of experimental teaching, and those who have practised this art, even at a great distance from the master, will agree with him that the pleasure of giving a well-illustrated experimental lecture on chemistry is not a small one, and even that a man may go on for thirty years and yet not be altogether tired of the job The reason for this is not far to seek Our science in its daily progress constantly opens up new paths which yield matter suitable for lecture experiment, and this gives a zest to the discourse unattainable by the teachers of most other subjects Mr Newth has collected an ample store, and he has described them clearly For the collection he has had favourable opportunity, to begin with he was a distinguished student at Owens, and there he may have picked up a few wrinkles, then he has for many years been Lecture Demonstrator to Frankland and Thorpe, and from them the wrinkles he has picked up have certainly been many But although doubtless some are of his own finding out, I think it would have been well if he had added after the description of each experiment the name of the authority with whom it originated Thus some have been described by the chemists I have named, others owe their existence to Hofmann, Bunsen, and others These additions are not only due to the authors, but would add to the interest of the book. Mr Newth should see to this in the next edition The old booksellers tell us that Faraday's "Manipulations" is a work which no lecturer should be without, and as everything which that prince of experimenters wrote or did is worthy of attention, they speak truly, and yet no modern chemists can be bound by Faraday's experience of sixty years ago Things are not as they were; and the methods of work and the illustrations of chemical phenomena which he details belong to a bygone age. And so Mr. Newth comes forward to give the lecturer of to-day a helping hand The first thing that strikes one on looking through his pages, is how simple are the experiments—so far as illustrating the chemistry of the non-metals goes, and he goes no further—needed to illustrate a course of lectures. We do not require the expensive and delicate instruments of the physicist With glass and india-rubber, as Liebig said, we chemists perform all our mysteries Only in a few cases, as, for instance, when we want to hand round wine-glasses filled with liquefied oxygen or air, or when we desire to show our students free fluorine and such like things, does the apparatus become expensive or the experiments troublesome All the ordinary and many of the extraordinary experiments detailed in the book may be carried out with little cost and without great trouble, indeed most of them may be made by the veriest tyro provided he stick to the letter of the description and does not attempt to vary the proceedings, as one I knew did, who thought that as sulphuric acid is a more powerful desiccating agent than lime, he would dry his ammonia by the former substance instead of by the latter material No account of any experiment, the author tells us, has been introduced upon the authority solely of any verbal or printed description, but every experiment has been the subject of his personal investigation and the illustrations are taken from his original drawings, so that we may be sure that every experiment will "go" if properly managed and fairly dealt with Many of the experiments are, of course, old stagers, but none the less useful, whilst others are new to me and probably to most people To mention many either old or new this is not the place, but one of them, which has struck me as interesting is an easy method of showing the freezing of water by its own evaporation first with a common air-pump, and second with no air-pump at all I always used a Carre's machine, by which a quart of water could be frozen, but Mr Newth gives an excellent description of how a beautiful icicle twenty to thirty centimetres long can be obtained both with and without an air-pump The secret of how to do this can best be learnt by reading pages 57 to 59 of the book "How to float soap bubbles upon carbon dioxide" has often proved a difficult question to answer experimentally, because if you managed, after a score of trials, to free your bubble from the pipe on which you blew it, the bubble usually bursts the moment it touches your heavy gas Mr Newth lets us into the secret You must remove every trace of hydrochloric acid, which is carried over with the gas, by washing, the presence of this acid being fatal to the life of a soap bubble Under chlorine (p 88) a description is given of the mode of sealing up bulbs filled with chlorine and hydrogen This was first done in the early sixties by my old helper and friend Mr. Joseph Heywood, of Owens, to whom both students and lecturers owe many an ingenious and striking experimental illustration As Mr Newth remarks, there are many obvious reasons why the old plan of filling a soda-water bottle with a mixture of equal volumes of the gases and then throwing it out of the lecture-room window into the street, if the sun happened to shine, is "unsuitable for a lecture experiment," and Heywood's bulbs answer the purpose better in all respects. The author does not tell us—as he ought to have done—

that Victor Meyer now seals up bulbs of oxygen and hydrogen (electrolytic gas) in a similar way, and that these, like their confrères of Cl and H, can be kept not only in the dark for any time, but, unlike these, also in the light without undergoing any change. The fact that many gases when perfectly dry do not combine is illustrated by the case of chlorine and metals—brass and sodium, pp 84 and 85—as well as of carbon monoxide and oxygen, for these gases will not explode if dry, p 189 A more striking way of illustrating this latter case than that with the eudiometer is not mentioned I will add it Dry a current of carbonic oxide over glass balls moistened with strong sulphuric acid, light the stream of gas issuing from a horizontal tube, then plunge over the blue flame a cylinder full of air which has been previously dried by shaking it up with a little strong sulphuric acid The flame instantly goes out Another case of the kind observed by Arnold lends itself to a lecture experiment He found that powdered iron will not burn in pure dry oxygen, and in order to be able to estimate hydrogen in iron it was found necessary to insert a small tube containing a drop of water, through which the oxygen passed before coming into contact with the iron, this tube being of course weighed both before and after the experiment This may well be included in the next edition, which I hope will soon be called for Another capital experiment to show that iron can be carbonized by contact with a diamond was recently described to me by Mr Gilbert Fowler, of Owens. A loop of pure thin iron wire is placed in a vertical glass tube surrounded by an atmosphere of hydrogen Below the loop is a splinter diamond (or some diamond dust) placed on the top of a glass rod working through the lower end of the tube After heating the wire by a current to the highest possible temperature without fusion, bring the diamond carefully into contact with the heated iron The metal at once fuses But of good experiments "there is no end" (Mr Newth describes 620 for the non-metals alone) whilst of a review of a book in NATURE there must be a speedy end, and I will end by advising all those who like to see and to show good experiments to get Mr Newth's book

H E ROSCOE

A MANUAL OF PHOTOGRAPHY

A Manual of Photography. By A. Brothers, F R A S (London Charles Griffin and Co, 1892)

MR BROTHERS has in this well-illustrated book brought together a great amount of information relative to the history, processes, apparatus, materials, &c, which will be welcomed by all who are interested, even if only in a general way, in the fascinating art of photography The work covers about 360 pages, is divided into five parts and is accompanied by a full index.

In the short historical sketch which is introduced as the opening chapter, the author by means of quotations and otherwise gain much information which is not readily accessible, and many facts that are not inserted in our treatises, and which consequently are not generally known. At the present day, when so many possess a camera of some sort or other, it is very curious to carry ourselves back to the time of Daguerre and to picture to ourselves the idea which he put forward when he wrote in his pamphlet, "Those persons are deceived who suppose that during a journey they may avail themselves of brief intervals while the carriage slowly mounts a hill to take views of a country" Whether this is or is not the case now we will not stop to discuss, but we may mention that many other very interesting extracts are made from the same source

The next three chapters deal with the chemistry, optics, and light as applied to photography In these there seems to be nothing that calls for special attention, unless it be to state that the author has written them in a charming manner, as for instance the short summary under the heading "Magnesium Light," which one reads with quite renewed interest

Coming now to Part II, Processes, we find the most important section of the whole book. As Mr Brothers rightly observes, the old processes previous to the introduction of the gelatine bromide methods have been put completely in the shade, not because they have been surpassed by better and more trustworthy ones, but simply because they require a little more care in manipulation and consequently the consumption of more time In order to remedy this to some extent he has given great prominence to them, dedevoting nearly 140 pages to them, including working details of the more important later processes For the sake of facility of reference they are arranged in alphabetical order, and in many cases they are accompanied by illustrations which show the actual results that can be obtained by the uses of the methods under consideration To cite them in anything like detail would carry us too far away, but we may mention one or two briefly The (wet) collodion process is of course here fully described the author lays special stress on the advantage of this process, for there is no doubt that where dry plates are now used far better results could be obtained by employing this old wet process The photo-mechanical process, collotype, receives also a rather lengthy description, but its utility and the excellence of the results obtained necessarily give it some prominence A specimen illustration of the last mentioned is inserted, as well as one of a recent application of this method for printing in colour. Printing on wood, photo-lithography, platinotype, &c, together with photogravine Woodbury type and a host of others, are all described, some briefly, others of greater importance somewhat more in full

Parts III and IV deal with the apparatus and materials used in the production of a finished picture In the former the author describes the particular characteristics of many of the various kinds of cameras and accessories, while in the latter are explained the chief uses and actions of the chemicals employed

Part V., the last, contains short notices of the applications to which photography has given rise Astronomical Photography is referred to at some length, and we may mention that we have an excellent reproduction of one of Mr Rutherfurd's beautiful lunar photographs taken at first quarter. The practical

hints in the concluding chapter should be found very serviceable

Mr Brothers has produced a very serviceable and useful addition to our photographic literature; as a handbook for students it perhaps is somewhat too bulky, but nevertheless it will be very much used by them Every photographer who wishes to know something about the art with which he is working, and who does not wish to limit himself to the mere cut and-dried manipulations, should at any rate make himself acquainted with the volume. W J L

MATRICULATION CHEMISTRY

Matriculation Chemistry By Temple Orme (London Lawrence and Bullen, 1892)

THIS is still another elementary manual dealing with the non-metals and their compounds According to the author it can be studied most advantageously if the rudiments of chemistry have first been acquired The book is built on pretty much the same plan as many already in existence, here and there, however, the reading is enlivened by ideas which, if not altogether commendable, have some pretensions to novelty

The author is evidently of opinion that much of the ordinary chemical knowledge can be presented in other ways Mass and weight first receive attention In this book there are no atomic weights, atomic masses reign supreme In using a balance we are told that we do not find weights, but "only masses" Indeed to bring this idea home the following curious question is set —"When you 'weigh' a thing in an ordinary balance, do you find its weight?"

After a passing allusion to constitutional formulæ, in which they are likened to pyrotechnic frames, the next important alteration with which the author concerns himself refers to the nomenclature of oxides Such a name as sulphur dioxide or carbon dioxide is discarded, for it is "founded upon a formula which is liable at any time to be altered so as to suit our knowledge of atoms and molecules" Anhydride is described as, "etymologically at least, a still more atrocious term", hence we find that throughout the book SO_2, CO_2, &c, are spoken of as acids P_2O_5 is said to be a tribasic acid, N_2O_5 a monobasic acid CS_2 is called sulphocarbonic acid, P_2S_5 thiophosphoric acid, N_2O hyponitrous acid, and so forth, in spite of the fact that such compounds as that formed from "hydric oxide and phosphoric acid (*sic*) are often called *acids* by modern chemists"

The definition of a salt is thus summarily disposed of —"You are often asked what a salt is, the only possible answer is that it is a compound"

Such methods of tampering with terms which have a generally-accepted meaning should, it seems to us, meet with no encouragement. They can only end in muddling the reader who wishes to pursue his subject by the aid of any of our standard works But matter which is liable to do more immediate harm is frequently to be noted For instance, it is stated that there is no such thing as the Law of Multiple proportions—it is only a corollary of the atomic theory If, according to its usual interpretation, a law is a generalized statement of fact, it is rather hard to see how its existence is affected by its relations to any theory

To most chemists the brilliant work of Moissan has sufficed to settle the question of the isolation of fluorine, the author is, however, still sceptical on this point P_2O_3 is given as the formula of phosphorous acid (*sic*), recent research has shown P_4O_6 to be correct The valency of potassium is said to have been fixed by a "minute study of its *gaseous* compounds," water is stated to be elastic with regard to *shape*, and from Avrogadro's hypothesis molecules of different gases are stated to be equal in size

Even when the author is apparently trying to be precise he is apt to mislead The following definition is an example —"A chloride means a compound of chlorine with some other substance which, though it is not itself metallic in its general characteristics, possesses that important property of a metal, the capability of uniting *energetically* with chlorine" Is it to be understood from all this that a chlorine compound which is not produced by energetic union—say an endothermic compound like C_2Cl_4—is not a chloride?

These extracts may serve to show that the book requires to be carefully overhauled before it can be placed with confidence in the hands of a beginner

OUR BOOK SHELF

Vegetable Wasps and Plant Worms, a Popular History of Entomogenous Fungi, or Fungi parasitic upon Insects By M C Cooke, M A, LL D, A L S [364 pp 4 pl and figs in text] (London S P C K, 1892)

IT is somewhat surprising that a book on a subject of such importance alike to the entomologist and fungologist has not been forthcoming long ago It is true that a Memoir on the subject was undertaken thirty-five years ago by Mr G R Gray, but, being privately printed, was limited in circulation To this work Dr Cooke admits his indebtedness for a large amount of information bearing on the entomological aspect of the subject, and it is to be regretted that he was not aware of the existence of a much extended manuscript revision of the same work, at present in the Botanical Department, Natural History Museum

Dr Cooke's book is professedly a popular work on the subject, and consequently does not deal with the economic side, relating to such matters as the "muscardine" or silkworm disease, further than to indicate the nature and affinities of the fungus causing the disease

The fungi parasitic upon insects are arranged under four primary groups. the *Cordyceps* group, the *Laboulbeniaceæ*, the *Entomophthoræ*, and lastly a heterogeneous collection of moulds, which, with few exceptions, are not truly parasitic and destructive The structure and general characteristics of these groups, with glimpses of their life-history, are dealt with in an introductory chapter Entomologists, whose main interest will be to ascertain the name of any fungus parasitic on an insect, will find this a comparatively easy matter, as the general arrangement is an entomological one, commencing with the Hymenoptera, and under each is given an account of all the fungi that are known to be parasitic upon species included in the order Numerous woodcuts in the text and four plates assist very materially in the determination of species. From the mycological standpoint the arrangement indicated above is purely artificial, and introduced

for a purpose, while for the benefit of those who desire to know more of the inter-relationship of the fungi enumerated, a classified list is given of all the species, arranged under their respective families, including the distribution and name of the host

For the general reader, who is not specially interested in either insects or fungi, there is a considerable amount of interesting information bearing on such subjects as vegetable caterpillars, vegetable wasps, foul-brood of bees, &c, and the interest is not lessened by following the transition from the romantic and highly imaginative accounts given by early travellers of these productions, to the statements in accordance with modern knowledge There is a slip on p 35, *Cordyceps Sheeringii* should be *C Sherringii* The indices are very complete and the figures, excepting one on p 10, good

Notes on Qualitative Chemical Analysis By P Lakshmi Narasu Nayudu, B A (Madras K Murugesa Chetty, 1892)

IT is interesting to meet with books such as this, which serve to indicate how the study of chemistry is progressing in the colonies and dependencies of the empire

The author sets out with the endeavour to keep the *rationale* of the various processes of qualitative analysis well to the front, as in this way he considers the value of the study as a means of scientific training can alone be brought out Group-reagents and the reasons for their use are first discussed as a preliminary to a somewhat exhaustive study of the reactions of the different basic and acid radicles At the end of each group tables are given showing at a glance the behaviour of the radicles towards the various reagents

It is somewhat astonishing that after such a minute study of the reactions of all the more common radicles, the author should give no schemes for the separation of the constituents of the different group-precipitates In spite of the fact that under each radicle he gives as many, if not more, reactions than are given in the larger works on qualitative analysis, he contents himself with merely going through the examination of a simple salt The expenditure of but little space would remedy this omission, which limits the sphere of usefulness of the book. It is to be noted also that film-tests find no place in the system adopted

It may be said that the author adheres well to his purpose of showing why any particular operation is performed The book contains a large amount of useful information Occasionally, however, the mode in which it is stated is peculiar "In the cold" is an expression commonly used in speaking of a reaction The use of "in the heat," a term often employed by the author, is, on the other hand, uncommon To speak, too, of "neutral solutions of zinc salts containing strong acids" is confusing In some cases, as when using bodies like potassium metantimoniate or sodium hydrogen tartrate, it would be advisable to give the name as well as the formula. it isn't every student who is acquainted with such substances It is erroneous to say that fluorine does not combine with carbon even at a high temperature. According to Moissan, all the allotropes of carbon, except the diamond, unite with fluorine, indeed some of the forms are, in the cold, spontaneously inflammable in the gas

The following typographical errors are omitted in the list of errata. On p. 47 "meterially" should be "materially," "gSo_4," &c should be "$MgSo_4$," &c on p 58, and "Ba_2P_2O" is given for "$Ba_2P_2O_7$" on p 69

Science Instruments. Catalogue of Scientific Apparatus and Reagents manufactured and sold by Brady and Martin. (Newcastle-on-Tyne, 1892)

AT the present time, when almost all branches of experimental science are growing so rapidly, and new and improved pieces of apparatus are continually coming into existence, it is satisfactory to find that instrument makers are trying to keep pace with the times, and to afford purchasers the means of ascertaining with the minimum trouble what apparatus can be obtained to serve a particular end This catalogue is an instance that such is the case It is a well-bound book, profusely and clearly illustrated The different kinds of apparatus, useful both for teaching and for technical purposes, are well classified To prevent mistakes in ordering, each piece of apparatus is separately numbered, and where a new form is figured, a few lines are added explanatory of the principle involved

The instruments quoted belong to various branches of experimental science—chemistry, bacteriology, physics, mechanics, and meteorology A selection of instruments made by the Cambride company, and miscellaneous apparatus, diagrams, chemical reagents, &c, are also included

The sections on bacteriology and gas analysis are especially full, and indicate the interest at present taken in these departments

A table of contents and an index are supplied On p 145 "Irish" is misprinted for "Iris", and what is termed an "optical bank," on p 164, is usually called an "optical bench."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

Universities and Research.

AT the discussion in Edinburgh on the proposed National Laboratory, Lord Kelvin and Sir Geo Stokes took marked exception to my contention that the primary business of Universities was research, contending that it was teaching In a sense their contention is true, but not in contradistinction to my contention The distinction would hardly be worth fighting over were it not that they took up the further ground that only those researches should be engaged in in Universities which were likely to interest the students Of course the leaders of science can if they choose sell the great birthright of Universities for a mess of fees, but I hope they will not be permitted to do so without protest What view the democracy take of Universities is of the very last importance with our democratic institutions, and I trust all those who have the welfare of the nation at heart will protest against the Universities being turned into coach houses In this connection it is most important to bear in mind the distinction between the functions of Universities and those of schools and colleges The function of these latter is primarily to teach those who resort to them The function of the University is primarily to teach mankind In former days, when the means for distributing information were very imperfect, students used to flock from all sides to learn directly from a great mind Nowadays the great mind distributes his teaching broadcast In old days the only way to learn what was being done to advance knowledge was to go to the place where knowledge was being advanced Nowadays we read the Transactions of our learned societies at home. But at all times the greatest men have always held that their primary duty was the discovery of new knowledge, the creation of new ideas for all mankind, and not the instruction of the few who found it convenient to reside in their immediate neighbourhood Not that I desire to minimize the immense importance of personal influence, it is overwhelming; but it is a question quite beside the one at issue, which is whether the advance of knowledge by research and the teaching of the whole nation by the discoveries made is not rather the primary object of Universities than the instruction of the few students who gather in their halls: that is the real question at issue between Lord Kelvin, Sir Geo. Stokes, and myself. Are the Universities to devote the energies of the most advanced intellects of the age to the instruction of the whole nation, or to the instruction of the few

whose parents can afford them an, in some places fancy, education that can in the nature of things be only attainable by the rich?

In view of the discussion upon the proposed Teaching University for London it is to be hoped that these things will not be overlooked amid the local questions and rival institutions It is to be hoped on the one hand that those who will have the privilege of learning in the greatest city in the world will not be deprived of the personal influence of its greatest men by relegating these to some haven of laboratories where no bracing breath of students shall interfere with the inmates On the other hand it is to be hoped that London will so far honour itself as not to be content until it sees its University a centre of thought and investigation from which shall radiate new ideas and discoveries to enlighten and benefit the whole nation Before I close there is a matter of great importance to which I fear sufficient importance is not attached by those who are directing this matter and that is the great objections there are to mixing up Universities and Colleges with examining boards. We here in Trinity College, Dublin, suffer very much from the fact that a considerable number of our students never reside here, but only come over for periodical examinations We only suffer in one way, while if London adopted this abominable arrangement it would suffer in two ways We suffer because our degree is much less valued than it would be if all our students were compelled to reside All our students have not that education got by friction with their fellows and by contact with trained intellects which no examination can test, and which is such a valuable training, and in consequence our degrees are the less valuable London would suffer in this way, and it is a very serious way too In addition to this London would suffer from the inordinate importance that would be attached to extern examiners if the University examined London and extern students So far we have escaped this danger, but it is inevitable in London because the extern element there would be large, influential and organized, while with us it is of little strength The result would be to perpetuate and intensify that horrible teaching for examinations which is so necessary an evil in the case of the majority of students, but from which the leaders of thought should be exempt It matters not that the syllabus nor even that the very questions are approved by the professor, if the examination is conducted to any serious extent by an independent mind The student will seek a coach, who will probably teach him very well indeed, but whose whole view of learning will be of the passing-an examination type, and who will infect his pupil with this miserable disease Gradually the professor himself will be involved in the vortex, and the whole University will gradually look upon the passing of examinations as the end of life for students, and this is the acme of coaching and the bathos of education

GEO FRAS FITZGERALD

Trinity College, Dublin, November 25

The Stars and the Nile

AFTER reading Mr J Norman Lockyer's papers on the connection of the orientation of Egyptian temples with the heliacal rising of certain stars, I was interested to find that a custom still exists in the neighbourhood of the Second Cataract having a strong resemblance to the old Egyptian custom

The Nuba people of this part foretell the first rise of the Nile by the heliacal rising of the Pleiades, or as they call it, "Turáya." For Sirius they have no special name, calling it merely "the driver" or "follower" of the three stars (Orion).

It must be remembered that the first sign of the rise at Wady Halfa occurs at the beginning of June, reaching Assouan about a week later, but for some days the increase is very slow, and scarcely perceptible except in the readings of the Nile gauges.

These Nuba people still preserve in their language many ancient Egyptian words, and possibly we may have here a trace of the old custom, the Pleiades being taken instead of Sirius on account of the earlier date of the rise in the district of the Second Cataract than in Egypt itself.

H G LYONS, Capt. R E

Cairo, November 14.

A Palæozoic Ice-Age

THE account by Dr Wallace in NATURE (p 55) of glacial deposits recently discovered in Australia is a most important and welcome addition to our knowledge But to us the surprising circumstance is that Dr. Wallace appears quite unaware of the fact that this is only an addition to a great series of discoveries, by no means confined to Australia, affording evidence of a Palæozoic ice age That the deposits near Sandhurst are Palæozoic may, in the absence of any indication to the contrary, be assumed, since they are clearly similar in position and character to the well-known boulder beds of Bacchus Marsh, and these have been correlated with the strata containing ice borne fragments, amongst the marine beds west of Sydney and also at Wollongong to the southward, and in Queensland to the northward All these beds have been shown to be upper carboniferous A good account of the facts known up to 1886 may be found in Mr R D Oldham's paper on the Indian and Australian coal-bearing beds (Rec Geo Surv Ind xix p 39).

It is scarcely necessary to refer to the fact that extensive Palæozoic glacial deposits, of the same age as those of Australia, have been found in several parts of India, some as far within the tropic as lat 18° N, others in the Salt Range of the Punjab, that the famous Dwyka conglomerates of South Africa are similar and in all probability contemporaneous, and that boulder beds of very possibly the same geological date have been observed in Brazil We should not have mentioned these but for the fact that the idea of a Palæozoic ice age is apparently novel to Dr Wallace We do not think, however, that the reason why so well-informed a naturalist is unacquainted with geological data long known to many is any mystery. It has become an accepted article of faith amongst most European geologists (there are, of course, exceptions) that no ice age occurred before the last glacial epoch, just as it is part of the geological creed that the carboniferous flora was of world-wide extension, and as it has become the prevailing belief that the deep oceans have been the same since the consolidation of the earth's crust Now the discoverers of glacial evidence in the carboniferous beds of India and Australia also assert that the carboniferous flora of those countries differed *in toto* from that of Europe and resembled the jurassic flora of European regions, and some of them add that the great southern flora of South Africa, India, and Australia must have inhabited a vast continent, part of the area of which is now beneath the depths of the Indian Ocean Partly from Indian and Australian geologists being regarded as heretics geologically, partly from other causes, the evidence of ice action in India and Australia has been generally ignored No better proof could be afforded of the fact that European geologists in general have omitted to notice the series of discoveries in the southern hemisphere and in India than the publication of Dr Wallace's paper

The glacial evidence as it now stands is extremely interesting and perhaps transcends in importance that of the Pleistocene glacial epoch For as the effects of the carboniferous ice-age were felt within the present tropics, either the earth's axis of rotation must have shifted considerably, or else the refrigeration of the surface must have been due to a cause distinct from that supplied by the late Mr Croll's theory, even when supplemented by Sir R Ball's amendment

Our own interest in the whole subject is chiefly due to the circumstance that we happened in 1856 to be the first who met with the ancient boulder-bed in India, and suggested that it might be explained by the action of ice The discoveries in Australia and South Africa were of course quite independent of those in India, but were, we believe, slightly later in date.

November 20 W T BLANFORD

HENRY F BLANFORD

Geology of Scotland.

MAY I supplement Prof. Green's history of geological mapping in Scotland (NATURE, vol xlvii. p. 49) by pointing out that Mr Cruchley published, on March 23, 1840, "A Geological Map of Scotland by Dr MacCulloch, F R.S, &c, published by order of the Lords of the Treasury by S. Arrowsmith, Hydrographer to the King." This fine map is on the scale of four miles to an inch. From the omission of "the late" before MacCulloch's name, it seems possible that the plates were in course of engraving before his death in 1835.

GRENVILLE A J. COLE

Royal College of Science for Ireland, Dublin

British Earthworms

I ENTIRELY concur with Dr. Hurst's view that the supposed new species, described by the Rev Hilderic Friend as *L rubescens* is in reality Savigny's *L festivus* I may add a further reason for discarding the term *L terrestris*, Lin , and substituting *L herculeus*, Sav , for our common large worm Savigny himself used "Enterion terrestre" to indicate a worm differing considerably from *L terrestris*, Lin , in the position and extent of the clitellum , moreover it belongs to the genus *Allolobophora* and not to *Lumbricus* at all

With regard to the second "new" species, *A cambrica*, recently described by Mr Friend, I believe that it is merely a variety of *A chlorotica*, Sav

According to the description it *appears* to differ from the latter species in three points —(1) colour , (2) extent of clitellum , (3) number of spermathecæ

(1) Now, amongst my collection of British worms I find one, of which a water colour sketch taken from the living specimen closely resembles Mr Friend's description of the colour of *A cambrica* My notes as to size, habits, &c , agree with his description I have carefully re examined my specimen, and find that it agrees perfectly with *A chlorotica* , or, in other words, I find that *A chlorotica* may vary—as Hoffmeister knew that it did vary—so much as to resemble *A mucosa*, and I may suggest that it is a mimetic resemblance

(2) Further, with regard to the clitellum of *A chlorotica* , in the table given by the Rev Hilderic Friend, it is stated to cover somites 29-36 As a matter of fact the next somite, 37, is nearly always included This brings *A cambrica*, Friend, into harmony with *A chlorotica*, Sav

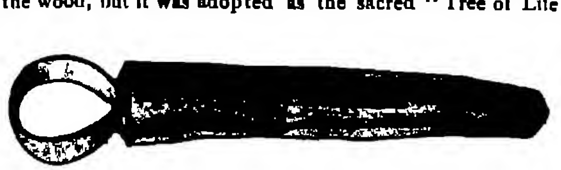
(3) Thus the only differential character left is the number of spermathecæ, and I cannot agree to the validity of a new species on this single character, several specimens should be examined to settle the point, as variation in this feature is known to occur

I take a certain amount of credit to myself for the useful faunistic studies on the earthworms of Great Britain, now being pursued by the Rev Hilderic Friend, for, if I mistake not, I put him in the way of recognizing their specific characters, when, some years ago, I named for him, with remarks thereon, sundry consignments of some scores of worms which he sent to me for that purpose WM BLAXLAND BENHAM

The Dept of Comparative Anatomy, Oxford,
November 21

Egyptian Figs

THE accompanying sketch represents an instrument used in Egypt for removing the "eye" or top of the sycomore fig It is a piece of hoop iron, blunt on one edge and tolerably sharp on the other, and fixed into the end of a stick The fruit of *Ficus sycomorus*, or "Egyptian fig," seems to be invariably infested with the insect *Sycophaga crassipes*, Westw , which I am informed by Rev T. F Marshall, who has kindly given me the name, is the same insect supposed to effect caprification in Malta, judging from specimens which I sent him This fig never produces ripe seed in Egypt, though it has been introduced from the earliest times Not only are the ancient coffins made of the wood, but it was adopted as the sacred "Tree of Life



It probably came from Yemen, where Dr Schweinfurth saw many seedling trees growing spontaneously. The tree bears three crops per annum, in May, June, and August—September. Boys cut off the top of the figs of the first two crops only. Dr E. Sickenberger, one of the professors in the School of Medicine, Cairo, informs me that the figs have no pleasant flavour until the operation has been performed —"They then become very sweet, but remain smaller than when not cut open. The object is *to let the insects escape* Those that are left become watery and tasteless, and are full of *namoos* or sycophaga." In his first description Dr. Sickenberger described the instrument as "a kind of thimble made of iron plate ending in a spatula like a finger-nail. It is fixed on the thumb of the right hand. The operation is only made on fruits which shall be picked up the following day The day after the operation the fig is quite ripe The male flowers in those figs are all aborted, and the females have never perfect seeds The figs of the third generation are larger, of an agreeable taste, and sweet-scented , but they are not operated upon, only because in August and September, though the trees are much fuller of fruit than in May and June, the people have so much to do at that time They are seldom sold, and only eaten by the owners of the trees, or else they are abandoned to the field mice, birds, and dogs, which latter are very fond of them These *nilg* fruits are full of sycophaga '

It will be seen that the instrument he has sent me is of a different shape to the one he describes , and the chief interest lies in the fact that Pliny also describes the process as closely corresponding with this modern method He even uses a similar term "nail" (ὄνυχας) πέπτειν οὐ δύναται ἂν μὴ ἐπικνισθῇ ἀλλ' ἔχοντες ὄνυχας σιδηροῦς ἐπικνίζουσιν ἃ δ' ἂν ἐπικνισθῇ, τετάρταια πέπτεται (*Nat Hist* xiii 14) Further, the Prophet Amos describes himself as *bôlês siqmîm* , and the authors of the LXX, writing in Alexandria, appear to have understood the expression and translated these words by κνίζων συκάμινα This is the same verb as that which Pliny uses , so that it would seem to be pretty certain that Amos performed identically the same operation on the figs as is still done in Egypt at this day It will be noticed that the idea was to ripen the figs It does not really do this, because there are no seeds , but it does make the fig sweeter It also liberates the insects, and without doing this the figs would be uneatable Jerome is the only author, as far as I know, who alludes to "grubs" being inside the fig

GEORGE HENSLOW

Iridescent Colours

THE article "Iridescent Colours" on p 92 puts me in mind of a notice which I published thirty years ago, while I lived in the United States It was entitled "Harmonies of Form and Colour" (*Stettiner Entom Zeitung*, 1862, pp 412–414), and a portion of it refers to the subject of the above-mentioned article in NATURE, and may be of interest to its readers —

"A fundamental observation, which proves the influence of the intensity of light upon colour, may be made on some insects of metallic coloration, inhabiting a large area from north to south About six years ago, while in Southern Russia, I took a walk during sunset, and was struck by the brilliancy of some metallic red *Chrysomelæ*, abundant in that locality I found that it was the common *C. fastuosa*, which I did not recognize at once, because in the environs of St Petersburg, where I lived at that time, it occurs in its metallic-green variety, with an iridescent blue stripe on each of the elytra. Still farther north it assumes a more violet metallic colour. The same is the case with *Chrysomela cerealis* and *C graminis* The first of these species is represented in St Petersburgh in the blue variety (*C ornata*, Ahrens), while the typical variety, occurring farther south, has purplish-red metallic stripes. It is evident therefore that the metallic colouring of these wide-spread species is gradually intensified from north to south, in the order of the colours of the spectrum. We may imagine the area which these beetles occupy, like an immense rainbow, reflected from their backs, violet in the north, red in the south ; the violet perhaps connected in some way with the magnetic phenomena prevailing in the polar regions. The longicorn beetle (*Callidium violaceum*) undergoes the same variation : violet in the north, blue in central Europe." C R OSTEN SACKEN

Heidelberg, Germany, November 27

The Afterglow

THERE has been for three weeks past a very remarkable renewal of the afterglow There is a quite deep secondary red glow after the stars are fully out. I should say that no such afterglow has been seen since 1886, or three years after the Krakatão eruption. There is also a great extension of the white hazy atmospheric corona around the sun, very marked also around the moon. I am unable, however, to make out any of the pink colour on the outer edge of the haze, which was so char-

acteristic of "Bishop's Ring," and distinguishable at Honolulu for two years Apparently there has recently been a great re-inforcement added to the material in the upper atmosphere, which produces the afterglows

Is this owing to the August eruption in Alaska, which is said to have distributed ashes at a distance of 250 miles?

Prof C J Lyons, in charge of tidal observations in Honolulu, reports the period of highest mean tide to have extended itself this year into November, or fourteen months later than the last similar period The mean sea level is now over ten inches higher than it was last April It is also somewhat higher than has been shown by any previous tide registers in Honolulu Mr Lyons regards this as of special importance, taken in connection with the oscillation of the earth's axis, now established by the combined observations at Berlin and Honolulu

Honolulu, November 8 SERENO E BISHOP

OSMOTIC PRESSURE

OF the various properties which have found a common explanation in the new theory of solutions, there are none perhaps to which more interest attaches than to osmotic pressure, and although, on account of the experimental difficulties, the observations as yet accumulated on this subject are but scanty, they have so largely contributed to the novel ideas involved in the new theory, that they merit special attention

Since accounts of osmotic pressure are finding their way into few English text books, it may be worth while glancing at the main features which have led up to the present state of the question

It has long been known that if an aqueous solution—say, of sugar—be separated from pure water by a piece of animal membrane, that movements of the water and of the sugar take place through the membrane If the solution be contained in an open vessel, the base of which is composed of membrane, on partially immersing the vessel in water it is easy to see that more water enters the vessel than solution leaves it The level of liquid within rises above that without the vessel, different pressures being thus set up on opposite sides of the membrane

To this process wherein currents pass through a membranous septum, the terms "osmosis," "osmose," and "diosmose" have been applied The last of these is perhaps to be preferred, as it serves to indicate that two currents are involved in the phenomena Investigations carried out as indicated above were concerned with the measurement of what was termed the "endosmotic equivalent" That is the ratio of the amount of water passing *into* the solution to the amount of dissolved substance passing in the opposite direction Consistent measurements of this quantity could not be obtained, however, for it was found that the nature of the membrane exercised a marked influence upon its magnitude The kind of membrane employed, or, with the same membrane, its thickness or freshness, or even the direction in which water passed through it, was of importance Thus in illustration of the last point, water passes more readily outwards through eel's-skin, more readily inwards through frog's-skin

To obtain quantitative relations in this field it thus became essential to eliminate the influence of the membrane, and more recently this end seems to have been attained by the use of membranes artificially prepared

These artificial membranes differ from those of animal origin in the remarkable particular that although they allow water to pass through, they present a barrier to the passage of certain dissolved substances On this account they have been termed semi-permeable membranes, and by their use measurements of osmotic pressure have been made possible

To carry out such measurements the first point to be solved was to obtain a membrane of sufficient strength The substance which has been found to be most satisfactory as a membrane-former is copper ferrocyanide When aqueous solutions of potassium ferrocyanide and copper sulphate are carefully brought into contact a pellicle of copper ferrocyanide is formed where the two solutions meet In this condition the pellicle is much too fragile to sustain even slight differences of pressure, but by the following simple device, employed first of all by W Pfeffer, satisfactory results have been obtained.

If a cell similar to the ordinary porous pot of a voltaic battery be lowered into a solution of copper sulphate while at the same time a solution of potassium ferrocyanide be poured into its interior, the two solutions meet somewhere within the walls of the cell and deposit a film of copper ferrocyanide Little diaphragms of membrane are thus produced stretching across the pores of the cell-wall, which furnishes the necessary support, and by taking suitable precautions a membrane may thus be obtained capable of withstanding a pressure of several atmospheres

The behaviour of a solution when separated from pure solvent by such a semi-permeable membrane differs markedly from what takes place when an animal membrane is employed In the latter case, at the outset water adds itself to the solution, the level of liquid and the pressure on the solution-side of the membrane thus rise until a maximum pressure-head is attained, which, roughly speaking, is greater the stronger the solution used Seeing, however, that dissolved substance is continually escaping from the solution through the membrane, as soon as the maximum is reached the pressure-head begins to fall until eventually it vanishes, the levels of liquid on either side of the membrane being the same

If, on the other hand, a semi-permeable membrane be employed, as before, a maximum pressure is attained, but since dissolved substance cannot leave the solution, this maximum pressure as well as the concentration of the solution remain constant

When this constant state of things is established the excess of pressure on the solution-side of the membrane over that on the solvent-side, whatever it may mean, is termed the "osmotic pressure" of the solution It is therefore customary to reserve the term osmose to phenomena relating to semi-permeable membranes, diosmose being used in cases where, as with animal membranes, dissolved substance as well as solvent can traverse the membrane. It is obvious that when the pressure is established as indicated above, the original concentration of the solution has been altered by the entrance of solvent, and the observed osmotic pressure refers of course to the solution having the final concentration. If, however, we imagine the vessel containing the solution to be closed at the top, a quantity of air being imprisoned over the solution, pressure may be set up by compressing this air, only a small quantity of solvent being allowed to enter If, further, the air enclosure be tapped by a manometer, measurements of the pressure may be taken, and by making the air enclosure and the volume of the manometer small enough the quantity of solvent entering while pressure is being established may be neglected, the original concentration of the solution remaining practically unaltered This is the principle of the method employed in measuring osmotic pressure in absolute units.

The question now arises, "Are these measurements really independent of the nature of the membrane? Has the difficulty which beset the older experiments been overcome?" To this question an immediate answer is forthcoming, for, as pointed out by Prof Ostwald, it follows from theoretical considerations that if the membrane employed is really semi-permeable, the observed osmotic pressure of a given solution must be the same, no matter of what material the membrane is com-

posed For suppose we have a quantity of solution enclosed in a tube, one end of the tube being closed by a membrane A, the other by a membrane B, and suppose it possible that a pressure P can be developed on the membrane A when it separates the solution from pure water, which is higher than the pressure p similarly developed when B separates the solution from pure water On immersing the tube in water, the latter will begin to pass through both membranes into the solution When the pressure p is attained passage through B will stop, but that through A will continue, but as soon as the pressure on the solution rises above p, water will be forced out through B The pressure P will thus never be attained, water will continuously enter through A, and pass out at B We will thus have a machine capable of doing an infinite amount of work, which is impossible. Similar reasoning shows that p cannot be greater than P, it follows therefore that the pressure developed on each membrane is the same, that the osmotic pressure must be independent of the nature of a truly semi-permeable membrane

Actual observations are on record in which the osmotic pressure did appear to vary with the membrane employed A sugar solution, for example, exhibited a much lower osmotic pressure with a membrane of Prussian blue or calcium phosphate than with copper ferrocyanide From the preceding argument it is concluded, however, that these membranes giving the lower values were not quite firm or not quite impermeable to the dissolved substance; the highest value is thus taken as the measure of the osmotic pressure which is nearest the truth

On glancing at the results which have been obtained, the first point which strikes one is the extraordinary magnitude of the pressures thus set up In the case of a 1 per cent. aqueous solution of nitre the pressure attains the value of 2½ atmospheres This value increases with the strength of the solution till at 3 3 per cent it is no less than 6 atmospheres, this pressure being the highest which any membrane yet prepared has been able to withstand With substances like sugar, other things being the same, the pressure is not so great, but in all cases, in order to keep it within workable limits, the solutions employed have to be dilute

Striking as the results are themselves, their explanation is not less remarkable The original measurements of osmotic pressure were made with the purpose of elucidating the movement of liquids in plant cells, and naturally the substances examined were such as occur in the vegetable organism—aqueous solutions of sugar, gum, dextrin, and the nitrate, sulphate, and tartrate of potassium For some years after these observations were made, they lay comparatively unnoticed, until Prof van't Hoff, of Amsterdam, turned them to a use undreamt of by their discoverer From a study of the properties of dilute solutions van't Hoff came to the conclusion that the osmotic pressure was due to the bombardment of the molecules of the *dissolved substance* on the semi-permeable membrane. For when the osmotic pressure is established and equilibrium exists between solvent and solution, in the same time, equal amounts of solvent, must pass in either direction through the membrane and the impacts of the solvent molecules on the membrane will then be equal and opposed on either side, and therefore negligible On this reasoning the pressure recorded on the manometer is taken to be that exerted by the substance in solution

On examining the magnitude of the pressure thus attributed to the dissolved substance, in the case of a solution of sugar van't Hoff next showed that it bore the closest resemblance to the pressure of a gas Indeed, if we calculate the pressure of a gas which at the same temperature contains as many molecules per unit volume as there are molecules of sugar per unit volume of solution, then the pressure of the gas and the osmotic pressure are the same. Moreover, on thermodynamical grounds it was established that on the above hypothesis as to the nature of osmotic pressure its magnitude should be quantitatively connected with measurements of other physical properties of solutions, more especially those on the lowering of the vapour-pressure, and of the freezing point of a solvent produced by the presence of dissolved material In this way a mass of evidence was collected, a general survey of which led to the foundation of the new theory of solutions On this theory the dissolved substance, if the solution be dilute, is supposed to behave as if it were gaseous, the pressure it exerts—the osmotic pressure—being equal to the pressure which it would exert if it were gasified, and occupying, at the same temperature, a volume equal to the volume of the solution

Unfortunately measurements of osmotic pressure have only been made on few substances, and only for solutions in water, but on turning to all the available observations to see how they support this novel conclusion, the most superficial examination serves to show that an agreement does not exist Unless in the case of sugar, for no substance of known formula which has yet been investigated does the osmotic pressure agree with the corresponding gaseous pressure These substances consist of salt solutions, and they invariably give higher osmotic pressures than theory demands Similar disturbing influences have been observed when other physical properties of these solutions were measured, and to account for the facts an additional hypothesis has been put forward by Dr Svante Arrhenius

Salt solutions are electrolytes, they conduct the electric current, and undergo simultaneous chemical decomposition into their constituent ions Experiment shows that such electrolytic solutions give high osmotic pressures, more particles appear to bombard the semi-permeable membrane than if the dissolved substance behaved as a gas The new hypothesis states that this is really the case, the additional number of particles being produced from the breaking up of the dissolved substance It states that in a solution which can be electrolyzed a portion at least of the dissolved substance exists already decomposed or dissociated into its ions, and that although these ions cannot be separated by diffusion they are so far independent that each can exercise an effect on the semi-permeable membrane

The extent of this electrolytic dissociation is supposed to vary with the chemical nature of the dissolved substance, and to increase with the dilution In very dilute solutions it may be complete, the whole of the dissolved substance being supposed to exist in the state of ions

The second hypothesis gives, therefore, some explanation why the osmotic pressure of a salt solution is greater than that of a non-electrolytic solution of sugar, it further fixes the limits between which the osmotic pressure ought to vary in the case of an electrolyte, for the lower limit should be that of undissociated gas, the higher should be that of completely dissociated gas, each original molecule having decomposed into as many submolecules as there are ions in each molecule of salt

So far as these limiting conditions go, the facts support the hypothesis In all cases the observed osmotic pressure is either equal to one or other of the limits, or lies between them A closer scrutiny leads, nevertheless, to apparent discrepancy. It is evident that a measure of the amount of dissociation can be obtained from osmotic pressure observations. For if we divide the observed osmotic pressure by the corresponding pressure of undissociated gas we have obviously, if the preceding hypotheses are valid, the ratio of the actual number of bombarding molecules to the theoretical number had no dissociation occurred The ratio of these two numbers is denoted by the letter "i," a factor first used by van't Hoff. Now, on the new theory, the value of "i" can be

obtained by measurements of other properties of salt solutions, the electric conductivity, the depression of the freezing point, &c, and the theory is compared with practice by seeing if the values of "*i*," as determined, say, from freezing point observations, agree with those deduced from the osmotic pressure The comparison shows that in some cases, some half-a-dozen in all, the two sets of values correspond, in others, and in by far the majority, no such correspondences exist In these latter instances it is argued, and with a certain amount of experimental evidence, that the salts were not without action on the membrane employed, and that, therefore, diosmose really took place, the membrane was not truly semipermeable In this way the discordant observations have been put out of court.

It is thus apparent that the leading hypotheses of the new theory do not receive confirmation of the weightiest kind from observations on osmotic pressure. Indeed, were they supported by such measurements alone, they would hardly be entertained Their mainstay, however, lies in the mass of experimental work on many other properties—evidence which it is much easier to obtain than the difficult measurements on osmotic pressure—which has been correlated and explained by their use been put forward in favour of the gaseous analogy Several physicists, starting from entirely different points of view, have arrived at the result that in a dilute solution the dissolved substance should obey laws similar to those which hold for gases At present the attitude of the prominent upholders of the new theory is one of indifference as to the exact mechanism of osmotic pressure. The numerical agreement between the measurements on solutions and those on gases is regarded as ample justification for considering dissolved substances to be in a *pseudo*-gaseous condition

Whatever the ultimate explanation of the facts may be, there can be no doubt that the existing speculations on the nature of osmotic pressure and allied phenomena have infused new life into the study of solutions Indeed, as instigators to fresh inquiry these hypotheses must take rank as the most fruitful of recent times.

J. W RODGER

A SANITARIAN'S TRAVELS

MR ROBERT BOYLE has travelled round the world no fewer than four times for the purpose of studying sanitary science and preparing the way for the intro-

GREAT RECUMBENT FIGURE OF BUDDHA, PEGU, BURMAH

It is only fair to add that both hypotheses, from physical as well as chemical standpoints, have met with a measure of adverse criticism The *rôle* played by the membrane has also been questioned It has been suggested that it is not really semi-permeable, allowing solvent only to pass, but just as a porous plug behaves towards a mixture of gases, it allows molecules with different momenta to traverse it at different rates Or, again, its action has been likened to that of a palladium film towards hydrogen, compounds being formed with the membrane substance on one side, these becoming diffused and dissociated on the other If either of these views be correct the pressures exerted by dissolved substances have probably never been measured

On the other hand, important theoretical support has duction of the ventilating and sanitary appliances he has invented. An interesting account of his fourth journey is given in a little book entitled "A Sanitary Crusade through the East and Australasia," consisting of a series of papers reprinted from the *Building News* In the course of this "crusade" Mr Boyle visited Burmah, the Malay native states, Sumatra, Siam, Borneo, Java, Australia, New Zealand, Samoa, the Sandwich Islands, and America. Of all the facts noted by him as a sanitarian the most remarkable are those relating to leprosy, a disease which he believes to be spreading to an alarming extent all over the world. He was particularly struck by the gigantic proportions the evil has assumed in Burmah The steps of the great Shwedagon pagoda at Rangoon, the Mecca of the Indo-Chinese Buddhists, he found to be

"closely lined from top to bottom with lepers, suffering from that loathsome disease in its worst forms and most advanced stages" A number of the victims examined by Mr Boyle "presented a most sickening and awful spectacle" Yet no provision worthy of the name appears to be made for the maintenance or treatment of these poor lepers, who are thus compelled to resort to begging to keep themselves in existence At Mandalay Mr Boyle came in contact with horrors of a similar nature During times of high festival the entrances of the great Arakan pagoda in that city are crowded by hundreds of lepers, so that the visitor has to pick his way carefully among them. In the Sandwich Islands also Mr Boyle was strongly impressed by the terrible effects of the curse of leprosy, which, he says, has nearly decimated the native population

He has a curious theory to the effect that the propagation of leprosy has been to a large extent connected with cannibalism, the disease "being spread wholesale through the eating of infected bodies" He has frequently seen in New Caledonia and the South Sea Islands human bodies "hanging up in the natives' huts, intended for future repasts, though then in an advanced stage of decomposition and exhaling a sickening odour"

The little book is by no means occupied only with these terrible subjects Reference is made to many interesting things which came under Mr Boyle's observation in the course of his journey We may especially note the impression produced upon him by Buddhist temples and various classes of objects associated with Buddhism in Burmah Pagan, an ancient capital of Burmah, situated on the Irrawaddy between Mandalay and Rangoon, contains an enormous number of Buddhist temples of various sizes and styles of architecture, and the city, as seen from the river, is described by Mr Boyle as "one of the grandest and most impressive sights he has ever seen." Lower down the Irrawaddy below Prome there is a cliff about two miles long and 300 feet high, on the face of which are carved innumerable figures of Buddha ranged in tiers from the bottom to the top He thinks that some of these figures cannot be less than twenty feet high Many of them are richly gilded, and the whole forms "a very brilliant and curious sight" We reproduce an illustration showing the great recumbent figure of Buddha, in the province of Pegu, of which Mr Boyle reports that "it is said to measure about 270 feet in length by 70 feet at the shoulder" In a paper read lately before the Anthropological Institute (see NATURE, November 10, p 46) Major R C Temple gives the length as 181 feet and the height at the shoulder as 46 feet This remarkable monument is built of brick, and Major Temple speaks of it as "well proportioned throughout." It is supposed to have been produced in the fifteenth century It was hidden from view by jungle until 1881, when it was accidentally discovered by a railway contractor

GAUSS AND WEBER

IN bringing before our readers the contents of a circular we have received with respect to the erection of a monument, in Gottingen, to the two world-renowned scientific workers and friends, Charles Frederick Gauss and William Weber, we do so, knowing that every scientific man, whether he be astronomer, mathematician, or physicist, will be only too glad to have a chance of paying some tribute, however slight, to their memory

Only about a year has gone by since the younger of the two, William Weber, passed away, having brought glory to the University of Göttingen, which was radiated throughout the whole scientific world. The work which both have done in the service of science cannot be said to be the property of their followers alone, but is a precious heirloom of mankind, which has proved, and will continue to prove in the future, valuable in many ways in the service of Technics, in methods of communication, and in civilization generally

Gauss, who is almost unequalled among the scholars of the century, has not only left imposing landmarks of his great mind in all domains of pure mathematics, but he has also by his work furthered all departments of its applications in astronomy and physics, while his investigations have become standard for the theoretical as well as for the observational side

What Gauss did for magnetism, Weber, whom Gauss had chosen for his fellow worker, attracted by his useful work on acoustics, did for the strength of galvanic currents, for their impelling electromotive forces, and for their resistances

Further, in teaching how to measure these quantities in absolute units, he has furnished extremely important methods for their investigation In this way not only has the science itself been furthered, but a firm basis for the development of electro-technics has been formed, the soundness of which is proved by its general adoption and which has contributed greatly to the tremendous advance witnessed during the last ten years The pamphlet then goes on to say "It is not the purpose of these lines to enlarge on the eminent works which we owe to the co-operation of these great investigators, we can only call to mind the fertile researches on the laws of the earth's magnetism, from which as it were a new branch of physics has developed; further, the attempts to encompass the phenomena of electrostatics, electrodynamics, and induction by one single law, attempts which, however a future generation may judge of them, will mark an important epoch in scientific development, and further, we may recall the most popular result of their co-operation, viz the erection of the first telegraph practically adopted for communication at a distance"

Since the year 1877 the birthplace of Gauss has possessed a memorial of him, but Göttingen, the place where he and Weber worked, and where the former died, and which consequently became celebrated, possesses no such memorial That this should be remedied is the object of this circular, and one has only to glance down the list of names attached to it—about 275 altogether—to see that it includes most of the learned men in Germany, and those of many distinguished foreigners Among these we are glad to see the name of Lord Kelvin, President of the Royal Society

The acting committee is composed of Prof Klein, E v Meier (Curator of the University), F Merkel (Prorector of the University), G Merkel (Over-burgomaster), Profs E Riecke, E. Schering, W Schur, W Voigt, H Weber, and S Benfey (banker), and it is to the last mentioned that subscriptions should be addressed (S Benfey, Bankgeschäft, Göttingen) The list will remain open until April 1, 1893

THE ANNIVERSARY OF THE ROYAL SOCIETY

YESTERDAY being St. Andrew's Day the anniversary meeting of the Royal Society was held in their apartments at Burlington House. The auditors of the Treasurer's accounts having read their report, and the Secretary having read the list of Fellows elected and deceased since the last anniversary, the President (Lord Kelvin) proceeded to deliver the anniversary address. The medals were then presented as follows —The Copley Medal to Prof Rudolf Virchow, For.Mem.R.S (received by the Foreign Secretary), for his investigations in Pathology, Pathological Anatomy, and Prehis-

toric Archæology; the Rumford Medal to Mr Nils C Dunér (received by the Swedish Minister), for his Spectroscopic Researches on Stars; a Royal Medal to Mr J N Langley, F R.S, for his work on Secreting Glands, and on the Nervous System, a Royal Medal to the Reverend Prof Pritchard, F R.S, for his work on Photometry and Stellar Parallax, the Davy Medal to Prof François Marie Raoult, of Grenoble, for his researches on the Freezing Points of Solutions, and on the Vapour Pressures of Solutions; and the Darwin Medal to Sir J D Hooker, F R S, on account of his important contributions to the progress of Systematic Botany, as evidenced by the "Genera Plantarum" and the "Flora Indica," but more especially on account of his intimate association with Mr Darwin in the studies preliminary to the "Origin of Species"

The Society next proceeded to elect the Officers and Council for the ensuing year The following is a list of those elected —President · The Lord Kelvin Treasurer Sir John Evans Secretaries Prof Michael Foster, The Lord Rayleigh Foreign Secretary Sir Archibald Geikie Other Members of the Council Capt William de Wiveleslie Abney, Sir Benjamin Baker, Prof Isaac Bayley Balfour, William Thomas Blanford, Prof George Carey Foster, Richard Tetley Glazebrook, Frederick Ducane Godman, John Hopkinson, Prof Joseph Norman Lockyer, Prof John Gray McKendrick, William Davidson Niven, William Henry Perkin, Rev Prof B Price, The Marquis of Salisbury, Adam Sedgwick, Prof William Augustus Tilden

In the evening the Fellows and their friends dined together at the Whitehall Rooms, Hôtel Métropole

The following is the address delivered at the anniversary meeting by Lord Kelvin —

Since our last Anniversary Meeting, the Royal Society has lost 27 Fellows on the Home list, and 5 Foreign Members, a sadly great number

Pedro (Dom) II. (d'Alcantara), Emperor of Brazil, December 5, 1891
Ramsay, Sir Andrew Crombie, December 9, 1891, aged 77
Stas, Jean Servais, December 13, 1891, aged 78
Bennett, Sir James Risdon, December 14, 1891, aged 82
Devonshire, William Cavendish, 7th Duke of, December 21, 1891, aged 83
Russell, William Henry Leighton, December 28, 1891, aged 68
Kronecker, Leopold, December 29, 1891
Wood, John, December 29, 1891, aged 66.
Airy, Sir George Biddell, January 2, 1892, aged 90
Henry, William Charles, January 7, 1892, aged 88.
Quatrefages de Bréau, Jean Louis Armand de, January 12, 1892, aged 81.
Adams, John Couch, January 21, 1892, aged 72
Paget, Sir George Edward, January 29, 1892, aged 83
Caird, Right Hon. Sir James, February 9, 1892, aged 76
Dittmar, William, February 9, 1892, aged 59.
Grant (Lieut -Col), James Augustus, February 11, 1892, aged 65
Hunt, Thomas Sterry, February 12, 1892, aged 66
Bates, Henry Walter, February 16, 1892, aged 67.
Hirst, Thomas Archer, February 16, 1892, aged 61
Kopp, Hermann Franz Moritz, February 20, 1892, aged 75
Gregory, Right Hon Sir William Henry, March 6, 1892, aged 75.
Knowles, Sir Francis Charles, March 19, 1892, aged 90
Bowman, Sir William, Bart., March 29, 1892, aged 76
Hofmann, August Wilhelm von, May 5, 1892, aged 74
Thomson, James, May 8, 1892, aged 71
Bramwell, George William Wilsher, Lord, May 9, 1892, aged 84.
Aitken, Sir William, June 25, 1892, aged 67
Schorlemmer, Carl, June 27, 1892, aged 58
Clark, Frederick Le Gros, July 19, 1892, aged 82
Sherbrooke, Robert Lowe, Viscount, July 27, 1892, aged 81
Sutherland, George Granville William Sutherland-Leveson Gower, Duke of, September 22, 1892, aged 64.
Tennyson, Alfred, Lord (Poet Laureate), October 6, 1892, aged 83
Calver (Captain), Edward Killick, October 28, 1892.
Biographical notices will appear in the Proceedings

During the past year, in the mathematical and physical section of the "Philosophical Transactions," eighteen papers have been published, and in the biological section, eleven, the two sections together containing a total of 1235 pages of letterpress and 50 plates Of the "Proceedings," fourteen numbers have been issued, containing 1223 pages and 20 plates This unusually large bulk is partly accounted for by the publication in the "Proceedings" of certain extra matters which the Council deemed likely to interest the Fellows One part (No 307), which forms an appendix to volume l, contains results of the Revision of the Statutes, to which I alluded in my Anniversary Address last year It consists of a summary of the second and third chapters, and a copy of the Statutes as now revised, followed by an interesting note on the history of the Statutes, which has been drawn up by our senior secretary, Prof Michael Foster In addition to these matters, the same number contains a complete list of the portraits and busts at present in the apartments of the Society, compiled by order of the Library Committee, a work which was much needed, as no such list had been made since Weld's Catalogue, printed thirty two years ago The new "list" is not a descriptive catalogue, but the names of the painters and donors, and the dates of the gifts, so far as a thorough and somewhat laborious examination of the Council minutes and Journal books has revealed them, are furnished The list of portraits is followed by a full descriptive catalogue of the medals at present in the possession of the Society, which has been carefully made by our clerk, Mr James, under the supervision of the treasurer.

Another extra number of the "Proceedings" (No. 310) is devoted to a First Report of the Water Research Committee on the Present State of our Knowledge concerning the Bacteriology of Water, by Profs Percy Frankland and Marshall Ward It contains 96 pages, full of most valuable information regarding the vitality of micro-organisms in drinking water, to which in a large measure the spread of Asiatic cholera, typhoid fever, and other zymotic diseases is now known to be due

In my Presidential Address of last year, I referred to this Water Committee as having been appointed by the Royal Society, in alliance with the London County Council, and this first instalment of its work seems amply to justify its originators in their expectations of results, most valuable for the public health, from the investigation which has been commenced.

A third extra number (No 311) contains the report of the Committee on Colour Vision. This Committee, from the time of its appointment in March, 1890, held over thirty meetings, in course of which it examined more than 500 persons as to their colour vision, and tried various methods and many kinds of apparatus for colour testing The report of the results of the whole inquiry contains a large mass of most interesting matter, and the Committee's work ends in a set of practical recommendations, from which we may hope that much benefit will come, in the prevention of inconvenience and disaster liable to be produced by mistake of colour signals, both at sea and on railways

Mr Ellis's communication (Roy Soc. Proc, November, 1892, vol lii, p. 191) to the Royal Society of last May, and Prof. Grylls Adams' communication (Phil Trans, vol. clxxxiii. 1891–92, p 131) of June, 1891, both on the subject of simultaneous magnetic disturbances found by observations at magnetic observatories in different parts of the world; the award of a Royal medal two years ago to Hertz, for his splendid experimental work on electro-magnetic waves and vibrations, and Prof. Schuster's communication (Phil Trans vol. clxxx. 1889, p 467) to the Royal Society, of June, 1889, on the "Diurnal Variations of Terrestrial Magnetism," justify me in saying a few words on the present occasion regarding terrestrial magnetic storms, and the hypothesis that they are due to magnetic waves emanating from the sun.

Guided by Maxwell's "electro-magnetic theory of light," and the undulatory theory of propagation of magnetic force which it includes, we might hope to perfectly overcome a fifty years' out-

standing difficulty in the way of believing the sun to be the direct cause of magnetic storms in the earth, though hitherto every effort in this direction has been disappointing. This difficulty is clearly stated by Prof W. G. Adams, in the following sentences, which I quote from his Report to the British Association of 1881 (p. 469) "On Magnetic Disturbances and Earth Currents" — "Thus we see that the magnetic changes which take place at various points of the earth's surface at the same instant are so large as to be quite comparable with the earth's total magnetic force; and in order that any cause may be a true and sufficient one, it must be capable of producing these changes rapidly."

The primary difficulty, in fact, is to imagine the sun a variable magnet or electro-magnet, powerful enough to produce at the earth's distance changes of magnetic force amounting, in extreme cases, to as much as 1/20, or 1/30, and frequently, in ordinary magnetic storms, to as much as 1/400 of the undisturbed terrestrial magnetic force

The earth's distance from the sun is 228 times the sun's radius, and the cube of this number is about 12,000,000. Hence, if the sun were, as Gilbert found the earth to be, a globular magnet, and if it were of the same average intensity of magnetisation as the earth, we see, according to the known law of magnetic force at a distance, that the magnetic force due to the sun at the earth's distance from it, in any direction, would be only a twelve-millionth of the actual force of terrestrial magnetisation at any point of the earth's surface in a corresponding position relatively to the magnetic axis Hence the sun must be a magnet[1] of not much short of 12,000 times the average intensity of the terrestrial magnet (a not absolutely inconceivable supposition, as we shall presently see) to produce, by direct action simply as a magnet, any disturbance of terrestrial magnetic force sensible to the instruments of our magnetic observatories.

Considering probabilities and possibilities as to the history of the earth from its beginning to the present time, I find it unimaginable but that terrestrial magnetism is due to the greatness and the rotation of the earth. If it is true that terrestrial magnetism is a necessary consequence of the magnitude and the rotation of the earth, other bodies comparable in these qualities with the earth, and comparable also with the earth in respect to material and temperature, such as Venus and Mars, must be magnets comparable in strength with the terrestrial magnet, and they must have poles similar to the earth's north and south poles on the north and south sides of their equators, because their directions of rotation, as seen from the north side of the ecliptic, are the same as that of the earth It seems probable, also, that the sun, because of its great mass and its rotation in the same direction as the earth's rotation, is a magnet with polarities on the north and south sides of its equator, similar to the terrestrial northern and southern magnetic polarities. As the sun's equatorial surface-velocity is nearly four and a half times the earth's, it seems probable that the average solar magnetic moment exceeds the terrestrial considerably more than according to the proportion of bulk Absolutely ignorant as we are regarding the effect of cold solid rotating bodies such as the earth, or Mars, or Venus, or of hot fluid rotating bodies such as the sun, in straining the circumambient ether, we cannot say that the sun might not be 1000, or 10,000, or 100,000 times as intense a magnet as the earth It is, therefore, a perfectly proper object for investigation to find whether there is, or is not, any disturbance of terrestrial magnetism, such as might be produced by a constant magnet in the sun's place with its magnetic axis coincident with the sun's axis of rotation Neglecting for the present the seven degrees of obliquity of the sun's equator, and supposing the axis to be exactly perpendicular to the ecliptic, we have an exceedingly simple case of magnetic action to be considered: a magnetic force perpendicular to the ecliptic at every part of the earth's orbit and varying inversely as the cube of the earth's distance from the sun The components of this force parallel and perpendicular to the earth's axis are, respectively, 0.92 and 0.4 of the whole, of which the former could only be perceived in virtue of the varying distance of the earth from the sun in the course of a year; while the latter would give rise to a daily variation, the same as would be observed if the red ends of terrestrial magnetic needles were attracted towards an ideal star of declination 0° and right ascension 270°. Hence, to discover the disturbances of terrestrial magnetism, if any there are, which are due to direct action of the sun as a magnet, the photographic curves of the three magnetic elements given by each observatory should be analysed for the simple harmonic constituent of annual period and the simple harmonic constituent of period equal to the sidereal day. We thus have two very simple problems, each of which may be treated with great ease separately by a much simplified application of the principles on which Schuster has treated his much more complex subject, according to Gauss' theory as to the external or internal origin of the disturbance, and Prof. Horace Lamb's investigation of electric currents induced in the interior of a globe by a varying external magnet. The sidereal diurnal constituent which forms the subject of the second of these simplified problems is smaller, but not much smaller, than the solar diurnal term which, with the solar semi-diurnal, the solar ter-diurnal, the solar quarter-diurnal constituents form the subjects of Schuster's paper. The conclusion at which he has arrived, that the source of the disturbance is external, is surely an ample reward for the great labour he has bestowed on the investigation hitherto, and I hope he may be induced to undertake the comparatively slight extension of his work which will be required for the separate treatment of the two problems of the sidereal diurnal and the solar annual constituents, and to answer for each the question:—Is the source external or internal?

But even though external be the answer found in each case, we must not from this alone assume that the cause is direct action of the sun as a magnet The largeness of the solar semi-diurnal, ter diurnal, and quarter-diurnal constituents found by the harmonic analysis, none of which could be explained by the direct action of the sun as a magnet, demonstrate relatively large action of some other external influence, possibly the electric currents in our atmosphere, which Schuster suggested as a probable cause. The cause, whatever it may be, for the semi-diurnal and higher constituents would also probably have a variation in the solar diurnal period on account of the difference of temperature of night and day, and a sidereal and annual period on account of the difference of temperature between winter and summer.

Even if, what does not seem very probable, we are to be led by the analysis to believe that magnetic force of the sun is directly perceptible here on the earth, we are quite certain that this steady force is vastly less in amount than the abruptly varying force which, from the time of my ancestor in the Presidential Chair, Sir Edward Sabine's discovery,[1] forty years ago, of an apparent connection between sunspots and terrestrial magnetic storms, we have been almost compelled to attribute to disturbing action of some kind at the sun's surface.

As one of the first evidences of this belief, I may quote the following remarkable sentences from Lord Armstrong's Presidential Address to the British Association at Newcastle, in 1863:—

"The sympathy also which appears to exist between forces operating in the sun and magnetic forces belonging to the earth merits a continuance of that close attention which it has already received from the British Association, and of labours such as General Sabine has, with so much ability and effect, devoted to the elucidation of the subject I may here notice that most remarkable phenomenon which was seen by independent observers at two different places, on September 1, 1859. A sudden outburst of light, far exceeding the brightness of the sun's surface, was seen to take place, and sweep like a drifting cloud over a portion of the solar face This was attended with magnetic disturbances of unusual intensity, and with exhibitions of aurora of extraordinary brilliancy. The identical instant at which the effusion of light was observed was recorded by an abrupt and strongly-marked deflection in the self-registering instruments at Kew. The phenomenon as seen was probably only part of what actually took place, for the magnetic storm in the midst of which it occurred commenced before, and continued after the event If conjecture be allowable in such a case, we may suppose that this remarkable event had some connection with the means by

[1] The moon's apparent diameter being always nearly the same as the sun's, the statements of the last four sentences are applicable to the moon as well as to the sun, and are important in connection with speculation as to the cause of the lunar disturbance of terrestrial magnetism, discovered nearly fifty years ago by Kreil and Sabine.

[1] Communication to the Royal Society, March 18, 1852 (*Phil. Trans.*, vol. cxlii. p. 143).

which the sun's heat is renovated. It is a reasonable supposition that the sun was at that time in the act of receiving a more than usual accession of new energy; and the theory which assigns the maintenance of its power to cosmical matter, plunging into it with that prodigious velocity which gravitation would impress upon it as it approached to actual contact with the solar orb, would afford an explanation of this sudden exhibition of intensified light, in harmony with the knowledge we have now attained, that arrested motion is represented by equivalent heat."

It has certainly been a very tempting hypothesis, that quantities of meteoric matter suddenly falling into the sun is the cause, or one of the causes, of those disturbances to which magnetic storms on the earth are due. We may, indeed, knowing that meteorites do fall into the earth, assume without doubt that much more of them fall, in the same time, into the sun. Astronomical reasons, however, led me, long ago to conclude that their quantity annually, or per century, or per thousand years, is much too small to supply the energy given out by the sun in heat and light radiated through space, and led me to adopt unqualifiedly Helmholtz's theory, that work done by gravitation on the shrinking mass is the true source of the sun's heat, as given out at present, and has been so for several hundred thousand years, or several million years. It is just possible, however, that the outburst of brightness described by Lord Armstrong may have been due to an extraordinarily great and sudden falling in of meteoric matter, whether direct from extraplanetary space, or from orbital circulation round the sun. But it seems to me much more probable that it was due to a refreshed brightness produced over a larger area of the surface than usual by brilliantly incandescent fluid rushing up from below, to take the place of matter falling down from the surface, in consequence of being cooled in the regular *régime* of solar radiation. It seems, indeed, very improbable that meteors fall in at any time to the sun in sufficient quantity to produce dynamical disturbances at his surface at all comparable with the gigantic storms actually produced by hot fluid rushing up from below, and spreading out over the sun's surface.

But now let us consider for a moment the work which must be done at the sun to produce a terrestrial magnetic storm. Take, for example, the magnetic storm of June 25, 1885, of which Adams gives particulars in his paper of June, 1891 (Phil. Trans., p. 139 and Pl. 9). We find at eleven places, St. Petersburg, Stonyhurst, Wilhelmshaven, Utrecht, Kew, Vienna, Lisbon, San Fernando, Colaba, Batavia, and Melbourne, the horizontal force increased largely from 2 to 2.10 p.m., and fell at all the places from 2.10 to 3 p.m., with some rough ups and downs in the interval. The storm lasted altogether from about noon to 8 p.m. At St. Petersburg, Stonyhurst, and Wilhelmshaven, the horizontal force was above par by 0.00075, 0.00088, and 0.00090 (C.G.S. in each case) at 2.10 p.m., and below par by 0.0007, 0.00066, 0.00075 at 3 o'clock. The mean value for all the eleven places was nearly 0.0005 above par at 2h. 10m., and 0.0005 below par at 3h. The photographic curves show changes of somewhat similar amounts following one another very irregularly, but with perfectly simultaneous correspondence at the eleven different stations, through the whole eight hours of the storm. To produce such changes as these by any possible dynamical action within the sun, or in his atmosphere, the agent must have worked at something like 160 million million million million horse-power[1] (12×10^{35} ergs per sec.), which is about 364 times the total horse-power (3.3×10^{33} ergs per sec.) of the solar radiation. Thus, in this eight hours of a not very severe magnetic storm, as much work must have been done by the sun in sending magnetic waves out in all directions through space as he actually does in four months of his regular heat and light. This result, it seems to me, is absolutely conclusive against the supposition that terrestrial magnetic storms are due to magnetic action of the sun; or to any kind of dynamical action taking place within the sun, or in connection with hurricanes in his atmosphere, or anywhere near the sun outside.

It seems as if we may also be forced to conclude that the supposed connection between magnetic storms and sun-spots is unreal, and that the seeming agreement between the periods has been a mere coincidence.

We are certainly far from having any reasonable explanation of any of the magnetic phenomena of the earth; whether the fact that the earth is a magnet; that its magnetism changes vastly, as it does from century to century; that it has somewhat regular and periodic annual, solar diurnal, lunar diurnal, and sidereal diurnal variations; and (as marvellous as the secular variation) that it is subject to magnetic storms. The more marvellous, and, for the present inexplicable, all these subjects are, the more exciting becomes the pursuit of investigations which must, sooner or later, reward those who persevere in the work. We have at present two good and sure connections between magnetic storms and other phenomena: the aurora above, and the earth currents below, are certainly in full working sympathy with magnetic storms. In this respect the latter part of Mr. Ellis's paper is of special interest, and it is to be hoped that the Greenwich observations of earth currents will be brought thoroughly into relation with the theory of Schuster and Lamb, extended, as indeed Professor Schuster promised to extend it, to include not merely the periodic diurnal variations, but the irregular sudden changes of magnetic force taking place within any short time of a magnetic storm.

[1] 1 horse power = 7.46×10^{9} ergs per second.

In my Presidential address of last year I referred to the action of the International Geodetic Union, on the motion of Prof. Foerster, of Berlin, to send an astronomical expedition to Honolulu for the purpose of making a twelve months' series of observations, on latitude, corresponding to twelve months' simultaneous observations to be made in European observatories, and I was enabled, through the kindness of Prof. Foerster, to announce as a preliminary result, derived from the first three months of the observations, that the latitude had increased during that time by ½ sec. at Berlin, and had decreased at Honolulu by almost exactly the same amount. The proposed year's observations, begun in Honolulu on June 1, 1891, were completed by Dr. Marcuse, and an elaborate reduction of them by the permanent Committee of the International Geodetic Union was published a month ago at Berlin. The results are in splendid agreement with those of the European observatories Berlin, Prag, and Strasbourg. They prove beyond all question that between May 1891 and June 1892 the latitude of each of the three European observatories was a maximum, and of Honolulu a minimum, in the beginning of October, 1891; that the latitude of the European observatories was a minimum, and of Honolulu a maximum, near the beginning of May, 1892; and that the variations during the year followed somewhat approximately, simple harmonic law as if for a period of 385 days, with range of about ½ sec. above and below the mean latitude in each case. This is just what would result from motion of the north and south polar ends of the earth's instantaneous axis of rotation, in circles on the earth's surface of 7.5 metres radius, at the rate of once round in 385 days.

Sometime previously it had been found by Mr. S. C. Chandler that the irregular variations of latitude which had been discovered in different observatories during the last fifteen years seemed to follow a period of about 427 days, instead of the 306 days given by Peters' and Maxwell's dynamical theory, on the supposition of the earth being wholly a rigid body. And now, the German observations, although not giving so long a period as Chandler's, quite confirm the result that, whatever approximation to following a period there is, in the variations of latitude, it is a period largely exceeding the old estimate of 306 days.

Newcomb, in a letter which I received from him last December, gave, what seems to me to be, undoubtedly, the true explanation of this apparent discrepance from dynamical theory, attributing it to elastic yielding of the earth as a whole. He added a suggestion, specially interesting to myself, that investigation of periodic variations of latitude may prove to be the best means of determining approximately the rigidity of the earth. As it is, we have now, for the first time, what seems to be a quite decisive demonstration of elastic yielding in the earth as a whole, under the influence of a deforming force, whether of centrifugal force round a varying axis, as in the present case, or of tide-generating influences of the sun and moon, with reference to which I first raised the question of elastic yielding of the earth's material many years ago.

The present year's great advance in geological dynamics forms the subject of a contribution by Newcomb to the Monthly Notices of the Royal Astronomical Society of last March. In a later paper, published in the *Astronomische Nachrichten*, he examines records of many observatories, both of Europe and America, from 1865 to the present time, and finds decisive evidence that from 1865 to 1890 the variations of latitude were much less than they have been during the past year, and, seeming to show that an augmentation took place, somewhat suddenly, about the year 1890.

When we consider how much water falls on Europe and Asia

how a careful observer in the British Islands may form a good judgment of the coming weather. The lecturer showed, with the aid of diagrams, the tracks followed by storm centres, with reference to the conditions of areas of low and high pressure The reason why storms usually proceed in a north-easterly direction across or skirting these islands was explained as owing to the high barometer generally to be found in the Atlantic in the vicinity of the Azores, while in the neighbourhood of Iceland there is a region where the barometer is generally lower than in the space surrounding it The storms generally advance so as to leave the low pressure on their left, and the high pressure on their right—moving round the south and east sides of the prevailing low pressure Considerable stress was laid upon the importance of observing the cirrus clouds, the different motions of which, in conjunction with the indications of the barometer, are useful guides both as to the approach of a storm and the track along which the centre is moving. Several illustrations of these facts were given by the lecturer, who also gave many valuable hints as to what may be learnt from the published daily weather charts

THE Leeds Naturalists' Club seems to be in no hurry about the publication of its Transactions, those for the year 1890 having only just been issued The volume, however, has been prepared with great care, and shows that much good work is being done by the Club. Among the contents is a most interesting abstract of a lecture by the Rev Edward Jones on relics found in Yorkshire caves Reference was made to the cave at Kirkdale, near York, and the Victoria Cave of Settle, both of which have been well worked and have given valuable results, but attention was directed mainly to the cave found at Elbolton or Thorp, which is situated ten miles north of Skipton and two miles from Grassington Through the energy of the president and members of the Skipton Natural History Society, this cave, which has been handed over to them, has been worked with great earnestness, and many bones have been turned up Human remains, representing some thirteen bodies, have been found in an excellent state of preservation These human beings must have been buried there, as they were all found in a sitting position, with the knees brought under the chin The cave, however, was not used only as a burial-place, for the remains of charcoal fires, burnt bones, and pieces of pottery have been found At the time when the lecture was delivered, the excavations had not revealed anything older than the Neolithic period Among the finds are several specimens of bones of bears, red deer, foxes, dogs, badgers, grizzle and brown bears, &c Some time after the delivery of the lecture the members of the Club made an excursion to this interesting cave, which was explored for a distance of a hundred feet, and to a vertical depth of thirty feet The visitors saw many stalactites and stalagmites in course of formation, and the osseous remains of animals, including some now extinct Mr Jones pointed out the former location of several human skeletons.

MR. J W TOURNEY contributes to *Science* (November 11) an excellent paper on cliff and cave dwellings in Central Arizona He refers especially to dwellings in cliffs rising a hundred feet or more above Beaver Creek, which flows into the Verde river In the perpendicular walls of one of these cliffs is a well preserved ruin known as Montezuma's castle It is midway between the rim of the cliff and the bed of the stream, and is neither house nor cave, but a combination of the two Not accessible from the summit of the cliff, it can only be reached from below, and even here not without the use of a ladder, which, if short, the climber must pull up from one ledge to another in making the ascent. The entire front is of artificial walls built of large, flat pieces of limestone, with openings here and there for doors and windows The rooms are small, only about five feet to the ceiling Generally a small opening two or three feet in diameter connects one room with another, and a small orifice in the ceiling gives access to the room above. The openings in the ceilings are never directly under one another, so that any one who might stumble could only fall the height of one story The floors are mostly of flat stones supported on timber cut from the surrounding mountains Many of the timbers are still sound The rooms all show considerable skill in their construction Those in the rear are dark, dungeon-like caves hollowed from the solid rock, and are now the abode of thousands of bats, which fly about in great numbers when disturbed by visitors A few miles above Montezuma's castle, on the opposite bank of the creek, a conspicuous cone-like mountain rises a few hundred feet above the surrounding country The summit is a narrow rim enclosing a crater some three hundred feet in diameter and with nearly perpendicular walls Standing on the rim one can look down a hundred feet upon the dark-blue water of a small lake in the bosom of the mountain The lake, a hundred yards in diameter and of unknown depth, is known as Montezuma's well In the steep sides of the crater are a number of caves, which at one time were the abode of man A few are natural, but the greater number are the result of human effort The rim is crowned with the fallen walls of an ancient ruin more than a hundred feet long Far down the mountain side, below the level of the water in the crater, the outlet of the well flows from between an opening in the rocks This stream is large and constant, and at present is used to irrigate a ranch in the valley below Ages ago the builders of caves and castles utilized this same stream to irrigate portions of the neighbouring rich valley

THE fourth volume of "Reports from the Laboratory of the Royal College of Physicians, Edinburgh," edited by J B. Tuke and D Noel Paton, has just been published The work completed in the Laboratory during the past year was so large that an account of the whole of it could not be included in the present volume

A LARGE dirigible balloon is being constructed (*La Nature* informs us) at the military balloon works at Chalais-Meudon, under the direction of Commandant Renard It will be similar in form to the *La France* of 1884-5, but longer, measuring about 230 feet in length and 43 feet in its greatest diameter By a new arrangement of motor it is expected to be able to make headway against air currents not exceeding 40 feet per second (or 28 miles an hour) The motor is not fully described, but it will act either with gasoline or the gas of the balloon, giving an effective force of 45 horse-power on the shaft The total weight of machinery, with supply of gasoline, &c, will be about 30 kilogrammes (or 66 lbs) per horse power Previously it has not been possible to make petroleum motors with a less weight than 150 to 200 kilogrammes per horse-power The screw will be in front, and a large rudder behind, the former will make about 200 turns per minute. The first experiments with this balloon are to be made in the early spring

DR. HEYDWEILER, of Würzburg, has constructed a new mirror electrometer for high potentials (*Zeitschr fur Instr*). It is a kind of torsion-balance with bifilar suspension, the charged bodies being a sphere and a ring The attraction between the two, when at different potentials, is zero when the sphere is at the centre of the ring, and also when it is infinitely removed Hence at some intermediate distance it is a maximum In the instrument as constructed there are two spheres of 2 cm diameter attached to the ends of a conducting bar bent in the form of an S The combination is suspended in a horizontal plane by two brass wires 0·1 mm. thick attached to the middle of the bar Two brass rings 10 cm. across are fixed in a vertical position such that the spheres can be made to coincide

with their centres In the zero position the spheres are at a distance of 3 1cm, this being a little less than the distance of maximum attraction The deflections are indicated by those of a mirror carried by a thin glass rod attached to the curved arm below, and the motion is damped by a vane immersed in some vegetable oil The tangents of the angle of deflection are proportional to the differences of potential to within 0 9 per cent., between the scale readings 0 05 and 0 4 The instrument is best adapted to potentials ranging from 6000 to 60,000 volts, but with potentials above 35,000 it is best to immerse it entirely in oil

AN account of a series of experiments to determine the temperature of the flame of water-gas is given by Mr E Blass, of Essen, in *Stahl und Eisen* The instruments employed were Wyborgh's air pyrometer, Chatelier's electric pyrometer, Hartmann and Braun's telephonic pyrometer, and others by Siemens, Seeger, and Ducretel It was found that Chatelier's formula for the variation of the specific heat of water vapour and other gases at high temperatures was practically reliable The temperatures of combustion were taken for various proportions of air and gas, beginning with a large excess of the latter With 0 18 cubic metres of air to one of gas, the temperature was 425° C Calculated according to the old formula this would have been 521 Allowing for variation of specific heat, the theoretical value becomes 409 For 0 714 of air, the temperature was 1170, for 4 18 it was 1218, for 9 79 it was 655, and for the proportion of air just sufficient for combustion the flame temperature was 1169°

A NEW "shortened telescope," constructed by Dr R Steinheil, is described in the *Zeitschr fur Instr* for November The principle resembles that adopted by Dallmeyer and Dr A Steinheil in their telephotographic objectives A negative system is introduced between the object-glass and the eye piece, thus increasing its equivalent focal length If a be the focal length of the objective by itself, r its distance from the negative lens, and the magnification m times that produced without the negative lens, the total length of the tube is given by $l = r + m\,(a - r)$ In a telescope actually constructed on this system, the object-glass had a focal length of 16 2 cm Its distance from the nearest surface of the negative lens was 12 cm, the equivalent focal length 60 8 cm, and the total length 27 8 cm Hence the magnification was 3 75 times that obtained by using the objective alone In this case, then, a magnification of 22 diameters was obtained with an effective aperture of 4 cm, a total length of 27 8 cm, and a one inch eye piece If the same magnification and illumination had to be obtained by a long-focus objective, the length would have to be 6. 8 cm Thus the length is reduced by more than one half without the usual disadvantages of short telescopes and eye-pieces of high power

ACCORDING to a writer in the *Pioneer Mail* of Allahabad, the thatch on Burmese houses gives a tempting shelter to snakes, especially during the rains, and many of the occupants of the houses would be surprised if they knew the number of snakes that share the shelter of their roof on a rainy night One night an officer was wakened up by a noise in his room, and by the light of a lighted wick, floating in a tumbler of oil, he made out that two combatants were disputing the possession of the small space in the centre of the bedroom The belligerents turned out to be a snake and a rat, that somehow had jostled against each other in the tiny tenement

A VALUABLE report on the geology of north-eastern Alabama and adjacent portions o Georgia and Tennessee, by C Willard Hayes, has been published as a Bulletin of the U.S Geological Survey Mr. Hayes explains that in writing the report he has tried to keep it as free as possible from technical terms, and, without sacrificing scientific accuracy, to present the facts in such a way as to make them intelligible to the largest possible number of readers in the region under consideration Many details which would be of interest to the geologist have been purposely omitted, and only those which were considered essential are given It is expected that the atlas sheets covering this region will shortly be published by the U S Geological Survey, and supply the details to those specially interested which are omitted from the report

A SECOND edition of Prof Oliver J Lodge's "Modern Views of Electricity" has been published by Messrs Macmillan and Co A new chapter on recent progress has been added

A VOLUME on "The Pharmacy and Poison Laws of the United Kingdom" has been issued from the office of *The Chemist and Druggist* It contains also a brief account of the pharmacy laws in force in Australasia, Canada, and Cape Colony

MR CHARLES E MUNROE, Torpedo Station, Newport, Rhode Island, U.S A, has completed the manuscript of the second part of his index to the literature of explosives The first part was issued in 1886 The second will be issued in pamphlet form if an adequate number of subscriptions is obtained

MESSRS FRIEDLANDER AND SON, Berlin, send us the latest of their lists of the books which they offer for sale It is a list of works relating to ornithology

PENTA IODIDE and penta-bromide of cæsium, together with several other penta-halogen compounds of the metals of the alkalies containing mixed halogens, have been isolated by Messrs Wells and Wheeler, and are described by them in the current number of the *Zeitschrift für Anorganische Chemie* Cæsium penta iodide, CsI_5, is obtained in an impure form when the crystals of the tri-iodide of cæsium, CsI_3, previously obtained by Prof Wells and described in our note of February last, vol. xlv p 325, is treated with hot water, or when solid iodine is treated with a hot solution of cæsium iodide Either of these processes produce it in the form of a black liquid, which solidifies in the neighbourhood of 73° The tri-iodide of cæsium, moreover, which is only sparingly soluble in alcohol, is found to be much more readily soluble when a quantity of iodine, corresponding to two atoms for each molecule of the tri-iodide, is added. Upon cooling, crystals of the penta-iodide of cæsium are deposited Remarkably well-formed crystals are obtained upon evaporation of a more dilute solution over oil of vitriol The crystals are black and the faces extremely brilliant, they sometimes attain a diameter of a centimetre They belong to the triclinic system according to Prof Penfield, by whom they have been measured They are at once distinguished from crystals of iodine by their form and brittleness. They melt at about 73° When exposed to the air they lose iodine about as rapidly as crystals of free iodine These crystals are anhydrous, and yield analytical numbers agreeing with the formula CsI_5. The penta-bromide of cæsium may be similarly obtained by agitating a concentrated solution of cæsium bromide with a large excess of bromine. When such a mixture is allowed to stand at a low temperature the excess of bromine slowly evaporates and the penta-bromide separates in the form of a dark red solid substance Cæsium penta-bromide $CsBr_5$, is a very unstable substance, losing bromine rapidly at the ordinary temperature. Anothe interesting compound is cæsium tetrachloriodide, $CsCl_4I$, which was obtained by dissolving forty grams of cæsium chloride in mixture of six hundred cubic centimetres of water and two hundred cubic centimetres of concentrated hydrochloric acid, adding

thirty grams of iodine, and then saturating the liquid with chlorine gas The temperature was raised slightly during the operation, and upon subsequent cooling the compound $CsCl_4I$ was deposited in the form of pale orange-coloured prismatic crystals belonging to the monoclinic system The compound is only slightly soluble in water, but, with a little loss due to decomposition, may be recrystallized from that liquid It is, however, quite stable in the air, and only decomposes upon heating, thereby producing the tri-halogen compound, $CsCl_2I$, fusing at 238°, the melting-point of this latter compound A similar compound, containing rubidium instead of cæsium, $RbCl_4I$, may be obtained in like manner in large orange-coloured tabular crystals, likewise belonging to the monoclinic system, but of different habitus to the crystals of the cæsium compound An analogous compound containing potassium, KCl_4I, was prepared so long ago as the year 1839, by Filhol Messrs Wells and Wheeler finally describe sodium and lithium salts of this description, both of which, however, contain water of crystallization They are represented by the formulæ $NaCl_4I\ 2H_2O$ and $LiCl_4I\ 4H_2O$ Both crystallize well, the former in rhombic prisms, the latter, however, is so extremely deliquescent that measurements of the crystals have not been obtained

THE additions to the Zoological Society's Gardens during the past week include two Common Marmosets (*Hapale jacchus*) from South-east Brazil, presented by Mrs Comolli, an Otter (*Lutra vulgaris*) British, presented by Mr Frederick Collier, a Black-backed Jackal (*Canis mesomelas*, ♂v) from South Africa, presented by Miss Thornton, a Common Jackal (*Canis aureus*, ♀) from Fao, Persian Gulf, presented by Mr W D Cumming, C M Z S, two Short-headed Phalangers (*Belideus breviceps*, ♂ ♀) from Australia, presented by Capt S M Orr, a —— Lemur (*Lemur* ——) from Madagascar, six Crab eating Opossums (*Didelphys cancrivorus*), four Ypecha Rails (*Aramides ypecha*) from South America, a Green cheeked Amazon (*Chrysotis viridigenalis*) from Columbia, a Yellow-cheeked Amazon (*Chrysotis autumnalis*) from Honduras, purchased, a Nilotic Monitor (*Varanus niloticus*) from Africa, received in exchange, two Shaw's Gerbilles (*Gerbillus shawi*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES (NOVEMBER 6, 1892) —The elements and ephemeris of this comet have been the subject of much computation during the present month The first result obtained gave a place resembling in many particulars that of the long-sought for Biela comet, but owing to an error in one of the observations, the corrected elements stated otherwise The current number of *Astronomische Nachrichten* (No 3129) gives four different systems of elements which have as yet been deduced, and it is quite worth while to produce them here, showing also the difference between the observed and reduced places for each in particular

Elements, Berlin M T.

	1892	1892	1892	1892
T =	Feb. 28 362	Mar 19 630	May 6 301	June 6·841
	° ′	° ′	° ′	° ′
ω =	340 25 82	339 11 87	334 46 90	338 19 09
☊ =	3[illegible] 21 15	332 7 30	339 37 87	346 13·01
i =	24 55 19	24 54 91	24 55 33	25 6 06
log q =	0 27766	0 26144	0 20868	0 14910
Mean place (O – R) dλ	– 1′ 04	– 0′ 81	– 0′ 47	+ 0′ 20
Mean place (O – R) dβ	+ 0 86	+ 0 84	+ 0 58	+ 0 41

The latest information about the elements is that which has originated from Prof. Kreutz, who has found *elliptic* elements for the comet, he also says that the elements indicate that perturbations have taken place on account of the comet's proximity to the planet Jupiter. The elements are reduced from the three places observed on November 9, 13, and 17, and are as follows —

Epoch 1892 Nov 17 5 M T Berlin.

M =	22 18 37 1
ω =	13 37 49 0 ⎫
☊ =	331 31 3 7 ⎬ 1892 0
i =	20 54 8 1 ⎭
φ =	24 39 30 7
μ =	500″ 407
log u =	0 567123
U =	7 09 years

Further observations of this comet are reported (*Comptes rendus*, No 21) At Algiers, MM Trépied, Rambaud, and Sy found its position on November 15, at 8h 53m 41s, Algiers mean time, to be App R A 0h 43m 22 28s App Decl +37° 43′ 3″ 9 The corresponding values found at Lyon by M. G Le Cadet at 8h 47m 33s, Paris mean time, were App R A 0h 43m 22 72s App Decl + 37° 43′ 5″·9 The comet presented a bright nebulosity in the form of an elliptic segment with its axis directed in the position angle 150°, its length and breadth both being 10′ The northern edge appeared rounded and well defined At the focus of the ellipse a condensation could be distinguished, about 20″ broad, with a prolongation inclined to the axis of the ellipse An attempt at calculating the elements of the orbit has been made by M Schulhof The slow motion of the comet renders this task very difficult Among the various systems of elements tentatively fixed there is only one which fairly agrees with all observations In this the excentricity is as small as 0 355386, so that it will probably be possible to follow the comet throughout its orbit with the most powerful instruments The other elements thus determined are π = 0° 0′ 39″ 1, ☊ = 328° 32′ 40″ 7, i = 20° 26′ 46″ 8, and log g = 0 360966

At Bordeaux, M F Courty succeeded in photographing the brighter portions of the comet on November 13, with one hour's exposure Another photograph, taken by MM Paul and Prosper Henry at Paris, was presented to the Academy by M Tisserand It was obtained on November 14, with the chart photographic equatorial The exposure lasted two hours It is a very fine photograph, showing a well defined and nearly circular contour The nucleus is bright, excentric and lengthened out Several stars can be seen through it There is no tail except the lengthening of the nucleus, which does not extend beyond the limits of the nebulosity

A BRIGHT COMET —A telegram from Kiel states that Mr W R Brooks has discovered a bright comet As determined at Cambridge, U S, its place was, on November 21, at 16h 44 6m Cambridge M T

R A 12h 59m. 15 6s
Decl + 13° 50′ 27″ 0
Daily motion + 1m 32s, and + 25′ respectively

Another telegram, also from Kiel, gives the position, as obtained at Vienna on November 24, at 15h 49 7m. (Vienna M T), as

R A 13h 3m 6 4s
Decl + 15° 0′ 36″

ASTRONOMICAL INSTRUMENTS UP TO DATE.—We have received a circular signed by Dr. L Ambronn, of the Gottingen Observatory, and Herr Julius Springer, publisher in Berlin, setting forth the contents of a work which they propose to publish with regard to the general principles, constructions, and methods of using astronomical instruments in general Such a book, of course, to be of the greatest value to science, must be completely done, but any one who is acquainted with the compiler and publisher mentioned above will be sure that each will do his share thoroughly and honestly. In constructing such a compendium of instruments as this is proposed to be, we might say it would be impossible for one man to do it alone, for the present state of the *feintechnik* has reached such a high pitch and the branches of astronomy are so numerous, that such an undertaking would simply be out of question. The object of this circular, besides stating the lines on which the work will be written, is to request the co-operation of all observatories. Astronomical science, especially the theoretical side, owes much, as we all know, to German workers, so that we can rely on a good response being given to this request. What is

asked is that descriptions, together with drawings or photographs not only of typical instruments but of the important parts of them, should be sent. Technical drawings also are requested, if obtainable, and these very probably could be obtained from the makers of the instruments in question. Of course it is not required that each observatory should send say a description, &c., of the transit instrument there in use, but it is hoped that any instrument of peculiar construction or special merit should be referred to. It is needless to add that all drawings, &c., if requested, will be returned with as little delay as possible, and the undersigners of the circular thank in advance all those who respond towards the completion of this undertaking. The address to which the drawings, &c., may be sent is as follows:—Dr. L. Ambronn, Gottingen, Kgl. Sternwarte.

MOTION OF β PERSEI.—*Astronomical Journal*, No. 277, contains a short note calling the attention of transit observers to the importance of observation of this variable, to confirm the irregularity in its proper motion. At the present time Algol and his neighbouring stars are conveniently situated, and it is hoped that the following list of stars will be added to working lists generally where their observation is not inconsistent with other work. The places are for the year 1875:—

	R.A. h	m	s	Decl. °	′
γ Andromedæ	1	56	14	41	43·7
β Trianguli	2	2	7	34	23·7
θ Persei	2	35	40	48	41·9
41 Arietis	2	42	38	26	44·6
γ Persei	2	55	45	53	0·9
ϕ Persei	2	57	10	38	21·3
β Persei	3	0	2	40	28·3
α Persei	3	15	24	49	24·9
δ Persei	3	34	2	47	23·1
ν Persei	3	36	42	42	10·9
η Tauri	3	40	3	23	43·0
ζ Persei	3	46	17	31	30·6
ϵ Persei	3	49	28	39	38·8
ξ Persei	3	50	51	35	25·8

PROPER MOTIONS.—M. Deslandres, in *Comptes rendus* of November 14, communicates the recent work he has been carrying out with regard to the spectroscopic determinations of proper motions. The first part contains a description of the apparatus employed, showing how he has completely altered one instrument specially for this work. During the ten months of the year he has obtained several proofs of stars susceptible of furnishing radial velocity. The following are among some of the important methods of procedure:—(1) The luminous "faisceaux" of the star and of the source of light have the same aperture, and are thus as identical as possible, a condition necessary to the absolute measure of displacements. (2) The displacements of spectra is measured not only with the Hy line of hydrogen, but with all the hydrogen, calcium, and iron lines. (3) The large surface of the mirror renders the possibility of measuring the velocities of 250 stars. Some of the results already obtained show that the work, when finished, will be of a very reliable and accurate kind. For instance, the velocity of Venus has been obtained instrumentally as 15 kilometers, while that calculated amounted to 13·55 k.m. The velocity of α Aurigæ on February 5, employing 30 lines of comparison, came out as 43·5 k.m., and the velocities of the components of β Aurigæ, a spectroscopic double, were obtained on the same day as − 84·5 k.m. and + 97 k.m.

GEOGRAPHICAL NOTES

THE measurement of an arc of the meridian between Dunkirk and the Spanish frontier, which has recently been completed with the highest precision by the French Government, shows that the measurement by Delambre and Méchain in determining the length of the metre was 126·6 feet, or $\frac{1}{10000}$th too short. The new measurement accords very closely indeed with the value as deduced from Clarke's ellipsoid.

A NEW weekly paper devoted to African geography, under the title of Kettler's *Afrikanische Nachrichten*, was started at Weimar in July last, with the object of collecting and publishing the most recent information on all matters connected with Africa and the Africans. An ingenious feature is that of giving a sketch map of parts of Africa, with a small section of a map of some well-known part of Germany on the same scale below it, for the purpose of ready comparison of distances.

MR. AND MRS. THEODORE BENT have arranged to spend the winter in Abyssinia studying the ancient monuments of Axum. They will leave this country about the middle of December. We understand that Mr. Bent would welcome a scientific man who might wish to work at any of the natural conditions of eastern Abyssinia, and take advantage of the arrangements which have been made for the safety and comfort of the party. It would, of course, be necessary for such a companion to pay his own expenses and provide his own outfit.

A SPECIAL general meeting of the Royal Geographical Society was held on Monday afternoon to consider some alterations in the rules, recently decided on by the Council. It was agreed to raise the entrance fee to the Society from £3 to £5, and to augment the life composition accordingly, relief being, however, granted by a diminution of the commutation fee to members of long standing. Other changes were made to bring the laws into harmony with the present practice of the Society in several minor matters. The meeting also passed a resolution associating itself with the act of the Council in no longer withholding the Fellowship of the Society from women.

MR. JOSEPH THOMSON'S JOURNEY TO LAKE BANGWEOLO

MR. JOSEPH THOMSON read a paper on his expedition to Lake Bangweolo in 1890–91 to the Royal Geographical meeting on Monday night. The paper was not only of a thoroughly scientific character, but also a model of literary grace, Mr. Thomson having the trained eye which enables him to detect and throw into prominence the really important features. The expedition went up the Zambesi by way of the Kwakwa creek, encountering considerable hostility and obstruction from the Portuguese authorities on the way. Mr. Thomson speaks warmly of the great work done by the Scottish missionaries in the Blantyre and Nyassa districts. Under the kind but firm control of the missionaries the warlike Angoni tribes came in thousands to cultivate the fields, which formerly they visited only for plunder, and for the first time in all his African travels Mr. Thomson found a spot where the advent of the white man was an unmitigated blessing to the natives.

Barometric observations made while waiting for porters on the western coast of Lake Nyassa made the elevation of the lake 1430 feet, a somewhat lower result than was formerly arrived at. On August 23, 1890, the expedition, comprising Mr. Grant, Mr. Charles Wilson, and 153 porters, started from Kotakota and struck westward through unmapped country, a rough and sparsely wooded plateau with little running water. The route lay along a strip of debateable ground, inhabited by an excitable, warlike tribe, and raided equally by Mwasi's people from the north and Mpeseni's from the south. Great tact was required to avoid bloodshed, but the expedition passed safely. Then crossing the fine fertile plain of the Loangwa river, they passed over and climbed the steep Muchinga mountains to the high plateau beyond. So far the rocks had been metamorphic, with intruded masses of granite, overlaid in the valley by sandstones, shales, and marls. At one place great fossil-tree trunks were found. The Loangwa-Kafue plateau was magnificent country, glorious with the tints of early spring on the stunted trees which formed a scraggy forest over most of the surface. But no sign could be seen of the Lokinga mountains, nor was any word heard from the natives of that range so conspicuous on the maps; but on the watershed of the plateau, 5000 feet above the sea, rose the Vimbe hills in a series of isolated domes, perhaps rising 1000 feet higher. A new lake, thirty square miles in area, was found in a dip of the plateau, and named after the Moirs. Then troubles began. Small-pox broke out amongst the porters, and when Chitambo's was reached no trace could be found of the lake, on the margin of which it was supposed to stand. While the white members of the expedition were attending to their sick followers some of the healthy Swahilis marched to Old Chitambo's (which is not in Ilala but Kalinde), now deserted, and twenty miles distant from the present village, finding the tree under which the heart of Livingstone was buried still standing, and the inscription on it legible. In the dry season the Chambeze does not enter Lake Bangweolo at all, but flows direct across the marsh to the Luapula, but in the wet season

the whole of the great marsh to the south is flooded up to Chitambo The level at that time was made out to be 3750 feet, about 250 feet lower than Livingstone's estimate After a rest for recovering health the expedition followed the Luapula eastward through fertile country, and leaving it where the curve from the north occurs, struck across for the Kafue, but small-pox reappeared, the land was ravaged by half caste Portuguese slave-raiders, Mr Thomson himself fell ill, and the course had to be changed to the south with the hope of turning west again But matters got worse instead of better, and after touching the borders of Manica, a return had to be made to Lake Nyassa, along the southern margin of the plateau, through deep valleys, and climbing the steep slopes of the Muchinga Mountains, here separated by the great parallel valley of the Lukosashe from the plateau. All the way the land was seen to be of immense possibilities for cultivation, but neglected, and inhabited by a wretched people governed by Mpeseni, himself the vilest of them all Kotakota on the lake was reached again on January 4th, 1891, after a total journey of 1200 miles, which resulted in many important rectifications of position and much information as to the future possibilities of the plateaux

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE —Dr Hobson, late deputy Lowndean Professor, has been elected a representative of the Mathematical Board on the General Board of Studies.

Plans for a handsome building to serve as the Sedgwick Memorial Museum of Geology have been submitted to the Senate, the estimated cost being £26,000 Four members of the Syndicate appointed to prepare the plans dissent from the report of the majority, chiefly on the ground that the internal arrangements are unsatisfactory, and that the cost, initial and annual, of the proposed building will be excessive The divergent views held on the subject will be discussed by the Senate on Saturday, December 3

The Senate have agreed to confer on Sir R S Ball, the new Lowndean Professor, the complete degree of M A, *honoris causa.*

SOCIETIES AND ACADEMIES

LONDON

Physical Society, November 11 —Mr Walter Baily, M A, Vice-President, in the chair —The discussion on Mr Williams's paper, the dimensions of physical quantities, was resumed by Dr Burton He remarked that the idea that so called "specific quantities," such as specific gravity, are pure numbers was an erroneous one, and liable to lead to difficulties The specific gravity of a substance was of the nature of density, and was only a simple number on the convention that the density of water was taken as unity If dimensions be given to specific quantities their interpretation would, he thought, be easy when the rational dimensional formulæ were found Referring to Prof Fitzgerald's comments, he said, although the contention that all energy is ultimately kinetic could not be gainsaid, the distinction commonly drawn between kinetic and potential energy involved nothing contrary to this view, and was useful and convenient in many cases. As to the dimensions of μ and k he was inclined to favour Mr Williams's views, for several considerations suggest that the two capacities of the medium are essentially different Arguments to show that μ was probably absolutely constant in the ether, whilst k might be variable, were brought forward Of the two systems of dimensions for μ and k suggested by Mr Williams, that which made μ a density seemed preferable —Prof A Lodge said he was greatly interested in propagating the idea that physical quantities are concrete, and therefore welcomed Mr Williams's paper. He thought it desirable to keep some names for abstract numbers, and "specific gravity" should be one If another name involving dimensions was required "specific weight," or "weight per unit volume," might be used Speaking of the dimensions of the various terms of an equation he did not think it was usually recognized that in ordinary algebra or Cartesian geometry the principle of directed terms was rigidly adhered to, for if directed at all every term of such an equation was directed along the same line In this respect ordinary algebra was more rigid than vector algebra. Even if circular functions were involved, as in polar co-ordinates, they had the effect of making the directions of the terms the same. Other instances of problems bringing out the same fact were mentioned Mr Boys thought Mr Madden had been arguing in a circle when he spoke of the astronomical unit of mass, and deduced the dimensions of mass as L^3/T^2 from the equation $MLT^{-2} = M^2/L^2$, for it was quite impossible that this equation could be true unless γ, the gravitation constant, was introduced on the right-hand side Mr Williams's method was quite the reverse, for he maintained that unless k and μ were introduced in the dimensions of electric and magnetic quantities, their dimensional formulæ could not indicate the true nature of those quantities, and hence were open to objection Mr W Baily, whilst agreeing with Mr Williams on most essential points, thought the total omission of L from dimensional formulæ made the expressions more complicated and less symmetrical For example, such expressions as XY/Z, X^2 and XYZ, which respectively represent undirected length, area, and volume, might with advantage be written L, L^2, and L^3 respectively The restriction of the dimensions of μ and k to those which give interpretable dimensional formulæ for electrical and magnetic quantities seemed scarcely justified Both the systems proposed could not be right, and he thought it would be more in accordance with our present want of knowledge, if a quantity U of unknown dimensions were introduced such that μ or $k = U^2$ density and k^{-1} or $\mu^{-1} = U^2$ rigidity This would keep in view the fact that the absolute dimensions of quantities involving U were unknown A list of the dimensions of the various quantities based on this arrangement was given Mr Swinburne, referring to the conventional nature of many units, said great differences exist between the ideas held by different persons about such units Starting with the convention that unlike quantities could be multiplied together, he might have six ampères flowing in an electric circuit under a pressure of ten volts, and he might say he had sixty volt-amperes The term "volt ampère" could be regarded as indicating that the sixty was the numerical result of multiplying a number of volts by a number of ampères, or on the other hand it might be understood as a new unit, a *watt*, compounded of a volt and an ampère Before Prof Rucker's paper on suppressed dimensions was published, an electrician might have suggested measuring the length of a bench by sending an alternating current through it and determining its self induction, which he regarded as a length Prof Rucker, however, would say that this could not give the right result, for μ must be taken into account He was inclined to think that dimensions were liable to mislead Referring to scientific writers as authorities, he said Maxwell had been careless in some cases, for he had sometimes given dimensional formulæ as zero, which really ought to have been $L^0 M^0 T^0$, or unity In French text-books the errors had been corrected Mr Williams, in reply to Mr Madden's remarks about self-induction being a length, pointed out that the subject might be looked at in two different ways, depending on whether one thinks of the *standard* of self-induction as the practical standard of measurement, or the *unit* of self induction as a physical quantity In the former case the *standard* was a length, but in the latter the *unit* was a quantity of the same *species* as self-induction, the nature of which was as yet unknown If its dynamical nature was known, then the absolute dimensions of all other magnetic and electric quantities would also be determined In answer to Prof. Fitzgerald's remarks he said it was hardly likely that he should be unacquainted with the common view that kinetic and potential energies were ultimately quantities of the same kind, for it was a view with which he was quite familiar The fact that they have the same dimensions was sufficient to show their identity, and the idea that all energy is ultimately kinetic was fundamental to his paper. This, however, did not imply that electrification and magnetization are of necessity the same, and the suggestion that they may be the same was only one of several "probable suggestions," all of which were entitled to consideration. His chief reason for regarding Prof Fitzgerald's suggestion as probably incorrect was that it led to a system of dimensional formulæ incapable of rational mechanical interpretation, and containing fractional powers of the fundamental units. Prof. Fitzgerald's system would make resistance an abstract number, and μ and k directed quantities, whereas the former was a concrete quantity and the two latter must be scalar in isotropic media. If he (Mr. Williams) had erred in treating electrification and magnetization as different phenomena he could only plead that he had

done nothing more than follow such authorities as Lord Kelvin, Dr Lodge, and Mr O Heaviside in the matter —The discussion on Mr Sutherland's paper, on the laws of molecular force, was reopened by Prof Perry reading a communication from the President, Prof Fitzgerald He objected to discontinuous theories, especially when Clausius had given a continuous formulæ much more accurate over a very long range than Mr Sutherland's discontinuous ones The introduction of Brownian motions without carefully estimating the rates required and energy represented, and without giving any dynamical explanation of their existence, was not satisfactory It would, he said, be most interesting if Mr Sutherland would calculate the law of variation of temperature with height of a column of convectionless gas, under conduction alone (for Maxwell thought the inverse fifth power law of molecular attraction was the only one that gave uniformity of temperature under these conditions), and if necessary make tests with solid bars Referring to the statement that molecular attraction at one cm was comparable with gravitation at the same distance, he thought Mr Boys would question this, and he suggested an *experimentum crucis* of the inverse fourth power law Both the inverse fourth and inverse fifth power laws, assumed symmetry which did not exist He also took exception to other parts of the paper Dr Gladstone, referring to the relative dynic and refraction equivalents given in Table XXVIII of the paper, said he thought it interesting to make a similar comparison between dynic and dispersion and magnetic rotation equivalents The result as exhibited in a complete table showed a certain proportionality between the four columns but the differences were beyond the limits of experimental error Mr Sutherland, however, sometimes reckoned the dynic equivalent of hydrogen as 0 215, and at other times looked upon it as negligible The analogies between the optical equivalents did not depend on the proportionality of the numbers so much as upon the fact that the refraction, dispersion, and magnetic rotation equivalents of a compound was the sum of the corresponding equivalents of its constituent atoms, modified to some extent by the way in which they were combined Whilst a somewhat similar relation held true for the dynic equivalents, the effect of "double linking" of carbon atoms, so evident in the optical properties, was scarcely perceptible The result of calculating the constants from Ml instead of from M^2l was next discussed, the effect of which was to quite upset the proportionality before noticeable Mr S H Burbury said that on referring to the author's original paper, on which the present one was based, he found that a uniform distribution of molecules was assumed. On this supposition the demonstrations given were quite correct, and the potential was a maximum If, however, the molecules were in motion the average potential must be less than the maximum, and the deductions in the present paper being based on wrong assumptions were liable to error Prof Ramsay remarked that many statements in the paper, on the subject of critical points, were very doubtful Separate equations for the different states of matter were not satisfactory, neither was the artificial division of substance into five classes The predicted differences in the critical points due to capillarity, had not been found to exist Speaking of the virial equation, he said that hitherto R had been taken as constant Considerations he had recently made led him to believe that R was not constant The whole question should be reconsidered regarding R as a variable Mr Macfarlane Gray said he had been working at subjects similar to those dealt with in Mr Sutherland's paper, but from an opposite point of view, no attraction being supposed to exist between molecules In the theoretical treatment of steam he found that no arbitrary constants were required, for all could be determined thermo-dynamically The calculated results were in perfect accord with M Cailletet's exhaustive experiments except at very high pressures, and even here, the theoretical volume was the mean between those obtained experimentally by Cailletet and Battelli respectively Prof. Herschel pointed out that Villarçeau had discussed the equation of the virial, where the chemical and mechanical energies were not supposed to balance each other Mr. Sutherland's paper all turns on the existence of such a balance, and he (Prof. Herschel) could not understand why this balancing was necessary. The discussion was then closed, and the meeting adjourned.

Geological Society, November 9.—W H. Hudleston, F R.S., President, in the chair.—The following communications were read:—A sketch of the geology of the iron, gold, and copper districts of Michigan, by Prof M. E. Wadsworth. After an enumeration of the divisions of the azoic and palæozoic systems of the upper and lower peninsulas of Michigan, the author describes the mechanically and chemically formed azoic rocks, and those produced by igneous agency, adding a table which shows his scheme of classification of rocks, and explaining it The divisions of the azoic system are then described in order, beginning with the oldest—the cascade formation, which consists of gneissose granites or gneisses, basic eruptives and schists, jaspilites and associated iron ores, and granites The rock of the succeeding republic formation are given as nearly as possible in the order of their ages, commencing with the oldest —Conglomerate, breccia and conglomeratic schist, quartzite, dolomite, jaspilite and associated iron ores, argillite and schist, granite and felsite, diabase, diorite and porodite, and porphyrite The author gives a full account of the character, composition, and mode of occurrence of jaspilite, and discusses the origin of this rock and its associated ores, which he at one time considered eruptive, but new evidence discovered by the State Survey and the United States Survey leads him to believe that he will have to abandon that view entirely In the newest azoic formation, the Holyoke formation, the following rocks are met with —Conglomerate, breccia and conglomeratic schist, quartzite, dolomite, argillite, greywacke and schist, granite and felsite (?), diabase, diorite, porodite, peridotite, serpentine, and melaphyre or picrite The conglomerates of the Holyoke formation contain numerous pebbles of the jaspilites of the underlying republic formation, a description of the Holyoke rocks is given, and special points in connexion with them are discussed. The author next treats of the chemical deposits of the azoic system, gives a provisional scheme of classification of ores, and discusses the origin of ore deposits. The rocks of the palæozoic system are next described, and it is maintained that the eastern sandstone of lower silurian age underlies the copper-bearing or Keweenawan rocks The veins and copper deposits are described in detail, and the paper concludes with some miscellaneous analyses and descriptions, as well as a list of minerals found in Michigan After the reading of this paper, the President noted that it presented three sets of questions of much importance, viz., those bearing on the archæan rocks, the iron deposits and jaspilites, and the copper and gold deposits respectively As regards the classification of the archæan rocks, some might wonder what the terms used by the author meant. The words laurentian and huronian used in Canada seemed not to be tolerated in Michigan The officers of the United States Geological Survey have described all the archæan formations noticed by the author, the cascade as the fundamental complex, the republic as the lower marquette, and the Holyoke as the upper marquette Was each State of the Union going to divide these archæan rocks after its own fashion? With regard to the iron rocks, he would observe that the author, after enumerating all the views in favour of their volcanic origin, now admitted that he was wrong, and that Irving and others were correct The most important question was how the iron ores were really formed, and to this it was difficult to find a complete answer in the paper Sir Archibald Geikie remarked that it was hardly possible to criticize a voluminous paper of this nature, in the reading of which much of the detailed statement of facts was necessarily omitted One of its most interesting points related to the nature and classification of the rocks intermediate between the base of the Cambrian system and the oldest or fundamental gneisses. The plan which Prof. Wadsworth followed of adopting local names for the several subdivisions of the series in each region was no doubt in the meantime of advantage, until some method of correlation and identification from region to region could be discovered. But it unavoidably led to temporary confusion, for the same rock group might turn out to have received many different names. He thought it would be of service if geologists could agree upon some general term which would denote the whole of the sedimentary groups or systems which intervene between the old gneisses and the *Olenellus*-zone Various names had been proposed, such as azoic, eozoic, proterozoic, algonkian, to each of which some objection may be raised. The existence of a number of very thick systems of sedimentary deposits between the base of the Cambrian formation and the gneisses was now well established in this country and in North America. In the upper members of this series fossils had been found, and it might eventually be possible to group the rocks by means of palæontological evidence. But in the meantime it would be convenient to class them under one general name which would clearly mark them off from the true archæan gneisses, &c., below them and the palæozoic rocks

above Dr Hicks congratulated Prof. Wadsworth on his important communication, but he strongly objected to the application of the term Silurian, instead of Cambrian, to the lower palæozoic rocks of America. Dr Hicks did not think that the author had proved his case with regard to the Keweenawan rocks, and he was still inclined to believe that they would prove to be, as suggested by other American geologists, of pre-Cambrian age—the apparent superposition being due to over-thrust faults The term eozoic, now that worm tracks have been discovered in the pre Cambrian rocks, is more correct than azoic for the sedimentary rocks of that age. Moreover, other organic remains will certainly be found, for it is inconceivable that ancestors of the forms comprising the rich fauna at the base of the Cambrian should not have been entombed in earlier rocks Mr H Bauerman, considering the three hypotheses as to the origin of the iron ores—namely, dehydration of limonites in sandy beds, transformation from siderite, and the breaking-up of highly ferriferous igneous masses into quartz and hæmatite —thought that the first was the most likely, although there were certainly difficulties in connexion with it which made it desirable that the newer views upon the subject should be presented He was therefore glad that they were likely to have a detailed exposition of the author's views in the journal As regards the origin of the copper deposits, he believed that Dr Wadsworth agreed with the views brought before the society several years since In conclusion, he called attention to the gold deposits, which were of comparatively recent discovery, and interesting from the large number of minerals associated with the auriferous quartz veinstuff Sir Lowthian Bell and Mr Marr also spoke —The gold quartz deposits of Pahang (Malay Peninsula), by H M Becher —The Pambula gold deposits, by F D Power

Zoological Society, November 15 —Dr A Gunther, F R S, Vice President, in the chair —The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of October 1892, and called special attention to a very fine male Ostrich (*Struthio camelus*) presented by Her Majesty the Queen, and to a specimen of what appeared to be a new and undescribed Monkey of the genus *Cercopithecus*, obtained by Dr Moloney at Chindi, on the Lower Zambesi, for which the name *Cercopithecus stairsi* was proposed Attention was also called to the receipt of a series of specimens of mammals, birds, and reptiles, brought by Mr Frank Finn, on his recent return from a zoological expedition to Zanzibar, and received from several correspondents of the Society at Zanzibar and Mombasa.—The Secretary exhibited (on behalf of Mr T Ground) a specimen of the Siberian Pectoral Sandpiper (*Tringa acuminata*) killed in Norfolk —Mr G A Boulenger read a paper describing the remains of an extinct gigantic tortoise from Madagascar (*Testudo grandidieri*, Vaill), based on specimens obtained in caves in South west Madagascar by Mr Last, and transmitted to the British Museum The species was stated to be most nearly allied to *Testudo gigantea* of the Aldabra Islands.—Mr W Bateson and Mr H H Brindley read a paper giving the statistical results of measurements of the horns of certain beetles and of the forcipes of the male earwig It appeared that in some of these cases the males form two groups, "high" and "low", the moderately high and the moderately low being more frequent than the mean form in the same locality It was pointed out that this result was not consistent with the hypothesis of fortuitous variation about one mean form.—A communication was read from Mr O. Thomas containing the description of a new monkey of the genus *Semnopithecus* from Northern Borneo, which he proposed to call *S everetti* after Mr A Everett, its discoverer —Mr G A. Boulenger read a description of a Blennioid fish from Kamtschatka belonging to a new generic form, and proposed to be called *Blenniophidium petropauli* The specimen had been obtained in the harbour of Petropaulovski by Sir George Baden Powell, M P, in September 1891

Royal Meteorological Society, November 16.—Mr A Brewin, Vice-President, in the chair —An interesting paper by Mr. J. Lovel was read on the thunderstorm, cloudburst, and flood at Langtoft, East Yorkshire, July 3, 1892 The author gives an account of the thunderstorm as experienced at Driffield on the evening of this day, the full force of the storm was, however, felt in the wold valleys, which lie to the north and north-west of Driffield, where great quantities of soil and gravel were removed from the hillsides and carried to the lower districts, doing a large amount of damage. Many houses in the lower parts of Driffield were flooded, and a bridge considerably injured The storm was most severe in a basin of valleys close to the village of Langtoft, where three trenches, sixty-eight yards in length and of great width and depth, were scooped out of the solid rock by the force of the water from the cloudburst. From the appearance of the trenches it is probable that there were three waterspouts moving abreast simultaneously This particular locality seems to be favourable for the formation of cloudbursts, as there are records of great floods having previously occurred at Langtoft, notably on April 10, 1657, June, 1857, and June 9, 1888 The author gives, in an appendix, a number of observations made on similar occurrences, together with particulars and opinions as to the cause of such outbursts by several eminent authorities —Mr W H Dines also read a paper, remarks on the measurement of the maximum wind pressure, and description of a new instrument for indicating and recording the maximum For some years the author has been conducting a large number of experiments with various forms of anemometer, and in the early part of the present year recommended the adoption of the tube anemometer for general use, as it appeared to possess numerous advantages The head is simple in construction, and so strong that it is practically indestructible by the most violent hurricane. The recording apparatus can be placed at any reasonable distance from the head, and the connecting pipes may go round several sharp corners without harm The power is conveyed from the head without loss by friction, and hence the instrument may be made sensitive to very low velocities without impairing its ability to resist the most severe gale In the present paper the author describes an arrangement of this form of anemometer which he has devised for indicating very light winds as well as recording the maximum wind pressure

Linnean Society, November 17 —Prof Stewart, President, in the chair —The President having announced a proposal by the council to present a congratulatory address to the Rev Leonard Blomefield (formerly Jenyns) on the occasion of the seventieth anniversary of his election as a Fellow of the Society, and in recognition of his continuous and useful labours as a zoologist, it was moved by Sir Wm Flower and seconded by Dr St George Mivart, that the address be signed and forwarded as proposed This was carried unanimously In moving the resolution, Sir Wm Flower took occasion to sketch the scientific career of Mr Blomefield, who is now in his ninety-third year, and to recapitulate the works of which he is the author under his earlier and better known name of Jenyns The address, which was beautifully illuminated on vellum, was then signed by those present —Mr. George Murray exhibited and made remarks upon a genus of Algæ (*Halicystis*) new to Britain, the species shown being *H ventricosa* from the West Indies, and *H ovalis* from the Clyde Sea area —Mr Buxton Shillitoe exhibited an artificial cluster of the fruit of *Pyrus sorbus*, as put up for ripening by cultivators in Sussex —A paper was then read by the Rev Prof Henslow on a theoretical origin of endogens through an aquatic habit based on the structure of the vegetative organs The lecture, which was very fluently delivered, was profusely illustrated, and drew forth some interesting criticism from Prof Boulger, Messrs Henry Groves, H Goss, and Patrick Geddes, to which Prof Henslow replied.—On behalf of Mr George Lewes, who was unable to be present, a paper was read by Mr W Percy Sladen on the *Buprestidæ* of Japan, upon which some criticism was offered by Mr W F Kirby

Royal Microscopical Society, November 16.—Dr. R Braithwaite in the chair —Mr. T F Smith read a note on the character of markings on the *Podura* scale.—An account of Mr W. West's paper on the freshwater algæ of the English lake district was given by Mr A. W Bennett, who thought it was an exceedingly important contribution to our knowledge of the algæ of that district-Mr F Chapman gave a *résumé* of Pt 3 of his description of the foraminifera of the Gault of Folkestone —Mr. C Haughton Gill read a paper on a fungus internally parasitic in certain diatoms, illustrating his subject with specimens and photomicrographs Mr Bennett said that he had observed structures which might be of a similar character in desmids. He should like to enquire if by the term "spores" Mr. Gill did not mean zoospores? Had he observed them to be possessed of vibratile cilia? And could he form any idea as to how they came to be inside the diatoms? It was possible that they might be transmitted in some way by inheritance, and if so that might account for their great abundance in particular species. Mr. Gill said

that the question how these things got into diatoms was one still under consideration As to the movements of the spores he was not at present perfectly certain that they moved at all more than a very short distance from the orifice of the beak, but he had not yet had time to examine them sufficiently to be able to answer the question as to whether they were ciliated Diatoms were by no means the tightly shut-up boxes which they were supposed to be; they could not live or absorb nutriment unless there was some sort of passage, and he thought there was very likely a means of penetration all over them to admit of the diffusion of fluid throughout — Mr E M Nelson called attention to the fine adjustment of Messrs W Watson's Van Heurck microscope, which he said had been wrongly described as being on Zentmayer's plan, he found that Messrs Watson's adjustment was provided with spring stops, which obviated all the evils complained of in Zentmayer's system, the adjustment-screw was also left-handed, so that the apparent and real motions were made to coincide, which was a great advantage when working with high powers

OXFORD.

University Junior Scientific Club, November 9 — The President, Dr J Lorrain Smith, in the chair — The President gave an exhibit to illustrate the relation of ventilation to respiratory products, after which he called on the Rev F J Smith for his paper on the inductoscript and spark photography The paper, which was illustrated with experiments, and a large and varied selection of lantern slides, dealt with the recent researches of the writer and others in an exhaustive manner It was shown how impressions of coins, &c, could be taken on photographic plates and paper by means of the electric spark, and the various results produced by changes of pressure, &c, in the atmosphere The second part of the paper dealt more with the instantaneous photography produced by the electric spark, and the exhibits included photographs of bullets and other rapidly-moving objects, which had been taken by the reader of the paper — Mr G C Bourne read a paper on Butschli's researches on protoplasm, which was followed by an animated discussion in which Prof Burdon-Sanderson and others took part

CAMBRIDGE

Philosophical Society, November 14. — Prof T McKenny Hughes, President, in the chair — The President exhibited (1) a live tarantula, (2) quartz crystals of unusual form The following communications were made — (1) Preparations were exhibited showing the division of nuclei in the sporangium of a species of *Trichia*, one of the Myxomycetes The nuclei divide throughout the sporangium, with clearly recognizable karyokinetic figures, immediately before the formation of the spores, by J J Lister (2) On the reproduction of *Orbitolites* Mr. H B Brady has described specimens of Orbitolites, which he obtained in Fiji, showing the margin of the disc crowded with young shells Mr Brady's material was worked at in the dry state, and it was at his suggestion that the author collected specimens preserved in spirit from the Tonga reefs Examination of this material shows that large brood chambers are formed at the margin of the disc during the later stages of growth These are at first lined with a thin layer of protoplasm At a later stage the central region of the disc is found to be empty, and the whole of the protoplasm is massed in the brood chambers in the form of spores. The spores have the structure of the "primitive disc," which during the early stages of growth of the Orbitolites occupies the centre of the shells They are liberated by absorption of the walls of the brood chambers, and each becomes the centre of a new disc, which is built up by additions of successive rings of chamberlets at the margin The reproduction of Orbitolites therefore takes place by spore formation The spore contains a single nucleus, lying in its "primordial chamber" After several rings of chamberlets have been added, a stage is reached at which the nucleus appears to be represented by numbers of irregular, darkly staining masses scattered through the protoplasm of the central part of the disc In the later stages numbers of oval nuclei are found in the protoplasm, often arranged in pairs, and in favourable preparations they may be seen to be undergoing amitotic division — The fragmentation of the nosperm nucleus in certain ova, by S J Hickson. — On Gynodiœcism in the Labiatæ (second paper), by J. C. Willis. — The observations made in 1890–91 on *Origanum* (see *Reporter*, No. 937, June 7, 1892) were continued, chiefly on female plants. Six of these, derived from seed of the hermaphrodite plants of 1890, were observed, and their variations noted It seems possible that some of the six, at any rate, were derived not from the normal, but from the abnormal (female) flowers of the parent Attempts were made to determine if the occurrence of female flowers or flowers with one, two or three stamens only, on hermaphrodite plants, was due to lack of nourishment. A string was tied tightly round the main stalk of an inflorescence, about the middle, and it was found that more variations (12 : 1) occurred above than below Analysis of the three years' observations shows that the abortion of the stamens tends to occur symmetrically rather than not, *i e* most commonly all four abort, and next in frequency is the abortion of the two anteriors then of the two posteriors These observations are still in progress, and it is hoped to publish full details in 1896 or later

PARIS

Academy of Sciences, November 21 — M d'Abbadie in the chair — Observations of the minor planets, made with the great meridian instrument of the Paris Observatory, from October 1, 1891, to June 30, 1892, by M Tisserand — Determination of the centre of the mean distances of the centres of curvature of the successive developments of any plane line, by M Haton de la Goupillière — Observations of Holmes' comet (November 6, 1892) made at the great equatorial of the Bordeaux Observatory, by M G Rayet — Exploration of the higher regions of the atmosphere by means of free balloons provided with automatic recorders, by M Gustave Hermite Small balloons were filled with coal gas and provided with recording barometers and minimum thermometers The former consisted of metallic aneroid boxes on Vidi's system, recording the pressure by the motion of a smoked plate in front of a glass style. These aneroids weighed less than 100 grs. The writer hopes to reduce their weight to 10 grs Some of the balloons were lost or destroyed, but most of them were returned, after a journey exceeding in many cases 100 km Two successful registrations of temperature have been made so far, giving a fall of 1° C for every 260 m and 280 m respectively — Observations of Holmes' comet made at the Algiers Observatory (*equatorial coudé*), by MM Trépied, Rambaud, and Sy — Observations of Holmes' comet (November 6) made with the *equatorial coudé* of the Lyon Observatory, by M G Le Cadet — Elliptic elements of Holmes' comet of November 6, 1892, by M. Schulhof (see our Astronomical Column) — On the calculation of inequalities of a high order Application to the long-period lunar inequality caused by Venus, by M Maurice Hamy — Distribution into four groups of the first *n* numbers, by M Désiré André — On electric oscillations, by M Pierre Janet A gap in a circuit containing a high resistance of some 20,000 ohms is bridged by another containing a coil resistance with self induction and a bridge resistance without. The terminals in the same gap are also connected with a condenser, and a Mouton's *disjoncteur* is introduced in the circuit, rotating at a high speed The differences of potential between the terminals of the two resistances are measured by an auxiliary condenser and a ballistic galvanometer It is thus possible to determine the form of the oscillations On suddenly breaking the short circuit in the gap, it was found that the ends of the resistance without self induction reached a constant difference of potential in a series of oscillations which were always of the same sign, whereas those of the other showed a series of positive and negative oscillations. — On some results furnished by the formation of soap bubbles by means of a resinous soap, by M Izarn Very thin and permanent bubbles are obtained by pounding together 10 gr. each of colophonium and potassium carbonate, adding 100 gr of water and completely dissolving by boiling. For use, it must be diluted with four times its bulk of water — Action of piperidine upon the haloid salts of mercury, by M Raoul Varet. — On the exchanges of carbonic acid and oxygen between plants and the atmosphere, by M. Th Schlœsing, jun — A new case of living *Xiphopage*, the Orissa twins, by M. Marcel Baudouin. — Notes on the feet of batrachians and saurians, by M. A. Perrin. — On asymmetric growth in polychætous annelids, by M. de Saint Joseph. — Influence of moisture on vegetation, by M. E. Gain. Experiments with soils kept in a given state of humidity have led to the following conclusions: For each plant there exists a certain proportion of moisture most favourable to its growth A high comparative moisture in the soil accelerates the growth, especially of the stem and leaves. The air being dry, fructification is slower with a dry than with a humid soil. Inflorescence is retarded either by dry soil or by moist air, and is hastened by the reverse con-

ditions. The most favourable conditions for exuberant growth of flowers are a moist soil and dry air, especially the latter.—Researches on the mode of production of perfume in flowers, by M. E. Mesnard. By the action of pure hydrochloric acid on sections immersed in strongly-sweetened glycerine, the essential oils are easily separated. It is found that the oil is generally located in the epidermic cellules of the upper surfaces of the petals or sepals. In every case the oils appear to have been derived from chlorophyll. The perfume is not given off until the oil is sufficiently freed from the intermediate products, and it exhibits some inverse relation to the amount of tannin and pigment produced in the flower.—On the existence of a conidian apparatus in the *Uredineæ*, by M. Paul Vuillemin.—On the presence of *Actinocamax* in the Pyrenæan chalk, by MM. Roussel and de Grossouvre.—Stratigraphic consequences of the preceding communication, by M. A. de Grossouvre.—On the formation of the Arve valley, by M. Emile Haug.—On an experiment which appears to produce an artificial imitation of the doubling of the canals of Mars, by M. Stanislas Meunier.

DIARY OF SOCIETIES.

LONDON

THURSDAY, DECEMBER 1.

LINNEAN SOCIETY, at 8.—Notes on Œcodoma cephalotes and the Fungi it Cultivates: J. H. Hart.—On a Small Collection of Crinoids from the Sahul Bank, North Australia: Prof. F. Jeffrey Bell.—Descriptions of Twenty-six New Species of Land Shells from Borneo: E. A. Smith.

CHEMICAL SOCIETY, at 8.—On the Formation of Orcinol and other Condensation Products from Dehydracetic Acid: J. Norman Collie.—Isolation of Two Predicted Hydrates of Nitric Acid: S. U. Pickering.—Anhydrous Oxalic Acid: W. W. Fisher.—Observations on the Origin of Colour and of Fluorescence: W. N. Hartley.—The Origin of Colour—Azobenzene: H. E. Armstrong.—The Reduction Products of *αα'* dimethyl *αα'* diacetylpentane: Dr. Kipping.—The Products of the Action of Sulphuric Acid on Camphor: Drs. Armstrong and Kipping.—Methods for Showing the Spectra of easily Volatile Metals and their Salts, and of Separating their Spectra from those of the Alkaline Earths: W. N. Hartley.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Experimental Researches on Alternate Current Transformers: Prof. J. A. Fleming, F.R.S. (Discussion.)

LONDON INSTITUTION, at 6.—Photographs of Flying Bullets, &c. (Illustrated): Prof. C. V. Boys, F.R.S.

SUNDAY, DECEMBER 4.

SUNDAY LECTURE SOCIETY, at 4.—Bacteria and Infectious Diseases (with Oxy-hydrogen Lantern Illustrations): Dr. E. E. Klein, F.R.S.

MONDAY, DECEMBER 5.

SOCIETY OF ARTS, at 8.—The Generation of Light from Coal Gas: Prof. Vivian B. Lewes.

VICTORIA INSTITUTE, at 8.—Principles of Rank among Animals: Prof. Parker.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—A New Form of Filter Press for Laboratory Use: C. C. Hutchinson.—The Production of Acetic Acid from the Carbohydrates: Messrs. Cross and Bevan.—Electrolytic Soda and Chlorine; the Present Aspects of the Question: Messrs. Cross and Bevan.

LONDON INSTITUTION, at 5.—Reading as a Recreation: Edmund Gosse.

ROYAL INSTITUTION, at 5.—General Monthly Meeting.

ARISTOTELIAN SOCIETY, at 8.—Symposium—Does Law in Nature exclude the Possibility of Miracle? R. J. Ryle, Rev. C. J. Shebbeare, A. F. Shand.

TUESDAY, DECEMBER 6.

ZOOLOGICAL SOCIETY, at 8.30.—A Revision of the Genera of the Alcyonaria Stolonifera, with Descriptions of One New Genus and several New Species: Sydney J. Hickson.—Upon the Convolutions of the Cerebral Hemispheres in Certain Rodents: F. E. Beddard, F.R.S.—On a New Monkey from South East Sumatra: Prof. Collett.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Monthly Ballot for Members.—The Manufacture of Small Arms: John Rigby. (Discussion.)

WEDNESDAY, DECEMBER 7.

GEOLOGICAL SOCIETY, at 8.—Note on the Nufenen-stock (Lepontine Alps): Prof. T. G. Bonney, F.R.S.—On some Schistose "Greenstones" and Allied Hornblendic Schists from the Pennine Alps, as Illustrative of the Effects of Pressure-Metamorphism: Prof. T. G. Bonney, F.R.S.—On a Secondary Development of Biotite and of Hornblende in Crystalline Schists from the Binnenthal: Prof. T. G. Bonney, F.R.S.—Geological Notes on the Bridgewater District in Eastern Ontario: J. H. Collins.

SOCIETY OF ARTS, at 8.—The Chicago Exhibition, 1893: James Dredge.

ENTOMOLOGICAL SOCIETY, at 7.—Further Observations upon Lepidoptera (Illustrated by the Oxy-hydrogen Lantern): Edward B. Poulton, F.R.S.—The Effects of Temperature on the Colouring of Pieris napi, Vanessa atalanta, Chrysophanus phlœas, and Tephrosia punctulata: Frederic Merrifield.—Notes on Hydroptilidæ belonging to the European Fauna, with Descriptions of New Species: Kenneth J. Morton. (Communicated by Robert McLachlan, F.R.S.)—On some Neglected Points in the Structure of the Pupa of Heterocerous Lepidoptera, and their Probable Value in Classification; with some Associated Observations on Larval Prolegs: Dr. Thomas Algernon Chapman.—Description of a New Species of Butterfly, of the Genus Cyllinaga, from Siam: James Cosmo Melvill.

THURSDAY, DECEMBER 8.

ROYAL SOCIETY, at 4.30.—On the Photographic Spectra of some of the Brighter Stars: Prof. J. Norman Lockyer, F.R.S.—Experiments in Examination of the Peripheral Distribution of the Fibres of the Posterior Roots of some Spinal Nerves: Dr. Sherrington.—Preliminary Account of the Nephridia and Body Cavity of the Larva of Palæmonetes varians: Edgar J. Allen.

MATHEMATICAL SOCIETY, at 8.—Note on Cauchy's Condensation Test for the Convergency of Series: Prof. M. J. M. Hill.—Additional Note on Secondary Tucker Circles: J. Griffiths.—Notes on Determinants: J. E. Campbell.—A Geometrical Note: R. Tucker.

LONDON INSTITUTION, at 7.—A Plea for Catholicity of Taste in Music (Illustrated): Sir Joseph Barnby.

SATURDAY, DECEMBER 10.

INSTITUTION OF CIVIL ENGINEERS, 1 to 4.—Students' Visit to the Machinery and Inventions Division, South Kensington Museum.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—Berzelius und Liebig, Briefwechsel 1831–1845 (München, Lehmann).—A Short Manual of Orthopædy, Part I.: H. Bigg (Churchill).—Congrès International de Zoologie, Deux Session à Moscou. Première Partie (Moscou).—Congrès International d'Archéologie 11-ème Session à Moscou, vol. 1 (Moscou).—A Catalogue of British Jurassic Gasteropoda: W. H. Hudleston and E. Wilson (Dulau).—Annuaire de l'Observatoire Municipal de Montsouris, 1892–93 (Paris, Gauthier Villars).—Les Textiles Végétaux: H. Lecomte (Paris, Gauthier-Villars).—Essais d'Or et d'Argent: H. Gautier (Paris, Gauthier Villars).—Past and Future: C. M. Jessop (K. Paul).—Toothed Gearing: A Foreman Pattern Maker (C. Lockwood).—Modern Views of Electricity, 2nd edition: Prof. O. J. Lodge (Macmillan).—The Universal Atlas, Part 21 (Cassell).—Grasses of the Pacific Slope, Part 1: Dr. G. Vasey (Washington).—Das Keimplasma, Eine Theorie des Vererbung: Prof. A. Weismann (Jena, Fischer).—Die Zelle und die Gewebe: Prof. O. Hertwig (Jena, Fischer).—Extinct Monsters: Rev. H. N. Hutchinson (Chapman and Hall).—The Algebra of Coplanar Vectors and Trigonometry: R. B. Hayward (Macmillan).—Science in Arcady: Grant Allen (Lawrence and Bullen).—The Chemical Basis of the Animal Body: Dr. A. Sheridan Lea (Macmillan).

PAMPHLETS.—Quelle est la Race la plus Ancienne de la Russie Centrale: A. Bogdanow (Moscou).—Descriptive Notes on certain Implements, Weapons, &c., from Graham Island, Queen Charlotte Islands, &c.: A. Mackenzie.—Notes on the Shuswap People of British Columbia: G. M. Dawson.—Some Laws of Heredity and their Application to Man: S. S. Buckman (Gloucester).—Sur la Constitution des Dépôts Quaternaires en Russie et leur relations au Trouvilles Résultant de l'Activité de l'Homme Préhistorique: S. Nikitin (Moscou).—Ueber die Entwicklung von Milz und Pankreas: Dr. C. von Kupffer (München).—Verg. Anatomische Studien über die Nerven des Armes und der Hand: Dr. W. Höfer (München).—Die Lendennerven der Affen und des Menschen: Dr. A. Utschneider (München).—Ueber das Vorkommen Offener Schlundspalten: Dr. F. Tettenhamer (München).

SERIALS.—Mittn. der Deutschen Gesellschaft für Natur und Völkerkunde Ostasiens in Tokio, 50 Heft (Tokio).—Traité Encyc. de Photographie, Premier Supplément. *A cinquième fascicule*, C. Fabre (Paris, Gauthier-Villars).—Natural Science, Decr. (Macmillan).—A Monograph of Oriental Cicadidæ, Part 7: W. L. Distant (London).

CONTENTS.

THURSDAY, DECEMBER 8, 1892

THE NEW UNIVERSITY QUESTION

THE correspondence between Prof Huxley and Prof Pearson which has appeared in the *Times* is not pleasant reading With infinite pains and trouble an Association had been formed to support the foundation in London of a university of a certain type A nucleus of the most eminent teachers or ex-teachers in London had collected around them a powerful body of supporters from the provinces In Prof Huxley as President, and Sir Henry Roscoe as Vice-President, the Association secured the services of two men distinguished both as professors and for their knowledge of affairs It appears to have been less fortunate in its secretary Prof Karl Pearson had some difference with his fellow committee-men on a question of procedure He himself has described the divergence as not fundamental and has publicly stated that he believes that the other members of the committee were aiming at securing the establishment of a university of the type which he himself approves So comparatively trifling was the issue, that, according to Prof Huxley, Prof Pearson himself proposed that the reason to be given for his resignation should be "pressure of work" No doubt can therefore exist as to the cogency of this motive His position was apparently even more clearly defined by his not voting against the course of action proposed on the occasion of a meeting which was shortly to take place between the Senate of the University of London and the Committee of the Association, and by his spontaneously pledging himself "to say nothing as a member of the deputation, contrary to what was then agreed to"

It is therefore no wonder that Prof Huxley was surprised, when on the very next day Prof Pearson wrote to the *Times*, discussing resolutions which Prof Huxley regarded as confidential and accusing his colleagues of various offences, of which the day before he thought so little that he had voluntarily stated that "pressure of work" was the reason to be given for his resignation

One good result may perhaps follow from Prof Pearson's action Owing to the sense which has unfortunately been attached to the word "absorb," and to the assumption that the title "Professorial University" meant a University governed solely by Professors, an opinion has got about that the members of the Association are impracticable persons, who have propounded an unworkable scheme It is true that both accusations are directly met by the published programme of the Association It is there made clear that a voluntary absorption is all that is aimed at, and that laymen as well as experts are to have a share in the management of the University Prof Pearson's defection has made it still more obvious that the Association scheme is intended, not to gratify theorists, but to support a policy which is capable of realization

Prof Pearson declares that he desires a University on the model of Berlin, but the question at once arises, Is the model to be followed exactly, or are modifications to be introduced? Is the University to be free from all State control? Prof Huxley desires that it shall be free, and under existing circumstances we cordially agree with him Let the State, if it will, nay as it must, support and subsidize the new University as it supports the British Museum, but let the control of the one, as of the other, be in the hands of an independent Governing Body But, if this condition is realized, there is at once a fundamental difference between the actual University of Berlin and the possible University of London The external element furnished in Germany by State control must in England be supplied by lay members of the Governing Body, and the difference thus established will run throughout the whole of the constitution

Prof. Huxley publishes in his letter to the *Times* an outline of a scheme for the organization of the University which is too interesting to be omitted here He explains that he gives the rough notes on which his evidence before the Gresham University Commission was based

The scheme is as follows —

"Do not venture to ask for all I want, but for as much as it seems possible to get on the way to that

"Suggestions tentative and open to modification

"(*a*) Retain title and prestige of University of London, reorganize it in such a manner as to secure general uniformity and efficiency of work with freedom and elasticity In short, unify without fettering

"(*b*) Make the institutions which contain technical schools of theology, law, medicine, engineering, and so on into colleges of the University Let these examine their own candidates for degrees, under conditions determined jointly by them and the Senate of the University, and present such as they declare fit to the University for *ad eundem* graduation

"(*c*) Deal in the same way with institutions giving adequate instruction in the other categories of University work—if they so please, or let the University examine

"(*d*) Provide ample means for instruction in the modes of advancing natural knowledge and art, either in material connexion with the existing University or in particular colleges

"(*e*) Professoriate to have large but not preponderant representation in Senate, and wide, but not exclusive, influence in regulating instruction and examination in accordance with the general aim at unification.

"(*f*) All state and municipal contributions, private endowments and University fees for instruction and examination to be paid into a University chest All professorial staff and current expenses (save in cases that may be reserved) to be paid out of the University chest, also building and fitting expenses where there is no sufficient endowment of a college The payment of the professorial staff to be primarily regulated by the kind and amount of the work done for the University, not by number of students.

"(*g*) No bar to be placed in the way of any one who desires to profit by any description of University instruction If, after trial, he does not profit, time enough to exclude. Value of exclusion as disciplinary measure."

Any one who takes the trouble to compare this scheme with the original programme of the Association will see that they are in close accord It is true that the Association put forward the complete voluntary absorption of the colleges as the result most to be desired, but it distinctly contemplated the possibility of relations between the University and institutions or colleges which were not completely absorbed, and it will be seen that the only terms on which Prof Huxley will permit relations to be established between the University and the colleges secure to the former a very large measure of authority

Prof Huxley himself describes his scheme as of a tentative character, but whatever plan be finally adopted it is desirable that the real aims and objects of the Association shall be fully understood

It is desired that there shall be one University in London which shall be a central authority to organize and improve higher education

No reasonable person has ever supposed that the existing University of London was to be destroyed as a sort of peace-offering to its critics, or that existing colleges were to be ignored or dragooned into self-effacement What is desired is that the Senate of the existing University should be reconstituted by the addition of professors teaching under the control of the University and by a reduction in the number of its lay members, if, with the new additions, it would otherwise be of unwieldy size

It is desired that a share in the benefits to be obtained from the University should be given to any college only in so far as it is willing to put into the hands of the University the appointment and control of those of its chairs which might be recognized by the University It is hoped that the advantages which would accrue from this partial fusion would be so great as to lead to the gradual voluntary "absorption" of the colleges To make this desirable end attainable it is necessary that the College Councils should not be represented, as such, on the Governing Body of the University, but no objection would, we believe, be felt to temporary arrangements which might facilitate the inauguration of the new state of things

The sooner it is clearly understood that the Association is the result of the labours and the exponent of the views of the "practical men" who are, according to Prof Huxley, to be found in the professorial ranks, the better it will be for the Association and for London Prof Pearson's withdrawal from the secretaryship appears, under all the circumstances, to afford a sufficient guarantee of this

IN SAVAGE ISLES AND SETTLED LANDS

In Savage Isles and Settled Lands Malaysia, Australasia, and Polynesia, 1888–1891 By B F S Baden-Powell, Lieut. Scots Guards, F R G S (London Richard Bentley and Son, 1892)

THIS book contains the impressions of Lieut Baden-Powell during a journey round the world of over three years' duration, jottings limited chiefly to his own personal doings and observations. The journey was evidently a leisurely peregrination with many divergences to places of interest off his direct route out to Brisbane in Queensland, whither he was bound to assume official duty on the staff of the governor of that colony, and an equally unhurried saunter home again through the Pacific and America The author does not propose to look at things with scientific eyes, and it is possible here and there throughout the book to detect that he has no profound acquaintance with the *ologies* Consequently his book does not fall to be rigidly criticized in these pages. His eyes, however, if not scientific, were kept at all events very wide open, and what came under his own observation is clearly and accurately described in a chatty and pleasant style and with a good deal of quiet humour It is easy to see that the "tramp" enjoyed his trip, and the reader, drawn on by his cicerone's mood, accompanies him through savage isles and settled lands with equal satisfaction Lieut Baden-Powell started off through the European continent *viâ* Cologne and Vienna to Rustchuk, thence across Bulgaria, through which "a railway journey is not very interesting" Nevertheless, "little picturesque villages are seen nestling in the valleys, and distant glimpses of the Balkans gained" Beyond Shumla we get through the mountains and "pass through miles of swamp, the railway almost level with the water, and reeds growing up all around, in some places so high as to cut out all view from the carriage windows Passing along the edges of large lakes, the train starts up thousands of wild fowl, which fly around till the air is quite darkened by them, and on we go, mile after mile, with more and more duck rising from the water," evidently a sportsman's paradise Thence our guide conducts us to Constantinople and on to Egypt, and though he takes us by well-trodden paths and tells us little that is new or wonderful, he enlivens the way with a constant flow of time beguiling talk and anecdote From Egypt Mr Baden-Powell sets out for southern Australia, but he wanders as usual off his main road for some weeks into Ceylon and India to luxuriate amid their tropic scenery and ancient monuments Of the three southern colonies of the Australias traversed on his way to Queensland he gives us a few brief notes Of the latter colony, where he spent some years in the enjoyable and not very arduous duties of A D C to Sir Anthony Musgrave and Sir Henry Norman, he has a great deal that is interesting to tell He visited much of the country, and saw something of its aboriginal as well as of its adopted natives, and found interest and amusement in both. At a vice-regal ball at Hughenden, a town 240 miles inland, he finds himself a fellow-guest with the butler of the hotel he was staying at, and his host's housemaid, "who was quite the belle of the ball, and who, when supper was served, turned waitress again Such is society in a Bush town" "It was in this district," he continues, "that I first set eyes on some real wild blacks. The aboriginals of Australia are an extraordinary people. To look at they are quite unlike any other human beings I ever saw A thick tangled mass of black hair crowns their heads, their features are of the coarsest, very large broad and flattened noses, small, sharp, bead-like eyes and heavy eyebrows They generally have a coarse tangled bit of beard, skin very dark and limbs extraordinarily attenuated like mere bones But they always carry themselves very erect . . They wander about stark naked over the less settled districts, and live entirely on what they can pick up . If not the lowest type of humanity they would be hard to beat. They show but few signs of human instinct, and in their ways seem to be really more like beasts." Mr. Baden-Powell thus summarizes his opinions on Australia as a field for emigration (and those who know the Australasian colonies will recognize their truth): "The labouring man will find it a paradise; the professional man will find his profession overstocked, and the man with money to invest will probably be ruined. . . . My personal advice to would-

be emigrants except of the lowest [? lower] class is like *Punch's*—Don't"

From Queensland it was easy and natural for our traveller to be attracted across to New Guinea, the land of so much myth and mystery Here he fell in with the indefatigable administrator, Sir W Macgregor, and was able to lend him a helping hand in the skirmishing incident on the capture of the natives of some villages guilty of the murder of several Europeans He spent some days at Samarai, the head-quarters of the south-eastern district, and we feel sure that the almost unsurpassable panorama visible from its hill-set bungalow of "mountains wooded to the peak," and green isles, spread out on every side, basking in an azure sea, and picturesquely veiled in haze as they lessen away to beyond the horizon, must have rewarded him for his visit, even at the expense of a bout of fever His account of what he saw and did in Papua occupies some eighty pages, and contains more trustworthy and interesting information than many of the narratives of men who have spent a much longer time in the country than Mr Baden-Powell did The next region he visited was the Malay Archipelago He only gazed on Sumatra, "that extraordinary island which contains probably a greater variety of big game, of useful plants, and of wonderful scenery than any other country of its size", but he visited many of the most interesting places in Java, and the Straits Settlements, and made extensive journeys in Borneo, where he shot some of "the very extraordinary-looking proboscis-monkeys (*Larvatus nasalis*) I should imagine," he remarks, "his ponderous nose would get very much in the way of his biting any one, and he certainly has no other means of defence" Our space will not permit us to follow Mr Baden-Powell through New Zealand and the various islands of the Pacific sojourned in by him, except to note his account of the preparation of "king's cava," of which he was a witness, in Samoa —

"This was a great event None of the Consuls even had ever before partaken of 'king's cava' But there was a certain amount of sham about it. First, the root was produced—genuine enough, I dare say Six men then sat in a row outside the house, the nine-legged cava bowl before them Each man was then given some water to wash his mouth out, and a packet of cava wrapped in a bit of leaf was given to each I shuddered at the awful thought of what was about to happen In true native fashion these nasty old men were undoubtedly going to chew the root, and I would have to swallow the nauseous stuff! I watched very carefully and was much relieved when I saw the packets collected again and put in the bowl. It was ready prepared [outside in a less orthodox and less disquieting fashion] and the little ceremony was only to represent formally the mode in which it ought to be done, the cava being 'taken as chewed.' Then the bowl was solemnly brought into the house and put on the floor at the end opposite the king"

This is an interesting instance of the evolution of what might have been as meaningless a ceremonial as are many of those survivals of abandoned customs which are familiar to us in many other parts of the world.

From Samoa Lieut. Baden-Powell made his way home by the usual route *viâ* the Sandwich Islands and through the States.

"In Savage Isles and Settled Lands" is a book we can heartily recommend. It is elegantly got up, is illustrated by excellent wood engravings, and has a map of the author's route. Nearly every page presents in a few words some bright vignette that will please and inform those who have never had the opportunity of visiting those lands and isles, and will set the home-come traveller a-dreaming with grateful satisfaction of delightful days that are past, and help him to live them over again more delightfully still in the present.

H O F

PROPERTY

Property Its Origin and Development By Chas Letourneau, General Secretary to the Anthropological Society of Paris, and Professor in the School of Anthropology (Walter Scott, 1892)

LESS than a generation ago the history of early civilization was summed up, if not in the three words hunting, pasture, and agriculture, at least in the formula of Sir Henry Maine "Society develops from family to tribe, and from tribe to State" Recent inquiries have discredited both of these formulas, and taken us back to the genesis of the family itself, and beyond civilization to barbarism and savagery If we listen to Prof. Letourneau (to say nothing of Morgan and Maclennan), we may reconstruct the evolution of society in all its stages out of savagery by the "ethnographic method,"—"looking upon existing inferior races as living representatives of our primitive ancestors" (Preface, page ix) It must be remembered that in using this ethnographic method we assume that the order of progress has been substantially identical in all cases, and also that the simplest forms come first in time (p 70, cf. 126) Both assumptions would need justification before the results of the new method could be finally accepted.

Prof. Letourneau had applied the method with great learning and ingenuity in his earlier book on the evolution of marriage In the volume before us he applies it to property He begins with a chapter on property amongst animals, ants and bees, as we might expect, are shown to be more highly developed in this matter than many men, and they have many of the vices of men They provide for the future Their property is that of a community, but one community wars on another for pillage. There are not only parasites, but idle aristocrats among them. The amazon ants, who cannot even feed themselves, but depend on their black slaves, are well known from Huber's description, and are a standing refutation of Solomon's high opinion of ants. On the whole, among animals, property is due simply to the instinct of self-preservation, and Letourneau ascribes it to the same origin in the case of men Among the "anarchic hordes," which come first in his series (p. 23), and of which the Fuegians are a specimen, there is collective property If union is strength it is weakness that first leads to union (cf p 368) But there is no personal property except in tools and weapons, "the immediate result of personal labour" (p 39) Provision for the future is unknown In the second stage (among the "republican tribes") the union is more highly organized; there is tribal government, with minute regulation of conduct in regard to the dealings of individuals with the necessaries of life. The most remarkable example is perhaps that of the people of Paraguay

among whom (as our author shows) the Jesuit missionaries found and did not make a system of communism (pp. 42 seq) In nearly all the instances of this class the sense of property was most strongly developed in regard to the hunting ground of the tribe, though (in the case of the Iroquois, &c) it embraced the Long Houses of the clans of the tribe, an anticipation of Fourier's phalansteries The differentiation of the clan from the tribe is ascribed to the growth of the taste for property itself (cf. p 365) Letourneau would explain the present universality of human sympathy as a bequest to us from the days when all property was common (p. 57) The republican organization passed into the monarchical, where the tribe was governed by its chief (pp 56 seq) This political change was rather an effect than a cause of coincident industrial changes, especially the introduction of private property in slaves and women "A comparison of the American tribes, placing them in a graduated series from the primitive system of communistic equality upward, plainly shows that, at least in this part of the world the establishment of aristocracy and hereditary monarchic power has merely crowned an economic evolution whereof the point of departure was the institution of slavery, and the consequent development of agriculture, whence arose the rupture of primitive equality, creation of exchangeable values, development of private property, contrast between rich and poor, foundation of castes, and hereditary succession" (p 61) This passage, amongst others, betrays the tendency—fashionable in some quarters at the present time—to regard all social development as due mainly, if not wholly, to economic causes Not that economists by profession are *gratæ personæ* to our author On the contrary, they are only mentioned to be rebuked, and their doctrines only to be caricatured (see pp 91, 96, cf 120, 124, &c) But, as by some sections of German Socialists, so by Letourneau, we are given to understand that the politics, religion, and general character of a society are determined by the conditions of industry and the terms of property therein prevailing, while no sufficient allowance is made for the reaction of the former set of phenomena on the latter

To sum up at this third stage in the development from savagery (the early monarchical system), the idea of personal property is extended from weapons and tools which a man has made, to the trees which he has planted, and then to the plot of ground he has cleared and sown After that the idea of private property may be considered to be full formed and definitely launched on its modern career of development (p. 72) The great cause of private property is agriculture Where there was only pasture, as with the Hottentots, the private property was only in cattle, women, and children (p 79) Agriculture brings us to extended forms of slavery, and to forms of property and modes of valuing and exchanging it that approach more and more to modern ideas

We need not follow our author into the *minutiæ* of his account of "primitive monarchies" and empires. He gives a survey of mankind from China to Peru, and from the earliest times to the period of Roman, feudal, and modern civilization. The earliest stages of the development are (rightly enough) treated more fully than the later, the later being the more generally known The differentiation of clan from tribe and of family from clan, the formation of village communities for the purpose of agriculture, the introduction of inheritance, and of private property in estates, are all traced out in chapters that are full of interest even when not above cavil

Prof Letourneau has perhaps been too ready to point a moral for the benefit of his own generation But after all he gives his readers the facts, and they may find their own moral, which may or may not be his One of the best instances where the materials presented seem to justify a different moral than the one drawn from them is that of the *dessa* or village community of Java It is pronounced to have excellent results, particularly in increasing population (p 121), and is contrasted with "the selfish African system" (p 122), but by our author's own account it is a combination of private and collective property, not an example of the latter by itself (cf pp 114, 115).

The book is, we may presume, translated from the French, and this will account for the use of "alienist" for "lunacy doctor" (p 370), "disengaging" for "analyzing" (p 373), and "salaried" for "wages-earning" (p 375) But, as a rule, the language is correct and clear English

J B

LEAPER'S "OUTLINES OF ORGANIC CHEMISTRY"

Outlines of Organic Chemistry By Clement J Leaper, F C S Specially written for Schools and Classes connected with the Department of Science and Art (London Iliffe and Son, 1892)

THIS little work is intended, as the title states, for the use of beginners But the author has made the way of beginners hard, by leaving in his pages the largest collection of misprints and other slips which we recollect to have met with in so small a compass.

On the very first page, in the opening lines, there occurs a wrong formula for urea, and the book ends with a wrong formula for aldehyde-ammonia We do not propose to convert this notice into a table of errata, but the following may be given as illustrating the sort of guidance which the beginner may expect On p 75, in the brief space of three lines, we meet with "$(COOH_2)$," "$C_3H_5(OH_3)$" and "$C_3H_5(OH_2)COOH$," as representing respectively oxalic acid, glycerin, and—monoformin! The blunder, in each case, consists, of course, in placing a coefficient inside instead of outside the bracket, but we doubt whether, even with this correction, the last expression, with its carboxyl-group in place of the group O CHO, would be recognized, even by an experienced chemist, much less by a beginner, as representing monoformin

Blunders, due to carelessness, are not confined to formulæ Thus we find "Pure white precipitate of silver *oxide* (p 13), whereas the context shows that silver *chloride* is meant, "*ethene* dichloride, $C_2H_2Cl_2$" (p 37), "lead the gas into lime water, and note the formation of insoluble *carbon dioxide* (p 51); "by the further chlorination of methyl chloride we get *ethylidene* chloride" (p 67), whilst, on p 99, "grains" is twice given instead of "grams" But the worst blunder we have met with occurs on p. 109, where, possibly owing to a transposition of the pages of the author's manuscript, the explanations

which should follow Experiment 112 (Preparation of Ethyl Nitrite) have been moved on by a whole page, and made to follow Experiment 115 (Preparation of Nitro-ethane) The utterly bewildering effect of this jumble, which is enhanced by the unexpected re-entrance of the subject of nitro-ethane in the middle of a paragraph a little later on, cannot be realized without reading the passage

The work is intended to combine practical with theoretical instruction The selection of experiments is, on the whole, judicious, and the practical directions are generally good This is not to be wondered at, as the author has evidently, in these points, followed pretty closely Prof Emerson Reynolds's "Experimental Chemistry," even to such details as the substitution of a tin oil-can for a distilling flask (p 99), or a peculiarity in the bending of a tube (p 74), and to the reproduction of some of the illustrations—in every case without acknowledgment Prof Reynolds is not, however, responsible for the illustration on p 17, in which the distillate from a Liebig's condenser is represented as falling from a considerable height into a flask placed below

It is not true that (p 12) "every organic compound containing nitrogen will, when fused with metallic sodium, convert the latter into sodium cyanide" Diazo-compounds do not yield any cyanide, and compounds containing sulphur as well as nitrogen form thiocyanate Nor is heating a cyanide with excess of concentrated sulphuric acid (p 76) a method of distinguishing it from a formate

The author's style is occasionally slovenly, and sometimes worse "Observe how the fact that oxalic acid so readily split up into CO, CO_2 and H_2O support (*sic*) this graphic formula for it" (p 117)

On the whole, we suspect that teachers will prefer a text-book which calls for fewer marginal corrections

OUR BOOK SHELF

An Introduction to the Study of Botany, with a special chapter on some Australian Natural Orders By Arthur Dendy, D Sc, and A H S Lucas, M A Small 8vo, 272 pages with about 30 pages of woodcuts (Melbourne and London Melville, Mullen and Slade, 1892)

THE authors of this little work are both teachers of Natural Science in the University of Melbourne and it is specially intended for the use of students in Australia With this object in view it would have been better perhaps to have selected common Australian types to illustrate the life history of the great divisions of the vegetable kingdom; but *Pinus* is taken as a representative of gymnosperms and *Vicia* of angiosperms Whether these plants are both easily procurable in Australia we are unable to say, but even in that case it would have been better to have taken native plants Possibly the preparation of illustrations may have influenced the authors, for they are largely, in the first part, "modified," "simplified," or "adapted" figures from well known books, or they are simply copied Taken as a whole, we do not doubt that this primer will prove useful to students, but it needs much revision to make it what it ought to be Here and there, where we have tested it, we have found serious shortcomings. Take for example the account of the divisions of the vascular cryptogams

"1. *Filicineæ*.—These are the ferns which constitute a very large and interesting subdivision The full account already given of the common bracken renders a detailed description unnecessary in this place There are two principal subdivisions of the *Filicineæ*, the homosporous, which produce only one kind of spore, and the heterosporous, which produce large megaspores and small microspores The former include all the ordinary ferns and are again subdivided into six 'families,' of which the Polypodiaceæ are the best known and most abundant, including most of the common ferns, such as Pteris"

One would have expected a word or two respecting the heterosporous group—the *Rhizocarpeæ*, with some mention of *Marsilea*, so memorable in the history of Australian exploration, but the authors seem to have come to grief between the older and newer classifications of vascular cryptogams, for in another place (p 90) we read of "heterosporous ferns" The definition of the *Equisetineæ* contains no reference to the spores, and the description of the *Lycopodineæ* contains no information at all It runs thus "This group includes the club-mosses (*Lycopodium*) and the beautiful *Selaginella*, a plant frequently grown in conservatories for decorative purposes They are all of rather small size, and are popularly spoken of as "mosses" owing to the general appearance of the plant with its numerous very small leaves"

Comment on such a description would be superfluous In the classification of the cellular cryptogams, lichens are altogether left out, and are apparently not mentioned anywhere In fact the same incompleteness and inexactness pervades the book, which opens with a eulogistic preface by W Baldwin Spencer, Professor of Biology in the University of Melbourne W B H

A German Science Reader (Modern German Series) Compiled by Francis Jones, F R S E (London Percival and Co, 1892)

THE idea of introducing to English readers extracts from the works of many well known German scientific authorities will be thoroughly welcomed The author has brought together sixteen very interesting articles on several branches of science, supplemented with notes, in which difficult passages are translated, and a glossary of the technical terms not usually found in dictionaries Among the articles we may mention, Electric Telegraphs by Bernstein, Ice and Snow by Kantz, Air by Muller, Aniline Dyes by Kekulé, Spectrum Analysis by Kirchhoff and Bunsen, &c W

More About Wild Nature By Mrs Brightwen (London T Fisher Unwin, 1892)

MRS BRIGHTWEN'S book on "Wild Nature Won by Kindness" was so widely appreciated that she has been encouraged to prepare a second volume of the same general character It speaks well for her knowledge of animals, and for her interest in their habits, that the new sketches are written in as fresh and bright a style as if she had never before occupied herself with the mass of subjects with which she deals. She is a careful and accurate observer, and all readers who care for natural history will find much to please them in the facts and impressions she records The author's illustrations add greatly to the charm of the text.

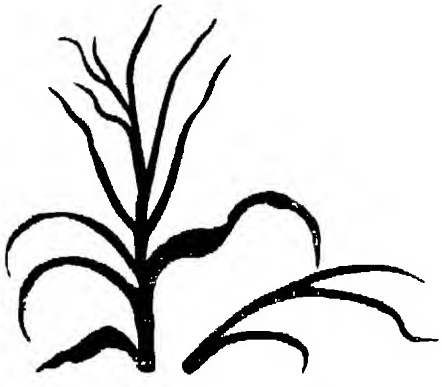
LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

Arborescent Frost Patterns

ON Sunday last, December 4, I observed a curious phenomenon, which I do not remember having ever seen before in the streets of London Along the Euston Road, the Marylebone

Road, and other thoroughfares having an east and west direction the paving flags were all covered with a striking, vegetable-like pattern which might be most appropriately described as an arborescent tracery The pattern was not formed of the usual small and delicate frost figures such as we are familiar with on window panes, but was made up of large and boldly fronded designs such as shown in the sketch, which I hurriedly made on the spot —



The "fronds" were from one to two feet in length, and often most gracefully curved A keen wind was blowing at the time from a few degrees north of west and the flags had evidently been coated with a thin layer of mud from the previous night's rain I attribute the pattern to the rapid freezing and evaporation of the water in this surface layer of mud which was going on during the morning I only noticed the tracery along east and west thoroughfares, in sheltered streets not swept by the cold wind no design was visible The phenomenon may be known well enough to others, but by many, like myself, it may have hitherto been passed over unnoticed My chief object in sending this description is to call attention to the very vegetable-like appearance of the pattern If allowed to dry in a calm atmosphere and then buried under a fine alluvial or other deposit a record would be preserved which the future geologist might at first sight be tempted to read as "vegetable remains" I have seen very similar tracery in the London clay about Clacton on Sea and elsewhere. R MELDOLA

Ice Crystallites

THE interesting facts recorded by your correspondent C M Irvine on p 31 recall some unrecorded observations of my own On several occasions during recent winters I have observed these crystallographic forms of ice on a gravel walk by the side of my lawn, in places where, owing to faulty gradients, the water does not completely drain away at the surface, and the ground just below the surface is in consequence more saturated with water than at other spots. The acicular ice forms have appeared in bundles standing up between the pebbles and capped by earthy material, just as described by Mr Irvine, and in previous communications to NATURE by Mr H Woodd Smith (see his letter on p 79) The nature of the soil agrees with that described by these two observers, so far as permeability to water is concerned, and I think they appeared on the occurrence of clear frosty weather after a thaw and melting of previous snow My observations, however, extended further than theirs appear to have done I was at the time pursuing the study of the glassy acicular *crystallites* of sulphur (which are erroneously described as "crystals" in most text-books on chemistry) These, on examination with polarized light (as I have described elsewhere) are found to be destitute of any crystalline internal structure (in fact truly vitreous or isotropic masses in spite of their crystallographic outlines), such structure developing, as devitrification proceeds, by crystallization in the orthorhombic system, to which the outlines of the crystallites do not conform

In NATURE (vol. xxxvii. p 104) is a letter from myself, recording some observations on the vitreosity of ice, as exhibited under certain suitable conditions by hailstones, and referring to a previous letter (*Ibid* vol. xxxvi. p 77), wherein the vitrification and devitrification of water was suggested as the possible cause of certain structural phenomena observed in them from time to time It was with those ideas present to my mind that during recent winters I have made an examination of the acicular ice forms referred to, which struck me as made up of unusually clear and transparent ice On taking my microscope out of doors, fitted with a polarizing apparatus, when the temperature was a few degrees below freezing, with a thick overcoat on to prevent the heat of one's body from affecting the ice-needles, I found that, on taking them from the ground and placing them at once on the stage between crossed "Nicols," they appeared to be *completely isotropic*, as they had no reaction on polarized light I have concluded, therefore, that these ice needles are strictly analogous (physically) to the prismatic crystallites of sulphur, and they resemble precisely the microscopic lathe shaped forms, into which I have seen a perfectly clear minute plate of sulphur-glass break up in the first stage of devitrification The explanation suggested by Mr Woodd Smith, that they may have been formed by a slow growth of ice at their base, the molecular movement of water in the soil keeping up the supply so long as refrigeration continued, has seemed to me the most natural one, their isotropic molecular structure is no doubt due to the rapidity of freezing owing to a sudden fall of temperature at the spot A IRVINE

Wellington College, Berks, November 27

The *Volucellæ* as Alleged Examples of Variation "almost Unique among Animals"

IT is barren work for the parties in a controversy merely to deny each other's statements without adducing further evidence Mr Bateson first stated that var *mystacea* did not mimic *Bombus muscorum* I replied that it did, and the statement in my letter in no way depended on the case at the Royal College of Surgeons, but on a careful comparison of the insects in the Oxford Museum It is useless for me to repeat that I regard it as an example of mimicry, not indeed equal to that afforded by the same fly and *Bombus hortorum*, but far better than many others which are generally believed to be instances of this principle (such as the resemblance of *Clytus arietis*, or even the resemblance—admitted by Mr Bateson in his first letter—of *Volucella inanis*, to a wasp) I therefore propose to furnish the Editor of NATURE with photographs of the *Volucellæ* and humble bees for reproduction, so that readers can judge of the matter for themselves I will do my best to obtain a negative which shows the coloured bands

Although I believed that the two London Museums supported my view, it will be obvious to any one who reads the letter that I did not rely on such support, but on my own comparison of the insects

Mr Bateson has offered no further evidence in support of his remarkable assertion that the variation of the *Volucellæ* is unique I am not surprised that he should pass over this part of my letter, for I felt sure that there was no further evidence to offer It will be remembered that this evidence was contained in the "brief statement of facts" given in his first letter, and is practically summed up in the sentence "This fly exhibits the rare condition of existing in two distinct forms in both sexes" In assuming this rarity to be so excessive that the words "almost unique" may be applied to it, and in evidently considering that we must proceed as far as the peach and nectarine in order to find a parallel, Mr Bateson exhibits a want of acquaintance with the facts of variation which is very surprising in one who is believed to have spent some years in their study For there is no essential biological difference between this variation and many others, examples of which I gave in my last letter, and which could easily be multiplied In fact, many a "showcase" would have corrected such a mistake Compared with the magnitude of this erroneous statement in Mr Bateson's first letter, the details under discussion assume very small proportions In considering that "no speculation is needed to enhance the exceptionally interesting facts of the variation and the resemblances of the *Volucellæ*," it would appear that Mr Bateson seeks to replace that most invaluable servant of science, speculation, by far reaching and unsupported assertion.

In his last letter Mr Bateson says "it is admitted that in making this statement Mr Poulton relied not on original authorities, but on the general impression of others" So far from this being the case I stated my belief that the impression is prevalent among those who *are* original authorities on the Hymenoptera and their parasites, and I also showed that nothing

is advanced by the authorities quoted by Mr Bateson which can be regarded as antagonistic to this impression by any one who knows a little about the working of heredity in insect varieties

A word about "showcases" I hope that no reader of NATURE may be led to think lightly of these as a means of instruction, and as one of the chief objects of a great museum because Mr Bateson states that there is a wrong identification in one at the Royal College of Surgeons, and because of the distinction which he is so careful to draw between these and other cases Some of the most valuable specimens in the world are in "showcases" They form one of the most admirable features in modern museum arrangement, and the best material obtainable is set aside for them This is equally true on the continent and in our own country, where Prof Sir W Flower and Prof Stewart have devoted an immense amount of time and labour to this department, an important recent feature of both their museums being the illustration of the uses of colouring in animals Prof Lankester too is developing the same method of instruction with great success in the Oxford Museum

It is in no way remarkable or reprehensible that four recent writers (Mr Lloyd Morgan, Mr Beddard, Mr Romanes, and myself) concerned with this subject and knowing the care taken in choosing these illustrations, should also make use of some of them in their published works.

One "difficulty" brought forward by Mr Bateson is so futile that I did not allude to it before, and only refer to it now because he repeats it He seems to think that doubt is thrown on the theory of mimicry because *V pellucens* does not resemble a wasp, and yet lives in its nests as if any believer in natural selection maintained that all closely allied forms must defend themselves in the same way!

As to Mr Bateson's statement at the end of his letter that he only intended to draw attention to the matter (and not to hurt me thereby), I can only say that this statement implies an extraordinary want of acquaintance with the niceties of the English language It is so easy to correct mistakes without leaving anything but a feeling of gratitude in the mind of one who has made them, that, in justice to Mr Bateson's intelligence, I am compelled to doubt the accuracy of his memory

Oxford, November 27 EDWARD B POULTON

"A Criticism on Darwin"

I WRITE to protest against what appears to be a growing habit on the part of certain publishing firms of advertising their books in a most misleading manner, viz by selecting any phrase from a notice of the book which may serve to indicate that the writer's opinion on the work as a whole is favourable, whereas, if quoted with its immediate context, the passage would prove the precise opposite For example, I see in NATURE and elsewhere an advertisement of Mr David Syme's book "On the Modification of Organisms, a Criticism of Darwin" (Simpkin, Marshall, and Co), in which I am quoted as having called the writer "a shrewd critic" Standing by itself these words imply that I have somewhere recommended the work as well worthy of perusal The fact of the matter, however, is, that the words occur in a foot note which I added to the proof of my recently published book on "Darwin and After Darwin," for the expressed purpose "of showing the extraordinary confusion of mind which still prevails on the part of Darwin's critics, even with reference to the very fundamental parts of his theory" Elsewhere in the same foot-note I refer to the writer's "almost ludicrous misunderstandings", and conclude by saying that he "shows himself a shrewd critic in some other parts of his essay, where he is not engaged especially on the theory of natural selection." I may now add that the only parts of his essay to which these advertised words apply are those where he treats of the deleterious effects of in-breeding

GEORGE J ROMANES

Animals' Rights

I AM not surprised that you should find my essay on "Animals' Rights" an "absolutely useless" one, for I certainly did not design it to be a congenial hand book for the apologists of Vivisection Nor do I the least object to your drawing what conclusions you like from the premisses laid down by me, even though you seek your justification of vivisection from the very definition that seems to me to be most clearly condemnatory of it. But, as a matter of fact, and not of personal opinion, I beg to point out that you have utterly misrepresented the leading principle of the book, and that the two contradictory definitions of animals' rights, which you attribute to *my* confusion of mind, are in reality the phantom creation of your own On p 9, in referring to Herbert Spencer's definition of *human* rights, I claim for animals a "due measure" (not an equal amount) of the same "restricted freedom"—a claim which by no means prohibits *all* use and employment of animals, as you conveniently assume On p 28 I give, not a second definition, but a repetition and amplification of the one given on p 9, and the "due measure of restricted freedom" is explained as being "a life which permits of the individual development, subject to the limitations imposed by the permanent needs and interests of the community" Surely this is intelligible enough, yet the reviewer has utterly failed to understand it H S SALT

38 Gloucester Road, N W, November 26

Induction and Deduction

MISS JONES has not quite understood me I maintain that definitions should be *arbitrary*, but not necessarily that they should be made *at random* If they are so made it will, as she points out, seldom happen that they turn out useful, or have any real applications, though this would not affect their logical validity if it amused any one to make them and investigate their consequences Such definitions with no real applications are actually made by pure mathematicians The peculiar value of the definitions of geometry consists however in the fact that they have so many real applications, and it is only by a long process of survival of the fittest that a few such happy definitions are weeded out from among the many which lead to nought The definitions of geometry could not now be laid down at random, but they are none the less arbitrary, for they require no support from any *à priori* considerations EDWARD T DIXON

Trinity College, Cambridge, November 28

The Present Comets

I HAVE to notice the following mistake in my letter which appeared in NATURE (vol xlvi p 561) I called comet Brooks, comet "*c*" I now find it should be called comet "*d*"

I have since writing been quite satisfied that the head of comet Swift extends less towards the *n* than towards the *s* (as suggested in my letter) T W BACKHOUSE

West Hendon House, Sunderland, November 26

The Afterglow

AFTER witnessing, with Profs Lyon and Orr, remarkable effects of afterglow on November 27, I waited for the next issue of NATURE (No 1205), in the expectation that similar phenomena would be mentioned as having been seen in the British Isles Curiously enough, the letter on "Afterglow" in that issue comes from Honolulu, dated November 8 It is possible, however, that the effects of volcanic dust from one of the great eruptions of the past summer are now beginning to be noticeable in opposite hemispheres The Krakatão eruption of August 27, 1883, appears to have caused exceptional afterglows in Honolulu on September 5, and in Western Europe by November 9, in the same year

From the top of Killiney Hill, on November 27, at 4 30 p m, we witnessed an extraordinary combination of cloud effects, such as I do not remember having seen since the winter of 1883-4 On the west, dense clouds were forming upon Two Rock Mountain, and streaming down into the hollow of Carrickmines, but beyond them a clear golden sunset, passing above into green and intense blue, was visible above the summits of the hills Fleecy cirrus clouds in the zenith were a delicate pink against clear blue, and this glow extended to all the higher cloud-masses in the east, until the sea itself became rose pink by reflection But in the extreme east the exceptional magenta tints, almost violet, that characterized many of the Krakatão glows, were strikingly apparent, though in part veiled by the low grey cloud of the Channel These effects were at their maximum when the sun had set half an hour, they would doubtless have been of much longer duration but for the near clouds forming on the mountains.

One's thoughts at once turned to the great eruption of Sangir in the Philippines, which occurred, however, as far back as

June 7 of this year Weather and locality have been against my seeing clear sunsets until to-day, when no unusual effects were noticeable, but Mr Bishop's letter makes it possible that in other places similar effects may be observable

GRENVILLE A J COLE

Royal College of Science for Ireland, Dublin, December 4

ELECTRICAL STANDARDS

THE following supplementary report has been presented to the President of the Board of Trade by the Electrical Standards Committee —

To the Right Hon A J Mundella, M P, President of the Board of Trade

Subsequently to the presentation of our former report to Sir Michael Hicks-Beach in July, 1891, we were informed that it was probable that the German Government would shortly take steps to establish legal standards for use in connection with electrical supply, and that, with a view to secure complete agreement between the proposed standards in Germany and England, the Director of the Physico-Technical Imperial Institute at Berlin, Prof von Helmholtz, with certain of his assistants, proposed to visit England for the purpose of making exact comparisons between the units in use in the two countries, and of attending the meeting of the British Association which was to take place in August in Edinburgh

Having regard to the importance of this communication, it appeared desirable that the Board of Trade should postpone the action recommended in our previous report until after Prof Helmholtz's visit

That visit took place early in August, and there was a very full discussion of the whole subject at the meeting of the British Association in Edinburgh, at which several of our number were present The meeting was also attended by Dr Guillaume, of the Bureau International des Poids et Mesures, and Prof Carhart, of the University of Michigan, U S A, who were well qualified by their scientific attainments to represent the opinion of their respective countries

It appeared from the discussion that a few comparatively slight modifications of the resolutions included in our previous report would tend to secure international agreement

An extract from the report of the Electrical Standards Committee of the British Association, embodying the results of this discussion, was communicated to us by the Secretary, and will be found in the appendix to this report

Having carefully reconsidered the whole question in view of this communication, and having received the report of the sub-committee mentioned in resolution 14 of our previous report, we now desire, for the resolutions contained in that report, to substitute the following —

RESOLUTIONS

(1) That it is desirable that new denominations of standards for the measurement of electricity should be made and approved by Her Majesty in Council as Board of Trade standards.

(2) That the magnitudes of these standards should be determined on the electro-magnetic system of measurement with reference to the centimentre as unit of length, the gramme as unit of mass, and the second as unit of time, and that by the terms centimetre and gramme are meant the standards of those denominations deposited with the Board of Trade

(3) That the standard of electrical resistance should be denominated the ohm, and should have the value 1,000,000,000 in terms of the centimetre and second

(4) That the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14 4521 grammes in mass of a constant cross sectional area, and of a length of 106 3 centimetres may be adopted as one ohm.

(5) That a material standard, constructed in solid metal, should be adopted as the standard ohm, and should from time to time be verified by comparison with a column of mercury of known dimensions

(6) That for the purpose of replacing the standard, if lost, destroyed, or damaged, and for ordinary use, a limited number of copies should be constructed which should be periodically compared with the standard ohm

(7) That resistances constructed in solid metal should be adopted as Board of Trade standards for multiples and submultiples of the ohm

(8) That the value of the standard of resistance constructed by a Committee of the British Association for the Advancement of Science in the years 1863 and 1864, and known as the British Association unit, may be taken as 9866 of the ohm

(9) That the standard of electrical current should be denominated the ampere, and should have the value one-tenth (0 1) in terms of the centimetre, gramme, and second

(10) That an unvarying current which, when passed through a solution of nitrate of silver in water, in accordance with the specification attached to this report, deposits silver at the rate of 0 001118 of a gramme per second may be taken as a current of one ampere

(11) That an alternating current of one ampere shall mean a current such that the square root of the time-average of the square of its strength at each instant in amperes is unity

(12) That instruments constructed on the principle of the balance, in which, by the proper disposition of the conductors, forces of attraction and repulsion are produced, which depend upon the amount of current passing, and are balanced by known weights, should be adopted as the Board of Trade standards for the measurement of current whether unvarying or alternating

(13) That the standard of electrical pressure should be denominated the volt, being the pressure which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere

(14) That the electrical pressure at a temperature of 15° centigrade between the poles or electrodes of the voltaic cell known as Clark's cell, prepared in accordance with the specification attached to this report, may be taken as not differing from a pressure of 1 434 volts, by more than one part in 1000

(15) That an alternating pressure of one volt shall mean a pressure such that the square root of the time-average of the square of its value at each instant in volts is unity

(16) That instruments constructed on the principle of Lord Kelvin's quadrant electrometer used idiostatically, and, for high-pressures, instrument on the principle of the balance, electrostatic forces being balanced against a known weight, should be adopted as Board of Trade standards for the measurement of pressure, whether unvarying or alternating

COURTENAY BOYLE — G. CAREY FOSTER
KELVIN — R. T GLAZEBROOK.
P CARDEW — J HOPKINSON
W. H PREECE — W E AYRTON
RAYLEIGH

T W P BLOMEFIELD, Secretary

November 29

ON THE PHYSIOLOGY OF GRAFTING[1]

THE volume before us contains the record of several years of research upon the effects of different forms of grafts (using the term in its widest significance) in the vegetable kingdom.

[1] "Ueber Transplantation am Pflanzenkörper. Untersuchungen zur Physiologie und Pathologie" Von Dr Hermann Vöchting. Mit 11 Lithographierten Tafeln und 14 Figuren im Texte. (Tübingen Laupp, 1892)

Opening with an historical introduction which deals briefly with the development of the art from classical times down to the present day, the author proceeds to indicate the general scope of his own investigations, and to describe the methods of experiment which he employed The immediate problems which he sets himself to solve are contained in two questions which occur on an early page of his book, namely—Is it possible to remove parts of a given plant and transplant them to any other position in the same or a similar plant? And upon this question follows the second—What is the nature of the reaction which occurs between the newly-introduced portion and the surrounding tissues?

But although these form the proximate questions which are to be answered by means of a large number of well-conducted experiments, it soon becomes clear to the reader that the chief interest which attaches to the results obtained depends on their application to the theory of polarity of cells and tissues which Prof Vochting has already put forward elsewhere

The plants chiefly (but by no means exclusively) used in the investigations were *Beta vulgaris* and *Cydonia japonica* The former is of a fleshy and succulent character, whilst the latter is a woody plant which happens to be specially adapted to the various operations of grafting, and, as it is a perennial, it admits of the results of the experiments being watched for a considerable period of time Prof Vochting distinguishes in every part of the plant between a "shoot pole" and a "root-pole," and these he considers to be always present, however small the plant member, or piece of excised tissue, may be The polarity manifests itself at the free surfaces, much as the effects of the magnetism of a bar magnet are visible at its ends, and moreover, just as the pieces of a broken magnet are themselves duly polarized, so also fragments of tissue exhibit relations of polarity identical with those characteristic of the organism from which they were derived

The first precaution necessary to secure success in grafting is to respect the existences of the shoot- and root-poles, and to insert the scion in such a way as to bring its poles into due correspondence with those of the stock Acting upon this principle it is found that, generally speaking, any member may be grafted on any other member unless there is some special reason to the contrary, such as may be connected, for example, with nutrition or water-supply The leaf of the beet will "take" if grafted on a root, and *vice versa*, and it was also found that it was possible, in the case of roots with diarch bundles, to effect a union even when the xylem planes in the two portions were made to cross each other at right angles, analogous results were also obtained with leaves Hence the author concludes that there is no inherent fixity in the organization of plants which predetermines a definite sequence of the chief members of which they are composed

Experiments were made with the object of determining the mutual reactions between the stock and the scion, and the conclusion arrived at is that beyond such changes as may be referred to nutritional and similar causes, the two remain unaltered, at least in so far as their specific characters are concerned Prof Vöchting criticises unfavourably the various alleged cases of the so-called "graft-hybrids," and points out that even in one of the best authenticated examples, that of *Cytisus Adami*, all attempts to produce the hybrid afresh have resulted in failure.

The most interesting part of the book is occupied with the account of researches into the behaviour of transplanted portions of tissue, the direction of whose "polarity" does not coincide with that of the parts into which they are introduced. When the inserted portion of tissue is rotated on its longitudinal axis so that its own tangential surfaces are applied to the radial ones of its new host, difficulties arise in the accomplishment of a complete union, and these difficulties are further increased to a maximum when the tissue is put in upside-down, so to speak, that is with its own poles presented to *similar* poles in the stock A great number of experiments were instituted to investigate these reactions, but space forbids any attempt to do more than briefly summarize the most important points In the case of *Cydonia japonica* a ring of rind was cut out of a twig and replaced in the reversed direction. In many cases the twigs behaved as if the tissue had not been restored at all, simply dying, whilst in others a subsequent healing took place. This healing was accompanied by a swelling at the upper junction, together with the appearance of a ridge of tissue which was formed along the longitudinal suture of the ring from above downwards and was derived from the cambium of the ring, and not by an ingrowth of callus from the uninjured cortex of the twig, as might perhaps be supposed In this way connection between the interrupted rind was re-established, and growth recommenced But both at the edges of the tissue-ridge, and also between it and the original underlying xylem, the cell elements were found to be disposed in a remarkable manner, forming curved unions with the cells of the healthy tissues. For the histological details the reader is referred to the original treatise, suffice it to say that Prof Vöchting believes that he has found in the appearances thus presented, additional evidence for the validity of his theory of the polarized condition of living tissues He conceives of these polarities as properties which are the expression of the innermost relationships existing between the constituents of which cells are built up He further regards the polarity of any tissue as irreversible when once the direction has been imparted to it, and he finds justification for this view not only in the details of his own experiments on grafting, but also in the results of investigations conducted by Kny and others, on the effects of compelling parts of plants to grow in a reversed position After discussing some of the objections to his theory, without, however, disposing of them all, the author concludes by stating, with considerable reserve, some of the wider applications of his theory in explaining geotropism and other allied phenomena.

The book certainly forms one of the most important of the recent contributions to plant physiology, and the experimental details are well illustrated in the eleven plates which accompany the text, whilst the diagrams in the body of the work serve to render the author's theoretical views more intelligible J. B F.

NOTES

A GOLD MEDAL is to be presented to M Pasteur on December 27, his seventieth birthday

ON Monday Lord Durham laid the foundation stone of a new wing of the College of Science, Newcastle, which, like the College of Medicine in the same city, is a branch of the Durham University The College of Science was established at Westgate hill, Newcastle, in 1871. Lord Armstrong laid the foundation stone of the present premises at Barras Bridge in 1887, and in the following year the existing wing was opened by the Marquis and Marchioness of Lorne The success of the institution is strikingly indicated by the fact that the increase in the number of students has rendered a new wing absolutely necessary

DR. WERNER SIEMENS, the well-known electrical engineer, died at Berlin on Tuesday. He was seventy-six years of age.

MR. W. H. PREECE, F R.S, has been appointed a member of the Royal Commission on Electrical Communication with Lighthouses, &c., in the place of Mr Edward Graves, deceased.

MR W MATTIEU WILLIAMS, who had a considerable reputation as a metallurgist and a popular writer on scientific subjects, died at his residence, near Willesden, on November 8 He was in his seventy fourth year Among his writings ar his well-known books on "The Fuel of the Sun," "Science in Short Chapters," and "Through Norway with a Knapsac k"

WE have to record the death of two distinguished Continental cryptogamists, Dr F v Thumen, the well known mycologist, formerly Director of the Chemico-Physiological Experiment Station at Klosternenberg, and Dr C M Gottsche, of Altona, one of the authors of the *Synopsis Hepaticarum*, and one of the leading authorities on Mosses and Hepaticæ, in the eighty-fourth year of his age

The Master and Fellows of Gonville and Caius College, Cambridge, have elected as Honorary Fellows the following graduates of the college —Alexander Henry Green, F R S, bracketed sixth Wrangler, 1855, formerly a Fellow of the College, late Professor of Mathematics, Yorkshire College of Science, now Professor of Geology, Oxford, Arthur Ransome, M D, F R S, First class Natural Sciences Tripos, 1856, Physician to the Manchester Hospital for Consumption and Diseases of the Throat, and George John Romanes, F R S, Sir Robert Rede's lecturer, 1883, late Professor of Physiology in the Royal Institution of Great Britain

AN important conference on technical education was held at Newcastle on Saturday It was summoned by the Technical Education Committee of the Northumberland County Council Sir M White Ridley, the Chairman of the Council, said that the scheme of the Technical Education Committee, generally speaking, had opened out two progressive educational roads from the elementary day school onward—first, for day scholars, by means of scholarships, and secondly, for evening students by a graduated system of classes The work in progress under that scheme had already been very extensive As regarded agriculture, there had been courses of lectures on manuring land, poultry-keeping, farm stock, dairy work, &c Educational courses had been given in mining, mechanics, electricity, engineering, ship building, &c As regarded the fishermen also, a very successful method had been adopted of teaching the men a few plain scientific facts with regard to coastal navigation, the habits of fishes, and so on. After the delivery of the Chairman's speech the Committee's scheme was carefully discussed.

PRIZES and certificates in connection with the City and Guilds of London Institute will be presented on Monday, December 12, at Merchant Taylors' Hall, Threadneedle street, by Mr William Anderson, F.R.S The Lord Mayor will preside.

AT the General Monthly Meeting of the Royal Institution on Monday, the special thanks of the members were returned to Mr Ludwig Mond for a donation to the fund for carrying on investigations on liquid oxygen

MR STREETER held a reception on Saturday at 18 New Bond Street for the first display of sapphires from the Montana mines At the same time an assortment of chrysoprase jewels was exhibited, and also a black diamond, said to be the largest yet discovered Mr Streeter also showed, among other things, a collection of different specimens of pearl-bearing oyster shell, and some curious formations of pearls in shell and loose, and in a variety of natural colours

IN the current number of the *Geological Magazine* it is noted that Mr Joseph E Carne, Curator of the Mining and Geological Museum, Sydney, New South Wales, who so ably assisted the late Mr. C S Wilkinson during the Mining and Metallurgical Exhibition at the Crystal Palace, Sydenham, in 1890, has been appointed by the Minister of Mines to the post of Geological Surveyor Mr Carne entered the service of the New South Wales Government in 1879

THE French Association for the Advancement of Science has received from an anonymous donor the sum of 600 francs, to be given in two prizes (of 400 and 200 francs), to the authors of the best memoirs containing an investigation, according to local documents, of the frequency of rabies, and the prophylactic measures in operation in a department of France, *la Seine excepted*, or in a region (two or three departments) of France or of Algeria The statistical figures must relate to ten years at least, and comprise the results of 1892 Manuscripts to be sent to the secretary in Paris before March 31, 1893. The following points are noted for investigation —The number of rabid animals, of dogs, of persons bitten, and dead through rabies, also of those vaccinated at the Pasteur Institute separate the cases of rabies in large towns from those in the rest of the department, measures of sanitary police, their effect and difficulty of application, causes of more or less frequency of rabies, and of vaccination, measures taken in frontier departments, &c

DR B PASQUALE has undertaken a study of the phenomena and causes of the very destructive disease of the vine known as "mal nero,' his observations having been made chiefly in Sicily The disease makes its appearance in the form of black spots and streaks on the leaves Dr Pasquale finds it to be always accompanied by a Schizomycete, which he believes also to be its cause, and which is parasitic, especially on the tissues rich in protoplasm and in other plastic substances, such as the cambrium, the medullary rays, the cortical parenchyma, and the soft bast of the axile organs

THE *Botanical Gazette* states that, in a report to the Cornell University, Prof L H Bailey firmly establishes the commercial value of the electric light for certain winter crops, especially for lettuce Certain kinds of plants, which are injured by the direct rays of the light, are not injured, but may even be benefited, when the light passes through a clear glass globe or through a glass roof Auxanometric records appear to show that the light accelerates growth, but does not change its normal periodicity This is in harmony with the observations of Prof G Bonnier, recorded in the *Comptes rendus*, who finds that the electric light promotes the formation of chlorophyll in all kinds of plants, both woody and herbaceous

THE third appendix, 1892, of the *Kew Bulletin* has been issued It consists of a list of the staffs of the Royal Gardens, Kew, and of botanical departments and establishments at home and in India and the colonies, in correspondence with Kew

M EDOUARD BRANLY, Professor of Physics at the Ecole Libre des hautes études, Paris, writes to us to complain that experiments made by him are attributed to Mr Dawson Turner in our account of "Physics at the British Association" (NATURE, August 18, p 384) We learn that in Mr. Turner's paper, and in the condensed report furnished by him for publication, full justice was done to Prof Branly's work The reference to Prof. Branly was unintentionally omitted when the report was being cut down for NATURE

MESSRS MACMILLAN & CO will publish immediately a new book by Professor Oliver Lodge, entitled "The Pioneers of Science" In this volume, which will be fully illustrated with portraits and diagrams, the author describes in popular language the history and progress of Astronomy His aim has been to state scientific facts and laws as simply as possible, to present in turn a living figure of each Pioneer, and to trace his influence on the progress of thought.

DURING the past week barometric depressions have reached our western coasts with considerable frequency. As these dis-

turbances were passing away from our islands, sharp frosts occurred in the north, where the shade temperature fell as low as 13° in the north of Scotland on Thursday, December 1 The gales which accompanied the depressions were confined more particularly to the north and west On Saturday, the 3rd instant, a large cyclonic disturbance appeared from off the Atlantic, and in the rear of this cold north westerly winds set in with snow or hail showers generally, in many parts of the country the snow was sufficiently heavy to interfere seriously with traffic The temperature continued to decrease, the highest daily maxima being generally below the average for the time of year, and at places in the north and north east of our islands the maximum thermometer at times did not rise above the freezing point For the week ended the 3rd instant the official reports show that the rainfall was greatly in excess in Scotland, and rather so in the south of England and some of the western districts, but in the eastern parts of Great Britain, and in the north of Ireland, there was a deficiency In the south-west of England the deficiency, from the beginning of the year, is still very great, being 22 per cent of the average amount

MR H C RUSSELL, in his presidential address to the Royal Society of New South Wales, mentions a very curious drift of a "current bottle" thrown from the Austrian man-of-war *Saida*, about half-way between Sydney and New Zealand This bottle found its way through twelve degrees of latitude and four of longitude to the coast of Australia, two miles north of Tweed River, where it was found just eleven months after it was thrown into the sea. Mr Russell states that from what is known of the currents, which set strongly to the south along the coast of Australia, it seems impossible that it could have travelled direct, and that it was therefore probably carried east ward to the coast of New Zealand, and thence northward towards New Caledonia, until it got into the current setting from there to the coast of Australia, a journey of at least 2,500 miles in 335 days, and doubtless subject to many deviations which made its course longer and all the more surprising

M W PRINZ, secretary of the Belgian Microscopical Society, has published an interesting paper on filiform inclusions in the quartz of St Denis, Mons, which strangely simulate organic structures He has at the same time discussed the origin of moss agates, and has repeated the experiments with colloid silica and certain salts by which very similar appearances are produced The paper, which is illustrated with a plate, is a valuable contribution to the literature of a very interesting subject

MR W HOLLAND contributes to the December number of the *Entomologists' Monthly Magazine* some good practical hints on sugaring Moths, he says, often come more readily when sugar is applied to the twigs and branches of the trees they feed upon, or twigs of something near their food-plant, than they will to sugar placed on the trunks of trees, *Xanthia citrago*, for instance, will hardly come at all to sugar put on the trunk of the lime tree, an occasional one only will be got in this way, but by sugaring below the tips of the outermost branches all round the tree Mr Holland generally finds about fifty on one tree, besides other species In the case of *Xanthia aurago* again, the best place to sugar is along the outside of the beech wood beneath the ends of the overhanging branches, or on the twigs of the hedge below them Mr Holland has repeatedly taken about 100 in a night in this way, when trunks sugared inside and outside the wood have not yielded one specimen Other things may be got in the same way by selecting the place according to the species wanted. Among other points to which he calls attention is the necessity of recognising early what is going to be a species of the year, for every year brings some particular kind more plentifully than usual The sugar Mr Holland uses is "Egyptian raw," a date sugar This is very dark and strong stuff, sand like, and free from lumps, and it mixes easily without boiling He simply mixes it with beer, and then adds a drop or two of essence of pears just before starting out There is rum enough in good sugar, and to add more is only to make the moths drop off before they can be bagged "Jamaica foots" is a good sugar too, but it is lumpy and needs boiling Old black treacle will do fairly well as a bait, but "golden syrup" Mr Holland believes to be a fraud Beet-root sugars, or refined sugars, are of course bad, and if he happens to be in a place where he can get only these, then, and then only, he adds rum

THE second volume of the Transactions of the Leeds Naturalists' Club, to which we referred last week, includes an interesting paper on the structure and life history of a fungus, by Mr Harold Wager, assistant lecturer and demonstrator in biology, in the Yorkshire College, Victoria University The paper deals with a small microscopic fungus, *Peronospora parasitica*, as a type of the fungi Mr Wager points out that, although in some respects this may not be the best type for the purpose, it has the advantage of having a comparatively simple structure and method of development easy to understand, and serving as an excellent introduction to the morphological study of the fungi This type is also the more interesting because many structural details, which are fully described by Mr Wager, have been more fully worked out in it than in any other The paper is carefully illustrated, and the author gives a useful summary of the methods employed in the examination of the various structures he mentions

A NOVEL utilization of aluminium is that for the construction of aluminium slate pencils Major von Sillich, of Meiningen, found that aluminium gives a stroke on a slate, and a German company has undertaken the manufacture of pencils based on that fact They are 5mm thick and 14mm long They need no pointing, and are well nigh inexhaustible and unbreakable The writing, which is as clear as with ordinary pencils, requires a little more pressure It can be erased with a wet sponge.

A COLORIMETER for comparing the intensity of colour in a solution with a standard solution has been constructed by Papasogli It consists of two graduated cylindrical vessels of equal diameter, through which light is transmitted from below A vertical telescope fixed above the tubes shows the two halves of the field equally illuminated if the amounts of coloration are the same If they are not, the heights of the liquids in the tubes can by a simple contrivance be so regulated that the colours have equal shades Under these conditions, the concentration of colouring matter is inversely proportional to the length of the column of liquid tested

THE Trinidad Field Naturalists' Club has held its first annual meeting, and has evidently good reason to congratulate itself on its success, which has surpassed the highest expecta tions of the members Mr Caracciolo, the chairman, in his presidential address, reminded the club that the gardens, plains, mountains, and rivers of Trinidad swarm with animal forms, about a good many of which very little is yet known.

THE latest instalment of the Transactions of the Institution of Engineers and Shipbuilders in Scotland includes the address by Mr Robert Dundas, president, at the opening of the pre sent session. Speaking of railways, Mr. Dundas said that a continual improvement in rolling stock generally can be noted Larger and more commodious carriages are gradually taking the place of the smaller ones, and there is a marked increase in the application of the bogie principle, which does well, and makes an easy running carriage when properly constructed

"Long carriages," said Mr Dundas, "cannot be built to go round ordinary curves without either a bogie or radial axle; and between the two experience leaves very little doubt as to which is the better. The radial axle is an awkward arrangement, and does not act with the same smoothness as a well constructed bogie with properly balanced springs to regulate its motion, and a bogie of short wheel base is not so good as a long one, the wheel base should always be more than the gauge to produce good results There is no better test to determine what is good or bad in rolling stock than the effect on the permanent way"

A valuable paper on the copper resources of the United States, read by Mr James Douglas before the Society of Arts on November 30, is printed in the current number of the Society's journal Mr Douglas notes that though for many years no new copper mine has been opened, the larger and richer ones, which have been able to maintain existence in the face of depressed prices, are directing their efforts, not so much towards increasing their capacity for production as towards reducing the cost of reduction, saving, as far as possible, the precious metals associated with their ores, and securing for themselves the profits which have heretofore been made by the refining companies, to whom they sold their furnace material "The effect of this change of policy," said Mr Douglas, "may tell upon the market It certainly will affect the copper refineries of this country and the continent It would seem, therefore, that the era of rapid expansion is drawing to its close, and a healthier one of economical treatment is being inaugurated The demand for copper is so great, that, if this policy be pursued by the large existing mines, there will be room for the appearance of new competitors, without imminent risk of over-production"

Mr W J L Abbott contributes to the new instalment of the Proceedings of the Geologists' Association an interesting note on the occurrence of walrus in the Thames valley *Trichechus rosmarus*, Linn, has been recorded from several places on the east coast, from the Dogger Bank, and from the peat near Ely In the Thames valley it was discovered at a depth of 33 feet 2 inches during the excavations for the new London Docks It was, however, considered to have "tumbled down from above," and so was passed by In 1888 Mr Abbott saw a tusk taken out of the gravel in the course of excavations for a wharf in Upper Thames-street, it was associated with bones of pachyderms Although he felt sure of its identity, he was unable to procure the specimen, probably because his eagerness to obtain it manifested itself to the workman, who immediately affected that he would not part with it. Not long afterwards, in an excavation between Leadenhall and Fenchurch streets a number of bones were taken out of the gravel which underlies the peat, which in turn underlies the Roman layer The upper part of the gravel is stained somewhat by the peat, as are the contained bones Amongst the latter there was a large part of the skull of a walrus, with one tooth still left *in situ*, the others having been destroyed in the rough usage to which it had been submitted in bygone times The state of preservation is seen to be exactly similar to that of the other bones found with it, while its position, Mr Abbott thinks, leaves no question as to its Pleistocene age He holds therefore that in future *Trichechus rosmarus* should be added to the Thames valley fauna

At the meeting of the chemical section of the Franklin Institute on October 18, Mr. Palmer read a note on a lilac colour from extract of chestnut He said that in experimenting with a commercial extract of chestnut wood, with the idea of making galloflavine therefrom, he had obtained an unlooked-for result. The extract was somewhat fermented; that is a part of the tannin had been changed into gallic acid; and the design was to convert this gallic acid into galloflavine by the usual method A solution of the 51° extract was made strongly alkaline with potash, and subjected to the action of a stream of air for about ten hours The temperature, meantime, was kept below 50° F At the end of the period of oxidation the potash was neutralized with acetic acid The solution so obtained was tested for galloflavine by working therein cotton and wool yarns with the addition of potash alum While no yellow colour was obtained, a clear, bright lilac was developed on both the animal and the vegetable fibre The body giving this colour has not as yet been separated from the oxidized extract

A book entitled "Mind and Matter an Argument on Theism," by the Rev James Tait, of Montreal, has been so well received that a third edition, revised and enlarged, has just been issued (London C Griffin and Co) Whatever may be said of Mr Tait's theology, he has a good deal to learn as to the temper in which the consideration of scientific problems should be approached It seems a little foolish, at this time of day, to talk about the "horrible plaudits" which "have accompanied every effort to establish man's brutal descent"

A paper embodying various suggestions to travellers was read at the June meeting of the Queensland branch of the Royal Geographical Society of Australasia by Mr J P Thomson, the honorary secretary of the Society The paper, revised and enlarged, has now been reprinted from the Society's "Proceedings and Transactions."

The Society for Promoting Christian Knowledge has issued a new edition of "Sinai from the Fourth Egyptian Dynasty to the Present Day," by the late Major H S Palmer The little book has been revised throughout by Prof Sayce

Messrs. Newton & Co have issued a catalogue of science lanterns, magic lanterns, dissolving view apparatus, and lantern slides, manufactured and sold by them The catalogue is accompanied by a supplementary list for season 1892-93

The additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus petaurista* ♂) from West Africa, presented by Mr W H Henniker, two Great Kangaroos (*Macropus giganteus* ♀ ♀) from Australia, presented by Sir Francis Wyatt Truscott, J P., F Z S, a Common Chameleon (*Chamaeleon vulgaris*) from North Africa, presented by Miss Truefitt, a Sykes's Monkey (*Cercopithecus albigularis* ♀) from West Africa, deposited

OUR ASTRONOMICAL COLUMN

Comet Holmes (November 6, 1892).—Computations of the orbit of this comet show now that it is an elliptic one, the period extending to 6·78 years, very nearly the same as that of Wolf Comet, 1884 III–1891 II The time of perihelion occurred on June 20·7357 of this year, and the comet's orbit may be mentioned as lying wholly between those of the planets Jupiter and Mars

The following elements and ephemeris are due to Mr. A. Berberich, and are derived from observations made on November 9 (Karlsruhe), November 18 (Hamburg), and November 25 (Berlin) —

Elements

Epoch 1892, November 25·5 Berlin M.T

$$
\begin{array}{rcl}
M & = & 22^{\circ}\ 56'\ 3''\cdot 6 \\
\pi - \Omega & = & 18\ 12\ 14\cdot 8 \\
\Omega & = & 331\ \ 4\ 23\cdot 2 \\
i & = & 20\ 39\ 38\cdot 8 \\
\phi & = & 23\ \ 9\ \ 0\cdot 6 \\
\mu & = & 523''\cdot 335 \\
\log a & = & 0\cdot 554151
\end{array}
\left.\begin{array}{l} \\ \\ \\ \\ \\ \\ \\ \end{array}\right.
$$

($\pi - \Omega$, Ω, i: Mean Equator, 1892.0)

Ephemeris Berlin Midnight

1892	R.A. h m s	Decl ° ′	Log Δ	Log r
Dec 8	0 45 33	+35 23·6	0·2580	0·3958
9	46 3	35 18·4		
10	46 34	35 13·4		
11	47 7	35 8·5		
12	47 41	35 3·7	0·2696	0·3981
13	48 17	34 59·0		
14	48 55	34 54·4		
15	49 34	34 50·0		

A NEW COMET (BROOKS, NOVEMBER 20).—On the evening of November 20 a telegram was received at Kiel announcing the discovery of a new comet by Brooks on November 20. Its position on November 20·875, Greenwich M.T. was given as R.A. 12h. 57m. 40s., Decl. +13° 25′. Its physical appearance was described as "circular, diameter equal to 1′, brighter than a third magnitude star, some eccentric condensation, no tail."

From observations made on November 21, 24, and 26, Prof. Kreutz has found the following elements and ephemeris, which has been communicated by a Kiel circular post-card:—

Elements.

T = 1893, January 6·953, Berlin M.T.

ω = 84 24·5
Ω = 185 10·7
ι = 143 18·6
$\log q$ = 0·08130

Ephemeris, 12h. Berlin M.T.

1892	App. R.A. h m s	App. Decl. ° ′	Log Δ	Br.
Dec. 8	13 28 54	+24 18·5	0·0876	2·3
12	13 39 55	28 20·5	0·0449	2·9
16	13 54 6	33 17·1	0·0001	3·7
20	14 13 17	39 19·3	9·9550	4·6
24	14 41 4	46 30·1	9·9126	5·7

A NEW COMET.—The comet which on the 24th was discovered by Mr. Freeman is now supposed most probably to be a nebula.

THE CHANNELS OF MARS.—In our Astronomical Column for November 17 we referred to the most recent hypothesis that had been put forward with respect to the doubling of the channels on the surface of Mars. Another suggestion has lately come under our notice, and this, although explaining the phenomena in quite a different way, has a point or two in its favour. This explanation appeared in the *Shanghai Mercury* on October 14, and was written by Mr. T. W. Kingsmill, the following being a brief summary of the main points:—

As Mars revolves round the sun, under the rule of gravitation, she must have tides on her surface, and since her moons are not sufficiently large to cause any sensible rise, her tides must be mostly solar. Now the best views we have of this planet is when he is in opposition, that is when we are interposed between him and the sun, so that we should always see him best at high tide. The writer then makes rather a strong point of the great eccentricity of the orbit of Mars, and the consequent heavy fall which he makes when plunging towards the sun. Situated further from the sun than we are, Mars of course must be reckoned as an older member of our system, and since he is smaller than our earth, it is only natural that his surface crust would be thicker than ours. Granting this then the internal pulp would not have such a power to compensate for this rapid fall, as our earth does internally, for there would not be much of it, so that an external compensation, assuming the crust to be too thick to alter its form, would have to take place at the surface. On the surface of course the water is the only available power, therefore we should expect, to put it in Mr. Kingsmill's own words, "that the water in the ocean would be projected into the Martial hemispheres, and as the planet approached the sun, solar tides would sweep round the planet, that the canals should sometimes appear and sometimes be duplicated . . . . is only what *à priori* might be anticipated."

Those interested in this question will be glad to hear that M. Stanislas Meunier (*Comptes rendus* for November 21, No. 21) has been continuing his experiments on this subject, which we referred to a fortnight ago. He finds now that by employing a metallic sphere instead of a polished mirror, and covering its surface with the veil as he did his former experiments the results are more striking, and bring out more clearly the phenomena really observed on the planet's surface.

ASTRONOMY AND ASTROPHYSICS.—The November number of *Astronomy and Astrophysics*, among many of its interesting articles contains one by Prof. Pickering on the lunar atmosphere, which will be read with much interest. Accompanying the article is an illustration of the recent occultation of Jupiter, at which time a dark band tangent to the moon's surface but on the planet was both observed and photographed. Prof. Coakley writes on the "Probable origin of Meteorites," the conclusions which he draws referring their origin to prehistoric lunar eruptions.

Prof. Hale, in addition to several articles on solar physics, describes generally the proposed new giant Chicago refractor, and from all accounts the observatory when finished and ready for work will be operated by simply pressing buttons; the observing chair will be entirely eliminated, the floor of the observatory, capable of motion in the vertical direction, serving the purpose. Mr. W. W. Campbell gives rather a lengthy account of his observations on the spectrum of the late Nova, and the result may be summed up in the words, "While the hypothesis of two bodies quite generally satisfies the observations, and has the further very great advantage of simplicity, there are a few not unimportant points furnished by the photographs which favour the existence of three or four bodies, two or three yielding bright line spectra and one a dark line spectrum."

A NEW OBSERVATORY.—M. S. de Glasenapp recently announced to the French Academy of Sciences that a new astronomical observatory has been erected at Abastouman, in the government of Tiflis. The observatory has been called Géorgieïoskaja, in honour of its founder, and it is situated at a height of 1393 metres above the level of the sea, its terrestrial co-ordinates being latitude + 41° 45′ 43″ longitude, east of Paris 2h. 41m. 58·5s. At present it is provisionally supplied with a refractor of about nine inches belonging to the St. Petersburg University. Work has already been begun, and from all accounts the situation seems to be most favourable, many double stars measures having been obtained, which in ordinary circumstances are accounted very difficult objects with such an aperture. The observatory was opened on August 23 of this year, and up to November 5 as many as 400 double stars have been measured, omitting observations of the total lunar eclipse and of some phenomena of Jupiter's satellites.

GEOGRAPHICAL NOTES.

DR. KARL DIENER has returned to Vienna from his geological expedition in the Himalayas, which has resulted in important additions to the data available for a geological description of the great mountain system. In June the expedition commenced work in North Kumaon, crossing the Utadurrha Pass (17,600 feet), and after more than three months spent amongst the border ranges of Tibet, returned to India by the valley of Alaknanda. For a month the party never camped at a less height than 14,500 feet, and the highest summit reached was over 19,000 feet.

DR. NANSEN is threatened with a serious rival in Lieutenant Peary, who has obtained leave from the United States Navy for three years to be spent in Arctic exploration. The base of his projected journey would be the farthest point reached by him on his recent journey in Greenland, and "an incidental object" would be to reach the pole by travelling over the frozen surface of the sea which he believes to surround it.

FRIEDRICH HELLER VON HELLWALD, well known as a writer on geography and ethnology, died on November 1, aged fifty years. He was born at Padua, and grew up with an equal knowledge of German and Italian, a fact to which much of his ultimate success as an author may have been due. He was an officer in the Austrian army, but devoted most of his time to historical research and literary work. His earliest work, "Amerikanische Völkerwanderung," appeared when he was twenty-four years of age, and later he wrote on the Russians in Central Asia, the native people of various parts of Asia, the history of civilization, and other subjects. His "Die Erde und ihre Völker" formed the basis of Stanford's "Compendium of Geography and Travel." For many years Hellwald edited the geographical journal *Das Ausland*.

CAPTAIN H L GALLWEY, vice-consul for the Oil Rivers Protectorate, gave, at the meeting of the Royal Geographical Society on Monday, a detailed account of his travels in the Benin country, of which notice has already been taken in this column (vol xlvi p 65) The fact that some of the deltaic streams are clear and transparent, while the Niger water is very muddy, makes it probable that they are small independent rivers An account of a visit to Benin city gives some idea of the decadence of native West Africa since the time of the early writers on the region, if these were to be trusted

MR F WILKINSON read a paper on the Kalahari desert, at the same meeting It described a waggon drive through part of the desert area in company with two others, whose names were disguised under initials. Although great scarcity of surface-water was found, and the draught oxen and horses had some times to be watered from "sucking holes," where natives sucked up the water and filled the buckets from their mouths, the land was fairly well grassed in most parts, and Mr Wilkinson believes it possible that it may subsequently become useful for grazing A rough geological survey of the district passed over was made Granite covered a large part of the surface, and appears to be the bed rock of the whole district examined Hard crystalline siliceo-calcareous beds and highly altered ferruginous shales, as well as quartzite were also found, but vast accumulations of blown sand masked the true geological structure in almost every place

THE Geographical Society of California claims to have achieved "an immense success" The Society was incorporated on December 11, 1891, for "the acquisition and dissemination of scientific geographical knowledge," and has already achieved a membership of 400 Monthly lectures have been given, and a bulletin has been published We hope that a society which has begun so well will fulfil the Latin proverb which it has adopted for its motto, "*Vires acquirit eundo*"

THE ANNIVERSARY DINNER OF THE ROYAL SOCIETY

THE anniversary dinner of the Royal Society was held on the evening of St Andrew's Day at the Hôtel Metropole It was more largely attended than any previous anniversary dinner, covers being laid for about 230 The chair was occupied by the President, Lord Kelvin On his right were Mr Shaw Lefevre, M P., Sir James Paget, the Italian Ambassador, Prof Raoult (medallist), Sir H Roscoe, M P, Sir James Lister, Lord Justice Lindley, Sir B Samuelson, Sir A Moncrieff, Sir U Kay-Shuttleworth, M P, Sir C E Bernard, the Dean of St Paul's, Mr. John Hutton, and Sir H Acland On the left of the chair were Mr Arthur Acland M.P, Prof Huxley, Mr James Bryce, M P, the Swedish Minister, Lord Ashbourne, Sir G Stokes, the Treasurer of the Society (Sir John Evans), Mr Alma Tadema, Sir R E Welby, Mr Herbert Gardner, M P, Sir Godfrey Lushington, Mr Bryant, and Dr Mackenzie. The vice-chairs were occupied by Sir B Baker, Prof Roberts Austen, Lord Rayleigh, Prof M Foster, Sir A Geikie, Mr Norman Lockyer, Dr Pye-Smith, Prof Vines, and Mr Rix (assistant secretary) The first toasts were "The Queen and the Prince and Princess of Wales," and "Her Majesty's Ministers and the Members of the Legislature"

Mr Shaw Lefevre, in the course of his reply to the latter, said that men of science as a rule were unwilling to abandon the quiet fields of research in order to launch on the stormy seas of politics, and if they were willing, they were too philosophical to swallow the creeds of either political party He thought that the two older Universities might help in this matter, and do more to justify their right of representation by emulating the example of the London University in returning men of science to Parliament If there was any man in the country whose presence in the House of Commons would add to its quality and power, it was Prof Huxley

Mr. Acland, in proposing the next toast, said,—I have to propose to those who are here present, and who do not bear the title of "F R.S," the toast of "The Royal Society"—a society ancient, independent, distinguished, and most beneficent in its operations during a course of more than two centuries. Why I, a mere politician, have been selected to propose this toast I do not know. In looking over a list of the late proceedings of your society a day or two ago, I tried to discover some links between yourselves and the Education Department, over which I preside I came across the words, "On character and behaviour," and I thought that that looked like the kind of language which we employ in our instructions to her Majesty's inspectors of schools But it was not so. The subject to which the words had reference was "on the character and behaviour of the wandering cells of the frog, especially in relation to micro-organisms." I feel that I must fall back upon some more substantial links than that, and I fall back upon the fact that I have the honour to preside over certain institutions in which members of your society are engaged There is the Dean of the Royal College of Science at Kensington, Prof Huxley, and your foreign secretary, Sir Archibald Geikie, and, altogether, including those who examine for us from time to time, there are something like thirty members of the Royal Society who are connected with those institutions, and I consider it a very high honour to be linked with institutions with which they are connected Whether some of my friends at Kensington look on their connection with the State in the same light, I do not know When I have the honour of going over the laboratories of my friends, Prof Thorpe and Prof Rucker, I am inclined to doubt it But as far as the present connection with the State goes, the Royal Society do most admirable service They act as unpaid judges for the administration of a sum of £4,000, which the State would find it very difficult to administer on its own account, and they do the work in so impartial and admirable a manner that no man in his senses could complain There is one other link between us There are present here a large number of men who are interested in the work of education, and I think they will agree with me that we have one great task before us Between the Universities and the University Colleges with which most of them are connected and the great sphere of elementary education there lies a large region, at present unorganized and chaotic, which we want to organize and bring into working order as soon as possible There are many men of science in these colleges who often greatly regret to find willing lads, with the highest scientific capacity, brought under their notice and care, whose only lack is a lack of adequate educational preparation for their work It is that which we want to remedy, and if I am enabled to take however humble a share in remedying it, I shall be proud of the task We want to engage in the task of the reclamation of waste, and one of the most serious of all wastes is the waste of intellect For those lads who go to our colleges in every part of Great Britain and Ireland we want to hold out one great possible goal—the blue riband of science—the title of Fellow of the Royal Society You at any rate in your scientific honours have no distinction of class, and, as your medallists to day will testify, no distinction between one country and another You regard all as equal when you adjudge your honours to the fittest men to bear them I connect with this toast the name of your distinguished President, Lord Kelvin It was truly said some nine years ago, when his claims were urged for the Copley Medal, "there is scarcely a branch of physical science to the substantive advantage of which he has not contributed", and I understand that while he has touched both the highest and the most abstruse subjects, he has not failed to condescend even to humble matters like the domestic water tap Among those of you who know far better than I do what Lord Kelvin has done, both for abstruse science and for the welfare of mankind, there can be no limit as to the value of his work to future generations I am sure that he himself cannot possibly say how great the value of what he has done may be in the far-off future But I understand from Sir Archibald Geikie that your president has attempted to put a limit to the inquiries of the geologists, when they look into the backward past. He has definitely said that in looking backwards they must not go beyond the moderate limit of twenty million years I understand that this is a grievance on the part of the geologists, but I hope that the President will not give unnecessary pain to his geological friends In the draft of the preamble of your charter—it was drafted by Sir Christopher Wren—it was said Fellows of the Royal Society, by "their labours in the disquisition of nature, would try to prove them selves real benefactors of mankind." I give you the toast of "The Royal Society," coupled with the name of Lord Kelvin, and I assert that your present President has done his part in proving himself a benefactor of mankind.

The Chairman, in replying, said,—I thank you very heartily for the kind manner in which you have received this toast. I feel the honour you do me, but I also feel my incapacity to say

what ought to be said for so great an institution I can only say in my own way that I believe the Royal Society, as an institution, has up to the present time persevered in well doing, and had been successful in its efforts The Royal Society has certainly endeavoured to carry out the objects of its institution—namely, to inquire into natural knowledge and the improvement of it The mode of carrying out that object was carefully considered, no doubt, by those who founded the Royal Society, and they determined to hold regular meetings, partaking somewhat of the character of a debating society—meetings where discussions could be raised by questions presented, and the truth arrived at thereby That object has been carried out from the inception of the Society to the present day, and the society has been imitated by other societies over a large part of the civilized world Indeed, the Royal Society itself only followed in the path of other learned societies in Italy, which had determined that by personal discussion of questions in regular meetings truth might be arrived at which otherwise might be lost We often find complaints that meetings of scientific societies are unsatisfactory We have even complaints that the important duty, the publication of their proceedings for the rest of the world, is not altogether ideally perfect Some who desire the progress of science above all, and heartily wish success to the Royal Society, think that the society ought to be a body for merely recording and indexing the work that has been done all over the world That is a part of the work of the Royal Society which is not neglected The council has had most anxious, careful, and laborious consultations from year to year with reference to this work—not only as to the publication of its own transactions and proceedings, but as to the cataloguing and indexing of the proceedings of scientific bodies and scientific workers all over the world One very important part of the work of the society consists of the cataloguing of all scientific papers published, and a very dry and fatiguing subject it is to work upon The difficulty here is *embarras de richesses* To get the titles only of these papers is itself a truly Herculean task If the Royal Society had not only capacity, but had also great funds at its disposal, it would make short work of this task It would not only index, it would publish the papers and would put them in such a form that any one could find his own particular subject at once, and the particular volume and page in which it was treated This is an exceedingly difficult subject, but the first necessity is funds, and if those were supplied all the rest would follow The publishing and indexing, however, is not the only work of the society The life and soul of its work is in its meetings and discussions, and whoever has not felt the stimulus of attending those meetings has hardly yet found out the spirit of scientific enquiry For myself, I say the fact that we can attend meetings of the Royal Society, and hear papers on subjects very far removed from the subjects of our every day work, is a stimulus which is of the highest value The worker who has heard what other people are doing goes back to his work with something which may help him in it, which, at any rate, brightens his life, and makes the drudgery and heavy work necessary for success in any scientific investigation less irksome and dry For myself I may say that my connexion with the Royal Society, extending over a great many years, has been one of unmixed benefit and pleasure, and has given to me some of the happiest of those pictures of knowledge and memory the possession of which constitutes so much of the delight of life Mr Acland remarked upon my having been hard upon the geologists I do not think that I have actually been so I do not believe in one science for the mathematician, another for the chemist, another for the physicist, and another for the geologist All science is one science, and any part of science which places itself outside the pale of the other sciences ceases for the time being to be a science The sooner it returns to the pale of the other sciences the better, and when all are working for a common good the better it will be for the progress of each

Prof. Huxley, in proposing the next toast, said that he had to discourse on the merits of the gentlemen to whom medals had been awarded There was one the adequate treatment of whose merits would occupy the whole available time, and yet Mr Shaw Lefevre wished him to say something about his capacity to become a legislator and also to give an opinion upon geological time He would answer the first interrogation by telling a story. When he was a very young man a solicitor in large practice discovered in him what that gentleman believed qualities that would command success at the Bar, which he had never discovered himself, and proposed to advance him an income for a certain number of years until he could pay the amount back out of the fees he was sure to earn He was sorry to say his reply was this, "So far as I understand myself, my faculties are so entirely confined to the discovery of truth that I have no sort of power of obscuring it" With regard to political life, the absolute contradictions that were made by politicians of opposite sides upon matters of fact were absolutely fatal to his chances in a political career Coming to the subject of the toast, he narrated the history of the Copley medal A bequest of £100 was left to the Society 188 years ago by Godfrey Copley, a Fellow of the Society, for improving natural knowledge The medal was thrown open to all the world, a step much disapproved by certain narrow-minded persons at the time, but that step was the real reason why, a century later, Sir Humphry Davy could really call it "the ancient olive crown of the society" The value of the medal was originally fixed at £5, people being able to get five per cent for their money in those halcyon days He did not like to dwell upon its appreciation now lest the County Council should put in a claim for unearned increment The medal had certainly done nothing for itself, the appreciation of its value had arisen entirely from surrounding circumstances, the chief being the wisdom and integrity of some eighty successive councils A complete list of the awards was published every year. Going back one hundred years from 1887—he had a reason for not taking a later date—the century began with John Hunter, and finished with Joseph Hooker Between them was a galaxy of the heroes of science, French, German, Scandinavian, Italian, American, and English, and, although one star might differ from another star in glory, none was unworthy of its place in the constellation The present council had not fallen below the standard of its predecessors, there was no biologist, no scientific physician, no anthropologist, no archæologist to whom the name of the illustrious Rector of the University of Berlin, Rudolph Virchow, was not familiar No one had done more to put pathology on a scientific foundation, no one had done more for critical anthropology, especially in connection with archæology Without venturing on the dangerous field of politics, he would add that these merits were, to his mind, greatly enhanced by the fact that Virchow had never merged the citizen in the philosopher, but amidst great difficulties and with undaunted courage, he had taken an active, a disinterested, and a thoroughly independent course in the Legislature of his country The next medal in order of age was that founded by Count Rumford at the commencement of this century, on equally cosmopolitan principles, but limited in scope to the physico-chemical sciences In these sciences hardly anything had attracted popular attention more of recent years than the marvellous power which spectroscopy had placed in our hands to discern the chemical composition of bodies which were millions and billions of miles away, and, for anything we knew to the contrary, these minute and careful inquiries into the constitution of stars might be *post-mortem* examinations In the accurate examination of stars by the spectroscope, he understood from others that Dr Dunér, of Sweden, had laid secure foundations for all future investigations The Royal medals were founded by the Sovereign some sixty-odd years ago, were now maintained by her Majesty, and were confined to British subjects. There were two medals every year, and they were usually allotted one to physical and chemical science, and the other to biological science They were usually given to younger men; and it was so in his own case forty years ago The value of the medal was inexpressible to him In his younger days, if a man took to science, it was thought he was going to the bad The receipt of the medal made an entire revolution in the minds of his friends, and he was a respectable person from that time On the present occasion the first of these medals was awarded to the present Director of the Astronomical Observatory in Oxford, Prof Pritchard, and he was told that there was no observatory in the three kingdoms in which so much admirable work of observation was being done Only a short time ago the Royal Astronomical Society awarded its gold medal to the Director of the Oxford Observatory. He was further told that the director was tackling what he understood was one of the most difficult pieces of astronomical work—parallax determination; and that he had already printed off more stars than anybody else. Besides this, he was hard at work on the great international chart of the heavens. It was obvious that this gentleman must be in the

full vigour of youthful energy, and therefore he treated with contempt a rumour that had reached him that the director was in his eighty-fourth year They would join with him in wishing Prof Pritchard a long continuance of the health and strength which were turned to such splendid account The second of these medals was awarded to Dr Langley, of the University of Cambridge, for the long-continued and very valuable physiological researches There was a familiar phenomenon observable before sitting down to dinner, and known as watering of the mouth If it were possible to determine the exact condition of that operation in physiology the exact knowledge would be a key to an immense range of the secrets of Nature It was these problems that Dr Langley had been investigating, and he had come nearer to their solution than any one else The Davy medal was awarded to a distinguished French *savant*, M Raoult, whose work was considered of the highest importance, and he rejoiced that the recipient of the medal was present The Darwin medal was instituted in honour of one of his best and dearest friends, and it was now conferred upon a man who was one of the stanchest friends he had had for the last forty years He might fairly appeal to Sir Joseph Hooker's present activity, put him down also among the young men, and thereby save the credit of the council in the matter of its own regulation To those who knew the "Life and Letters of Darwin," talk about Sir Joseph Hooker's right to the Darwin medal was as futile as the attempt to judge Manlius in sight of the Capitol He knew no more remarkable example of life long devotion, of stores of information laid open, of useful criticism, and of still more useful encouragement, by one man to another, than that exhibited by Sir Joseph Hooker in this picture It might be that even the man whose motto was "It's dogged as does it," and who so patiently laboured for half a lifetime at the great fabric of the origin of species, might have fainted by the way without this friend's aid And assuredly Hooker's great study of geographical distribution was a most important factor in Darwin's work It lay in the eternal fitness of things that Wallace and Hooker should receive the Darwin medal, and that these old young men should give it a heightened value for the young young men to whom it would hereafter pass

Prof Raoult returned thanks, speaking in French.

Dr Langley responded for the other medallists and himself

Sir James Paget briefly proposed "The Guests"

The Swedish Minister, in responding, said—The honour to be your guest and to participate with you in the celebration of this interesting day cannot be more thankfully felt than by me, who still has to consider this favour, above all, as a compliment to the country where you have selected this year your Rumford medallist This distinction to my fellow-countryman, Prof Dunér, whose merits Prof Huxley has so eloquently explained to you, is a new link in the long chain of tokens of sympathy and appreciation from this society to scientific Scandinavians, a chain of which one of the oldest links is the creation of the Linnean Society More than a hundred years have passed since, and in the meantime many systems have been altered, and, especially in the last twenty years, those alterations have so closely followed the one upon the other that we laymen have been accustomed to believe we were entitled to ask every new morning, "What great discovery will this day bring?" In one department, however, scientific men as well as laymen cannot admit the possibility of any alteration, and that is in our conviction and belief that this country occupies a prominent place in the universal scientific movement—a proof of which, among many others, is the fact that no other institution in the world encourages as much as does this society other countries' scientific researches

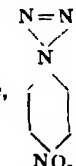
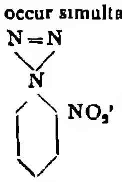
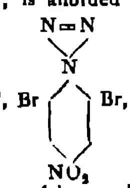
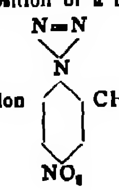
Mr. Alma-Tadema also responded, remarking in the course of his speech that there was no art without science, neither was there any science without art and that art coloured life as the sun colours the flowers of nature

AZOIMIDE

A FURTHER communication concerning azoimide, the interesting compound of hydrogen and nitrogen, N_3H, discovered two years ago by Prof Curtius, is contributed to the current number of the *Berichte* by Drs. Noelting and Grandmougin of Mülhausen, in conjunction with Herr O Michel. As described in our note of vol. xliv p. 600, Drs. Noelting and Grandmougin have previously shown that azoimide may be obtained by indirect means from the singular compound prepared somewhere about the year 1866 by the late Dr Peter Griess, and which has hitherto been known as diazobenzene imide, $C_6H_5{-}N\left\langle\begin{matrix}N\\ \|\\ N\end{matrix}\right.$ This compound is now recognised as the phenyl ester of azoimide It is, however, a substance of very considerable stability, and successfully resists the attack of concentrated alcoholic potash, even under pressure Although thus stoutly resisting direct attack, Drs Noelting and Grandmougin have shown that by undermining its constitution by the introduction of a couple of nitro groups in the place of two hydrogen atoms, it becomes weakened so greatly as to be no longer capable of withstanding the action of the alkali, and is decomposed with production of the potassium salts of azoimide and dinitro phenol—

$$C_6H_3(NO_2)_2N_3 + 2KOH = C_6H_3(NO_2)_2OK + N_3K + H_2O$$

This interesting result is now supplemented by showing that it is not necessary to introduce *two* nitro groups in order to render diazobenzene imide sufficiently negative in character as to be susceptible to the attack of alcoholic potash, that *one* such group suffices, provided it be introduced in the para or ortho position A nitro group introduced in the meta position appears to exert much less weakening power, quite inadequate for the purpose

Para nitro diazobenzene imide, , is a substance crystallizing well in colourless tabular crystals When these crystals are allowed to fall slowly into a cold solution of one part of caustic potash in ten parts of absolute alcohol, they instantly dissolve and the liquid becomes coloured a deep red If this red solution is warmed for a couple of days over a water bath, and the larger portion of the alcohol subsequently distilled off, upon acidification of the residue with dilute sulphuric acid, and again distilling, azoimide, N_3H, passes over along with the vapours of water and alcohol In order to free the azoimide from alcohol it is only necessary to neutralize the distillate with soda, and evaporate the solution to dryness, when the sodium salt of azoimide, N_3Na, is obtained, the sodium salt is then dissolved in water, the solution acidified with sulphuric acid, and subjected to distillation, when an aqueous solution of azoimide is obtained The yield of azoimide is usually only about 40 per cent. of the theoretical, owing to secondary reactions which occur simultaneously with the main one The ortho compound,  treated in a similar manner, also furnishes azoimide to the extent of about 30 per cent. A very much larger yield, about 85 per cent, is afforded by the dibrom derivative of the para compound,  a substance which is readily obtained in the form of long colourless prisms. Azoimide has also been obtained to the extent of 30 per cent. of the theoretical amount by the decomposition of a nitro toluene derivative of azoimide of the constitution 

THE NEW STAR IN THE CONSTELLATION OF AURIGA[1]

THE appearances which the new star has presented were exceedingly remarkable, and observations, both spectroscopic and photometric, were far more numerous than have been obtained during former occurrences of this kind The latter have been sufficient to establish the unsuitability of several explanations which have been suggested with regard to former new stars, suggestions which at the time appeared more or less plausible On the other hand, however, it is very difficult to establish, from the publications of observers up to the present time, all details required for a general proof of a definite hypothesis It appears to me appropriate to suggest a new attempt at explanation, which seems to tally better than others with the principal results of observation, the final tests of which hypothesis must, however, for the present remain a matter for the future But if this attempt should in the present instance meet with difficulties—a case which I admit to be possible, if not probable—it yet deserves a somewhat more detailed explanation, because it thoroughly takes account of, as I believe, possible conditions, and therefore certainly contains a possible hypothesis with regard to the appearances of certain new stars In the following remarks I shall strictly adhere to the facts which are to be considered, according to the statements of the observers, as the result of their observations, whereas a proof of the latter is beyond the limit of this article I may here mention that I have already suggested the most essential of the following remarks in March of the present year.[2]

The chief results of observations, which may be said to contain the characteristics of all the appearances, are —

1 According to Herrn Lindeman[3] the light curve of the Nova presented the following appearances —

"From February 1 to 3 the photometric curve rises quickly to a brightness of 4 7m, then gradually sinks till February 13, and then quicker until February 16 to 5 8m, reaches a second maximum of 5 14m on February 18, has a second minimum on February 23, likewise of 5 8m, and then a third maximum on March 2 again of 5 4m, upon which it sinks till March 6, slowly at first, and then quicker, in a straight line till March 22 down to 9 3" I may here add that from the photographs taken at Harvard College, it was possible to show that the star became visible from the beginning of December, 1891, that already in the period of time December 20–22 it showed a maximum of brightness which reached almost, but apparently not entirely, a maximum on February 3

2 The spectrum of the Nova was most remarkable Prof Vogel, in summing up the results obtained at Potsdam,[4] writes —

"The observations have led to the exceedingly interesting result that the spectrum of the Nova consists of two superposed spectra, and that a number of lines, especially those of hydrogen, which appear bright in one spectrum and dark in the other, are closely adjacent to one another This fact admits of hardly any other explanation than the presence of two bodies, the component motions of which in the line of sight are very considerable . The bodies separate from one another with a relative velocity which during four weeks' observations (in February) suffered no appreciable change, and which amounted to at least 120 miles per second" It may be further added[5] that among the very broadened bright lines there were noted several intensity maxima, two being especially striking

It has been suggested as an explanation of the facts of observation that two heavenly bodies have passed very close by one another, and that thus changes in their atmospheres have arisen which have caused the sudden brightening up of the bodies The above hypothesis is, however, in this form too vague to be followed in detail In reverting to an idea of Klinkerfues, it is true that a more distinct picture of the whole occurrence has been drawn, by assuming tidal effects of the two bodies upon each other in this manner where the tidal crests of the atmosphere appear, there the darkenings take place by absorption, and where the ebb predominates a brightening is the result, because here the absorbing strata of the atmospheres are less powerful It must be mentioned, however, that the statical theory of Ebb and Flow that has been applied is altogether inappropriate to give an idea of the deformations which doubtlessly occur at such a near proximity The effect of the two heavenly bodies on each other in Nova Aurigæ, as is still to be shown, would have to be one that is almost always suddenly appearing and immediately afterwards vanishing Moreover it must not be overlooked, that with incandescent bodies their atmospheres must be regarded as outward shells which quite gradually emerge into denser strata, while these also are deformed in a lesser degree In other respects, too, it will be difficult to explain the appearances of a new star as a consequence only of the effects of absorption of atmospheres It has also been assumed for the most part that besides these (absorptions), eruptions of gas from the centre of the body take place This assumption, it is true, contains nothing impossible, but without a definite form it hardly admits of discussion At all events it will be necessary to suggest further hypotheses in order to apply this attempt at explanation to single cases Moreover, it remains yet unexplained why in Nova Aurigæ the one spectrum is chiefly an absorption spectrum and the other a gas spectrum By special assumptions this difficulty can be certainly eliminated, but it is not very probable that on this account confidence can be placed in the correctness of the hypothesis

Other facts appear, however, in the case of Nova Aurigæ which do not speak in favour of this hypothesis, however generally it may be expressed It is at least very striking that just in this case such enormously great velocities of cosmical bodies appear, such as have hitherto not been found anywhere else The occurrences of these velocities must therefore be numbered among the facts to be explained Further on formulæ will be given from which, at least to a certain degree, the mechanical conditions of the close approach of two bodies can be computed From this it follows that in the case of Nova Aurigæ the two bodies can describe a parabola round each other only if their masses are much larger than 15,000 times the sun's mass. For a hyperbolic movement one can obtain an essentially smaller value of the mass, by assuming that the enormous relative velocity of 120 miles observed has been produced to a small degree by attraction and has existed almost entirely from the beginning Thus the choice is left between the assumption of extremely large masses or the giving up of an explanation of the great relative velocity Neither of these two assumptions contain, it is true, an impossibility, but I do not think that doubtful proofs for the correction of the hypothesis can be noticed in either of them According to my opinion they rather render it (the hypothesis) very little plausible

The formulæ already mentioned indicate what will be explained further on, namely, that the supposed effect of the two bodies, in the case in hand, must have taken place very quickly indeed, perhaps even in the period of a few hours. This effect must necessarily have occurred upon the first brightening up (beginning of December 1891) Why then the Nova attained several weeks later (beginning of February 1892) a second maximum, and to all appearances a greater maximum, and why the light curve sank only very little till the beginning of March but afterwards very rapidly, seems to me, on the ground of the hypothesis in question, to be explainable only with great difficulty, if it can be explained at all. At all events, this difficulty will remain unless it be altogether removed in detail

The difficulties hinted at above entirely disappear in the following supposition. There is no doubt, especially in accordance and with the results obtained from stellar photographs, in which Mr. Max Wolf has co-operated, that space is entirely filled with more or less extensive formations of very thinly scattered matter With regard to their physical properties, these formations will probably show very varied constitutions, the reason for which we will leave an open question, as we do not wish to investigate it here. It is itself not very improbable that a heavenly body should get into such a cloud, but in any case it is more probable than the grazing together of two compact bodies, as is required in the above-discussed hypothesis. As soon now as the body commences to enter a cosmic cloud a surface heating will be set up at once, and indeed it must be so, whatever may be the constitution of the thinly-scattered matter In consequence of this heating, the products of vapourisation will form round the body, these will partly be separated

[1] Translation of an article by H Seeliger, in *Astronomische Nachrichten* (No. 3118).
[2] "On a General Problem of the Mechanics of the Heavens," p. 93 (München, 1892.)
[3] *Astr Nach*, No. 3094
[4] *Vierteljahrsschrift der Astr Gesellsch*, Band 27, p. 141
[5] *Astr. Nachr.*, 3079, p. 110.

from it and will adopt very quickly that velocity which the adjacent parts of the cloud possess.

It is interesting to compare this process with a similar one, which takes place in a well-known way in the appearance of shooting stars or fireballs. In this case a compact body enters with a certain velocity into a formation of very thin matter (the upper strata of the atmosphere), is heated and partly vapourized, and a luminous tail, which is clearly visible for a long time after the sudden appearance of the meteor, marks the path which the latter has taken. The detached particles have quickly lost their relative velocities against the air, for they apparently do not partake of the movement of the meteor.

If we consider spectroscopically the star on its commencement to become bright by resistance, two superposed spectra will openly reveal themselves, one in general continuous and provided with absorption bands in consequence of the heaping up of the glowing gases, and the other in the main consisting of bright lines. Both spectra, according to the relative motion in the line of sight, will appear pressed up against one another. Thus altogether an appearance is found very similar to that observed in Nova Aurigæ, and they will agree entirely if one assumes that also those parts of the cloud nearest the body have sustained physical perturbations by a direct frictional warming of the detached particles, &c. This assumption seems to me to contain by no means a difficulty considering our lack of knowledge with respect to the properties of this cloud matter. Whether this is at all necessary I am unable to say on the ground of the publications at hand.

The investigation is important to decide whether, on the lines laid out, we can obtain a plausible explanation of the great relative velocities shown by the two spectra. When the body approaches the cloud the latter will evidently lengthen itself in the direction of the former. This lengthening will grow with the mutual approach, just as the relative velocity of the single parts of the cloud will grow towards the body. Without certain suppositions on the structure of cloud matter it is difficult to conceive of the processes of movement which take place, so we must content ourselves with contemplating the one or the other case, which admits of a closer investigation.

If, for instance, we suppose that the single particles of the cloud follow for the main part the effect of the body, they will describe conic-sections—that is, hyperbolas round the centre of the latter as forces. Their greatest relative velocity decreases quickly with the distance of the body, so that the surroundings of the latter will be filled with particles moving with very different velocities. One can easily see that no very extraordinary assumptions are necessary to suppose very great velocities for these particles that pass near the surface of the body, velocities amounting to those stated in the case of Nova Aurigæ, even if they are at the outset very small. It follows from the above that the spectral lines of the particles which are moving from the body with such different velocities must be very much enlarged, and that to explain the different brightenings of the single parts of the lines as probably intensity maxima does not raise the least difficulty, but is a necessary accompanying phenomenon. This point seems to me to be important, for it cannot be deduced from the hypothesis of two compact masses passing close by one another, and must here lead to the rather improbable assumption of several moving bodies.

As long as the body remains in this, so to speak, atmospheric formation, the appearances above mentioned must always be called forth anew, whence it follows that the peculiarities of the spectrum conditioned by the whole state of things, not considering smaller perturbations, must on the whole remain constant for some time, a point which in the above hypothesis is at first not by any means clear. In a similar manner it will not be astonishing if the star during that time changes its brightness less strongly, while after its exit from the cloud this brightness will decrease rather rapidly. This too agrees with the light-curve in the case of the Nova. Finally, even the periodical fluctuations of the magnitude can be explained quite naturally. We call to mind here the well known fact confirmed lately by the photographs of Max Wolf, that similar occurrences appear in shooting stars, which may, indeed, be explained with difficulty.

We must, however, in any case assume that the star entered the cosmical cloud in question about the beginning of December and left it not long before the beginning of March. Now the question is urged upon us: How was it possible that for such a long time the great relative velocity could remain constant though such a resistance must have taken place that could develope the heat necessary for the glowing of the body? We are here going to decide this question by comparing the resisting power of the star to that of a meteor in the upper strata of our atmosphere.

Let us assume, quite generally, that the motion of the star in a straight line is given by the equation

$$\frac{dv}{dt} = -\lambda v^n \qquad (1)$$

(1) where v is the velocity, n a positive number > 1 and λ a constant, which is directly proportional to the surface of the globular body and the density of the medium and inversely proportional to the mass of the body. We compare equation (1) with the equation for the motion of a meteor

$$\frac{dv'}{dt'} = -\lambda' v'^n$$

in which the time t' is referred to another unit selected for the purpose. If we suppose $v' = \mu v$, $t' = \nu t$, $\lambda = \lambda' \nu \mu^{n-1}$. The latter equation becomes identical with (1), that is the movement of the star corresponds point to point with the motion of the meteor, if the latter equations are satisfied. Representing now m, O, r, δ, m', O$'$, r', δ', as masses, surfaces, radii, and densities of the star and meteor, and D and D$'$ the density of the cosmical clouds and the upper strata of the atmosphere in question, we have —

$$\frac{\lambda}{\lambda'} = \frac{\mathrm{DO}m'}{\mathrm{D'O'}m}, \quad \nu = \frac{1}{\mu^{n-1}} \; \frac{\mathrm{DO}m'}{\mathrm{DO'}m}$$

or also

$$\nu = \frac{t'}{t} = \left(\frac{v}{v'}\right)^n \frac{r'\delta'\mathrm{D}}{r\delta\mathrm{D'}}$$

If we put $r = k$ times the sun's radius (= 700 million metres) and $r = r$ metres, and further corresponding to the observations of the new star $v = 30$ (unit of velocity of Earth in its orbit) and $t = 100$ days and $v' = 2$ which corresponds to a relatively quickly moving meteor and finally $n = 2$, we have —

$$\nu = \frac{15}{k} \; \frac{\mathrm{D}\delta'}{\mathrm{D'}\delta} \; \frac{r'}{700 \text{ millions}}$$

$$\text{and } t' = 0^s \cdot 185 f, \quad f = \frac{r'\delta'\mathrm{D}}{k\delta\mathrm{D'}}$$

Thus the movement of the star takes place proportionally in 100 days, just as that of the meteor in 0.185 seconds if we suppose $f = 1$. As we are free to assume $\frac{\mathrm{D}}{\mathrm{D'}}$ small, we can obtain a very small fraction of a second, and since within a hundredth part of a second the movement in the highest regions of our atmosphere shows no longer a perceptible decrease of velocity, such a decrease will not enter in the case of the star. We have evidently to deal here with the same appearance which points out that small heavy objects possess a far greater resistance to air than large ones, and that with large meteors (fireballs) the air resistance, as it has been proved, influences the elements of the orbit far less than is the case with small meteors.

We have still to show that in spite of the small decrease of movement, enough energy of movement is changed into heat in order to bring the star into a surface-glowing condition, and such a condition has by all means taken place in the Nova. We must therefore calculate the quantities of heat Q and Q$'$ which is radiated in one second of time, and from a unit of surface on both bodies. If we call P and P$'$ the losses in acting power during the times t and t', v_0 and v_0' the velocities before the entrance into the resisting media, we have:—

$$\mathrm{Q} = \frac{\mathrm{P}}{\mathrm{O}t}, \quad \mathrm{Q'} = \frac{\mathrm{P'}}{\mathrm{O'}t'}$$

$$\text{and } \mathrm{P} = m\,(v_0^2 - v^2), \quad \mathrm{P'} = m'\,(v_0'^2 - v'^2)$$

and taking into consideration the above equations:

$$\frac{\mathrm{Q}}{\mathrm{Q'}} = \frac{\mathrm{D}}{\mathrm{D'}}\left(\frac{v}{v'}\right)^{n+1}$$

with the above numbers $\frac{v}{v'} = 15$, n will be $= 2$

$$\frac{\mathrm{Q}}{\mathrm{Q'}} = 3375 \cdot \frac{\mathrm{D}}{\mathrm{D'}}$$

so that we can assume that the density of the cosmic medium, compared to these already very thin air strata, in which evidently

the glowing of the meteor occurs, is not very dense, and that one yet gets the necessary quantity of heat.

It may be remarked that we can vary all these numbers within very wide limits without fearing any contradiction, so that we may conclude, therefore, that no difficulty in the suggested hypothesis arises from this point of view.

I have now to deduce the formulæ I have mentioned above, and it will be seen that these are very interesting.

If we take μ as the sum of two masses revolving round each other in a conic section, V the velocity, and retaining for the rest the customary nomenclature, we have for the parabola

$$V^2 = k^2\mu \frac{2}{r}, \quad r = \frac{q}{\cos^2 {}^1/_2 v},$$

$$\tan {}^1/_2 v + {}^1/_3 \tan^3 {}^1/_2 v = \frac{k\sqrt{\mu}\, t}{q^{3/2}\sqrt{2}}$$

Whence it follows without further difficulty

$$\mu = \frac{V^3 t}{4k^2 \sin {}^1/_2 v\,[1 - {}^1/_3 \sin^2 {}^1/_2 v]}$$

One takes c as the velocity of the earth in its orbit with the radius R and puts the sun's mass and the mass of the earth = 1, so that $k^2 = c^2 R$. If we consider further that the expression

$$\sin {}^1/_2 v\,[1 - {}^1/_3 \sin^2 {}^1/_2 v]$$

can attain the maximum value $\frac{\sqrt{2}}{3}$, it follows that

$$\mu > \frac{3}{4\sqrt{2}} \left(\frac{V}{c}\right)^3 \cdot \frac{ct}{R}$$

or if t be given in solar days

$$\mu > 0.00912 \left(\frac{V}{c}\right)^3 t \tag{4}$$

To apply this to the Nova we must remember that $\frac{V}{c} > 15$, because the orbital velocity may be greater than that in the line of sight. Besides, more than two months have passed since the supposed grazing of the bodies took place, which time must coincide closely with that of perihelion, up to the time that we have still spectrum observations in hand. Thus t is much greater than 60. Formula (4)—

$$\mu > 14779 \times \text{sun's mass}$$

gives thus a limit which supposes masses far too small. In reality we might perhaps assume double this without challenging contradiction.

The consideration of a hyperbolic movement takes a similar though less simple form.

If V_0 represents the velocity at an infinitely large distance, we have

$$V^2 - V_0^2 = \frac{2k^2\mu}{r},$$

and according to the Theoria Motus—

$$\frac{r}{a} = \frac{e - \cos F}{\cos F},$$

$$e \tan F - \log \tan (45° + 1/2\, F) = \frac{k\sqrt{\mu}\; t}{a^{3/2}},$$

from which it is found at once that—

$$\left.\begin{aligned} \mu &= \left(1 - \frac{V_0^2}{V^2}\right)^{3/2} \left(\frac{V}{c\sqrt{2}}\right)^3 \frac{ct}{R} X \\ X &= \left(\frac{e - \cos F}{\cos F}\right)^{3/2} \cdot \frac{1}{e \tan F - \log \tan (45° + 1/2\, F)} \end{aligned}\right\} \tag{5}$$

The expression for X, if one allows F to vary from 0°–90°, first decreases, reaches a minimum, and then increases to infinity. The minimum value can easily be determined for then

$$\frac{3}{4}\frac{e \sin 2F}{(e - \cos F)^2} [e \tan F - \log \tan (45° + 1/2\, F)] \text{ must be } = 1$$

This equation can be easily solved for special values of e. For the theoretical calculation which is requisite, I have employed another proceeding, as I have already computed the serial values of X for a special value of e, as the following table shows:—

	$e = 1.5$	2.0	4.0	6.0	8.0	10.0
F = 4	10.207	14.393	24.882	32.111	37.988	43.071
8	5.224	7.302	12.554	16.182	19.135	21.689
12	3.614	4.987	8.494	10.930	12.913	14.630
16	2.852	3.866	6.505	8.348	9.853	11.156
20	2.429	3.226	5.345	6.835	8.059	9.118
24	2.178	2.827	4.603	5.806	6.902	7.802
28	2.017	2.569	4.343	5.204	6.112	6.902
32	1.941	2.400	3.753	4.740	5.555	6.265
36	1.900	2.293	3.510	4.411	5.158	5.810
40	1.892	2.234	3.345	4.181	4.877	5.486
44	1.911	2.211	3.240	4.029	4.688	5.266
48	1.953	2.220	3.187	3.941	4.574	5.131
52	2.017	2.257	3.179	3.911	4.528	5.072
56	2.101	2.323	3.217	3.936	4.547	5.086
60	2.208	2.420	3.301	4.020	4.633	5.175
64	2.341	2.552	3.438	4.170	4.797	5.351
68	2.510	2.729	3.644	4.404	5.056	5.635
72	2.728	2.968	3.944	4.754	5.451	6.070
76	3.026	3.307	4.390	5.286	6.055	6.739
80	3.477	3.830	5.108	6.152	7.048	7.843
84	4.308	4.802	6.480	7.824	8.972	9.991
88	6.991	7.938	10.960	13.320	15.321	17.091

For very large values of e the minimum of X occurs if

$$\sin F = \sqrt{2/3},$$

and the minimum value of X becomes

$$\text{Min X} = \sqrt{\frac{3\sqrt{3} \cdot e}{2}} = 1.612\sqrt{e} \tag{6}$$

But one practically commits no error if one employs (6) also for the values of e nearly equal to 1, as is evident from the following computation of the minima values taken from the above table, and calculated according to formula (6).

e	Direct	Formula
1	1.5	1.6
1.5	1.9	2.0
2	2.2	2.3
4	3.2	3.2
6	3.9	3.9
8	4.5	4.6
10	5.1	5.1

One obtains:—

$$\mu > 0.0104\left(1 - \frac{V_0^2}{V^2}\right)^{3/2} \left(\frac{V}{c}\right)^3 \sqrt{e}\; t \tag{7}$$

For the above assumptions—

$$t = 60, \; \left(\frac{V}{c}\right) = 30,$$

we find

$$\mu > 16850\sqrt{e}\left(1 - \frac{V_0^2}{V^2}\right)^{3/2}$$

which formula holds good for values of e, which do not quite equal 1. In order to include also the parabola we suppose

$$\mu > 15000\sqrt{e}\left(\frac{V^2 - V_0^2}{V^2}\right)^{3/2} \tag{7a}$$

Thus in this case we result in extremely large masses, which are not very probable, or we must assume that $\frac{V_0}{V}$ = very nearly 1. Even for $\frac{V_0}{V} = 0.9$, according to the above formula, $\mu > 1200\sqrt{e}$, and we may consider the above given assertion as justified. It has already been remarked that this suggested inequality proves only that μ is very much greater than the right side (of the equation).

It is easy to find a higher limit for μ if $\frac{V_0}{V}$ does not differ much from unity.

If we put $\frac{V^2 - V_0^2}{V^2 + V_0^2} = \nu$, we obtain $\cos F = \nu e$, and according to formula (5)

$$\mu = \left(\frac{1 - \nu}{1 + \nu}\right)^{3/2} \left(\frac{V}{c}\right)^3 \frac{ct}{R} \cdot \frac{\nu}{e\nu \tan F - \nu \log \tan (45° + 1/2\, F)}.$$

Given t, e, and ν, we can calculate the right-hand side. But we seek, however, the maximum value of

$$y = e\nu \tan F - \nu \log \tan (45° + 1/2F) = \sin F - \nu \log \tan (45° + 1/2F)$$

by determining e as function of ν. It is

$$\frac{\partial y}{\partial e} = \left(\cos F - \frac{\nu}{\cos F}\right)\frac{\partial F}{\partial e} = \frac{\nu(1 - \nu e^2)}{e\sqrt{1 - \nu^2 e^2}}$$

Thus y increases so long as $e < \frac{1}{\sqrt{\nu}}$, and decreases continually for $e > \frac{1}{\sqrt{\nu}}$. The maximum for y takes place when $e^2 = \frac{1}{\nu}$, and is

$$y = \sqrt{1 - \nu} - \nu \log\left(\frac{1 + \sqrt{1 - \nu}}{\sqrt{\nu}}\right)$$

Thus we have

$$\mu > \frac{ct}{R}\left(\frac{V}{c}\right)\left(\frac{1 - \nu}{1 + \nu}\right)^{3/2} \frac{\nu}{\sqrt{1 - \nu} - \nu \log\left(\frac{1 + \sqrt{1 - \nu}}{\sqrt{\nu}}\right)}, \qquad (8)$$

and with $\frac{V}{c} = 30$ and $t = 60$ days,

$$\mu > 27800\left(\frac{1 - \nu}{1 + \nu}\right)^{3/2} \frac{\nu}{\sqrt{1 - \nu} - \nu \log\left(\frac{1 + \sqrt{1 - \nu}}{\sqrt{\nu}}\right)}$$

For the above example $\frac{V_0}{V} = 0.9$ results $\mu > 2800$ as considerably larger masses than formerly.

I have now further to prove that a very close proximity of the two bodies can have only taken place for a very short space of time. To do this we use the following relations.

We find above for the parabola

$$\mu = \frac{V^3 t}{4k^2 x}, \quad x = \sin \tfrac{1}{2}v(1 - 2/3 \sin^2 1/2v)$$

It follows, therefore, that

$$V^2 = \frac{2k^2\mu}{r}$$

$$r = \frac{Vt}{2x}$$

Thus we have

$$r > \frac{3}{2\sqrt{2}} \quad Vt = 1.06Vt \qquad (9)$$

For the hyperbola we have

$$r = \frac{2k^2\mu}{V^2 - V_0^2}$$

and, according to formula (5)

$$2k^2\mu = \frac{(V^2 - V_0^2)^{3/2}}{\sqrt{2}} tX$$

Therefore,

$$r = \frac{\sqrt{V^2 - V_0^2}}{\sqrt{2}} tX$$

For eccentricities which are not very nearly equal to 1, we had

$$X > \frac{3^{3/4}}{\sqrt{2}} \quad \sqrt{e},$$

and it is certainly

$$r > \frac{3^{3/4}}{2} \sqrt{e} \sqrt{V^2 - V_0^2} \quad t > 1.05 \sqrt{V^2 - V_0^2}\, t \qquad (10)$$

For $V_0 = 0$

(10) is naturally changed into (9). For the hyperbola, however, it is possible to suggest a second relationship.

Since

$$2\frac{a}{r} = \frac{V^2 - V_0^2}{V_0^2}.$$

(5) can also be written

$$k^2\mu = \left(\frac{a}{r}\right)^{3/2} V_0^3 tX$$

and because $k^2\mu = aV_0^2$, it follows that

$$r = \sqrt{\frac{a}{r}} \quad V_0 tX = V_0 ty,$$

where

$$y = \frac{e - \cos F}{\cos F} \cdot \frac{1}{e \tan F - \log \tan (45° + 1/2F)}$$

An easy calculation yields now

$$\frac{\partial y}{\partial F} = \frac{-1}{e \sin F - \cos F \log \tan (45° + 1/2F)} [(1 + e^2) \cos F - 2e + e \sin F \log \tan (45° + 1/2F)].$$

It is quite evident that the quantities in brackets always remain positive, for it is

$$\log \tan (45° + 1/2F) = 2 \tan \tfrac{1}{2} F + \tfrac{2}{3} \tan^3 1/2 F + \ldots > 2 \tan 1/2 F,$$

and in consequence of it the quantity in brackets $> (e - 1)^2 \cos F$.

Thus, $\frac{\partial y}{\partial F}$ is negative, and y decreases as F increases. From this it follows that $y > 1$, and the relation $r > V_0 t$, is the result.

If we apply this formula to Nova Aurigæ, we obtain for

$\frac{V_0}{V}$	$\sqrt{V^2 - V_0^2}$	V_0
0.5	108 miles,	60
0.6	96	72
0.7	86	84
0.8	72	96
0.9	—	108

In the vicinity of perihelion the velocity has been under every condition greater than 120 miles, and we shall therefore obtain values of r that are considerably too small, by supposing $r > t \times 85$ miles. One day before or after perihelion it is therefore certain that $r > 7.3$ million miles.

It will therefore hardly be possible to assume that any noticeable influence of the supposed two bodies can have lasted longer than a few hours.

Since the above article was written Nova Aurigæ has by its reappearance attracted considerable attention, and especially by the observation as made by Prof. Barnard. With regard to this reappearance one must necessarily see an evident confirmation of the critical part of my article. Nor has my hypothesis been contradicted in any way, for it is evident in itself that the supposed formations of the nebulous or dusty matter are more copious in certain parts of space, and one may have different ideas of the distribution of density of these formations.

To the observation made by Prof. Barnard (*Astr. Nach.*, 3114) I wish to add the following remarks. I had formed an idea of the whole process which caused the outburst of the Nova, which idea is as perfectly represented in Prof. Barnard's drawing, kindly communicated to me by Prof. Kreutz, as I could expect. During the appearance of the Nova in the winter nothing similar was seen so far as I know. It does not follow from this, therefore, that it did not exist, and it would also have been possible to have expected information from the photographs as has often occurred before. I applied on this account to Dr. Wolf, in Heidelberg, and asked him whether he had photographs of the region of the Nova at that time, and whether, perhaps, any nebulous object was to be seen on them; but, unfortunately, Dr. Wolf did not possess such photographs. It remains doubtful, I am sorry to say, whether so delicate an object would have been visible on the plates. W. J. LOCKYER

HINTS FOR COLLECTORS OF MOLLUSKS.[1]

AFTER the collector has brought home the spoils of his excursion there is still a good deal to be done before the wet and dirty shells, covered with parasitic growths or inhabited either by the original mollusk or some hermit crab, will be ready to be placed in the cabinet. Some of them, if living, may find a temporary place in an aquarium for the study of their habits, but, for the most part, the collector will wish to prepare his specimens either for anatomical use in the future or as dry specimens for his cabinet. The preparation of mollusks for anatomical purposes has been described in a special chapter of these instructions. For ordinary rough work nothing is better than clean 90 per cent. alcohol diluted with a proper proportion of water. If the specimens are large they should be first put into a jar kept for that special purpose, in which the alcohol is comparatively weak, having, say, 50 per cent. of water added to it. After the immersion of specimens in this jar for several days the fluids will have been extracted by the alcohol, and a specimen can then be removed, washed clean of mucus and dirt, which will almost always be found about the aperture of a spiral shell, and

[1] Reprinted from "Instructions for Collecting Mollusks, and other Useful Hints for the Conchologist," by William H. Dall; issued by the Smithsonian Institution as Part G of *Bulletin* of the U. S. National Museum, No. 39.

placed in its own proper jar of 90 per cent alcohol diluted in the proportion of 30 per cent. with pure water Specimens to be prepared for the cabinet require the removal of the soft parts if they are still present, the cleaning off of parasitic or incrusting growths, and, in the case of bivalves, securing the valves in a convenient position for the cabinet The different classes of shells may be treated under several heads

Land and Fresh Water Shells

Land and fresh water shells are much more easy to deal with than marine shells. In the case of spiral shells, such as *Limnæa*, *Planorbis*, *Paludina*, &c , the shell may first be washed clean of mud or comfervoid growth, which may be conveniently done with the assistance of an old tooth or nail brush In the case of these forms the easiest way to remove the soft parts is to place the shell for twenty four hours in weak alcohol, after which those parts can readily be removed , but in any case where the expense of alcohol is an object to be avoided, it will be sufficient to place them in a small tin kettle, or other receptacle suitable for the purpose, and cover them with cold water, which should then be slowly brought to the boiling point. As soon as it has reached the boiling point it may be removed from the fire The shells should not be put into water already boiling, as it frequently cracks delicate shells, and the sudden change of temperature injures their polish and general appearance

For removing the soft parts from spiral shells the collector will usually find a crooked pin sufficient For this purpose one of those long steel pins used by ladies as hat pins is convenient By heating the pointed end in the flame of a candle or alcohol lamp the temper can be taken out of the steel, so that it can be readily bent into any shape desired The proper form for reaching the retracted parts in a spiral shell will of course be a spiral. With a small pair of plyers, different forms can be experimented with, and those which are most satisfactory decided upon. After the right form has been obtained, by heating the pin again and plunging it suddenly into cold water, the temper of the steel will be measurably restored and the instrument ready for use Similar pins in their ordinary condition are convenient for cleaning out sand or parasites from the recesses of sculptured shells, and for other purposes The attachment of a gastropod to its shell is at the central axis or pillar of the shell, usually from half a turn to a turn and a quarter behind the aperture. By applying the pressure of the extractor carefully in this vicinity the attachment will give way and the extractor may be withdrawn, bringing with it the soft portions of the animal In large and heavy shells, in which the muscular attachments are strong and deep-seated, and it is desired to obtain a good hold of the animal in order to extract it from the shell ordinary steel fish-hooks may be used These may be softened by heat, straightened out, and twisted into a spiral of the proper form, and retempered Then they can be securely fastened to small wooden handles by the shank of the hook In this way the barb of the hook will assist in retaining the soft parts on the extractor when it is withdrawn from the shell Several German firms advertise sets of implements for cleaning, cooking, and extracting the animals from shells of mollusks, but it would seem to the writer that any person of ordinary intelligence and some little mechanical ingenuity, such as all naturalists are expected to possess, should be able to provide himself with the necessary apparatus without purchasing expensive paraphernalia of this kind. Shells which have no operculum require merely to be cleaned after the animal has been removed, and in the case of land and fresh-water shells this is usually a very simple matter Shells which possess an operculum should retain it in the cabinet, as it is often of great value in determining the relations of the species, since the operculum is a characteristic feature in the economy of the animal It should be detached from the body of the animal after the latter has been extracted from the shell, carefully washed and cleaned, and if flat and horny may be dried between two pieces of blotting paper, under a weight This will prevent it from becoming contorted in the process of drying For removing the thick incrustation of lime and peroxide of iron which frequently forms upon fresh-water shells, a few tools resembling engraver's tools or the little chisels in use by dentists for excavating teeth are very convenient. A suitable tool, however, can easily be made by softening and grinding down an old file to a triangular point. A little experience will enable the collector to become expert in scaling off the objectionable matter without injury to the surface of the shell.

Naked slugs should be preserved in alcohol, after being sketched in the living state Some of the older naturalists had a way of skinning slugs, inflating and drying the empty skins for preservation in their collections, much as entomologists sometimes treat caterpillars , but this ingenious device has nothing to recommend it to a scientific collector, even if he has the dexterity to practise it The internal shell of such slugs as *Limax* may be represented in the collection if desired, but, in any case, specimens should be carefully preserved in spirits.

The bivalve shells, such as *Unio*, if taken alive, may be left in the sun for a short time, when they will usually open, and, the muscle connecting the two valves being cut, the valves may be cleaned It is desirable for cabinet purposes to preserve the two valves in their natural position, attached to each other by the ligament which holds them together in life This ligament dries to a very brittle, horny substance Consequently the shells must be placed in position when fresh in order to make a success of the operation After cleaning away the animal matter and thoroughly washing the interior of the shell, it is a good plan to note the locality with a soft lead-pencil upon the shell itself. Then bring the two valves together in their natural position and tie them in that position with a piece of tape or soft twine, which should be allowed to remain until the ligament is thoroughly dry Specimens prepared in this way are more valuable for exchange and more attractive to the eye than those with which less care has been taken It is always desirable, however, to have some specimens with separated valves of every bivalve species in the cabinet, in order that the characteristics of the interior may be easily examined

Fresh-water bivalves are usually covered with a thin and highly polished, often very elegant, greenish or brownish epidermis. Sometimes the shell is so thin that, in drying, the contracting epidermis splits and cracks the shelly portion so that it becomes worthless for the cabinet This often happens with marine mussels, but it is almost characteristic of the thin fresh-water *Unionidæ* Various methods have been adopted to prevent this unfortunate result Some collectors have varnished their shells immediately after they were obtained. Others have used sweet oil or other oils in the hope of keeping the epidermis in a soft condition These applications are all objectionable for one reason or another, as the first endeavour of the collector who desires to make a really scientific collection should be to keep his specimens as nearly as possible in a perfectly natural condition The most satisfactory substance for application to the shells in question is probably ordinary vaseline, which should be applied in very small quantities, so that the specimen will have no greasy feeling and will absorb the vaseline sufficiently not to become sticky to the touch Glycerine, which has been recommended by several collectors, like oil, leaves the surface sticky and offensive to the touch, besides rendering it liable to catch everything in the way of dust with which it may come in contact

Very small gastropod shells need not have the soft parts removed If they are put into a vial of alcohol for twenty-four hours, then taken out and allowed to dry, the soft parts will become desiccated without any offensive odour, and they may be placed in the cabinet without further preparation. It may be noted, however, that if the cabinet contains many such shells, care should be taken to guard against the access of mice and vermin, which are apt to attack them in the absence of something more attractive in the way of food For those shells which possess an operculum, after the operculum has been dried and the shell cleaned and ready for the cabinet, it is customary to insert a little wad of raw cotton, rolled so as to fit the aperture snugly, the outer surface of it being touched with a drop of mucilage The operculum can then be laid upon this in its natural position and the mucilage and cotton will retain it so without making it difficult to remove for an examination of the shell if desired at any time For the preservation of eggs of mollusks when they have a horny or calcareous shell, small glass tubes securely corked are the best receptacles. Most of these eggs are so small that they may be preserved in a dry state or in alcohol without trouble, but the eggs of some of the tropical land snails are so large that it will be necessary to drill a small hole and extract the fluid contents as if they were bird's eggs in order to preserve them. Such eggs are the best preserved in alcohol.

Marine Shells.

The preparation of marine shells for the cabinet does not essentially differ from that required for land or fresh-water shells, except that in the marine shells the muscular system is

often much more strongly developed and the creatures themselves much larger than the fresh water forms, and the manipulation is therefore somewhat more difficult. The marine forms are also more apt to be incrusted with foreign bodies, bored by predatory sponges, like *Cliona*, or even by other mollusks, or perforated by certain annelids which have the power to dissolve the lime of which the shell is composed, and in this way secure a retreat for themselves.

Shells which do not contain the living animal are frequently occupied by hermit crabs or by tubicolous annelids. The latter fill up the larger part of the spire with consolidated sand or mud, in the centre of which they have their burrow. The hermit crabs do not add anything to the shells which they occupy, but, on the contrary, by their constant motion are apt to wear away the axis or pillar of the shell, so that often a specimen of this sort may be very fairly preserved and yet on the pillar show characters entirely different from those which one would discover in a specimen which had never been occupied by a crab. A shell which the crab has selected for its home is often taken possession of, as far as the outside is concerned, by a hydractinia, a sort of polype, which produces a horny or chitinous covering which is very difficult to remove from the shell to which it is attached. As the hydractinia grows it finally covers the whole shell, to some extent assumes its form, and then, if the creature has not attained its full growth, this is apt to take place around the edges of the aperture, which are continued by a sort of leathery prolongation which assumes in a rough way the form of a shell. The crab, when he grows too large for the shell in which he has ensconced himself, is usually obliged to abandon it and find a larger one, which is always a difficult and more or less dangerous operation, but if his shell is overgrown by the polype referred to, it often happens that the polype and the crab grow at about an equal rate, so that the latter finds himself protected and does not have to make a change. It is supposed that the polype profits to some extent by the microscopic animals attracted by the food or excrement of the crab, so that this joint housekeeping is mutually beneficial, and, for such cases, since the word *parasite* would not be strictly accurate, the word *commensal* has been adopted. These modified shells often assume very singular shapes. The polype is able in the course of time to entirely dissolve the original calcareous shell upon which its growth began, so that if the spire be cut through it would be found throughout of a horny or chitinous nature. Some of the older naturalists were deceived by forms of this sort and applied names to them, supposing that they were really molluscan shells of a very peculiar sort.

In removing the animal matter from the shell of large gastropods it will often require a good deal of time and care to get out all the animal matter from the spire, but it is well worth while to take the trouble, as the presence of such matter forms a constant attraction for museum pests of all descriptions. A medium-sized syringe is convenient for washing out the spire of such shells. The ordinary marine gastropods may be treated in a general way like the fresh-water gastropods. There are, however, abnormal forms, especially among tropical species, which require particular attention. Some species become affixed to corals and overgrown by them, retaining only a small aperture through which the sea water can reach the prisoner. Such specimens are best exhibited by retaining a part of the coral and cutting the rest away, showing at once the mode of occurrence and the form of the covered shell. Borers are always more difficult to handle and prepare for the cabinet than other mollusks. They are usually more or less modified for their peculiar mode of life, and frequently rely upon their burrow as a protection, so that the shell is reduced, relatively to the animal, to a very small size. Most of these forms are best kept in alcohol. The hard parts may properly be represented in the cabinet by other specimens. Some of the bivalves, such as the American "soft clam," possess very long siphons, covered with a horny epidermis, and it becomes a question as to whether an attempt should be made to preserve this epidermis in the cabinet or not. The writer has seen very nicely prepared specimens in which the fleshy portions had all been taken out and replaced by cotton, so that the epidermis of the siphon retained its original position and form; but such specimens are always very delicate, easily broken, and liable to attack by insects, so that it would seem hardly worth while to go to the trouble, when specimens may be preserved complete in alcohol showing all the features referred to. Boring shell-fish, like *Pholas*, frequently have accessory pieces, which are liable to be lost when the soft parts are removed unless care is taken to avoid it. Other bivalves have the internal ligament reinforced by a shelly plate, which is called the ossiculum. This is very easily detached and lost, and, being an object of great interest, special pains should be taken to preserve it, even if it should become detached.

JAPANESE CAMPHOR

THE United States Consul at Osaka gives in a recent report the following particulars, reprinted from the November number of the *Board of Trade Journal*, respecting the Japanese camphor trade:—

The camphor tree, from which the resinous gum is distilled, is a species of the laurel, and is found in the provinces of Tosa, Hiuga, and Satsuma, in the south of Japan. Large groves of the trees are owned by the Japanese Government, the wood being very desirable for shipbuilding. The districts in which the camphor tree is found are mountainous and situated far from the sea. No reliable information can be obtained as to the cost of producing the gum before being transported in junks to Hiogo. The peasants who engage in distilling the roots and branches of the trees are said to be poor, and employ the rudest machinery.

The market value of crude camphor gum and of oil of camphor per picul ($133\frac{1}{3}$ lbs.) during the past year was as follows:—Drained, 38.25 dols.; wet, 37.00 dols.; old dry, 43.50 dols.; average, 36.50 dols.; camphor oil, 5.25 dols.

The highest and lowest prices during the same period were as follows:—Highest, 40.00 dols.; lowest, 33.00 dols.

Camphor gum is exported in tubs measuring about $6\frac{1}{2}$ cubic feet; oil in kerosene tins and cases. The grades are from old dry down to new wet, and the various grades depend upon the quantity of adulteration. In oil there are two grades—white and brown.

Adulteration is practised for the most part by adding water and oil just as far as the buyer will tolerate. In some cases 20 lbs. of water will run out of a tub in twelve hours. The unadulterated article, known as the good old dry, can sometimes be bought. The only system of tests in determining value of the different qualities is by burning and by absolute spirit. The percentage of pure camphor which the crude yields when refined varies according to the quality of the crude. The average percentage of gum produced from the wood as compared with the original weight of the wood cannot be accurately ascertained here, the only foreigner known to have visited the camphor districts having declined to furnish any information on the subject.

The total exports of camphor from Hiogo during 1891 in catties of $1\frac{1}{3}$ lbs. each amounted to 3,850,400 catties consigned to the following destinations: Europe (countries not specified), 1,777,300 catties; London, 335,600 catties; Germany, 209,200 catties; United States, 1,277,000 catties; China, 51,900 catties; France, 199,400 catties.

As regards the manufacture of camphor the following particulars are extracted from a report by the United States Consul at Nagasaki.

Camphor is found alike on high elevations and in the valleys and lowlands. It is a hardy, vigorous, long-lived tree, and flourishes in all situations.

Many of these trees attain an enormous size. There are a number in the vicinity of Nagasaki which measure 10 and 12 ft. in diameter. The ancient temple of Osuwa, at Nagasaki, is situated in a magnificent grove of many hundred grand old camphor trees, which are of great age and size, and are still beautiful and vigorous. It is stated that there are trees at other places in Kiu Shiu measuring as much as 20 ft. in diameter. The body or trunk of the tree usually runs up 20 and 30 ft. without limbs, then branching out in all directions, forming a well-proportioned, beautiful tree, ever green and very ornamental.

The leaf is small, elliptical in shape, slightly serrated, and of a vivid dark-green colour all the year round, except for a week or two in the early spring, when the young leaves are of a delicate, tender green. The seeds or berries grow in clusters and resemble black currants in size and appearance. The wood is used for many purposes, its fine grain rendering it especially valuable for cabinet-work, while it is used also for shipbuilding. The roots make excellent knees for ships.

In the manufacture of camphor the tree is necessarily destroyed, but, by a stringent law of the land, another is planted

in its stead The simple method of manufacture employed by the natives is as follows —

The tree is felled to the earth and cut into small pieces, or, more properly speaking, into chips

A large metal pot is partially filled with water and placed over a slow fire. A wooden tub is fitted to the top of the pot, and the chips of camphor wood are placed in this The bottom of the tub is perforated so as to permit the steam to pass up among the chips

A steam-tight cover is fitted on the tub From this tub a bamboo pipe leads to another tub, through which the enclosed steam, the generated camphor and oil flow This second tub is connected in like manner with a third The third tub is divided into two compartments, one above the other, the dividing floor being perforated with small holes, to allow the water and oil to pass to the lower compartment. The upper compartment is supplied with a layer of straw, which catches and holds the camphor in crystal in deposit as it passes to the cooling process The camphor is then separated from the straw, packed in wooden tubs of 133½ lbs each, and is ready for market

After each boiling the water runs off through a faucet, leaving the oil, which is used by the natives for illuminating and other purposes

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Cambridge —Mr W Ridgeway, late Professor at Queen's College, Cork, has been elected to the Disney Professorship of Archæology for the customary period of five years Prof Ridgeway's recent work on the origins of weights and measures have made him well known as a scientific archæologist

Mr R T Glazebrook, F R.S , Assistant Director of the Cavendish Laboratory, has been appointed a member of the Financial Board , Mr Lewis, Professor of Mineralogy, and Dr Gaskell, F R S , have been elected members of the General Board of Studies , and Mr E W MacBride, Scholar of St. John's College, has been appointed Demonstrator in Animal Morphology, in the place of Mr J J Lister, of the same College

The Museums and Lecture Rooms Syndicate propose to introduce the electric light into the dissecting room of the Anatomy school, the lecture room, and histology class room of the Department of Physiology, and the Philosophical Library, at an expense not exceeding £100

By the death, on November 30, of Dr F J A Hort, Lady Margaret Professor of Divinity, the University has lost not only a great theologian, but a distinguished student of science Dr Hort was second to Prof Liveing in the Natural Sciences Tripos of 1851, the first ever held He received the mark of distinction in Physiology and in Botany In 1856, and again in 1871, he was an examiner for Honours in this Tripos Throughout his life his interest in the scientific progress of the University was deep and hearty.

A Syndicate has been appointed to consider the whole question of the times of holding Tripos examinations, and the changes that would follow if these were altered The disadvantages of the present system, by which much of the benefit of the Easter term and of the Long Vacation are lost to students and teachers alike, have of late been forcibly brought before the Senate. It is to be hoped that, by bringing about a rational "Easter" or otherwise, the Syndicate's efforts may lead to a reformation.

SCIENTIFIC SERIALS.

American Meteorological Journal, November, 1892.—Wind measurement by H W. Dines. The two instruments generally in use, viz. the Robinson cup anemometer and the pressure plate, are both more or less unsatisfactory in obtaining the extreme pressure. The wind never blows uniformly, whereas the instruments are calibrated on the supposition that it does so. And the method of exposure is often unsatisfactory ; any obstacle to the free circulation of the wind either at the side or even behind or below the anemometer, vitiates the results. The usual factor k for conversion of velocity to pressure in the equation $P = kv^2$ is too high. The value ·005 was given originally in a book on engineering, with a footnote stating that the experiments on which it rested were doubtful, but it has since been copied without the note Recent experiments show that ·003 is probably more correct, but with such a varying element as the wind, any factor is of little use in deducing extreme pressures from velocity anemometers. Instruments of different sizes give different results, and those calibrated by indoor trials give more wind than those tested out of doors In some respects it is more desirable to register the pressure than the velocity, but a pressure plate which is to register 30lb per square foot is hardly suitable to record so small a force as one ounce, so that on many days no sign of motion is given The author concludes from many careful experiments that the tube form of anemometer is most likely to give satisfactory results, as, apart from electricity, it is the only kind in which the motion or pressure can be transmitted to a distance without loss by friction In this instrument the registering apparatus is placed away from the part exposed to the wind —The storms of India, by S M Ballou In this article, which is a continuation of previous papers, the author treats of the storms which accompany the winter and summer rains —The first aerial voyage across the English Channel, by R de C Ward This voyage was successfully carried out by Dr Jeffries and M Blanchard on January 7, 1785 The balloon left Dover at 1h p.m , and descended a few minutes before 4h p m , not far from Ardres —On the production of rain, by Prof C Abbe. The author reviews the natural process of the formation of rain, viz. saturation by aqueous vapour, condensation into visible particles, and the agglomeration of these into drops large enough to be precipitated The problem of artificial formation of rain will be partially solved if some method is invented to bring about a sudden formation of large drops out of the moist air that exists between the small particles of every cloud

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, November 28.—M d'Abbadie in the chair.—Note accompanying the presentation of a work on the new methods of the "Mécanique Céleste," by M Poincaré —On the existence of distinct nervous centres for the perception of the fundamental colours of the spectrum, by M A Chauveau If one goes to sleep on a seat placed obliquely in front of a window which allows the light from white clouds to fall equally on both eyes, the coloured objects in the room appear illuminated by a bright green light during a very short interval when the eyelids are opened at the moment of awakening The phenomenon is not observed except at the moment of awakening from a profound sleep. From this it is concluded that there are distinct perceptive centres for the green, and probably also for the violet and the red Of these, the green centres are those which first regain their activity on awakening —Note on the observatory of Mont Blanc, by M J. Janssen —On the laws of expansion of liquids, their comparison with the laws relating to gases, and the form of the isothermals of liquids and gases, by E H Amagat The substances examined were water, ether, alcohol, carbon bisulphide, hydrogen, nitrogen, air, oxygen, ethylene, and carbonic acid, the pressures ranging from 50 to 3000 atmospheres, and the temperatures from 0° to 200°. For both liquids and gases, the isothermals present a slight curvature turned towards the axis of abscissæ The angular coefficient increases with the temperature. This effect is specially pronounced in the liquids, where it corresponds to a widening-out of the network, well exemplified in carbonic acid, in the part corresponding to the lower temperatures. This widening-out gradually disappears as the temperature rises , in the lighter gases, the variation with the temperature is very small.—Observations of Holmes's comet ("f" 1892), made at the Paris Observatory (west equatorial), by M. O Callandreau —On a remarkable solar protuberance observed at Rome on November 16, 1892, by M P. Tacchini.—On universal invariants, by M Rabut.—On straight-line congruences, by M. E Cosserat —On the passage of a wave through a focus, by M P Joubin. An apparatus for showing the complementary character of transmitted and reflected Newton's rings is mounted vertically, and illuminated by a small bright point placed at a distance of 1·20m along the axis of symmetry. On moving a microscope along the axis of reflection the rings first appear with a black centre, which changes into white at the first focus of reflection, and again into black at the second.—On the depression of the zero, observed in boiled thermometers, by M L. C Baudin. The secular

depression of the zero, brought into prominence by heating to 100°, may be greatly reduced by keeping the thermometers for several days immersed in a liquid boiling at 400° or 500°.—On the fusion of carbonate of lime, by M. A Joannis —Action of antimony on hydrochloric acid, by MM A Ditte and R Metzner.—On the zincates of the alkaline earths, by M G Bertrand —On anhydrous and crystallized fluorides of iron, by M C Poulenc —Preparation of metallic chromium by electrolysis, by M Em Placet An aqueous solution of chrome alum, to which is added an alkaline sulphate and a small quantity of sulphuric or other acid, is electrolyzed Pure chromium is deposited at the negative pole It is very hard, and of a fine bluish-white colour It resists atmospheric influences, and is not attacked by concentrated sulphuric acid, by nitric acid, or by concentrated potash solution Articles made of brass, copper, or iron may be coated with chromium, thus giving them a metallic lustre resembling oxidized silver Large quantities of the metal can be prepared without difficulty —On the preparation of hydrobromic acid, by M E Léger —Reply to M Friedel's observations on the rotatory power of the diamine salts, by M Alb Colson —Point of fusion of solvents as the inferior limit of solubilities, by M. A Etard —Action of the chlorides of dibasic acids on cyanacetic sodium ether, succinodicyanacetic ether, by M Th Muller —On the functions of hydurilic acid, preparation of potassium hydurilates, by M C Matignon —Researches on the colours of some insects, by M A B Griffiths —Microbicidal action of carbonic acid in milk, by M Cl Nourry and C Michel —On a nervous ganglion of the feet of *Phalangium opilio*, by M Gaubert —Myxosporidia of the bile duct of the Fishes, new species, by M P Thélohan —On the modifications of absorption and transpiration which occur in plants under the influence of frost, by M A Prunet The rapid dessication of the young shoots of frozen plants is due to the substitution of an intense evaporation for the normal function of transpiration, and to an almost complete suspension of absorptive function —*Æcidiconium*, a new genus of Uredineæ, by M Paul Vuillemin —On the classification and the parallelisms of the miocene system, by M Ch. Depéret —On the existence of micro granulite and orthophyre in the primary formations of the French Alps, by M P Termier —On the mineralogical modifications of the calcareous strata in the inferior Jurassic of Ariège due to lherzolite, and their bearing on the history of this eruptive rock, by M A. Lacroix —On the geographical distribution, the origin, and the age of the ophites and lherzolites of Ariège, by M. de Lacvivier —Geological observations on the *Creux de Souci* (Puy-de-Dôme), by M Paul Gautier

BERLIN

Physiological Society, October 28 —Prof du Bois Reymond, President, in the chair —Prof Gad spoke on the respiratory centre on the basis of experiments made in his laboratory by Herr Marenescu. According to these, the centre for the co-ordination of the respiratory muscles lies in the *formatio reticularis grisea* and *alba* below the hypoglossal centre, on each side of the hypoglossal tract, whereas in the apex of the *calamus scriptorius* there is an inhibitory centre (nœud vital) whose stimulation may cause death It further appeared from these experiments that the respiratory centre is not confined to a limited area, but is diffuse and quite distinct from Flouren's "nœud vital"

November 11 —Prof du Bois Reymond, President, in the chair.—Dr. Ad Loewy had investigated the influence on respiration of the upper tracts leading from the cerebrum to the respiratory centre, an influence which is specially marked after section of the vagi. He found that these tracts do not simply hand on to the centre impulses received from the periphery up the trigeminal nerve, but that they automatically maintain the rhythm of the centre after the vagi have ceased to function Dr. René du Bois Reymond spoke on the sensation of warmth which ensues on immersing the hand in a vessel of carbon dioxide. Sulphurous acid, bromine vapour, nitrogen peroxide, ammonia and hydrochloric acid gas produce the same effect. The intensity of the sensation varies with the different gases. Thus carbon dioxide produces the same sensation as air warmed to 20°, while that of nitrogen peroxide is as of air at 30° and that of ammonia and hydrochloric acid gas as of air above 40°. The phenomena do not as yet admit of a physical explanation, but must be regarded rather as resulting from a chemical stimulation of the sensory nerves for heat perception. The President exhibited a torpedo recently born in Berlin, in which he had detected an active electric organ immediately after birth, by means of a nerve muscle preparation and a galvanometer This observation was first made in 1831 by Davy, but had not since then been repeated

BOOKS, PAMPHLETS, and SERIAL RECEIVED.

BOOKS —The Scenery of the Heavens G E Gore, 2nd edition (Sutton) —Johnston's Catechism of Agricultural Chemistry, from the Edition by Sir C A Cameron, revised and enlarged by C M Aikman (Blackwood) —Coal Pits and Pitmen R N Boyd (Whittaker).—Practical Electric-Light Fitting T C Allsop (Whittaker).—Sound and Music Rev J A. Zahm (Chicago, McClurg) —Results of Meteorological Observations made in New South Wales, 1880, 1881, 1882, 1883, and 1884 (Sydney, Potter) —Mineral Resources of the United States, 1889-91 D T Day (Washington).—Proceedings of the American Association held at Washington (D C) —Meteorological Observations and Results at the U S Naval Observatory, 1888 (Washington D C) —Magnetic Observations at the U S Naval Observatory, 1891 (D C).—The Building of the British Isles A J Jukes-Browne 2nd edition (Bell).—Poems in Petroleum J C Grant (E W Allen) —Electric Lighting and Power Distribution Part 1 W P Maycock (Whittaker) —Old and New Astronomy R A. Proctor completed by A C Ranyard (Longmans) —Painters' Colours, Oils, and Varnishes G H Hurst (Griffin).—Elementary Mechanics of Solids and Fluids A L. Selby (Oxford, Clarendon Press).—The Chemistry of Life and Health C W Kimmins (Methuen).—The Mechanics of Architecture E W Tarn (Lockwood).—Electrical Papers 2 vols. O Heaviside (Macmillan).

PAMPHLETS — Notes de Géographie Littérale J Girard (Paris). —Physical Geography and Climate of New South Wales H C Russell 2nd edition (Sydney, Potter) —La Grandissima Macchia Solare del Febbraio, 1892 A Riccò (Rome) —Fumo di Vulcano; A Riccò (Rome) —Sopra il Periodo Eruttivo dello Stromboli A. Riccò G Mercalli (Rome).—Ueber Heterogene Induktion versucheines Beitrags zur Kenntnis der Reizerscheinungen der Pflanzen Dr F Noll (Leipzig, Engelmann) —Observations on Dew and Frost Hon R Russell (Stanford) —The Cry of the Children A Free Lance (Williams and Norgate).

SERIAL —Insect Life vol 5, No. 2 (Washington).

CONTENTS.

In the chapter on blood and lymph a fuller account of leucocytes with their varieties and functions, and especially of the proteid and other substances associated with them, would certainly have been desirable. It is of course easy, in reviewing so small a book, to find instances of curtailment and of omission, but the life history of the leucocytes is of supreme importance medically, that even the account of the derivatives of hæmoglobin might, for their sake, have been shortened.

The phenomena of muscular contraction are well described, and the account of muscle and nerve currents is especially clear and to the point.

In the chapter on the vascular mechanism two tracings of pressure in an artificial schema are taken from Prof. Foster's text-book. The tracings are accurately reproduced. In the description of these we are told that, after a high peripheral resistance is introduced into the circuit, "the pressure on the arterial side at first rises with every beat till it has attained a certain height, where it remains stationary, merely oscillating with every stroke of the pump. The venous manometer, on the other hand, shows no rise of pressure, and its oscillations becomes less and less, till they disappear and the flow becomes continuous." A glance at the tracing shows, however, that there is a rise of pressure on the venous side, and moreover a maintained rise. This is a very important point about the tracing. A student grasps readily the action of the arterial blood pressure in forcing the blood from the aorta to the capillaries, but he is at a loss to understand why it comes back again from the capillaries towards the heart. It cannot be too much insisted on that we have a pressure, a small and gradually falling pressure, in the veins, and that this is the important determining cause of the venous flow. The author, in this the proper place to bring this prominently forward, leaves it out entirely, though it is incidentally referred to later on, and leads the student to suppose that the presence of the valves in the veins and the aspiration of the thoracic movements, important though they may be, are the chief factors.

The subject of endocardial pressure and of the pulse is treated, clearly and concisely, in the light of Hurthle's important work. This is particularly welcome, as, if I am not mistaken, this is the first occasion that these researches have been brought before English readers.

In the discussion of the causation of the heart's beat it does not seem clear why "the beat always starts in the sinus" when we are told that the sinus contracts feebly and slowly. The fact that the sinus has a more rapid rhythm than the other chambers of the heart, and so initiates the whole cycle, is not distinctly brought out. The author follows Schmiedeberg's opinion in stating that muscarin acts by stimulating the nerve-endings of the vagus. This is by no means certain, and we should have welcomed some mention of Gaskell's opinion that its action is a direct one on the muscular tissue, and some of the reasons for taking that view. In the description of the vasomotor mechanisms I have found no adequate statement of the important part vaso-dilator nerves play in regulating the circulation in skeletal muscle.

In the account of the nervous mechanism of respiration, which is well up to date, in including some of the results of the work of Head, we should have expected also some statements of Marckwald's observations on the influence of section of the medulla above the respiratory centre. No reference seems to be made of the influence of impulses reaching the respiratory from higher centres of the brain. It is also unfortunate that when the student turns, as directed, to Fig. 61 he finds that the tracing selected of the effect on the respiration of section of the vagi does not show the increase in amplitude as it does the decrease in rate, although he is told that both the changes are brought about. On page 266 there is an obvious misprint, the word "expiratory" should be "respiratory." On page 291 there is another misprint, "B_2" in the equation should be, of course, "Br." A few lines further on there is, however, a serious error. We read, "From the amount of nitrogen given off the amount of urea present in the urine, may be calculated. 35.5 c.c. of nitrogen correspond to one gram of urea." The theoretical amount calculated for one gramme of urea is 372.7 c.c. at standard temperature and pressure, while 35.5, or more exactly 35.4 c.c., is the amount which Hufner found was actually liberated not by one gramme, but by one decigramme of urea.

The chapters on the special senses and on the central nervous system are some of the best in the book. The methods of tracing fibres in the cord and brain are fully gone into, so also is localization of function, and indeed the account of the brain throughout is very clear and good.

At the end of the book is a short appendix, in which is given a description of apparatus purely physical in nature. Every teacher will agree with the author that it is not only desirable, but necessary, to put this in a manual of physiology. The ignorance of the construction and use of the simplest physical apparatus, which the average medical student carries with him into the physiological laboratory, is usually almost as perfect as it can be. Much of the time of a demonstrator of physiology has at first to be given to the teaching of some of the simplest physical methods.

L. E. S.

APPLIED MECHANICS.

Elementary Manual on Applied Mechanics. By Prof. Jamieson. (London: C. Griffin and Co., Limited, 1892.)

THIS is the latest addition to the series of books introduced by Prof. Jamieson during the last few years. Like his useful work on the Steam Engine, it is the outcome of the course of lectures which he delivers to his own students. It is replete with the many mechanical contrivances to be found in the workshop, one chapter being devoted to the consideration of the screw-cutting lathe alone.

The illustrations, with which the book abounds, and the necessary descriptions of the various machines considered, are all that one may wish for.

An excellent feature of the book will be found in the manner in which, after having enunciated a principle, the author has applied it to some well-chosen examples. In this direction he has proceeded to an extent which will be highly appreciated by the student. Further, he has availed himself of any opportunity to obtain results experimentally, and these form a very instructive series of examples for the young engineer.

A careful perusal will show that the author considers it desirable that all matters pertaining to units, definitions, symbols, &c., should be carefully attended to But in his treatment of these he has not been entirely successful.

Take, for instance, his definition of the moment of a force on p 15 —"The moment of a force is equal to the force multiplied by the perpendicular distance from a point on its line of action" This is rather ambiguous, and we should prefer to see the words, *with respect to a point*, included in the definition

In a footnote, p 214, objection is taken to f being used for acceleration, since it "naturally represents a force" Then why use e for strain in the formula $e = \frac{l}{L}$, where e just as naturally represents an elongation, and strain is not an elongation, as the author clearly shows in another footnote on p 232?

Again, in a footnote on p 2 we have "$M = \frac{W}{g}$, where M stands for the mass, W for the weight in pounds, and g for the acceleration of gravity"

Now on p 215 the reader is asked to accept as correct the formula for centrifugal force, $P = \frac{Wv^2}{gr}$ lbs, but (continues the author) since $M = \frac{W}{g}$, then $P = \frac{Mv^2}{r}$ poundals Why should this substitution produce the change from pounds to poundals? We fail to see what is gained by having an ellipse for the figure representing motion in a circle

There is a want of consistency when an acceleration is spoken of as "a feet per sec in one second" in one place, and as "a feet per sec." on p 219 On the same page, too, $\frac{Wv^2}{2a}$ should evidently be read as $\frac{Wv^2}{2g}$

The examples worked out in the chapter on bending moments will show the student how to apply the principle of moments to the case of a beam loaded in any given manner. This is preferable to merely using a set of formula, a system attended with most disastrous results.

At the end of each chapter will be found a good selection of examples on the matter considered therein. We are informed that another volume dealing with the more advanced portions of the subject is in the course of preparation. G A B

OUR BOOK SHELF.

Man and the Glacial Period By G. Frederick Wright, D.D., LL.D, F.G S.A. (London Kegan Paul, Trench, Trübner and Co, 1892)

THE title of this book raises expectations which the contents fail to satisfy Out of 374 pages only sixty are devoted to the consideration of "the relics of man in the Glacial Period," and the treatment of the subject is, to say the least, uncritical. The reader does not learn from Prof. Wright that strong doubt has been expressed as to whether some of the "finds" of human relics in North America were really made in undisturbed glacial deposits, while his discussion of the European evidence is crude and inadequate, not to say misleading The author has apparently only a slight acquaintance with the literature of the subject, acquired chiefly from such recondite sources as Lyell's "Antiquity of Man," and treatises on general geology Of the many interesting facts bearing on man's relation to the Ice Age which have been discovered since those works were published our author is apparently ignorant Nor has "a summer spent in Europe" sufficed, as who could expect that it should, to make up for his other deficiencies Fortunately, the major portion of his volume deals with the glacial phenomena of North America, for here he is on safer ground We feel sure, however, that many of his statements and conclusions will receive scant support from geologists across the water. It would be interesting to know, for example, what evidence can be adduced to show that the southern part of the United States was submerged during the Glacial Period to the extent of 500 feet, so as to bring the waters of the Gulf of Mexico into Illinois and Indiana Again, we were under the impression that the author's "Ohio Lake," which he supposes came into existence when the great ice-sheet advanced into that region, had been effectually disposed of by Mr Leverett and Prof. Chamberlin Throughout the book the unity of the glacial period is confidently upheld, a view which Prof Wright is, of course, entitled to maintain, but he might have informed his readers that with few exceptions American geologists are quite of another opinion. He fails to understand the evidence adduced by Chamberlin and others in favour of the periodicity of glaciation, while so far as one can gather from his pages, he seems to know nothing of the facts bearing on this question which geologists in Europe have accumulated, especially during the past few years

Altogether we much prefer the author's earlier work, "The Ice Age in North America," of which the present is more or less of an abstract In the former the facts of American glacial geology were given in considerable detail, and the writer's crude speculations and hypotheses were less obtrusive. Should the present work come to a second edition we would advise Dr Wright to get some scientific friend to assist him in its revision Loose unscientific phraseology and incorrect definitions are of not infrequent occurrence throughout the volume Thus we read of "glacial ice," of "beautiful crystals of porphyry," &c, and are told that névé is the "motionless part" of a glacier, although a little further on we learn that it is from this "motionless" névé that "the glacier gets both its supply of ice and the impulse which gives it its first motion" Obviously Dr Wright is unacquainted with the observations of MM Pfaff, Klocke, and Koch on the movement of névé, while he might increase his knowledge of glacier motion by studying what Messrs. McConnel and Kidd have to say upon that interesting subject

Beetles, Butterflies, Moths, and other Insects By A W. Kapple and W. Egmont Kirby (London: Cassell and Co, 1892)

THIS work is a slight sketch of the more prominent British insects, intended for youthful and very inexperienced entomologists. The first section is devoted to classification, the key to the orders of insects being a fairly workable one, though it takes no account of the very numerous exceptions. Then follows a section on structure, in which when describing the eye the authors ignore the latest experiments on the subject, proving that the compound eyes form but a single image of the object seen; they also treat the tongue or proboscis as if it were homologous throughout the orders, whilst in lepidoptera it is developed from entirely different organs from what it is in the others, except in the very lowest family; and again when describing the legs they fall into the almost incredible error of speaking of the first joint as the trochanter, saying it is joined to the thorax by a hinge-

plate, the coxa, the first joint being in fact the coxa and the trochanter, the short joint articulating it to the femur Then follow short sections on the metamorphoses of insects and their habits and haunts, and longer sections on the collecting and preserving of perfect insects and larvæ, which are far more correct than the preceding ones, though very slight and quite insufficient for the initiation of a beginner The main part of the book is devoted to short descriptions of the more prominent British insects under their various orders and families, and illustrated by twelve coloured plates, which are decidedly good for cheap chromographic work, this is by far the most useful portion of the book, and well-marked forms will easily be recognized from the figures and descriptions, even though many species are placed in their wrong families

Ostwald's Klassiker der Exakten Wissenschaften Nos 31-37 (Leipzig Wilhelm Engelmann, 1892)

WE have already called attention to this admirable series of small volumes It consists of scientific papers which may be said to have marked definite stages in the development of science The only fault we have to find with the series, as we have already stated, is that only the German papers are given in the language in which they were originally written All the others are translated This is undoubtedly a mistake, for much may often depend on the precise words used by a great master of research In other respects the series is excellent, and should be of genuine service to scientific students The papers reproduced in the present set of volumes are Lambert's "Photometrie," three volumes (1760), photo-chemical researches, by R Bunsen and H E Roscoe (1855-59), an attempt to find the definite and simple conditions in accordance with which the constituent parts of inorganic nature are connected with one another, by Jacob Berzelius (1811-12), on a general principle of the mathematical theory of induced electrical currents, by Franz Neumann (1847), observations on the moving power of fire and the machines fitted for the development of this force, by S Carnot (1824)

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

"Aminol, a True Disinfectant"

WILL you grant me space, in order to avoid misunderstanding, to make the following explanation?—

(1) I recently learned that certain samples marked "Aminol, a true disinfectant" have been sent to various gentlemen, accompanied by a leaflet, in which my name, without my authority, is associated with those samples. Allow me to inform your readers that those samples contain "aminol" in water in the strength of one in five thousand Now, the experiments which I carried out with "aminol," as regards its disinfecting power of microbes, were made with a solution of the strength of one in six hundred, and the disinfecting power of this strength was the following spores of *Anthrax bacilli* remained unaffected after eight hours' exposure, only after an exposure for twenty-four hours did the number of living spores decrease, but some escaped disinfection even after so long an exposure. *Anthrax bacilli*, *Staphylococcus aureus*, and others were destroyed, but only after a prolonged exposure.

(2) A substance is advertised and circulated under the name of "Periodate crystals," and is associated with my name without my authority. Until quite recently I have made no experiments with it. A few years ago I made a few experiments, merely of a tentative character, with a solution which was labelled "Periodate," but not with the substance advertised as "Periodate crystals" With these latter I have recently made experiments, and I find that their solution in full strength has no disinfecting power on microbes, pathogenic and non-pathogenic, amongst which may be mentioned the bacillus and spores of anthrax, the bacillus of typhoid and of diphtheria, of cholera and of erysipelas, the *Bacillus prodigiosus*, the *Staphylococcus aureus*, and others Likewise I find that injection of large quantities of the solution into guinea pigs already infected with anthrax or diphtheria, has no power whatever in arresting or altering the normal course of these diseases to their fatal issue

E KLEIN

Tracery Imitation

I TOOK occasion some months ago to publish the result of observations on my child H 's progressive attempts at drawing after outline "copies" set before her.[1] Examination of the series of her drawings made almost daily during the period from her nineteenth to her twenty-seventh month showed in them no apparent form or shape They are simply vigorous pencil markings, answering as well to one "copy" as to another—or to none Quite suddenly, however, in her twenty eighth month, she seemed to catch the idea of breaking the "copy" (man) up into parts, and succeeded in making head, body, arms, legs, &c, in sufficient degree of relative proportion to show that here was, in her case, the rise of what I called in the article cited, "tracery imitation" of a visual picture

At that time I had no explanation to offer, but simply recorded the observation I have now, however, reached a way of explaining the rise of this apparently abrupt connection between muscle sense and sight—an explanation suggested to me by a passage in Stricker's argument for the eye-movement theory of the visual apprehension of figure or outline[2]

Before a child begins to acquire "tracery imitation," his drawings have no shape, but they show uniformly certain systems of angles, curves, &c, due to the easiest and most natural movements of the arm The eyes, however, have been in a measure already educated to recognize certain shapes or "copies" There are, therefore, in consciousness two series of associations—one of eye-movement sensations, a, a^1, a^2, a^3, a^4, &c, with a certain strength of revival, which we may call x the other, an associated series of arm-movement sensations, n, n^1, n^2, n^3, n^4, &c, representing a path of least resistance in arm movement Let us call its strength or degree of tendency to progressive revival y

Now, before the rise of "tracery imitation" y is greater than x, for the reason that the arm is restricted to a very few movements, and these are largely automatic Once start one of these movements, and the tendency to carry it out is very strong The tendency of the eye-movement series, on the contrary, to regular revival is slight, very few objects, copies, &c, being so clear and isolated as to give frequent unbroken reproductions Consequently, the arm-movement series, n, n^1, n^2, &c, wins the day, and an abortive "drawing" is the result

But the time comes soon when the reverse is true—when x is greater than y The eye-movement series gets strengthened constantly by the repeated exploration of familiar figures, especially if, as in the case of my child, the eye be trained by having the same "copies" set from day to day On the other hand, the arm and hand movement series gets constantly lesser and weaker, since the increasing mobility of the muscles, in the varied new activities of this period of infancy, is acquired at the direct expense of the early "cast iron" reactions which are largely organic. Both of these tendencies were very marked in H —the first, in the more pronounced recognition of the "copies" set before her; the second, in the less uncouth manner of holding her pencil, moving the fingers, disposing the arm, &c. Hence, it is simply a matter of education that x should soon overweigh y, and the elements of the eye series a, a^1, a^2, a^3, &c, should draw after them the arm series

An association thus begins to be formed between the several members of the a series and certain correct elements of arm sensation; these latter go to form, under this leading, a new n series, which gradually becomes independent as an acquisition. That each new tracery combination is thus learned separately is seen in the fact that after H. learned to trace certain "copies" (man, bird), she was yet entirely unable to trace any others.

[1] *Science*, New York, January 8, 1892

[2] "Du Langage et de la Musique" (French ed.), chap. xiii., see also his "Studien über die Association der Vorstellungen"

She was even unable to trace a circle, except as part of a man (the head)

In a paper presented at the London meeting of the International Congress for Experimental Psychology last August, I insisted that voluntary movements are possible in the child only after a great variety of motor "elements" have become available through great diffusion and mass in involuntary (imitative) reactions.[1] The above phenomenon, thus explained, serves to illustrate the broader position

As there is no literature on this subject, the question of "tracery imitation" has not even been put before, to my knowledge, I should be glad to have opinions upon it It is evident that if one hold the other theory of the visual apprehension of figure, *i e* that it is given by sight apart from sensations, of eye-movement, he could still hold the explanation which I have offered above, by substituting for the series of eye-movement sensations, a, a^1, a^2, &c , a series of visual sensations, v, v^1, v^1, &c J MARK BALDWIN

Difficulties of Pliocene Geology

CONSIDERING the very great importance which the later tertiary beds must occupy in all speculations about the origin of man and the present geographical distribution of plants and animals, it is unfortunate that they should have attracted so little attention among English geologists

The fact is perhaps not unnatural when we consider how very scantily they are represented in this country , the Norwich Crag being virtually the only bed where remains of pliocene land animals have occurred. The Norwich Crag is itself a very puzzling bed, where marine remains and land remains are found mixed together, the whole having been reassorted, and I do not know of a single pliocene land surface remaining intact in Britain The so-called forest-bed can no longer be classed as pliocene, but is clearly of pleistocene age. A real mark of the true pliocene horizon in Europe is the occurrence of the mastodon and its associated fauna

If we are to use the mastodon as a test we shall have to travel southward as far as Auvergne, if we are to find a pliocene land surface *in situ* Unfortunately Auvergne is a very dislocated and broken country, and the sequence of the later deposits is very hard to make out, and I much question whether it be possible to find sections showing the true reading of the beds in question nearer than Florence

I am writing in the hope that I may persuade Dr Forsyth Major, who knows the valley of the Arno so well, to communicate to NATURE some account of the results arrived at by the Italian geologists

At present the question is one of great perplexity Let me refer to two points First, How comes it that in no part of the world, so far as I know, has a single fragment of an undoubted pliocene beast been found in a cave? The carnivora of pliocene times must have frequented caves just as much as the bears and hyenas of pleistocene times, yet how comes it that we can nowhere find any tertiary remains in any cavern? It will not do to appeal to denudation, for if there be deposits anywhere protected from denudation it is those in caves. Can it be that every mountain chain where limestone rocks occur is younger than pliocene times?

Again, we know that in America, both north and south, the mastodon survived to the end of the Pleistocene age, and lived alongside of the mammoth and the Columbian elephant In Europe there is very great doubt whether the mastodon and any form of elephant were ever contemporaries. No doubt the teeth of the mastodon have been found with those of the elephant in the Crags, but the Crags have been so rearranged that it is impossible to draw any safe conclusions from them. It is at all events extraordinary that, according to the French geologists, the two beasts have never been found together in France I believe the same conclusion has been arrived at by the Italian geologists, but upon this point there is some uncertainty, and it would be very interesting to have the opinion of so competent an authority as Dr Forsyth Major upon the point It is one of importance, for upon it depends largely the question of whether there was a continuity in Europe between the pliocene and pleistocene land, or whether, as I am disposed to believe, there was a break between the two involving perhaps a violent revolution. There are other interesting questions involved in the issue I have raised, upon which you may possibly permit me to write on another occasion. Meanwhile the burden of my present letter is to point out how little we really know about the pliocene land, and how useful it would be to know more HENRY H HOWORTH

The Athenæum Club, December 5

[1] An abstract of the paper is to be found in *Science*, November 18, 1892, and also in the Proceedings of the Congress.

Meteors

A FINE meteoric shower was observed here on the night of November 23, from 7h 30m to 12h 30m , when the observations were interrupted by cloud[1] The meteors were evidently "Bielids," the radiant at 8 30 being near a point, R A , 1h 20m , Dec , 40° 30′ The radiant, however, was not well defined, its area being at least 4° in diameter For a single observer, in a position which commanded only about one-sixth of the visible hemisphere, the meteors numbered about six a minute, which would indicate at least seventy-five a minute for the entire sky, exhaustively observed

At ten o'clock two observers, standing back to back in an open space, counted 104 meteors in five minutes , the position of the radiant being then, R A , 1h 30m , Dec., 41° 30′ —very near Upsilon Andromedæ At this time the radiant seemed to be rather more definite than earlier, and several nearly stationary meteors determined the place with reasonable precision

An hour later a similar count by the same two observers gave 100 meteors in four minutes and a half, and the radiant was determined at R A , 1h 40m , Dec , 40° The rate of frequency continued about the same until the sky clouded up an hour later, and must, I think be estimated as high as from 80 to 100 a minute for the whole number that might have been seen by a sufficient corps of observers This would foot up from 24,000 to 30,000 for the five hours

I am not quite certain whether the apparent change in the position of the radiant is, or is not, real , but a motion very similar in amount and direction is given by Denza in his observations of the meteoric shower of 1885 (see NATURE, vol xxxiii page 151)

Comet "*f*" (Holmes's) was about 10° west and 4° south of the mean radiant at R A , 0h 40m , Dec , 36° 45′. It was barely visible to the naked eye

Most of the meteors were very small, not exceeding the fifth magnitude , but a few, perhaps one in ten, were above the second, and in the course of the night four were seen which rivalled or surpassed Jupiter The brighter ones left bluish trains, which remained visible for three or four seconds The smaller ones often came in "flights" of three or four together, and fully half the paths were more or less curved and wavy from the resistance of the air

It is worthy of notice that the heliocentric longitude of the earth at the time of the shower was about 62°, instead of 65° which was the longitude of the descending node of Biela's orbit at the last appearance of the comet in 1852, and was the longitude of the earth at the time of the showers of 1872 and 1885 The fact suggests the inquiry whether perturbations since 1885 will fairly account for such a recession of the node

It is obvious also that if the meteoric swarms encountered by the earth in 1872 and 1885 were really moving in the orbit of Biela's comet (which at its last appearance had a period of 6·6 years), then the swarm encountered the other night, just seven years later, must have been an entirely different one—unless indeed the perturbations since 1885 can account for a retardation of nearly five months.

Last night was for the most part overcast, but a watch of fifteen minutes through occasional openings in the clouds showed only one or two possible Bielids. Evidently the shower was not continuing with any intensity. C A YOUNG

Princeton, N.J., U S , November 25

[1] Our "Eastern standard time" is just five hours slower than Greenwich time

Comparative Sunshine.

AFTER explaining that by "sunshine" I intend that which *would* fall upon the earth if there were no atmospheric obstruction, one must first notice the very elementary truth that the amount of such sunshine at any assumed time and place is in proportion to the altitude of the sun at noon, and also the

length of the day. Except at the time of the equinox, the gradual lengthening or shortening of the day, as the solstice is approached, most materially affects, especially in the higher latitudes, the total amount of sunshine received in twenty four hours.

But are there any convenient and readily accessible tables—as there easily might be—which would at a glance show numerically the comparative amounts of sunshine at certain selected times and places? I would wish to see such tables, say, for every tenth day, for the three months from an equinox to a solstice, for about every third degree of latitude in each hemisphere. I see not how, without this, either the causes or the effects of meteorological changes in different regions at different seasons can be justly estimated. I would propose to express the amount of sunshine during twelve hours at the equator at the equinox by, say, 100, the figures rising above this, or falling below it. Thus there would be more than 100 given for the latitude of the Tropic of Cancer at the summer solstice, with a vertical sun and more than twenty four hours' sunshine, with 100 for a latitude still further north. REGINALD COURTENAY

The Imperial Hotel, Sliema, Malta, November 14.

Quaternions

By the kindness of the author I have just received a copy of Mr. Heaviside's paper "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field" (*Phil. Trans.*, 1892, p. 423), in which he reopens a question debated in your columns some time ago—the question of Quaternions *versus* other methods of vector analysis for the use of physicists.

At present the matter stands thus:—There are two widely known systems of vector analysis before the public—Quaternions and the Ausdehnungslehre—and quite a multitude of less known ones, of which Prof. Gibbs's seems to be one of the least open to objection, and of which, in my opinion, Mr. Heaviside's is by no means so. It would take too long, however, to justify this opinion, but I wish to make an appeal to Mr. Heaviside and Prof. Gibbs on grounds independent of the merits or demerits of their particular systems.

Of the Ausdehnungslehre I do not feel competent to speak. As to Quaternions, there are undoubtedly some inconveniences in physical applications, and I am quite willing to concede that a grave one is the very frequent use of the letters S and V (Mr. Heaviside uses the latter). I do not regard the sign of the scalar product which vexes the soul of Mr. Heaviside as of any consequence. But while thus admitting that a better system than Quaternions is conceivable, I think I can show that the position of the dissenters is little short of suicidal.

The band of physicists who use and urge the use on others of vector analysis is woefully small. Let me put a question to two of the justly best known of that band, Prof. Gibbs and Mr. Heaviside. What is the *first* duty of the physical vector analyst *qua* physical vector analyst? I think I may anticipate that the answer will be—to convince the world of mathematical physicists that vector analysis must be unshelved and set to work. The next question that arises is one of tactics. What should be the plan of campaign to bring this desirable result about? Here I am afraid we cannot hope for unanimity even among the members of the small band, and this is to be most grievously deplored. But surely every sane man will agree that what most certainly the analysts should not do is to present their arguments to those they would convince in a dozen different mathematical languages, each of which is puzzling enough to those learned in allied languages. Grant this, and it follows that Quaternions and the Ausdehnungslehre should be left in sole possession of the field. The day for Prof. Gibbs's improvements is not yet. Prof. Gibbs and Mr. Heaviside have not yet convinced the rest of the small band—not to say each other—of the merits of their algorithms. Let me implore them to sink the individual in the common cause, and content themselves with the faith that posterity will do them justice.

Apart from the question of notation there seem to be two schools of opinion as to the proper conduct of the campaign. To vary the metaphor, Maxwell, Clifford, Gibbs, Fitzgerald, Heaviside prescribe a course of spoon-feeding the physical public. Hamilton and Tait recommend and provide strong meat. I do not think that harm, but rather good, will come from this double treatment, as one course will suit some patients and the other others. *But* let the spoon feeders provide nourishment of the same *kind* as the other physicians. Is not Maxwell, Clifford, and Fitzgerald's food as digestible as Prof. Gibbs's and Mr. Heaviside's? ALEX. MCAULAY

Ormond College, Melbourne, October 31.

Animals' Rights

MR. SALT disputes the justice of the statement that he has given two contradictory definitions of animals' rights, inasmuch as, according to him, that which he has set forth on p. 28 is but a repetition and amplification of the one to be found on p. 9.

By the definition on p. 9 animals' rights are said to consist in a "due measure" of the restricted freedom which constitutes the right of man, *i.e.* (as Mr. Salt notes) the freedom "to do that which he wills, provided he infringe not the equal liberty of any other man"—"a restricted freedom" which guarantees to the harmless individual *the security of his life and liberty*.

But on p. 28 the rights of animals (which were said before to consist in a "due measure" of that just quoted) being here stated to be "subject to the limitations imposed by the permanent needs and interests of the community," are found to be burdened with so serious a qualification that *security for the life and liberty of the harmless individual is by it completely destroyed*.

A European might settle with confidence in an unknown island, on the assurance that he would be allowed a measure of the general right of the natives to the freedom to do that which they would, provided they infringed not the equal rights of any other, but were he afterwards to discover that the "measure" of this right which was considered to be the "due" of a foreigner was in reality limited "by the needs and interests of the community," and that, a community where the custom of enslaving and eating strangers had existed from time immemorial, we venture to assert that his departure from the island would be effected with as little delay as possible. We should much regret misrepresenting Mr. Salt's statements, but the assertion that the second definition of rights is but a repetition and amplification of the first is manifestly untenable, and if, by "*due measure*" for animals of the rights of man, Mr. Salt would have us understand that he meant—only such a measure as is consistent with the nullification of the most fundamental privileges secured by them, he must have been discussing the subject in a vein of sarcasm which we are bound to confess we had quite failed to appreciate.

THE REVIEWER.

The Height and Spectrum of Auroras

THERE was a magnificent aurora on the evening of the 4th, part of which, from 10h. 46½m. to 48m. or 49m., was an intense red. I noted the positions of some of the features at the exact half hours and also at some other times, for comparison with any observations that may have been made in other places, for ascertaining the height of the phenomenon; and I hope some such observations have been made of the recent display, and will be made of further ones in the future, for Dr. Veeder, of Lyons (New York), has kindly consented to calculate the heights from the observations.

I am surprised that none of our persevering photographers have as yet obtained a good photograph of the auroral spectrum. I do not think it would be more difficult than the stellar photographs that have been taken, seeing that the exposure might go on for hours. It would be desirable to have it done with a camera that could be pointed in any direction at will, so that wherever the observer saw a bright portion of the aurora he could direct the instrument to it. T. W. BACKHOUSE.

Sunderland, December 6.

The Teaching of Botany

THERE appeared in NATURE (vol. xxxi. p. 229) a paper entitled "Experiments suitable for illustrating Elementary Instruction in Chemistry," by Sir H. E. Roscoe and W. J. Russell. I have long felt the want of a similar series of experiments in physiological botany. There is not much difficulty in teaching the morphological side of the subject, but it is not easy for the ordinary high-school teacher to devise and carry out a suitable series of experiments for demonstrating the more important aspects of physiological botany. If some master in the

subject would do for botany what Sir H E Roscoe has done for chemistry he would confer a great boon on teachers and young students A H

Egyptian Figs.

MY attention has been called to a very obvious slip of the pen in my note on Egyptian Figs, in that I have written "Pliny" instead of "Theophrastus" The former, as all know, was a *Latin* author, but he simply copies from the latter Having both authors before me at the time, I accidentally put one name for the others The refs. are as follows —Theoph iv 2, Dioscor I I, Plin xlii 7 GEORGE HENSLOW

A Palæozic Ice-Age

I CANNOT understand how, when writing on this subject *ante*, p 101), I overlooked the circumstance that the ancient boulder-beds of Australia, India, and South Africa received full notice in Prof J Prestwich's "Geology," vol ii pp 143 146

December 9 W T BLANFORD

SCHEELE

DURING this month Sweden commemorates the one hundred and fiftieth anniversary of the birth of one who has conferred an imperishable lustre on her annals Carl Wilhelm Scheele—although a German by nationality, for he was born at Stralsund, the capital of Pomerania—spent practically the whole of his short life in Sweden, and is usually regarded as a Swede The son of a tradesman, Joachim Christian Scheele, and the seventh child of a family of eleven, Scheele, as a boy, gave little promise of the genius and power which astonished the scientific world towards the close of the last century It is perhaps indicative of a certain mental imperfection that he should have been wholly incapable of learning a foreign language, although he lived in Sweden during more than half his life his knowledge of Swedish was so imperfect that his memoirs, addressed to the Academies of Stockholm and Upsala, were invariably written by him in German and had to be translated by others before publication By what influences he was led to the study of chemistry is unknown There was nothing apparently in his home life, or in the mode or circumstances of his education to direct his inclination towards science As a boy he began the study of pharmacy, and at his own wish was apprenticed to an apothecary at Göteborg named Bauch, with whom he remained eight years Here he had access to the standard treatises on chemistry of that time, and he devoted all his leisure, often working far into the night, to the study of the works of Neumann, Lemery, Kunkel, and Stahl Kunkel's Laboratorium was, indeed, his chief instructor in practical chemistry, and it was by diligently repeating, in the first instance, the experiments contained in that book that he acquired that extraordinary manipulative skill and analytical dexterity on which his success as an investigator ultimately rested

When twenty-three years of age Scheele removed to Malmö, and some years afterwards to Stockholm, where he superintended the shop of an apothecary named Scharenberg It was about this time that his career as a discoverer began, by the isolation of tartaric acid from cream of tartar. He ascertained many of the characteristic properties of this acid and prepared and examined a number of tartrates These early efforts met, however, with a somewhat untoward reception. It seems that Scheele drew up an account of his observations and forwarded it to Bergman, who then filled the chair of chemistry in the University of Upsala as the successor of Wallerius. Bergman failed to appreciate the significance of the work of the young and unknown apothecary and by some mischance the manuscript was lost. The importance of the discovery was, however, recognized by Retzius, who induced Scheele to write a second account of his work and to submit it to the Academy of Sciences at Stockholm, by whom it was eventually printed In 1771 Scheele published his memorable essay, "On Fluor Mineral and its Acid," in which he first demonstrated the true composition of fluorspar, showing that it "consists principally of calcareous earth saturated with a peculiar acid," named by him "fluor-acid" Although he found that the "fluor-acid" (hydrofluoric acid) dissolved "siliceous earth," he failed to recognize the change thereby produced in the "fluor-acid" and was thus led to an erroneous conception of its real nature He was in fact led astray by the circumstance that his experiments were for the most part made in glass vessels, and hence the fluor-acid was contaminated with more or less silica and hydrofluosilicic acid The origin of the silica in the acid prepared by Scheele was first clearly indicated independently by Wiegleb and Meyer In 1773 Scheele went to Upsala as pharmaceutical assistant to Mr Lokk, in whose shop he chanced to meet the chemist Gahn Lokk and Gahn were speculating on the cause of the different mode of action of distilled vinegar on nitre before and after fusion This was explained by the young assistant, who pointed out the nature of the change effected on nitre by fusion, and the fact that it is converted into a salt (potassium nitrite) from which a peculiar acid, different from true "spirit of nitre," can be obtained by treatment with distilled vinegar Gahn, struck with the sagacity of the young pharmacist, offered to introduce him to Bergman The invitation was at first declined, Scheele had not forgotten the unfortunate incident of the tartaric acid memoir Eventually he allowed himself to be convinced that Bergman's action was due more to inadvertence than to indifference, and the acquaintance which followed rapidly ripened into a strong friendship In 1774 Scheele, at the suggestion of Bergman, published his well-known memoir "On Manganese, Manganesium, or Magnesia Vitrariarum" This essay, although marred and in part obscured by the phlogistic conceptions of the period, will for ever remain one of the classics of chemistry In it Scheele not only established the nature of "pyrolusite" or "wad," but, in studying the action of acids upon the mineral, he was led to the discovery of baryta and of chlorine, the properties of which he minutely describes. In 1775 appeared his memoir on arsenic acid which he prepared in several ways; he discovered many of the more striking properties of this body and obtained a number of its salts In the course of the investigation he discovered arseniureted hydrogen, and the well-known pigment Scheele's Green In the same year he published his essay on benzoic acid, the "flowers of benzoin" of the apothecary After a stay of two years in Upsala Scheele was appointed by the Medical College *provisor* of the pharmacy at Köping, a small town on the north shore of Lake Malar Instead of the prosperous business he had been led to expect he found nothing but discomfort and disorder, and the remainder of his life was spent in a constant struggle with privation and debt, relieved at length, to some extent, by a grant, at Bergman's instigation, from the Stockholm Academy. Of this money Scheele set aside one-sixth for his personal necessities, and devoted the remainder to his researches. In 1777 he took over the business of the pharmacy from the widow of the former proprietor, but it was only by unremitting industry that he was able to discharge the obligation he thereby incurred Not a year passed, however, without Scheele publishing two or three memoirs, every one of which contained a discovery calculated to enhance his reputation as the greatest experimenter of his time This untiring devotion to science at length began to tell upon a frame constitutionally weak and doubtless further enfeebled by privation, and by the worry

of debt and difficulties He struggled on, however, a martyr to rheumatism and suffering from a complication of internal disorders until he was struck down in the spring of 1786 Some time before his fatal illness he had formed the resolution of marrying the widow of his predecessor so soon as his circumstances should permit on his death-bed he carried out this project, bequeathing to his wife such property as he had been able to acquire Two days afterwards (May 21, 1786) he died at the age of forty-four

The eleven years during which Scheele lived at Koping were fruitful in investigations of the highest importance in every department of chemistry In that time he discovered molybdic, tungstic, and arsenic acids among the inorganic acids, and lactic, gallic, oxalic, citric, malic, mucic, and uric among the organic acids He also discovered glycerin, determined the nature of Prussian blue, and prepared hydrocyanic acid He demonstrated that plumbago is nothing but carbon associated with more or less iron, and that the black powder left on the solution of cast-iron in mineral acids is essentially the same substance He determined the chemical nature of sulphuretted hydrogen, discovered arseniureted hydrogen, and invented new processes for preparing ether, powder of algaroth, calomel, and *magnesia alba* He made numerous analyses of air by absorbing the oxygen with a mixture of iron filings and sulphur He concluded that "our atmosphere contains always, though with some little difference, the same quantity of pure or fire air [oxygen] viz $\frac{9}{33}$ which is a very remarkable fact, and to assign the cause of it seems difficult, as a quantity of pure air [oxygen] in supporting fire, daily enters into a new union, and a considerable quantity of it is likewise corrupted or changed into aerial acid (carbon dioxide) as well by plants as by respiration, another fresh proof of the great care of our Creator for all that lives"

Scheele's greatest work, however, is unquestionably his treatise on "Air and Fire," which appeared in 1777 with a preface by Bergman, who, according to Thomson, superintended its publication. This elaborate essay shows Scheele at his best and at his worst, it testifies to his genius as an experimentalist and to his weakness as a theorist No one can read this, or indeed any other of Scheele's memoirs, without being impressed by his extraordinary insight, which at times amounted almost to divination, and by the way in which he instinctively seizes on what is essential and steers his way among the rocks and shoals of contradictory or conflicting observations No man was ever more staunchly loyal to the facts of his experiments, however strongly these might tell against an antecedent or congenial hypothesis Had Scheele possessed that sense of quantitative accuracy which was the special characteristic of his contemporary Cavendish, his work on "Air and Fire" would inevitably have effected the overthrow of phlogistonism long before the advent of Lavoisier His memoir is essentially an essay on oxygen, of which he was an independent discoverer, in its relations to life and combustion. It is perhaps idle to speculate on the causes which prevented his clear recognition of the full truth It may have been that he was essentially a *préparateur* like Priestley, and that quantitative chemistry had few attractions for him, it is far more probable that the character of his work was determined by the circumstances of his position, by his poverty, his lack of apparatus, and his want of assistance As it is, it remains one of the most remarkable circumstances in the history of human knowledge that a man working under such adverse conditions in a small village on the shore of a Scandinavian lake should have been able to change the entire aspect of a science.

It was stated by Crell, the editor of the well-known *Neue Entdeckungen* and *Annalen*, in which many of Scheele's papers first appeared, that the great Swedish chemist was invited to this country with the offer of an easier and more lucrative position than that which he had at Köping, but that his partiality for Sweden and his love of quiet and retirement delayed his acceptance of the offer until a change in the English ministry put a stop to the negotiations Thomson, the author of the "History of Chemistry" in mentioning this circumstance, expresses his doubts as to its truth, and states that he made enquiries of Sir Joseph Banks, Cavendish, and Kirwan, but none of them had ever heard of such negotiation Indeed the circumstance is intrinsically improbable "I am utterly at a loss," says Thomson, "to conceive what one individual in any of the ministries of George III was either acquainted with the science of chemistry or at all interested in its progress What minister in Great Britian ever attempted to cherish the sciences, or to reward those who cultivate them with success? If any such project ever existed, it must have been an idea which struck some man of science that such a proposal to a man of Scheele's eminence would redound to the credit of the country But that such a project should have been broached by a British ministry, or by any man of great political influence, is an opinion that no person would adopt who has paid any attention to the history of Great Britain since the Revolution to the present time."

T. E THORPE

WERNER VON SIEMENS.

ERNST WERNER SIEMENS was the eldest son of Christian Ferdinand Siemens and Eleonore Deichmann, he was born in 1816 at Lenthe in Hanover, where his father was engaged in the business of agriculture and forestry

From his very childhood the subject of this memoir learnt the lessons of self control and responsibility, for owing to his mother's delicate health and his father's occupations, the care of his younger brothers and sisters devolved on himself and his sister Mathilde, in these younger days he also learnt tact, and his father taught him that difficulties had to be faced and overcome, and that duties must never be avoided

In 1823, a few months after the birth of his brother William (whose lamented death occurred here nine years ago), the family removed to Menzendorf near Lubeck, in the Grand Duchy of Mecklenburg In the Gymnasium of Lübeck Werner was educated up to his eighteenth year, when, by the advice of his father—who with rare prescience saw in Prussia the nucleus of German Unity and Empire—he went to Magdeburg to volunteer for service in the Prussian Army For three years he studied in the Military School of Berlin, and in 1838 received his commission as a lieutenant in the artillery, and returned to Magdeburg, he was soon transferred to the Technical Division of the Artillery at Spandau, and afterwards to Berlin.

In July, 1839, his mother died, and six months afterwards his father, and then, at only twenty-three years of age, he became the veritable guardian of his younger brothers and sisters.

In 1842 he took out a patent in Prussia for electroplating and gilding, and having established a factory in Berlin for putting his invention into practice, he urged his brother William to devote his attention to the subject This the younger brother did, and the story of his enterprise and success in this country then and ever since has been told by Dr William Pole in his most interesting biography of him, to this volume and to the works of Dr Werner von Siemens, the first volume of a translation of which has recently been published by Mr Murray, we are indebted for much of the information contained in this short notice

In 1844 the young artillery officer was appointed to the important post of Superintendent of the Artillery workshops, and in 1847 he became a member of the commission then instituted for introducing the electric telegraph into Prussia Next year his military duties called him to Kiel, where in conjunction with his brother in-law, Prof Himly, he protected that port against the attack of the Danish fleet, by means of submerged mines connected with the shore by cables, at once the precursor of the submarine cable and the torpedo In the summer of 1848, as commandant of Friederichsort, he built the fortifications for the protection of the harbour of Eckenförde, which afterwards became so celebrated In the same year he was recalled to Berlin in order to erect a line of telegraph from Berlin to Frankfort-on-the-Maine, the first electric line laid in Germany, and with this his official military career terminated, and he devoted his attention altogether to those scientific discoveries and

inventions which have made the name of Siemens a household word in every region of the globe.

In 1874 Dr Werner Siemens was elected a member of the Royal Academy of Sciences of Berlin, and the speech he made upon that occasion enables one to understand and appreciate his connexion with physical science He was professionally connected with the application of science, which unfortunately left him but little leisure for those purely scientific investigations to which he always felt specially attracted. He says, to quote his own words in the speech just referred to, "My problems were generally prescribed by the demands of my profession, because the filling up of scientific voids which I met with presented itself as a technical necessity. I will only here mention cursorily my method of measuring high velocities by means of electric sparks, the discovery of the electrostatic charge of telegraph conductors and its laws, the deduction of methods and formulæ for testing underground and submarine cables, as well as for determining the position of faults occurring in their insulation, my experimental observations on electrostatic induction, and the retardation of the electric current thereby, the conception and realization of a reproducible basis of measurement for electrical resistance, the proof of the heating of the dielectric of a condenser by sudden discharge, the discovery and explanation of the dynamo electric machine I think I may claim that many of my technical contributions are not without scientific value, among which I may mention the differential regulator, the manufacture of insulated conductors by pressing gutta-percha around them, telegraphic duplex, diplex, induction and automatic recording instruments, the ozone apparatus, and measuring instruments of different kinds I had the honour of seeing these recognized by receiving from the Berlin University the distinction of Doctor of Philosophy, *honoris causa*"

The reply to this speech was made on behalf of the Berlin Academy by Prof du Bois Reymond, the Secretary of the Physical and Mathematical Section, and some of the words he then spoke will show how Germany appreciated one of her ablest sons, one whom we also may claim, for when Werner Siemens was born, the King of England was Elector of Hanover "By appropriating such a scientific form as yours, my dear Siemens, no Academy need be untrue to the laws of its foundation Yours is the talent of mechanical discovery, which primitive people not improperly described as divine, and the cultivation of which constitutes the ascendancy of modern culture Without having yourself worked with your hands in practical mechanics, you have reached the highest point in that art as creating and organizing head With clear view and daring mind you soon grasped the great practical problems of electric telegraphy, and thus secured to Germany an advantage which Gauss, Wilhelm Weber, and Steinheil could not have procured for it Your labours were for electricity what Frauenhofer's were for light, and you are the James Watt of electro-magnetism. Now you rule over a world which you created. Your telegraph lines surround the globe Your cable ships navigate the ocean Under the tents of nomads using bows and arrows, through whose hunting grounds your messages pass, your name is mentioned with superstitious awe"

This poetical description is fully justified by the great undertakings that have been carried out by the Siemens firm The Indo-European telegraph, 2750 miles in length, passes across Europe, through a part of Russia to Tabreez and Teheran in Persia, and thence to India. But for the international character of the firm this work could probably never have been accomplished But with Mr Carl Siemens in St Petersburg, Dr Werner in Berlin, and Mr William in London, to carry out the necessary negotiations, the tender was accepted in June, 1869, and the work was completed in December of the same year Since then eighteen cables of a total length exceeding 21,000 miles have been constructed at their Woolwich works and laid in the Atlantic by the *Faraday*, by the firm of Messrs Siemens Brothers and Co, Limited, of which firm Dr Werner von Siemens was Chairman and Mr Alexander Siemens is the Director in London.

In a single line of the speech just alluded to Dr Werner refers to the dynamo machine On this machine the whole supply of electricity for lighting, transmission of power, and other large purposes is dependent; and it is interesting in this connexion to note that the only rival to the electric light for large effects is the regenerative gas lamp invented by Dr. Werner's youngest brother, Mr Frederick Siemens, the Inventor, with Sir William Siemens, of the regenerative gas furnace.

Dr. von Siemens was a Knight of the Prussian order *pour le mérite*, an honour conferred only on those who have been distinguished for their services to science and industry. The honorary degree conferred upon him by the University of Berlin, and his membership of the

Royal Academy of Sciences of Berlin, have already been referred to. Dr von Siemens was a member of many learned societies, and only in the spring of this year he was elected one of the sixteen honorary members of the Institution of Civil Engineers. The late Emperor Frederick III of Germany conferred upon him the patent of nobility in 1888, and the present Emperor has expressed his sympathy with his sorrowing widow and family.

Dr. Siemens was unfortunately one of those attacked during the influenza epidemic, and although he recovered from it, it left him weak, and he has since been ailing more than once. A work on which he has been spending his spare moments was an autobiography, giving reminiscences of himself and of the firm of Siemens and Halske. This was published in Berlin a fortnight ago. On Tuesday, the 6th inst., Dr Werner breathed his last at half-past six in the evening, just within a week of completing his seventy-sixth year. It may truly be said of him that although he has passed from us, his life's labours will ever endure, having left an indelible mark on the world's progress.

The funeral took place on Saturday. The London, Belfort, Vienna, and St Petersburg factories of the firm of which the deceased was a member, sent officials and workmen; the many thousands following the hearse, and the respectful attitude of the bystanders in the streets through which the funeral procession passed testifying to the regard in which he was held. The Emperor William was represented by Prince Leopold, the Empress Frederick by Count Seckendorff, and the German Empire by Chancellor Caprivi. Science and art and industry, the City of Berlin and the town of Charlottenburg were represented by deputies and deputations, all combining to do honour to one esteemed of all.

E. F. B.

NOTES

WE are glad to announce that Sir Archibald Geikie has undertaken to write the Life of Sir Andrew C. Ramsay, his predecessor in the Geological Survey. Sir Andrew Ramsay spent nearly the whole of his scientific career in the service, so that the record of his life and the story of the progress of the Survey are closely bound together. This is the third member of the staff of the Survey whose memoirs Sir Archibald Geikie will have written, the two others being Edward Forbes (whose Life he wrote in conjunction with the late Prof. George Wilson) and Sir Roderick Murchison. Sir Archibald joined the staff under Ramsay, and grew into the closest relations of friendship with him.

WE regret to have to record the death of Mr H. T. Stainton, F.R.S. He died on December 2 at the age of seventy. He was indefatigable in his study of entomology, to which he made many important contributions. His chief work is "Natural History of the Tineina," in four languages, with many plates. His "Manual of British Butterflies and Moths" is also well known. Mr. Stainton was one of the founders of the *Entomologists' Monthly Magazine*, and remained to the end of his life one of its editors. He was for many years secretary of the Ray Society and of the Zoological Record Association, and one of the secretaries of Section D of the British Association. From 1848 he was a Fellow of the Entomological Society, of which he was at one time president; and from 1859 he was a Fellow of the Linnean Society, of which he was at one time vice-president. He was elected a Fellow of the Royal Society in 1867.

THE Chemical Society held a special meeting on Tuesday, the anniversary of the death of Stas. A paper, prepared for the occasion by Prof. J. W. Mallet, F.R.S., on "Jean Servais Stas and the measurement of the relative masses of the atoms of the chemical elements," was read and discussed.

THE new Victoria buildings of University College, Liverpool, which include the Jubilee Tower, were formally opened on Tuesday. Lord Spencer, as Chancellor of the Victoria University, took part in the ceremony. At a banquet held in the evening, Mr. Bryce announced that the Queen, out of certain funds belonging to the Duchy of Lancaster, had been pleased to bestow upon the two great Lancashire Colleges a sum of £4000, to be applied in some permanent form, such as might be agreed upon by the authorities of the Colleges, particularly the principals, to commemorate the event of that day, and Her Majesty's interest in the growth of the institution.

ON Monday, at Merchant Taylors' Hall, Dr. William Anderson presented the prizes in connection with the City and Guilds of London Institute for the Advancement of Technical Education. Afterwards, addressing the students, Dr Anderson called attention to the extraordinary advantages enjoyed by students of the present day in comparison with those within the reach of students of the past generation. In nearly all towns men and women were improving their knowledge in almost every branch of art and science to which their necessities or their inclinations led them. He had come to the conclusion that the aids given nowadays to manufactures and commerce were absolutely indispensable if England was to hold her own, and to overcome the difficulties which high-priced labour, the restrictions of the Legislature, and the interference of trade organizations imposed.

DR T. JEFFREY PARKER, F.R.S., of Dunedin, Otago, New Zealand, who is now in this country, will read a paper on the cranial osteology, classification, and phylogeny of the Moas (Dinornithidæ) at the Zoological Society's meeting on the 14th of February.

THE committee appointed by the Board of Agriculture to inquire into the plague of field voles in Scotland have declined for the present to recommend the adoption of the plan lately carried out in Thessaly by Prof. Loeffler, who claims to have got rid of voles in that district by feeding them with prepared bait containing the germs of mouse typhus. It is thought that Prof. Loeffler may not have attached sufficient weight to other causes which have doubtless operated to reduce the swarms of voles in Thessaly, such as the heavy rains which on the low ground would flood the holes and runs of the mice. The chairman of the committee, Sir Herbert Maxwell, and the secretary, Mr. J. E. Harting, with the sanction of the Board of Agriculture and of the Treasury, are about to proceed to Thessaly for the purpose of taking evidence there and reporting.

A NEW edition of M. Alphonse Bertillon's important book on "Identification Anthropométrique" will be published in January. The book has been entirely recast and considerably enlarged. It is the result of ten years of observation, and has been prepared, not merely for the anthropometric service directed by the author, but for all who desire to have a proper comprehension of man's physical qualities. In addition to the copies intended for the use of the penal administration of the French Ministry of the Interior, a small number of copies will be reserved for persons who may desire to subscribe for them.

ON the evening of Thursday the 8th instant a deep barometric depression advanced upon our north-west coasts, and proceeded with considerable rapidity in a south-easterly direction, completely traversing Great Britain, as far as Dover, and travelling throughout its course at the rate of about 36 miles an hour. Its passage was accompanied by gales and by heavy rain or sleet, with severe snowstorms on the east coast. This disturbance passed away to the eastward, and was followed on Saturday by a fresh depression which appeared in the north-west, causing a strong gale in that district, and heavy squalls in most other parts. The changes of temperature were very

irregular, the air being warm and moist under the influence of the cyclonic systems, but cold and relatively drier in the rear of the disturbances, in Scotland the frost was at times severe, the lowest of the minima being as low as 8° in the east of Scotland. In the early part of the present week a temporary improvement took place, with a generally rising barometer and falling thermometer, but these conditions soon gave place to a fresh disturbance in the north-west, accompanied by south-westerly winds generally. The *Weekly Weather Report* for the period ending the 10th instant showed that the temperature was below the mean in all districts, the greatest deficiency being about 7° over the northern parts of the kingdom. Rainfall exceeded the mean in the north-west of England and the north of Ireland, but in all other districts it differed little from the average amount. Bright sunshine was more prevalent than for many weeks past, except in the north of Scotland, where only 5 per cent. of the possible amount was registered.

A Foreign Office "Report on the Social and Economical Condition of the Canary Islands" (No. 246, 1892) contains some details with respect to the climate. There is no record of the freezing point having been touched at Laguna (Teneriffe), 1840 feet above the sea. At Vila Flor, also in Teneriffe, 4335 feet above the sea, the highest point where cultivation exists, the lowest temperature recorded in 1890-91 was 28°, the lowest reading at the sea level during the same period was 49°. The highest summer reading at Laguna was 104°.9 in 1885. The average maximum temperature near the sea in the summer is about 82°. The annual rainfall at Laguna is 29.4 inches, but at Santa Cruz (Teneriffe), at the sea level, it is only about 11 inches, and at Las Palmas it is as low as 8.4 inches. The greater part of the rain falls in the Monte Verde, where the vapour is carried from the sea by the trade wind. The rain generally begins early in October and ceases early in May.

The country between the Nile and the Red Sea has not always been so barren as it is to-day. There is ample evidence that in former times bodies of cavalry from three to five hundred in number ranged without commissariat difficulties over districts which are now deserts. The Arabic names of the valleys are names for trees, and there can be little doubt that at one time the valleys abounded with the trees after which they were called. How is the change to be explained? Much light is thrown on the problem by a most interesting paper printed in the new number of the *Kew Bulletin*, to which it has been communicated by Mr. E. A. Floyer, F.L.S., Inspector-General of Egyptian Telegraphs. It is an extract from the report (which will be published in French by the Egyptian Government) of the expedition despatched by the Khedive to this region in 1891. The writer believes that the mischief has been done during the last twelve hundred years, and that it is to be attributed to the Arab and his camel; the camel having eaten the leaves and shoots of the trees, the Arab having converted into charcoal the stem, root, and branch. The writer is inclined to state the matter thus: So long as the valleys were all the Arab had to depend on for feeding his camels, so long he preserved his trees for his camels. But by degrees some Arabs got a footing in the Nile Valley. They hired their camels to the farmer to carry their harvest. They went back to their deserted valley and brought away the trees in form of charcoal. Thus the land was gradually made bare. If this explanation is correct—and there is evidently much to be said for it—the writer points out that a like cause may be invoked over large areas to explain, for example, the disappearance of the frankincense and spices from Southern Arabia, to explain the thousands of chariots and horsemen in Palestine, and to explain how in early times a greater fertility and population existed in many countries whose history, like that of Palestine, seems out of proportion to their present circumstances. It is a pity, by the way, that in so good a paper nature should be spoken of as having produced in the camel "a Frankenstein." Frankenstein in the story was not the monster, but the monster's creator.

It is by no means certain that the harm which the camel is capable of doing in Egyptian territory has even yet been exhausted. The writer of the report considers it possible that the prosperity in Egypt in which all Englishmen are rejoicing may seal the destruction of the remaining trees, and leave the country bare save of *Calotropis procera* and the plants which nourish a few sheep and donkeys, attended by herdsmen, fed by grain from the Nile Valley. "The camel," he says, "will then, having so to speak burnt its boats, be domesticated in the Nile Valley. And it is interesting to speculate as to how he will develop there. Already the massive Cairo camel is a type distinct from other camels, surpassing all in its cumbrous massive proportions."

The December number of the *Kew Bulletin* contains, besides the paper on the disappearance of desert plants in Egypt, interesting sections on the Taj Gardens, Agra; Indian gutta-percha; the Gold Coast botanical station; Ramie machine trials at New Orleans; Lord Bute's "Botanical Tables"; and miscellaneous notes. Reference was made to the "Botanical Tables" in the historical account of Kew, printed in the *Bulletin* in 1891, p. 291. Since that was written the authorities at the Royal Gardens have had an opportunity, through the gracious permission of the Queen, of examining the copy in the Royal Library at Windsor, which formerly belonged to Queen Charlotte, to whom the work was dedicated. On the fly-leaf of the first volume of the Windsor copy is the following note in pencil, written by the Rev. John Glover (appointed Royal Librarian by William IV.):—"Of this work only sixteen copies were printed for presents, at a cost, it is said, of more than £10,000. This copy belonged to Queen Charlotte, and was purchased at the sale of Her Majesty's Library for, I believe, £100." There seem, however, to have been only twelve copies. The general nature of the contents is indicated in the *Bulletin*. There are nine volumes, and the work contains 654 plates, all of them apparently drawn and engraved by John Miller, an excellent German artist—Johann Sebastian Mueller, who thus anglicised his name.

Ceylon is sending to the Chicago Exhibition a complete reproduction of a Buddhist temple and many interesting specimens of ancient Sinhalese art, including, according to the *Ceylon Observer*, "exquisitely carved pillars, massive doorways and dados, beautiful windows and frescoed panellings of courts." There will also be, among other things, a display of jewellery, lace, and pottery. It is hoped that these treasures will do something to further in America "the interests of the most modern product of Ceylon, tea."

At the recent meeting of the Congress of Americanists at Huelva, Mrs. Zelia Nuttall, of the Peabody Museum of American Archæology and Ethnology, Cambridge, Massachusetts, presented a preliminary note on the calendar system of the ancient Aztecs. Guided by a statement in a Hispano-Mexican MS. which she has recently discovered in the National Central Library of Florence, Mrs. Nuttall claims to have found the key to the Aztec calendar system. She exhibited tables showing that the Mexican cycle was 13,515 days, and that it comprised 52 ritual years (less five days at the end of the cycle), of 260 days each, or 51 lunar years of 265 days each, based on nine moons, or 37 solar years each of 365 days. At the end of the fifty-first lunar year 10 intercalary days placed the solar years in agreement with the lunar years in such a manner that the new cycle recommenced in the same solar and lunar positions as the 13,515 preceding days. Each period commenced with a day bearing one of the four names: *acatl, tecpatl, calli, tochtli*. The calendar system and tables, 14 metres long, designed to

illustrate this communication, were subsequently placed on exhibition in the Spanish section of the Historical Exhibition at Madrid. Her Majesty the Queen of Spain commanded that Mrs Zelia Nuttall should be presented to her, and expressed much interest in her work

No one expects to see the corncrake in Great Britain after the summer months. According to the *Llangollen Advertiser*, a specimen was caught last Thursday in the neighbourhood of Pentrefelin, Llangollen Several local naturalists have seen the bird, and agree that it is a corncrake.

A NEW luminous fungus has been forwarded to Europe from Tahiti. It is said to emit, at night, a light resembling that of the glowworm, which it retains for a period of twenty-four hours after having been gathered, and it is used, by the native women, in bouquets of flowers for personal adornment in the hair and dress It belongs to the section "dimidiati" of the genus *Pleurotus*, in which no luminous species has been hitherto known, although there are several in the genus, and has been named by M Hariot *Pleurotus lux* It is believed to grow on the trunks of trees.

A THEORETICAL investigation of the conditions under which Lippmann's coloured photographs are produced is given by M G Meslin in the *Ann de Chim et de Phys* for November He maintains that the colours produced are complex, and belong to the higher orders of Newton's scale This is illustrated by the change in colour observed when the thickness of the film increases. When moist air is blown upon it the film swells, and the bright colours give way to others consisting principally of red and green The impure nature of the spectrum ordinarily obtained would account for its "metallic" appearance Besides, there is a blue or greenish blue region which extends beyond the red end of the spectrum The composite nature of the colours reflected from the surface of the spectrum photograph may be shown by projecting a similar spectrum upon the film The colours will then appear very brilliant But if, for instance, the green is projected upon the red of the film, green is reflected all the same, although less distinctly than before The same thing happens in other parts of the spectrum On moving it from the violet towards the red, the violet, arriving at the green portion, is interrupted by a broad band. On further displacement this band, the breadth of which is about equal to the distance between the E and the b lines, moves through the green and yellow and reaches the red. At this moment the blue and violet regions show the greatest brightness. There is only one band observed throughout. This observation is in accordance with the thickness attributed to the layers, viz. between 200 and $350\mu\mu$. Hence the paths traversed by the light will range from $400\mu\mu$ to $700\mu\mu$, giving $\frac{\lambda}{2}$ for none of the colours, $\frac{3}{2}\cdot\frac{\lambda}{2}=600\mu\mu$ for the violet, $650\mu\mu$ for the blue, and $700\mu\mu$ for the green. It will be still greater, i.e. $\frac{3}{2}\frac{\lambda}{2}$ for the red, in the infra red region of the spectrum. There we shall have a black band in the red, while the blue is at its maximum, owing to the retardation being equal to two wave-lengths. Hence the blue region beyond the red corresponds to the infra red region of the incident spectrum, which in long exposures is able to produce a photographic effect.

DURING the year 1891 about 450 more persons were killed by wild beasts in India than during the preceding year. The number in 1890, however, was abnormally low, and the *Pioneer Mail* calculates that last year's figures were about 250 in excess of the mean. In one district of Bengal—Hazaribagh—no fewer than 205 deaths were due to a single brood of man-eating tigers. The yearly average of persons destroyed by wild beasts in our Eastern dependency is between 2500 and 3000. The mortality from snake-bite is on a much larger scale. Year by year it varies from something over 21,000 to something over 22,000.

AN excellent account of the Experiment Stations established in the United States in the interest of agriculture is given by Mr R Warington, F R S, in a paper issued by the National Association for the Promotion of Technical and Secondary Education A fully equipped Experiment Station, he says, is a large and costly piece of machinery, embracing many departments of work There is one in every State of the Union, and in some States there are more than one, the total number is fifty four These Stations are endowed by Congress, £3000 a year being paid to the Station or Stations of each State If the income derived from the State Legislatures, and from other sources, be included, the average income of each Station is nearly £4000 In nearly every instance the station is connected with the States Agricultural College, and the Station buildings are in its immediate vicinity The publications of the Stations are made in the form of periodical bulletins and annual reports, for the printing of these a special grant is made by the State, and they are distributed by the Federal Government post free The issues are very large 60,000 copies of each Station bulletin are printed in Ohio Any farmer in the State can at his request receive the bulletins regularly without payment Mr Warington expresses a hope that our own County Councils may be encouraged to try to do for agriculture in Great Britain what is so energetically done for it in America by the various States

A SERIES of investigations on soils is in progress at the Maryland Agricultural Experiment Station, in co-operation with the U.S. Department of Agriculture and the Johns Hopkins University So far the work has been on the physical structure of the soil and its relation to the circulation of soil water, and the physical effect of fertilizers on soils as related to crop production The surface tension of various solutions was first of all determined The solutions chosen included common salt, kainit, superphosphate of lime, soil extract, and ammonia The soil extract was made by shaking up a little soil with just sufficient water to cover it. The water was afterwards filtered off and used for the determination This operation reduced the surface-tension of water considerably, but the experiments do not appear sufficiently complete to indicate reasons for this Analyses of the soils are not given Ammonia and urine lowered the surface-tension of water considerably below that of the soil extract, and still more below that of pure water Common salt and kainit increase the surface tension of water, and no doubt this is the reason why the application of these substances to the soil tends to keep it moist, whereas the excessive use of nitrogenous manure has the reverse effect

THE Chamber of Commerce at Reims has published the statistics of the trade in champagne since 1844. In 1844 45 the value of the trade was 6,635,000 francs, and in the following year it exceeded seven millions. In 1868 69 it amounted to nearly sixteen millions, but fell to nine millions in 1870-71, and then rose in 1871-72 to twenty millions. The value in 1872 73 was twenty-two millions, and it oscillated between this sum and seventeen millions until 1889-90, when it became twenty-three millions. The figures were 25,776,000 in 1890-91, 24,243,996 in 1891-92. The number of bottles used in France rose from 2,225,000 in 1844-45 to 4,558,000 in 1891 92, while the number exported rose during the same period from 4,380,000 to 16,685,900. The year in which most bottles were sent abroad was 1890-91 (nearly twenty-two millions)

MESSRS. SWAN, SONNENSCHEIN AND CO have issued a translation, by Dr E. L. Mark, Professor of Anatomy in Harvard University, of the third edition of Dr Oscar Hertwig's

"Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbelthiere" The volume is entitled "Text-Book of the Embryology of Man and Mammals" The translator, in his preface, expresses his belief that the work "covers the field of vertebrate embryology in a more complete and satisfactory way than any book hitherto published in English"

THE latest instalment of the Proceedings of the Academy of Natural Sciences of Philadelphia contains a valuable paper, by Prof. E D Cope, on the Batrachia and Reptilia of North Western Texas The statements presented in the paper are based on collections made along the eastern border of the Staked Plain of Texas, between Big Spring (on the Texas Pacific R R.) on the south, and the Salt Fork of the Red River, near Clarendon (on the Denver and Fort Worth R R) on the north, a distance of about 250 miles The collections were made incidentally to geological and palæontological explorations conducted by a party of the Geological Survey of Texas, which was under the direction of Mr William F Cummins While attached to this party Prof Cope picked up such specimens as came in his way, and a good many others were obtained by Mr Cummins and by Mr William L Black of the party The total number of species enumerated is thirty-three The paper may be regarded as supplementary to one published as Bulletin 17 of the U S National Museum in 1880, on the Zoological position of Texas

THE following are the lecture arrangements at the Royal Institution before Easter —Sir Robert Stawell Ball, six lectures (adapted to a juvenile auditory) on astronomy, Prof Victor Horsley, ten lectures on the brain, the Rev Canon Ainger, three lectures on Tennyson, Prof. Patrick Geddes, four lectures on the factors of organic evolution, the Rev Augustus Jessopp, three lectures on the great revival—a study in mediæval history, Prof C Hubert H Parry, four lectures on expression and design in music (with musical illustrations), the Right Hon Lord Rayleigh, six lectures on sound and vibrations. The Friday evening meetings will begin on January 20, when a discourse will be given by Prof Dewar on liquid atmospheric air, succeeding discourses will probably be given by Mr Francis Galton, Mr Alexander Siemens, Prof Charles Stewart, Prof A. H Church, Mr Edward Hopkinson, Mr. George Simonds, Sir Herbert Maxwell, Bart, the Right Hon Lord Rayleigh, and other gentlemen

THE micro organism which has been shown to be the exciting cause of tetanus or lockjaw is just now especially attracting the attention of bacteriological investigators. Kitasato, who it will be remembered was the first who successfully isolated the bacillus of tetanus, has been continuing his researches on the protective inoculation of animals against this malady. In the current number of the *Zeitschrift fur Hygiene* appears an account of some extremely interesting results which he has obtained with mice and guinea-pigs In his experiments Kitasato introduced subcutaneously into these animals small splinters of wood which had been previously soaked in bouillon-cultures of tetanus, so prepared that only the spores were present He wished in this way to imitate as nearly as possible the actual manner in which tetanus is communicated, and which in consequence of the sensitiveness of the bacillar form to heat and light and the extremely refractory nature of the spores, is almost invariably due to the accidental introduction of the latter This theory is also supported by the fact that between the infliction of the wound and the development of symptoms of tetanus there is invariably a distinct lapse of time, during which the spores grow into bacilli and elaborate their toxic products within the system of the animal affected, after which the typical appearances of tetanus arise. The protective material used in these investigations was the serum of a horse artificially rendered immune against tetanus, and in every case out of those mice which had received a small wood-splinter two were put aside and not subsequently inoculated with the protective serum Kitasato found, as he had expected, that a definite period of time elapsed between the introduction of the splinter and the development of tetanus symptoms, but with hardly an exception, all those mice subsequently treated with the serum recovered, whilst those which had received no protective treatment died exhibiting the typical characteristics of tetanus Moreover, it was found that the earlier the application of the serum took place after the infection and quite irrespective of the appearance of any signs of tetanus, the more successful was the result and the smaller the dose of serum necessary, whilst when the wood splinters and the serum were introduced together no symptoms whatever of tetanus declared themselves The same successful results were obtained in the case of guinea-pigs In connection with the excessively hardy nature of the spore-form of tetanus, Hervieјean (*Ann de la Soc méd chir de Liége*, 1891) has found that even after eleven years such spores still retain their power for mischief A small fragment of wood was extracted from the ankle of a child who had died of tetanus, and after being kept for nearly eleven years part of it was introduced under the skin of a rabbit, which afterwards died of tetanus The infection was further confirmed by the discovery of tetanus bacilli in the pus of the wound

THE chloraurates and bromaurates of cæsium and rubidium have been prepared by Messrs Wells and Wheeler, and are described in the current number of the *Zeitschrift fur Anorganische Chemie* They are all four beautifully crystalline substances The crystals, which have been measured by Mr Penfield, belong to the monoclinic system, and form an isomorphous series of identical habitus These salts are so comparatively insoluble in water that they are obtained in the form of crystalline precipitates when concentrated solutions of chlorides or bromides of cæsium or rubidium are mixed with strong solutions of chloride or bromide of gold They are, however, sufficiently soluble to admit of recrystallization from water The crystals of cæsium chloraurate, $CsAuCl_4$, exhibit an orange-yellow colour, those of the corresponding rubidium salt, $RbAuCl_4$, possess a more deeply orange tint, while the two bromides, $CsAuBr_4$ and $RbAuBr_4$, are jet-black but yield a dark red powder upon pulverization The cæsium compounds are much less soluble than the rubidium ones, so that the crystals are usually much smaller The more soluble rubidium salts readily form very large crystals; the chloride in particular yields crystals whose size appears only to be limited by that of the crystallizing vessel and the depth of the solution The crystals, however, whether large or small, all partake of the same character; they are elongated prisms terminated by the basal plane, orthodome, clinodome, and small pyramidal planes. The faces are usually extremely brilliant, but those of the bromides are often singularly hollow or cavernous In addition to this well defined series, another chloraurate of cæsium has been obtained containing water of crystallization This salt, $2CsAuCl_4.H_2O$, is formed when a large excess of gold chloride is present compared with the amount of cæsium chloride. It separates in the form of light orange-coloured tabular crystals belonging to the rhombic system, which exhibit the peculiar property of undergoing an internal change accompanied by elimination of the water of crystallization, within a few minutes of their removal from the mother liquor The change is probably due to the passage of this hydrated salt into the relatively more stable anhydrous chloraurate described above. It betrays itself in a most interesting manner under the microscope, in polarised light. When a crystal plate is removed from the mother liquor,

rapidly dried by means of blotting-paper and placed under the microscope, the Nicols being crossed, it simply produces the usual effect of causing the field to become coloured with some homogeneous tint But after the expiration of three or four minutes the molecular change begins to be rendered apparent at the circumference of the field by a rapid augmentation of the polarizing effect, in another moment it commences to dart across the field in all directions, the brilliantly coloured rays being feathered with offshoots, reminding one of the rays of crystallizing ammonium chloride This beautiful effect continues until, in less than ten minutes after the removal of the crystal from the mother liquor, the rearrangement of the molecules has become so general that light is no longer able to penetrate, and the crystal becomes completely opaque Messrs Wells and Wheeler have also attempted to prepare the analogous compounds containing iodine, but have not yet obtained them in a condition so pure or well crystallized as the salts described above

The additions to the Zoological Society's Gardens during the past week include a white fronted lemur (*Lemur albifrons* ♀) from Madagascar, presented by Mr M C Parker, a brown capuchin (*Cebus fatuellus* ♂) from Brazil, presented by Mr Earle Tudor Johnson, a large-eared fox (*Otocyon megalotis*) from Mashonoland, South Africa, presented by Mr B B Weil, two black-backed jackals (*Canis mesomelas*) from South Africa, presented by Capt. Ralph H Carr-Ellison, a common fox (*Canis vulpes* ♀) from Arabia, presented by Miss Morgan, a leadbeater's cockatoo (*Cacatua leadbeateri*) from Australia, presented by Lieut.-Colonel Warton, a Rhesus monkey (*Macacus rhesus*) from India, deposited

OUR ASTRONOMICAL COLUMN

Comet Holmes (November 6) —The following is the ephemeris for Comet Holmes for the ensuing week —

1892	R A. (app.) h m s.	Decl (app) ° ′	Log r	Log Δ
Dec. 15	0 49 34	+34 50 1		
16	50 15	45 8	0·4004	0 2813
17	50 57	41 6		
18	51 41	37 5		
19	52 27	33 6		
20	53 14	29 8	0 4027	0 2931
21	54 3	26 1		
22	0 54 53	+34 22 6		

Owing to the extremely bad weather, observations of this comet have not been numerous, but from all accounts not much change has taken place in the general appearance, except that the central nucleus seems to possess two small tails, which extend towards the ragged edge of the exterior portion

Comet Brooks (November 20, 1892) —Last week the only ephemeris of this comet at hand was one showing its position every fourth day, but Prof Kreutz has now communicated to *Astronomische Nachrichten*, No 3132, a daily ephemeris, from which the following is extracted —

1892.	R A. (app.) h m. s.	Decl (app). ° ′	Log r	Log Δ.	Br.
Dec. 15	13 50 10	+31 57·3			
16	54 6	33 17 2	0 0974	0 0001	3·67
17	13 58 19	34 41 2			
18	14 2 53	36 9 5	0·0946	9 9775	4 13
19	7 51	37 42·2			
20	13 17	39 19 3	0·0921	9·9550	4·63
21	19 13	41 0 8			
22	25 46	42 46·6	0·0898	9·9332	5·17

From the column showing the brightnesses it will be seen that a considerable increase in this comet is taking place. The comet will be easily found by the fact that it lies in the prolongation of a line joining β and γ Bootis (December 18) at a distance equal to that between those two stars.

The New Brooks' Comet —The following positions of this comet are reported from Marseilles, by MM Esmiol and Fabry —

Date	Marseille Mean Time h m s	App R A. h m s	App P D ° ′ ″
Nov. 24	17 45 16	13 3 14 6	74 51 33
24	17 6 53	13 4 39 39	74 33 18 1
29	16 43 46	13 11 1 76	72 11 46 7
30	16 41 49	13 12 45 77	71 34 49·0

The comet presented the appearance of a nebulosity about 1′ in diameter, diffuse at the edges, and brighter towards the centre, but without a well defined nucleus Its brightness was about that of a star of eleventh magnitude.

Nova Aurigæ —Nova Aurigæ has again increased in magnitude, observations showing that visibly it is 8 5, while photographically it is three magnitudes fainter

Astronomy at Columbia College, U S A —The latest number of the bulletin issued by this college informs us that with the consent of the governing body of the New York Hospital and the college trustees, a new but small observatory is about to be erected on the site Bloomingdale The instrument, which is at present being constructed by Wanschaff, at Berlin, is a zenith telescope, and it is one of a pair which is going to be used for observations to obtain accurate determinations of the variations of terrestrial latitudes The other instrument, by order of the Italian government, is going to be mounted at the Royal Observatory of Capodimonte Both instruments will soon be, if not already, in working order, the observers in America are Prof Rees and Mr Jacoby, while M Higola will undertake the Italian observations

The library of this college has been recently very much increased by the purchase of the fine library of astronomical and physical works belonging to Mr Struve, former director of the Pulkowa observatory This addition amounts to no less than 4361 bound and unbound books, together with 3056 pamphlets

Companion to the Observatory for 1893 —This annual *Companion* for the coming year is very similar to the one last published Mr Denning gives a list of the principal meteor showers deduced from recent observations, while ephemerides for the planets, together with their satellites, are also inserted Solar observers will find the ephemeris given on page 22 very useful, this table giving the position-angle of the sun's axis, and the heliographic latitudes and longitudes of the centre of his disc In addition to several other handy tables and ephemerides, the times of minima of variable stars not of the Algol type, variable stars of the Algol type, maxima and minima of variable stars, and finally a table of double stars are also included

GEOGRAPHICAL NOTES

Major Thys, who has recently returned from the Congo Free State, reports that the railway from Matadi to Stanley Pool is progressing rapidly. The works are practically completed for only 14 kilometers out of the 400, but this includes the most difficult region, including the greater part of the ascent to the plateau. In a few months it is hoped that 40 kilometers will be completed, and the malarial coast-belt can then be traversed rapidly, obviating a serious risk to the health of travellers to the Upper Congo.

We are pleased to find that the Manchester Geographical Society has published the concluding part of the seventh volume of its Journal although, as we had occasion to remark on the appearance of the previous part, it is greatly to be regretted that the people of Manchester do not take a greater interest in a Society which is one they have reason to be proud of It is, we are convinced, solely to this want of local appreciation that the Journal has to be issued so far behind its proper date as to impair the usefulness of its contents In the current number there is an interesting paper on Japan by Mr. W M Steinthal.

Mr. G A. Craig has, we understand, resigned the secretaryship of the Liverpool Geographical Society on account of ill-health.

The *Scottish Geographical Magazine* for this month contains a paper by Captain Lugard, entitled "Characteristics of African

Travel" The Society presented Capt. Lugard with its silver medal and an honorary diploma of Fellowship A similar award has been made to Mr Joseph Thomson in recognition of his services to Geography in Africa

Dr J Troll, an Austrian explorer, is at present engaged in a journey through Central Asia He reached Samarkand in the end of October Thence he proposes to pass through Russian and Chinese Turkestan and Mongolia, intending to return by Pekin and Shanghai In the course of his journey he hopes to visit the ruined city of Karakoram, the ancient capital of Jenghiz Khan.

A railway has recently been opened from Wiborg, in Finland, to the Imatra Falls, thus bringing the finest rapids in Europe within six hours of St. Petersburg Hitherto the falls have been reached by canal-steamer and coach, the journey occupying not much less than twelve hours

Mr. Joseph Thomson proposes to use the name "Livingstonia" to describe the whole British sphere of influence north of the Zambesi and west of Lake Nyasa It is little to the credit of British cartographers that the attempts hitherto made to associate Livingstone's name with the continent of which he was the greatest explorer have practically failed

THE DESTRUCTION OF IMMATURE FISH

Mr Ernest W L Holt contributes to the new number of the Marine Biological Association's Journal another very interesting paper on the results of his North Sea Investigations He has much to say as to the destruction of immature fish in the North Sea, and makes the following observations on proposed remedial measures —

It will be admitted that the continued destruction of large numbers of valuable fish before they have had a chance of reproducing their species can only result in increased deterioration of the industry, and that some measures must be taken to put a stop to it unless we are prepared, and able, by artificial propagation to restock the sea as fast as we deplete it Briefly the various proposals that have been put forward fall under three headings, viz. closure of grounds frequented by small fish, restriction of sale of undersized fish, and enlargement or alteration of mesh. We have seen that some of the smack-owners have adopted the eminently practical method of forbidding their boats to fish where they are likely to catch much small stuff; but the buyers, though as loud as any in their outcry, do not appear inclined to avail themselves of their undoubted power to check the evil The proposals for legislative action have been so much discussed of late that I need only advert to such as affect the North Sea district

It is a matter of common knowledge that the bulk of the destruction by deep-sea trawlers takes place on the eastern grounds, to which I have alluded elsewhere, and since these lie wholly or in part outside the three-mile limit, it has been proposed that they shall be closed to trawling by international agreement Whether such agreement could ever be arrived at is questionable and if it were, it is not likely that the ensuing legislation could be easily enforced The great extent of the grounds would involve an enormous and costly Marine Police force, of mixed nationality, and even were such a body much more efficient than one has any reason to expect, there might be considerable difficulty in adequately watching grounds which extend in some cases over fifty miles from shore Indeed, on our own coasts and elsewhere the success with which legislation limited to the territorial area has hitherto been enforced is hardly such as to encourage us to extend the principle to the open sea.

The various standards of size which have been advocated, in proposals for prohibiting the sale or possession of undersized fish, differ according as the subject has been treated with regard to the marketable qualities of the fish, or to its powers of reproduction; and it may be assumed, I suppose, without argument that the latter is the more rational method of treatment Still it may be as well to recapitulate the sizes proposed at the Fishery Conference at Fishmongers' Hall last February, since they may be taken to represent the most recent trade opinion on the subject.

They are for turbot and brill twelve inches, for soles and lemon sole (*Pleuronectes microcephalus*) ten inches, and for plaice eleven inches. How far they fall short of the biological limits, at least for the North Sea district, can be judged by comparing them with the table of sizes on p. 384 of the Journal; and, indeed, I may remark that the prohibition of the sale of turbot and brill under twelve inches in length is rather a work of supererogation, since the number of smaller fish of these species that come to market, at all events at Grimsby, is utterly insignificant

The benefit to be expected from any measure of prohibition depends of course on the vitality of the fish, and it is very generally asserted that the bulk of the small fish trawled on these eastern grounds would not survive if returned. My own experience leads me to believe that this view is correct[1] so long as the present system of long hauls is maintained Hence we must seek for such a limit as will render the grounds most frequented by these small fish unprofitable to the fishermen (since any less limit would only involve an infinitely greater waste than takes place at present), and in doing so it is necessary to glance at the general conditions of this fishery

Exclusive of less important forms, the species chiefly met with are plaice, turbot, and soles The plaice, on most grounds, do not exceed a length of fifteen inches, and are mostly less than thirteen inches in length The turbot are fairly abundant, but, as I have already shown, almost all immature, soles are scarce It is only the certainty of being able to fill up with small plaice that induces the fishermen to cross to the eastern side, since the soles and turbot would not nearly pay his expenses by themselves. Now I am confident that if the Conference limit of eleven inches for plaice were enforced, there would still be enough saleable fish left to make the grounds worth visiting, whereas if it were raised to fifteen or even fourteen inches the grounds would assuredly be left alone, and although such would be below the biological limit, I believe the practical closing to our huge fleets of such a magnificent nursery for young plaice would be in itself a sufficient protection for the species. Certain rough patches of ground, practically surrounded by areas yielding only small fish, abound with only large fish, these would still be accessible to fishermen, whereas in any scheme of geographical restriction it would hardly be possible to exempt them. Moreover the restriction of size would probably do away with the destruction of small plaice by shrimp or sole-trawls, since the fish are not injured by being caught in these nets, and if unsaleable[2] would probably be returned

For turbot, brill, and sole I would advocate the adoption of the biological standards They are all rather hardy forms, and it appears that immature brill and such immature turbot as are found on our own coasts are chiefly caught on certain banks where the intricate nature of the ground renders short hauls a necessity, so that they could be returned to the sea in good condition, as indeed the smaller of them usually are at present by many fishermen With regard to soles, I do not think that many undersized fish are caught by deep-sea trawlers,[3] and the substitution of a size limit for the present prohibition of the use of a fish-trawl in the Humber would do away with the anomaly of a law which is not enforced. There is a strong feeling amongst inshore fishermen that the bye-law alluded to is unequal in its operation, since it offers no check to the destruction of small fish on off-shore grounds, only accessible to large boats. Hence a regulation as to the size of fish landed is perhaps preferable to one based solely on territorial conditions somewhat imperfectly understood

An objection which I have heard urged against any scheme for keeping our trawlers off the eastern grounds is that the summer sole trade in the North Sea would thereby be left entirely in the hands of foreigners. I think that this is, perhaps, rather overstating the case, but anyhow I cannot see that it furnishes any excuse for the present enormous destruction of small plaice and turbot, whilst it is at least possible that the abstention of our own fleet from these grounds in the summer would result in a corresponding increase in the number of soles in the localities where that species congregates in the winter months. I have no knowledge of the migrations of soles, but the Great Silver Pit is equidistant from the Humber and the nearest eastern ground, and as it is the nearest point at which similar physical conditions can be attained, it does not seem improbable that the winter supply of soles in the Pit is in part recruited from the east side of the North Sea.

[1] Owing to the great mass of fish caught in a single haul, I consider it quite possible to hold this view without throwing any doubt on the value of the results obtained by my friend Dr Fulton in his experiments on the vitality of trawled fish (Report S F B, 1891).

[2] The possession, as well as the sale, should be prohibited, to guard against the possible danger of small fish being utilised as manure when the fisherman is also a farmer in a small way.

[3] The small soles caught on the Dogger and on the Dowsing are really solenettes (*Solea minuta*).

Another objection is that boats of British nationality are not the only ones engaged in the small fish trade, and it is true that during the summer months a number of German, Dutch, and Danish boats are occupied in catching small plaice. But they are all of small tonnage, some of them only open boats; and I understand that from the manner in which the trawl is handled by German and Danish boats no injury is done to the unmarketable fish, whilst the saleable part of the catch appears to be exported chiefly to London. Hence the proposed measures of prohibition would give no advantage to these nations. The German steam trawlers, according to my information, do not molest the small plaice at all. Of the proceedings of the Dutch bombs I have little knowledge, but from the small size of their gear, their share in the destruction cannot be a very large one. Foreign caught fish, except Norwegian salmon and mackerel and Dutch soles, including only a small percentage of undersized fish, rarely come to the Grimsby market, but on two occasions large consignments of small plaice, comprising, as I compute, some 31,000 fish, were sent from Denmark, and recently a consignment of turbot has arrived from Norway. These last fish were about 300 in number, all undersized, viz. from 9½ to 17 inches, whilst 4 were only from 8 to 9 inches. This is the only instance which has come under my notice of any considerable number of turbot less than 12 inches being present in the market, and, as we have seen, our own fishermen were not concerned in it.

The last and perhaps the most important objection arises from the difficulty in allowing for that variation in the size of fish of the same species on different parts of our own coast to which Mr. Calderwood alluded in the last number of the Journal, p. 208. The impossibility of utilizing a uniform size limit for all districts is sufficiently exemplified by the limit of 11 inches for the plaice proposed by the Conference of last February, which was the result of a compromise between the trade representatives of the North Sea and south and west coast districts. While perhaps unnecessarily high for the Plymouth district, we have seen that it is altogether too small for the North Sea. The difficulty of having different limits, of local application, will only be felt at such a central port or market as London, to which fish are brought, whether by rail or sea, from all districts, but with proper organization the obstacle does not seem insuperable. It is conceivable that the law might be evaded by running cutters from boats fishing in one district to the parts of another, where the limit was lower, but it is little likely that the firms which are in a position to undertake them, would lend themselves to such operations. There is not the slightest reason to apprehend a general conspiracy of evasion amongst the fishermen, and the boats which respected the law would form a more efficient police than all the cruisers in the navy, so far as one may judge by the conditions on the Scotch coast, where convictions of trawlers for infringement of the territorial restriction are frequently secured by the evidence of local line fishermen.

I must leave to others, who are acquainted with the local conditions, to decide whether the imposition of a size limit is desirable in other districts, but for the North Sea I have not the slightest hesitation in recommending this method of legislation, in the terms I have proposed above, as cheaper and likely to be infinitely more efficacious than any other that can be devised in maintaining the supply of the more important kinds of flat fish. I need hardly observe that its application to the halibut, which is chiefly a line fish, could not fail to be beneficial to that species, since there is no question but that fish caught on the hook will usually survive if returned;[1] but I do not think that the limit need be as high as the biological one, owing to the difference in the conditions of the trawl and line fisheries.

I am not prepared to enter at present into the question of mesh legislation, beyond pointing out that it appears to be the only method by which the destruction of immature round-fish, notably haddock and whiting, can be checked, since these species are fatally injured by being caught in the trawl, and would not survive if returned. Any great enlargement of the mesh does not appear advisable, since it would afford an opportunity of escape to the mature sole, of which that active species would be extremely likely to avail itself. The remedy seems to lie rather in an alteration of the arrangement of the meshes in the cod-ends, so as to prevent them from closing. On this subject I have been making investigations, but they are not yet sufficiently complete to yield reliable deductions. It is sufficiently evident, as has often been pointed out, that the great breadth of some of the flat-fish render it impossible to deal with the whole question by restrictions of mesh alone.

The last matter with which I have to deal is the destruction of very small fish by shove-net and shrimp "seines." If it were only possible to induce the men to cull out the small fish in the water they would do no harm at all, and practically I suppose that, as matters are, they do not greatly injure any species of known value except the plaice, although the small number of sole, turbot, and brill destroyed may represent, from the relative scarcity of these species, a more considerable injury than one would suppose. When fishing by day the shove-net men usually return the fish to the sea, but by night this is impossible, and the seine men do not seem to make any effort in that direction either by day or night.

It is a difficult question to deal with, since the shrimp appears to be almost a necessity to some people; at the same time the small plaice which are destroyed must represent an infinitely greater value than the shrimps. If hatcheries were established, and young turbot, brill, sole, and plaice were enlarged after they had been reared through the delicate larval and metamorphosing stages, it is reasonable to suppose that they would be conveyed or would find their way to the sandy margins, which seem best adapted to the succeeding stages of their life-history, only to fall into the net of the shrimper.

I should say that to prohibit the use of any sort of shore shrimp nets during night-time would be a beneficial measure, but there is perhaps sufficient reason for abolishing the industry altogether. Those engaged in it might be sufficiently compensated at a moderate expenditure, if indeed it be not contrary to public policy to admit the existence of a vested interest in an occupation which is essentially injurious to industries affecting a much greater section of the community.

[1] Except fish with air-bladders, caught at considerable depths.

THE NEW TELEPHOTOGRAPHIC LENS

IN a small pamphlet of thirty pages, written and published by Mr. T. R. Dallmeyer, the author brings together the various notices bearing on the subject of his new telephotographic lens that have appeared during the last twelve months. He also gives an account of the "simple" and "compound" telephotographic lens, with general instructions for their use, including tables of their properties, and a table showing the diameters of circles of illumination necessary to cover the various sized plates used at the present day.

The telephotographic lens is, we may say, the latest advance made in the science of optics as applied to photography. By it we are now able to obtain large pictures of animate things situated at long distances with short exposure. In this invention Mr. Dallmeyer has produced a useful, and what may prove a valuable, instrument, and he has opened up quite a new horizon which will not suffer from lack of workers.

Hitherto the principle involved in the apparatus for the production of large images consisted first in obtaining the primary image, and second in subjecting this image to the process of enlargement. To obtain the former a concave mirror, or more generally double convex lens, has been employed, while the subsequent magnification has been produced by placing a secondary magnifier or second positive lens behind the plane of the primary image.

This method, except in the case of astronomical work, has not been, we may say, popularly used, for the cumbrousness of the apparatus required, and the length of time necessary for exposure have quite prohibited its use for anything but inanimate subjects.

It is well known that the focal length of a lens is measured for practical purposes from the principal plane passing through one of the nodal points nearest the principal focal plane to that plane. In most lens-constructions this nodal point lies within the lens-mount. Now it will be seen that if this nodal point could be thrown in front of the lens, that is, on that side away from the focus, the focal length, if measured from the lens, would be shorter. This is exactly what Mr. Dallmeyer has done. In the simple telephotographic lens the anterior element, which is of large aperture and short focus, is a positive lens, while the posterior is negative, and of a fractional part of the focal length of the former lens. A diagram showing the lenses in position and the path of a ray of light remind one at first sight of the principle of the Galilean telescope, with this difference, that the rays emerging are not *divergent*, but *convergent*. In the construction

under consideration the size of the image thrown on the screen can be varied at will by simply altering the distance between the elements, but the further the lens is from the focussing screen, the more will be the time of exposure

With such a lens as this Mr Dallmeyer has taken many excellent pictures, but perhaps the best idea of its properties will be gathered from the facts obtained by photographing—by means of two cameras, one supplied with a "long focus landscape lens," and the other with the "new telephotographic lens"—the flame of an oil lamp placed at a distance of 20 feet With *equal* extensions of the camera the image of the flame given by the new lens was five times greater than that by the other

In the *compound* lens the anterior element before referred to is here replaced by a complete portrait lens, while a negative symmetrical combination takes the place of the posterior element This lens may be said to be more perfect than the *simple* lens, Mr Dallmeyer having been able to introduce considerable improvement in the construction

Some excellent work done with this lens has been exhibited by Messrs F Mackenzie and Annan at the Camera Club The pictures represented a building at a distance of 500 yards The first, taken with an ordinary rapid rectilinear lens with an extension of 14 inches, gave the house as ⅜ of an inch long The second—with the compound tele photo lens, extension 9 inches from the back lens—gave 2½ inches as the size of the house, while the third, with 30 inches' extension, gave the house as 6¼ inches Although these numbers can give one a very good idea of what this new lens can accomplish, yet the direct copies from photographs inserted in the pamphlet under consideration convey a more vivid impression

There is no doubt that this lens will find some very valuable applications, that of astronomical photography not being the least of them, for every one knows the great advantage a *short* telescope has over a long one if the degree of magnification in both are equal W

ARBORESCENT FROST PATTERNS

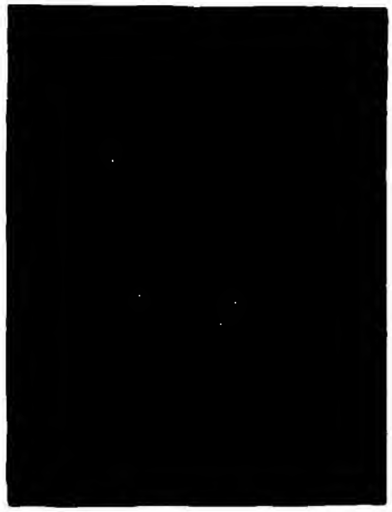
WE have received the following letters with regard to arborescent frost patterns, to which Prof Meldola called attention in last week's NATURE —

I AM very glad that Prof Meldola has called attention to the curved figures of frozen mud (of which the specimens on December 4 were unusually fine), because I hope that some one will explain why the sexangular crystallization which is universal in snow, and general in water, is exchanged both on windows and on muddy pavements for curves Probably I ought to know all about it, but I cannot remember seeing an explanation, and shall be obliged by reference to one, which will probably be of interest to others besides G J SYMONS

62, Camden-square, London, N W

THE interesting "fronds" of muddy ice observed by Prof. Meldola (p 126) are not very uncommon on the pavements in these "Northern Heights" I saw them on the date which he named, and have more than once studied them I then noticed that the "interstitial" pavement seemed partly cleared of mud, as if the water had drawn this towards the groups of crystals The mode of formation recalled to my mind certain phenomena in crystal building within rocks, and I suspect the mud has its influence. Indeed, it seems to me very probable that all these "dendritic" growths of crystals are the results of "impeded" or "constrained" crystallization, to some of which I have called attention in noticing a structure in the Charnwood syenite (*Quart Jour Geol Soc*, 1891, p 101) On this point Prof. Sollas makes some important remarks in his well-known paper on the Wicklow granites. T G BONNEY

THE beautiful curved forms assumed by the ice on the paving flags last Sunday were very noticeable in this neighbourhood and Hampstead as well as in other parts of London What I observed were not quite like those described and figured by Prof. Meldola, but resembled rather the scrolls and volutes which are frequently used in decorative art The finest piece that I saw was in this square, where several of these scrolls radiated from a central point, and spread over several feet of the pavement. A friend, Mr. E. Swain, observed that where one of these scrolls came upon a puddle of clear water the crystals were continued in a straight line Such forms are not at all unusual in the freezing of muddy water, and at the present moment the puddles in the road opposite my house are filled with rectilinear crystals of ice, which assume a curved form in the mud at their margins. The peculiarity on Sunday was their large size and beauty Something analogous takes place when gold or silver is reduced from solutions of its salts by more electro positive metals. Under certain circumstances



the metal will present itself in the form of curved crystals, if the term be allowable A pretty spray of gold of this character is figured in the report of my lecture "On the crystallization of silver, gold and other metals," in the proceedings of the Royal Institution, vi, 428 If a piece of cuprous oxide be immersed in a solution of nitrate of silver, there shoot from its surface thin threads of silver, which, after proceeding straight forward for a while, suddenly turn at an angle of 120° or 60°, and make perhaps many other deviations but sometimes these threads, instead of being straight, are curved, and in that case the threads that branch from them are curved likewise A magnified drawing of such a formation is given herewith These strange departures from the usual rectilinear course of crystal formation are very curious, and deserve more study than has hitherto been given them J H GLADSTONE.

17, Pembridge-square, December 10

PROF MELDOLA's letter (p 125) has been interesting to me, as I noted a striking and similar phenomenon here on Thursday, December 8, in the forenoon The trottoirs of several streets (east, west, north and south) were covered all over with beautiful patterns, somewhat different from Prof Meldola's illustration, there being innumerable dark, broad, sharply contoured leaf-like patches, distant several inches from each other, and connected by finely curved and branched tendril-like stalks. Foggy, with a faint north breeze I should presume the "leaves" were due to sparse drops of sleet fallen during the night.

Freiburg, Badenia, December 10 D WETTERHAN.

THE graceful arborescent frost patterns described by Prof Meldola in last week's NATURE were very conspicuous on the foot-bridge by the side of Charing Cross railway bridge, on the same morning, this being a situation still more exposed to the wind which he mentions as the probable cause

December 12. J T. RICHARDS.

I OBSERVED the same phenomenon as Prof Meldola describes in NATURE of December 8, on the same date, December 4, on pavements in Cheltenham, about 10 45 a.m ; after mid-day they had gone. I saw the patterns on pavements running north and south, as well as east and west. They were most exquisite; some like the illustration, others much more minute, but always in a connected design over the whole flag They had all the appearance of fossil vegetation. I never saw anything of the kind before J J ARMITAGE.

December 13.

MR. A. W. BENNETT and Mr. E. L. Garbett have also sent communications corroborating the phenomenon observed by Prof Meldola. The former attributes it to "defoliation of the stones as the result of weathering or wear"

THE MAKING OF RIFLES

AT a recent meeting of the Institution of Civil Engineers, Mr John Rigby, superintendent, Enfield Factory, read an interesting paper on the manufacture of small arms We reproduce from the abstract printed for the Institution Mr Rigby's lucid account of the various processes of manufacture of the components of the Lee Metford Mark I magazine rifle, of 0·303 inch bore, the weapon adopted for the British Army—an account which he prefaced with a general description of the Enfield Factory

The most important part of a rifle was the barrel, which had always engaged the special attention of gun-makers Up to the time of the Crimean War, it was, for the bulk of British troops, a comparatively rude tube of iron, lap-welded under rolls and tapering externally, with a cylindrical bore of about ¾ inch diameter The barrel of the present day was a steel tube of accurate workmanship, only $\frac{3}{10}$ inch bore, almost perfectly true and straight, rifled to $\frac{5}{1000}$ inch, and so closely inspected that the existence of the most minute grey or seam in the bore, requiring a highly-practised eye to detect it, was sufficient to condemn it The material used was produced either by the Siemens Martin or the crucible process of manufacture, and was supplied to Enfield as a solid round bar 1⅜ inch diameter and 15½ inches long After severe testing, this bar was passed through a rolling mill to draw it to its full length it was then taken to the forge, the swell at the breech-end was stamped to the required shape by a steam-hammer, and afterwards straightened cold The next step was to submit the bar, without annealing, to the turning and drilling-machines The latter were horizontal, the drills operating from each end. In the process of drilling, the barrel revolved at nearly 1,000 revolutions a minute against half round bits held flat down, a capillary tube, of brass, supplying a soap-and-oil emulsion, at a pressure of 80 lb to the square inch, to wash out the swarth and cool the cutting edge The drills advancing from each end continued boring until a small disk about $\frac{1}{10}$ inch diameter broke out, and the two holes met The tendency *of the drills to follow the line of axis of a revolving bar was* one of those curious occurrences in practical mechanics which might be accounted for after observation, but which no one would predict Occasionally, through some defect in the steel, a drill wandered from the axial line, in this case the barrel was taken from the machine and reset sufficiently to bring the hole true again To test its truth, a ray of light was made to illuminate the flat bottom of the hole while the barrel slowly revolved It was very rarely that a barrel was rendered waste from bad drilling Rough-boring followed with a three edged bit, the blade being about 4 inches long The rough external turning was effected in self acting lathes, which gave the required curved taper. Three or four cutters acted simultaneously, each producing a long cutting that attested the quality of the metal of the barrel The operation of barrel-setting followed Previous to rough turning, the barrels were fairly straight internally, but the removal of the metal caused slight inequalities which were tested by the eye of the barrel setter, and corrected by transverse blows. This constituted skilled labour of a peculiar character, and was performed by young men of good sight, who were specially trained for the purpose After middle life the eye generally lost some of the quality necessary for this work, and it was rare to find a man excel in it after that period. Many mechanical devices had been contrived to supersede the simple ray of light laid, as if it were a straight edge, along the surface of the bore, but the eye still remained the arbiter of straightness and could be relied on for very accurate results. The construction of the barrel was completed by the important operation of rifling In British small-arm factories the system was followed of planing out each groove separately with a hooked cutter, and had been brought almost to perfection In Continental and American factories the grooves were ploughed out by cutters, with several cutting or knife-edges set at an angle and following one another in the manner of a single-cut file or float. Similar machines had been tried at Enfield, but did not give as smooth a cut as the slower-moving, single-tooth machines. A few passes of a lead lap, fed with fine emery, removed any burr that might remain, and completed the polish; a cylindrical lap, spinning rapidly, was then passed through, and gave the final finish to the barrels. The limits of gauging were from 0·303 to 0·305 inch.

Next in importance to the barrel was the mechanism of the breech, for which the material preferred was crucible cast-steel of a mild character, but capable of being hardened in those parts exposed to the pressure of the bolt The body was forged in two operations under the steam-hammer, it was then drilled and subjected to a long series of operations, in the course of which the end was recessed to receive the screwed end of the barrel, and the corresponding thread in the recess was milled out in a specially-contrived machine, which insured that the thread should always start in the same place relative to the gauged part of the body, a point of great importance The bolt, also of crucible cast steel, was forged under the steam hammer A special machine, invented at Enfield, was used to finish the bolt after shaping After machining, the bolts, packed in wood charcoal in iron cases, were heated and hardened by immersion in oil The temper of the handle was then reduced in a lead bath The rest of the bolt was tempered straw colour The bolt-head was similarly hardened and tempered

The other components of a complete rifle were mostly shaped by mills built up to the proposed profile, or by copy-milling machines The process of drifting was used with good results at Enfield All such slots or perforations as had parallel sides, and were not cylindrical, were so finished. The common practice in drifting was to push the drift, but at Enfield much better work was accomplished by pulling It was found that used in this way drifts were very valuable for interchangeable work The sides were cut with successive teeth, each slightly larger than the preceding one, and the whole length of the drift was drawn through Emery wheels were also largely used at Enfield as a substitute for finish-milling and filing The wheels ran under hoods connected with a pneumatic exhaust that carried away the heated particles of steel and grit It was popularly supposed that a machine once adjusted to turn out a component of a certain size and shape was capable of reproducing such in large numbers, all absolutely identical This was so far from being the case that no die, no drill, and no milling-cutter actually made two consecutive articles the same size The wear of the cutters or dies proceeded slowly but surely, and it was only possible to produce in large numbers components of dimensions *varying between a superior and an inferior limit* In small-arm manufacture a variation of about one two thousandth of an inch was about the amount tolerated, but it varied according to the size of the piece A difference of diameter of one two thousandth of an inch in the sight axis-hole, and in the size of the pin or axis, would cause a serious misfit, whereas a similar difference in the measurement of the magazine, or of the recess in which it lay, would be quite immaterial The operations of gauging, proving the barrel, and sighting, were successively described, as also the manufacture of the stock, which was of the wood known as Italian walnut, though largely grown in other countries Among the smaller components, the screws were mentioned as being rapidly produced by the automatic screw-making machines of Pratt and Whitney.

The Component Store received the various finished parts, which numbered 1591, or, including accessories, 1863, and issued them to the foreman of the assembling shop Theoretically, the assemblers should have nothing to do but to fit and screw them together, but in practice small adjustments were found necessary The amount of correction was generally exceedingly small, and was done wherever possible with the aid of emery wheels The completed arms were submitted to inspection, and then issued in cases of twenty each to the Weedon Government Store or elsewhere

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The General Board of Studies propose that, in view of the increased attention given to palæontology in the Geological Department, a Demonstrator in Palæozoology be appointed, whose stipend shall be paid out of the students' fees.

The Botanic Garden Syndicate report the completion of the fine range of plant-houses, which have for some years been in course of erection at a cost of some £6000. It is noteworthy that the expense has been kept within the estimate

The Senate has determined to raise the fee for the Doctor's degree (including M D. and Sc.D) from £20 to £25. It has rejected the proposal to increase the annual dues of undergraduates from 17s. to £2, and of graduates from 17s to £1, which was put forth in view of the financial needs of the University, by the Fees Syndicate The proposal to accept life-

compositions for the annual dues was also rejected Dr Allbutt Regius Professor of Physic, has been appointed an Elector to the Chair of Botany, in the place of the late Dr Hort

The discussion on the plans for the new Geological Museum (given at length in the *University Reporter* for December 13) was highly interesting, and appears on the whole to have been favourable to the scheme proposed, subject to relatively unimportant modifications Prof Newton objected that the arrangement of its contents should be zoological rather than stratigraphical, and the Registrary (Mr J W Clark) took exception to the plan of lighting, which would be better if it were from the top rather than the sides The geological staff were unanimous that the plan put forward was that which best met their needs It was agreed that the architectural effect of the museum would be very fine, and worthy of Sedgwick's memory

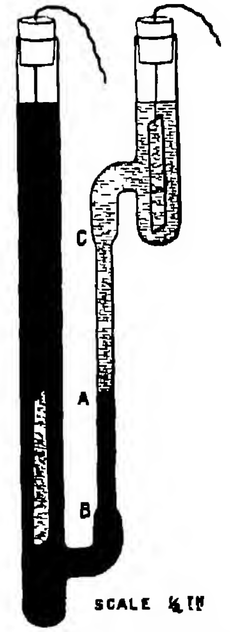
SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 24.—"Ionic Velocities." By W C. Dampier Whetham, B A, Fellow of Trinity College, Cambridge Communicated by J J Thomson, F R S

From a series of determinations of the electrolytic conductivity of various salt solutions combined with Hittorf's values for the migration constants, Kohlrausch calculated the velocity of different ions under a potential gradient of one volt per centimetre Dr O Lodge actually observed the velocity of the hydrogen ion as it travelled along a tube filled with sodium chloride dissolved in jelly, decolourizing phenol-phthallein as it went He found 0029 cm per sec, and Kohlrausch gives 0030

The author has measured the specific ionic velocity of other ions by observing the motions of a junction between two salt



solutions of slightly different density and different colours, when a current was passed across it From the velocity of the boundary, that of the ion causing the change in colour can be deduced, The apparatus consisted of two vertical glass tubes about 2 cms. in diameter, joined by a third considerably narrower, which was bent parallel to the others for the greater part of its length The tube was filled with the solutions in such a manner that the boundary was formed in the vertical part of the junction tube.

When the solutions are of different specific resistances there will be a discontinuity of potential gradient at the boundary and a consequent electrification. The effect on the velocity of the boundary is, however, non-reversible, and, for small differences, can be eliminated by taking the mean of the velocities in opposite directions. The direct estimation of potential gradient is unsatisfactory, but by measuring the current (γ), the area of cross-section of the junction tube (A), the specific resistance of the solution (r), and the velocity of the boundary (v) we can find the specific ionic velocity v, for $v_i = \frac{vA}{\gamma r}$.

The first solutions used were those of copper and ammonium chlorides dissolved in aqueous ammonia, the former being blue, the latter colourless. The junction travelled with the current with a velocity of 1 57 cm per hour going upwards and of 1 60 cm per hour coming downwards The mean gives as the specific ionic vel of Cu in solutions of 1 gram equiv. per litre 000309 cm per sec. This agrees exactly with Kohlrausch's number for infinitely weak solutions of '00031 cm per sec Other measurements were made for chlorine and for the bichromate group (Cr_2O_7).

The method was extended to alcohol solutions The velocities of both ions of a salt were determined by using two pairs of solutions. Thus the velocity of chlorine was found by using a cobalt chloride-cobalt nitrate pair, the colours of which are blue and red respectively, and that of cobalt by a cobalt chloride-calcium chloride pair, these being blue and colourless The sum of these velocities was compared with that deduced by Kohlrausch's method from the conductivity of the solution The following are the results :—

SPECIFIC IONIC VELOCITIES

I —*Aqueous Solutions.*

Ion	Velocity observed	Velocity calculated
Copper	0 00026* 0 000309	0 00031
Chlorine	0 00057* 0 00059*	0 00053
Bichromate group (Cr_2O_7)	0 00048 0 00047 0 00046	0 000473

* Preliminary observations.

II —*Alcoholic Solutions.*

Salt	Vel of Anion observed	Vel of Kation observed	Sum of vels. observed	Sum of vels calculated
Cobalt Chloride	0 000026	0 000022	0 000048	0 000060
Cobalt Nitrate	0 000035	0 000044	0 000079	0 000079

December 8 —"On the Velocity of Crookes' Cathode Stream" By Lord Kelvin, P R S

In connection with his splendid discovery of the cathode stream (stream from the cathode in exhausted glass vessels subjected to electric force), Crookes found that when the whole of the stream, or a large part of the whole, is so directed as to fall on 2 or 3 sq. cm of the containing vessel, this part of the glass becomes rapidly heated up to many degrees, as much as 200° or 300° sometimes, above the temperature of the surroundings.

Let v be the velocity, in centimetres per second, of the cathode stream, and ρ the quantity of matter of all the molecules in 1 c c. of it Supposing what Crookes' experiments seem to prove to be not far from the truth, that their impact on the glass is like that of inelastic bodies, and that it spends all their translational energy in heating the glass The energy thus spent, per square centimetre of surface struck, per second of time, is $\frac{1}{2}\rho v^3$, of which the equivalent in gramme water centigrade thermal units is approximately $\frac{1}{2}\rho v^3/42{,}000{,}000$. The initial rate at which this will warm the glass, in degrees centigrade per second, is

$$\frac{\frac{1}{2}\rho v^3}{10^6 \times 42\ \sigma a} \quad \ldots \quad \ldots \quad (1),$$

where σ denotes the specific heat of the glass, and a the thickness of it at the place where the stream strikes it

The limiting temperature to which this will raise the glass is

$$\frac{1}{E} \times \frac{\frac{1}{2}\rho v^3}{42{,}000{,}000} \quad \ldots \quad \ldots \quad (2)$$

where E denotes the sum of the emissivities of the two surfaces of the glass in the actual circumstances.

It is probable that ρ differs considerably from the average density of the residual air in the enclosure. Let us take, however, for a conceivably possible example, $\rho = 10^{-8}$, which is what the mean density of the enclosed air would be if the vessel were exhausted to 8×10^{-6} of the ordinary atmospheric density.

To complete the example, take

$$v = 100,000 \text{ cm. per sec.}$$

(being about twice the average velocity of the molecules of ordinary air at ordinary temperature); and take

$$\sigma a = \tfrac{1}{4} \text{ cm},$$

as it might be for an ordinary glass vacuum bulb, and take

$$E = \tfrac{1}{8000},$$

which may not be very far from the truth

With these assumptions, we find, by (1) and (2) approximately, 1° per second for the initial rise, and 375° for the final temperature, which are not very unlike the results found in some of Crookes' experiments

The pressure of the cathode stream of the velocity and density which we have assumed by way of example is ρv^2, or 100 dynes per square centimetre, or about 100 milligrams heaviness per square centimetre, which is ample for Crookes' wonderful mechanical results.

The very moderate velocity of 1 kilom per second which we have assumed is much too small to show itself by the optical colour test. The fact that this test has been applied, and that no indication of velocity of the luminous molecules has been found, has, therefore, no validity as an objection against Crookes' doctrine of the cathode stream

Chemical Society, November 17.—Sir Henry Roscoe, Vice President, in the Chair —The Chairman congratulated the Fellows on the great improvement effected in the Society's rooms by the alterations carried out during the recess An address has been forwarded to the sister society in Berlin on the occasion of the celebration of its twenty-fifth anniversary A resolution was passed at a meeting of the Council expressing deep regret that, through the death of Dr Longstaff on September 23 last, the Society has lost its senior Fellow and one of its Founders. The following papers were read:—Fluosulphonic acid, by T E. Thorpe and W. Kirman This paper has been already reported in this volume, page 87.—Note on the interaction of iodine and potassium chlorate, by T E Thorpe and G H Perry The reaction which occurs when iodine and potassium chlorate are heated together is usually represented by the equation $3KClO_3 + I_2 = KClO_4 + KCl + KIO_3 + ICl + O_2$, the authors find, however, that the main reaction consists in a simple interchange of iodine and chlorine thus—$2KClO_3 + I_2 = 2KIO_3 + Cl_2$.—The magnetic rotation of sulphuric and nitric acids, and of their aqueous solutions, also of solutions of sodium sulphate and lithium nitrate, by W H Perkin, sen The author has previously shown that the molecular rotation of sulphuric acid is considerably influenced by the presence of water, the rotation rapidly falls for small dilutions, but diminishes as the amount of water is increased The results are now extended, in the cases of sulphuric acid and sodium sulphate there is no apparent connection between the values representing the rotation and the extent to which dissociation is supposed to occur down to solutions containing 9 per cent. of acid or 12 per cent. of sodium sulphate At a temperature of 90° the rotation is increased instead of diminished as indicated by the dissociation hypothesis. The results are not inconsistent with the assumption that the hydrate $(HO)_4SO$ is formed In the case of nitric acid, the curve connecting rotation and percentage of acid is a straight line down to solutions containing 33 per cent. of HNO_3, and then apparently bends down somewhat; the results are not in agreement with the exigencies of the dissociation hypothesis. A compound of the composition $(HO)_3NO$ may be produced. Lithium nitrate resembles nitric acid in its behaviour. The rotations of strong aqueous solutions of the haloid hydrides change very rapidly with small dilutions, but more slowly with larger dilutions, becoming finally nearly stationary; such behaviour is not in accord with the dissociation hypothesis.—Note on the refractive indices and magnetic rotations of sulphuric acid solutions, by S. U Pickering. Van der Willingen's results for the refractive indices of sulphuric acid solutions yield curves showing a well-marked "break" at 84·5 per cent. (H_2SO_4, H_2O), another "break" at 57 7 per cent. (H_2SO_4, $4H_2O$), and another at 24–30 per cent. The first two of these are also found on the magnetic rotation curves and all three of them agree with breaks found in the examination of other properties. The molecular volumes of solutions of the same strength as those used by Perkin when plotted out exhibit the same three breaks on the curve.—The hydrate theory of solutions Some compounds of the alkylamines with water, by S U Pickering The following table gives the compositions of a number of crystalline hydrates of fatty amines which the author has succeeded in isolating and analyzing —

$EtNH_2,5H_2O$	$EtNH_2,5·5H_2O$
$PrNH_2,5H_2O$	$Bu^{\alpha}NH_2,7H_2O$
$Et_2NH,5H_2O$	$Me_2NH,7H_2O$
$Pr_2NH,5H_2O$	$Pr^{\alpha}NH_2,8H_2O$
Me_2NH,H_2O	$PrNH_2,8H_2O$
$Et_3N,2H_2O$	$Et_2NH,8H_2O$
$Me_3N,3H_2O$	$Me_3N,11H_2O$

The freezing points of the hydrates ranged from + 5° to − 71°; indications of the existence of other hydrates were also obtained by "breaks" in the curves representing the freezing points of the solutions, and in every instance but one a hydrate of the composition thus indicated in the case of one amine was actually isolated in the crystalline condition in the case of some other amine In connection with this subject Prof Thorpe showed a very pretty experiment to illustrate the fact that whilst a mixture of triethylamine (15–50 per cent) is clear and transparent at ordinary temperatures, the solution becomes turbid on warming, owing to the amine being thrown out of solution, on applying pressure to the warm liquid, however, re-solution occurs.—The atomic weight of boron, by E Aston and W Ramsay The authors have investigated the atomic weight of boron, the atomic weight found from determinations of the water of crystallization of borax is 10 921 ± 0 01 The conversion of anhydrous sodium borate into sodium chloride by distilling it with hydrochloric acid and methyl alcohol and weighing the sodium chloride obtained gives an atomic weight of 10·966 for boron The authors consider that Abrahall's number (10 825) for this constant is too low, as the boron bromide employed by him might have been contaminated with the compound BBr_3,HBr.—Methoxyamido-1 3-dimethylbenzene and some of its derivatives, by W R Hodgkinson and L. Limpach An almost theoretical yield of 1 2 · 4-metaxylenol may be obtained by steam distilling a diazotized 5 per cent. solution of the corresponding xylidine sulphate The product solidifies in a mixture of solid carbonic anhydride and ether On nitration a theoretical yield of a mononitro-derivative ($NO_2 . OH = 1\ 2$) is obtained A number of other compounds are described.—An extra meeting of the Society will be held on Tuesday, December 13, at 8 p m, the anniversary of the death of Stas A paper by Prof J W Mallet, entitled "Jean Servais Stas, and the measurement of the relative masses of the atoms of the chemical elements" will be read and discussed

Physical Society, Nov. 25.—Prof S P Thompson, F R.S, Vice-President, in the chair.—The following communication was made: Experiments in electric and magnetic fields, constant and varying, by Messrs Rimington and Wythe Smith In the first set of experiments shown exhausted electrodeless tubes and bulbs were rotated rapidly in a constant electric field between two parallel charged discs. Double fan-shaped images were produced by the tubes, due to the displacement currents which pass to equalize the potentials at the ends of the tubes These fans were not symmetrical with respect to the lines of electric force, but were displaced in the direction of rotation In explanation of this phenomenon it was pointed out that as a tube rotated the potential difference between its ends increased until this difference was sufficient to break down the dielectric in the tube The discharges would therefore pass at the ends of the intervals during which the difference of potential was rising, and consequently the images would be displaced from the symmetrical position in the direction of rotation. The number of discharges produced during one revolution was found to depend on the strength of the electric field, but not on the speed of rotation, and that end of the tube which was approaching the negatively charged plate appeared brightest. These experiments were referred to as examples of the direct conversion of mechanical energy into light. Instead of rotating tubes in a constant electric field, the tubes were next kept stationary, and a varying electric field produced by connecting the plates with an influence machine allowed to spark, under these conditions the tubes and bulbs were seen to glow. Using large suspended plates charged by an induction coil, long tubes were caused to glow brightly even at considerable distances away from the plates. The glow could be apparently wiped out by passing the

hand along the tube. Another series of experiments were performed in varying magnetic fields. With a view to showing Hertzian phenomena to large audiences the authors tried Geissler tubes to replace the spark-gap in resonators, with great success. When large Leyden jar circuits were used the effects were very brilliant. Another form of resonator consisted of a bent wire terminating in two plates, between which an exhausted tube was placed. This tube became luminous when the resonator was placed in the vicinity of a fairly large Hertz oscillator. Other experiments similar to those shown before the society at Cambridge by Prof. J. J. Thomson, on discharges in exhausted bulbs were then made, the bulbs being placed with a coil of wire of four turns, forming the connection between the outer coatings of two small jars, whilst sparks passed between knobs connected with the inner coatings. The bulbs glowed brightly at each discharge, rings of light being seen near their inner surfaces. On putting a ring tube outside the coil this was also seen to glow. The most brilliant part of the glow always occurred in close proximity to the wire coil. A secondary coil, wound by the side of the above-mentioned primary, could be short-circuited at will; this had the effect of decreasing or extinguishing the luminosity in the bulb or tube. Bright sparks passed between the secondary terminals when held a short distance apart, but the shock experienced by touching the ends was not serious. The above arrangement, with the addition of two Geissler tubes placed in series between the outer coatings of the jars, was used to illustrate the fact that closing the secondary diminishes the impedance of the primary circuit of a transformer. Experiments on condensers made of tin foil on glass were shown. In one of them, parts of the coatings in the form of letters had been removed, and the spaces became luminous when the condenser was connected with an induction coil. In another experiment a glass plate was moved to and from a condenser, and a musical note could be heard whose pitch increased as the distance between the glass plates diminished. The note was said to be the octave of an open organ pipe, whose length was equal to the distance between the plates. Mr. Swinburne thought some of the effects shown were not Hertzian, but merely cases of ordinary mutual induction. He inquired whether the vacuum tubes would still glow if the Leyden jars were removed from the so-called resonating circuits. He was also of opinion that in the magnetic experiments the surfaces of the bulbs, and not the enclosed gases, took the charges. Mr. Watson asked if the authors had tried screening off the long waves by a wet cloth. If the effects still existed, this would prove that they were Hertzian. Mr. Blakesley wished to know if the images of the rotating tubes were at equal angular distances. Mr. Smith pointed out that these distances were not equal, but corresponded to equal changes of potential. Prof. Ayrton remarked that the only cases where the materials of the bulbs, tubes, &c., did not influence the results were those in which discharges were produced by varying magnetic fields. Mr. E. T. Carter thought an induction coil a more efficient machine for producing the glow in tubes than the alternator, &c., used by Mr. Tesla. Mr. Trotter asked if the authors had observed whether the glow produced by passing a discharge through a wire wound in a long pitch spiral round a tube formed an open or a closed circuit of light. Prof. S. P. Thompson said he first noticed that sparks passed between pieces of metal in the vicinity of an induction coil sparking into a condenser in 1876, when he was showing some experiments on telegraphic apparatus before the society, but unfortunately he did not pursue the subject. Long before Mr. Tesla's investigations Dr. Bottomley had shown that exhausted tubes could be caused to glow, but it was not until Tesla produced such phenomena on a large scale that people recognised how much light could be got in that way. Mr. Rimington, in replying to a question by Prof. Thompson, said the notes heard when the glass plate approached the condenser were of very high pitch. The explanation why in the experiments performed in varying magnetic fields, the bright parts of the luminous discharges were near the wire, appeared to be that the E.M.F. was greatest in these places. Although he had not tried the experiment, suggested by Mr. Swinburne, of taking off the Leyden jar, he felt sure that doing so would stop the glow.

Geological Society, November 23.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—Outline of the geological features of Arabia Petræa and Palestine, by Prof. Edward Hull, F.R.S. The region may be considered as physically divisible into five sections, viz. (1) The mountainous part of the Sinaitic Peninsula; (2) the table-land of Badiet-el-Tîh and Central Palestine; (3) the Jordan-Arabah valley; (4) the table-land of Edom, Moab, and the volcanic district of Jaulân and Haurân; and (5) the maritime plain bordering the Mediterranean. The most ancient rocks (of Archæan age) are found in the southern portion of the region; they consist of gneissose and schistose masses penetrated by numerous intrusive igneous rocks. They are succeeded by the lower carboniferous beds of the Sinaitic peninsula and Moabite table-land, consisting of bluish limestone with fossils, which have their counterparts chiefly in the carboniferous limestone of Belgium, and of a purple and reddish sandstone (called by the author "the desert sandstone," to distinguish it from the Nubian sandstone of Cretaceous age), lying below the limestone. The Nubian sandstone, separated from the carboniferous by an enormous hiatus in the succession of the formations, is probably of Neocomian or Cenomanian age, and is succeeded by white and grey marls, and limestones with flint, with fossils of Turonian and Senonian ages. The Middle Eocene (Nummulitic limestone) beds appear to follow on those of Cretaceous age without a discordance, but there is a real hiatus, notwithstanding the apparent conformity, as shown by the complete change of fauna. In Philistia a calcareous sandstone in which no fossils have been observed is referred to the Upper Eocene; for the Miocene period was a continental one, when faulting and flexuring was taking place, and the main physical features were developed—*e.g.* the formation of the Jordan-Arabah depression is referable to this period. In Pliocene times a general depression of land took place to about 200–300 feet below the present sea-level, and littoral deposits were formed on the coasts and in the valleys. To this period belong the higher terraces of the Jordan-Arabah valley. The Pliocene deposits consist of shelly gravels. Later terraces were formed at the epoch of the glaciation of the Lebanon mountains, when the rainfall was excessive in Palestine and Arabia. The volcanoes of the Jaulân, Haurân, and Arabian desert are considered to have been in active operation during the Miocene, Pliocene, and Pluvial periods; but the date of their final extinction has not been satisfactorily determined. After the reading of this paper the president remarked on the interest of the geology of an area, which was that of the Bible. Many authors had recorded their observations on this district, one of the latest being the author of this paper. Some years ago Mr. Holland had read a paper before the Society, and he (the speaker) believed that that writer was actually the first to prove the existence of carboniferous fossils in the Sinaitic peninsula. He remarked that *Lepidodendron mosaicum*, described by Salter, was somewhere preserved in the Society's museum, so that the Society had long ago had evidence of carboniferous rocks. Mr. Bauerman's paper, which was a reconnaissance in a comparatively unknown district, created great interest; and when that paper was read doubt was expressed as to whether the fossils then exhibited were carboniferous or triassic. After the researches of Prof. Hull there was no doubt that carboniferous rocks do occur in the region. As regards the granitic rocks (extending far up the Nile valley, in the Sinaitic peninsula, and elsewhere), they were all of much the same character, and, according to Sir William Dawson, occurred at two horizons—the lower rocks being granitoid and gneissic, the upper more or less volcanic, but still pre-carboniferous. He asked the author whether the Poudingues de Jebel Haroûn of Lartet were or were not ancient volcanic rocks. The Nubian sandstone of older writers included many things, but the age of the various sandstones was now satisfactorily determined by the author. Some were carboniferous, others (in the speaker's opinion) cenomanian. The calcareous formations of Judæa were well known from the writings of Lartet, Fraas, and others; but the exact line of demarcation between the Nummulitic limestone and the true Cretaceous had never been determined. It was a curious fact, as stated by Von Zittel, that not one fossil was common to the two deposits, which were nevertheless quite conformable. Miocene beds appeared to be absent, for, as noted by Lartet and confirmed by the author, this was a period of movement, when the great valley and the great fault were initiated. He (the speaker) felt that there were many difficulties connected with the depression which had not yet been cleared up. Lartet, Hitchcock, and others had traced the general direction of the fault; but the author had determined its exact site at more than one point. The most interesting point in this connection was the question of the age of the 700-foot saddle separating the Akabah watershed from the Jordan-Arabah depression. This

THURSDAY, DECEMBER 22, 1892

MR C. DIXON ON BIRD-MIGRATION.

The Migration of Birds: an Attempt to reduce Avian Season-Flight to Law By Charles Dixon (London Chapman and Hall, 1892.)

AMONG prevalent fallacies there are few more mischievous than that which holds a man to be an authority on a subject because he has written a book about it If the subject be one concerning which the scientific hold divers opinions, or even hesitate to deliver an opinion at all, so much is to the good of such an author, for he will be able to pose all the more securely in the character of a *savant*—though after all that only signifies a "knowing one" If the author can boast of some two, three, or even half-a-dozen works already published, the fallacy becomes almost insuperable, notwithstanding that in zoological works of a popular nature, it is scarcely too hard to say that those who write the most know the least. Nevertheless it remains the duty of the conscientious reviewer to be instant in season with his protest against this general confounding of author with authority We have read several of Mr Charles Dixon's works, but hitherto we have been so fortunate that we have been able to keep *in petto* the judgment we have formed of them. It is not given, however, even to reviewers to struggle against fate, and it has been ordained that we should have to criticize his recent volume, the title of which may be read above To the first sentence of his preface—"There is no branch of Ornithology more popular than that which treats of the Migration of Birds"—we offer no strong objection, and rejoice that there is one spot of ground, be it never so small, that we may occupy in common, but (woe it is !) that here we must part company, for the very next sentence contains a statement which we would willingly let pass as a harmless exaggeration, were it not intensified by the words which follow—and "after that, the dark"!

Mr. Dixon's acquaintance with the subject he has selected is shown by the beginning of his second paragraph—"Notwithstanding the immense popularity and importance of Migration, strange as it may seem, no work has hitherto been devoted expressly to its discussion" He is therefore not aware of the essays of Schlegel and of Marcel de Serres, which (whatever we may now think of them) were in their time "crowned" by the scientific society that published them, and though he straightway proceeds to name the works of Professor Palmén and Herr Gatke, it is to complain of them that they "have only dwelt upon a portion of the subject." Far be it from us to say that Mr. Dixon has not read their works, but really there is nothing to show that his knowledge of them is more than may be picked up from the extracts which have been translated into English and published in this country, or that he has read them to any purpose—that of Herr Gätke especially, because, when further on (pp. 181-186) he comes to deal with it more particularly, he regards it as if it were a "mere record of captures or reputed captures of birds in Heligoland, speaking of it with contempt, and the original and rather peculiar views on migration of its author are passed over in silence, as though they were utterly unknown to him. Mr. Dixon states that he is "equally cognizant of the researches of Weissemann" (*sic*) and others, which, except that Dr Weismann, we think, would deny his having made any, we do not take upon ourselves to gainsay, though our older writers are utterly ignored, and we have a shrewd suspicion that the anonymous author of the "Discourse on the Emigration of British Birds," published at Salisbury more than one hundred years ago, was, from actual observation, more familiar with the main facts than Mr Dixon is—all flourishes about "avian fly-lines" and "season-flight" notwithstanding—and therefore would have been more competent than he "to bring our knowledge of Migration within the limits of order or to reduce it to Law"

Now this is exactly what in our opinion Mr Dixon has not done. What the "Law of Migration," of which we read here and on the title-page, may be it passes us to discover The phrase is full of sweetness, but its elucidation, if we may say so, fails in light So also is that about bringing our knowledge "within the limits of order," though that may be here taken to mean a dissertation within the limits of 300 pages or thereabouts containing something on the origin and descent of birds, a good deal about the precession of the equinoxes and the eccentricity of the earth's orbit, but still more about glacial epochs Concerning the "Law of Migration" it is pointless Let our author at once speak for himself in what seems to be a sort of summary of his faith, though it is long and not reserved to the end of his volume —

"We will now conclude by following in detail the migration of some single species, say from its Post Pliocene glacial initiation to the present day, in order clearly to demonstrate Why the habit [of migration] has been acquired, and How it is practised

"We will select the Spotted Flycatcher (*Muscicapa grisola*) for the purpose It is one of our best known summer migrants, and one whose present geographical distribution admirably illustrates the phenomenon of Migration When the Sub Polar regions of the northern hemisphere last enjoyed a warm, almost semi-tropical climate—one of the mild periods of the Glacial Epoch—the Spotted Flycatcher inhabited in one unbroken area the Arctic woodlands from the Atlantic to the Pacific. Probably it was a resident species becoming partially nocturnal during the Polar night, food was abundant, its conditions of life were easy, and it multiplied apace, and became a dominant, firmly established species during the thousands of years that it dwelt in this Sub-Polar habitat. So matters continued until the slow precession of the equinoxes, in conjunction with increasing eccentricity of the earth's orbit, began to have a marked influence on the climate, and gradually the fair forests and the verdant plains were devastated by the ever-increasing cold Age after age the Spotted Flycatcher was driven slowly south; summer after summer grew colder and shorter, the periods of Polar darkness more severe. At last matters became so serious that the birds began to leave their northern haunts in autumn, probably because their food became scarce as the various insects either retreated south or began to hibernate Further and further southward these annual journeys had to be taken, until the Flycatcher at last found its way during winter into Africa, Persia, Arabia, India, China, and even the Philippines and the Moluccas. Summer after summer the belt of breeding-ground became wider and wider, and vast numbers of individuals became separated from

the rest of the species by the lofty mountain ranges, the deserts, and other physical barriers, which would effectually assist a forest or woodland haunting species. More and more severe became the winters, longer and longer, the glaciers descended lower and lower, exterminating or driving before them all living things. At last the Spotted Flycatcher, or the form which then represented this species, came to be divided into two enormous colonies—an African one and a Chinese one—the individuals of each being completely isolated from each other, summer and winter alike. During the ages that this state of things continued, the Flycatchers became segregated into two species, owing primarily to the absence of any intermarriage; the eastern race became smaller, the tail shorter, and the breast-streaks broader, or the western race became larger, with a longer tail and narrow breast-streaks. It is almost impossible to say which form now most closely resembles the ancestral species; but such are the present differences between the two races known to ornithologists respectively as *Muscicapa grisola* (the Western and British form) and *Muscicapa griseisticta* (the Eastern form). Such was the state of things at the close of this Inter-Glacial Period.

"Then came the gradual immigration north again, as precession and lower eccentricity initiated a milder climate. Age after age the journey in the spring became longer. Certain routes to and fro came to be recognized highways of passage; and so imperceptibly did the northern breeding grounds expand that the birds became regular migrants, looking upon the movement north to higher and cooler latitudes each spring as an undertaking never to be missed. Warmer and warmer became the southern haunts, stimulating and widening migration flight to the cooler temperatures prevailing near the edges of the retreating glaciers, where a suitable breeding climate could only be found.

"Let us confine our attention solely to the birds that bred in the British Islands. In the Præ-Glacial ages this area formed part of Continental Europe; a rich and fertile corner, abounding in insect life, full of haunts the Flycatcher loved. After the banishment of its race and the exile of its ancestors in Africa, the northern journey at first did not extend further than the edges of the glaciers on the Mediterranean coasts of Europe. But as these disappeared, and a warmer climate began to prevail in higher latitudes, the annual summer flight was increased. Every century the northern breeding range had increased, creeping slowly across France; higher and higher with the growing vegetation; nearer and nearer to the haunts of old. During the slow, gradual elevation and submergence that isolated Albion from the rest of Europe during Post-Glacial time, the regular spring journey across the sea became wider and wider; but with the intense and inherited love of home in their tiny breasts, the individuals that were born and bred in this district never failed to return each year. For 60,000 years or more has this species now crossed the sea, returning every season, not only to our islands, but each pair of individuals, as long as they live, come back to the exact locality of their previous nests. This long journey, gradually growing longer and longer during thousands of years, until it is now at least a thousand miles in length, has grown to be a deeply rooted custom sanctioned by the practice of ages of experience and need, and looked upon now as part of the Flycatcher's very existence!" (pp. 58-62.)

This, we think, is Mr. Dixon at his best, and we are anxious that our readers should so see him. He goes on to call it a "thoroughly demonstrable instance," which shows what his idea of a demonstration is. We do not deny that all may have happened as he here prescribes, but who knows that it did? To begin with, we may ask what proof is there of the existence on the earth itself of *Muscicapa grisola* "when the Sub-Polar regions of the northern hemisphere last enjoyed a warm, almost semi-tropical climate"? That its ancestors then lived we do not doubt, but who can tell us what they were like? What is meant by its "becoming partially nocturnal during the Polar night"? If so its eyes must since have undergone a considerable change, and that would hardly be unattended by a corresponding change in other parts of the bird's structure. But still it is a pleasing suggestion that "its conditions were easy" in those millenniums, and we hope Mr. Dixon may be right, though for our own part we cannot help fearing that the struggle for existence must have already begun. Certainly it set in at last, and those terrible glaciers drove the poor bird before them, with the effect—Mr. Dixon, we think, is to blame for not giving us the geographical details (which of course must be known to him) of the process—of dividing the species or the form which represented it, and may be presumed (though this is not mentioned) to have by that time got rid of its owls' eyes, "into two enormous colonies—an African one and a Chinese one." These were so isolated that inter-marriage between the individuals of the two portions was impossible, the remarkable consequence of which was that "the Eastern race became smaller" than the Western—a character distinctive indeed of the human races, the Pygmies excepted, now inhabiting the same lands—but with "the tail shorter"—a contradictory character, since the long tail of a Celestial is the really important part of him. We are also told that "it is almost impossible to say which form now most closely resembles the ancestral species," an unexpected confession of ignorance (the "almost" is good) after so much information, but one to which we see the necessity of bowing. However, what is the upshot of all this? And how is any "law" illustrated by it? Setting aside the vagaries on which we have just commented, it reads to us as being merely an amplification of suggestions that were tentatively and cautiously submitted in these columns more than eighteen years ago (NATURE, vol. x. pp. 416 and 459). The partiality of birds for their old homes was then, and (so far as we know) for the first time, pointed out as one possible factor in establishing migratory habit, and, as another (and equally for the first time), the growing divergence of breeding and feeding areas through climatic causes was briefly and clearly set forth by Mr. Wallace. Notwithstanding Mr. Dixon's assertions, he does not seem to have advanced the question one bit, but he has overwhelmed it in a flow of words with a great deal that is, and apparently always will be, incapable of proof. Here and elsewhere throughout this volume we are brought to face one of that school of biologists, the growth of later years, which may be called the Assertive. In some respects it is a very nice one to join. You have only got to say what first comes into your head, and all goes well. Everybody that differs from you is a fool. To some extent this school resembles that Dogmatic one which a few naturalists here and there still remember, inasmuch as the dissentient from either was regarded with the same contempt. The Dogmatists have had their day, but if we look back upon their doings, we shall see that in most cases they had something to go upon which

was not entirely assertion They were very fond of facts, and undoubtedly preferred founding their dogmatism upon them—indeed, nothing could be more distasteful than to suppose each dogma had not a sound basis In most cases the worst of which they can even now be accused is that the facts were often above their comprehension, or were understood in the wrong sense But these men would have scorned the grounding of their dogmas upon imagination They were perfectly aware (only it had not then been so neatly put) that "Imagination is the fire of Discovery the best of servants though the worst of masters." Now the Assertive school, of which in this country Mr Dixon, if he was not the joint-inventor, may be looked upon as a chief leader, rests nearly all on imagination It matters little whether there is reason behind their assertions or not, and generally, we regret to say, there is none Conjectures follow upon conjectures and are put forward for the most part as if they were serious deductions from observation It is not so many weeks since some words, that seem very applicable here were addressed to a scientific audience —

"We have had enough of the untrained writer of papers, the jerry-builder of unfounded hypotheses whose ruins cumber our field of work"[1]

Mr Dixon, with his long string of previous books, may demur to being termed a writer of this kind, but he certainly needs to be taught the meaning of the word "probable" and its derivatives When he has learned it perhaps he will use it in its fit sense With him, at present, it is in many cases to be rendered "possible," while in not a few *impossible* would be the true equivalent Now according to all etymologists, and the harmless drudges known as dictionary makers, "probable" signifies *something that can be proved* Any reader of average intellect will be able to calculate how seldom this unhappy word is correctly used by Mr Dixon It has long been a custom in certain fevers to affix an ice-cap on the patient's head whereby the burning brow is cooled, and some temporary relief afforded, but of late years, as pretty well all know, there has sprung up a small group of writers to whom ice on the brain, instead of being a soothing remedy, is a direct incentive to acts and dicts bordering upon lunacy On behalf of the Glacial Epoch, the Post-Pliocene Glacial Epoch, to be very particular, we must protest against its being constantly paraded as the greatest event in the history of the globe, to which in its momentous effects all others must give place That it produced considerable changes and especially in the geographical distribution of plants and animals none can doubt, but that it is accountable for all that Mr Dixon lays to its charge is hardly likely, and is most decidedly not "probable," since means of proof are wanting But Mr Dixon, with others of the Assertive school, is not consistent in his statements, and is apt to forget on one page what he has written on a preceding one For instance, we are told (p 33) that "From the commencement of this Glacial Epoch, the Migration of birds, as we see it at the present time, was probably initiated", and yet, only a few lines further on, our author declares "that we do not require even the occurrence of one Glacial Epoch to account for the Migration of birds," and (p 34) that "such a cause amply sufficient in every respect is to be found in the varying places of Earth's [*sic*] orbital eccentricity in combination with the precession of the equinoxes"—this statement being immediately followed by a passage, the application, or even the meaning, of which is not easy to understand —

"That these majestic phenomena are in any conceivable way connected with the migratory movements of birds seems utterly impossible, but in them the habit has its root, and the simple season-flight of a Cuckoo or a Nightingale to and fro between the shores of Africa and England is inseparably and directly connected with the erratic movement of a planet in its orbit, nay, with the constitution of a universe!"

This note of admiration is our author's own far be it from us to impair its influence

Though we have confined our remarks to the earlier part of Mr Dixon's book, we have already devoted a good deal of space to him There is, however, another point on which we must say a few words. He has thrown out a direct challenge to NATURE, and we should be sorry not to meet it That he believes in migration the whole volume shows, but there is yet left in his mind a cranny wherein lurks what we may perhaps call a "pious opinion" in favour of torpidity—as a luxury in which a lazy bird may occasionally indulge, even though that bird may be one possessing powers of flight far beyond the average He is very severe on an anonymous reviewer in these columns in that the "Theory," we use Mr Dixon's word, of Torpidity "was subjected by him to the bitterest ridicule and denounced as folly" Thereupon he favours us (pp 12, 13) with another version (substantially, let us say at once, the same as the original, but with fewer details) of the story told by the Duke of Argyll in these pages (NATURE, vol xv pp 527, 528) to say nothing of some other observations, quite irrelevant, as it seems to us, communicated by his Grace to him But further than this, he cites as an additional witness in defence of the impeached "Theory," Dr Elliott Coues, who is said to give it "all the support of his authority as an ornithologist of the highest eminence" Now we have a great respect for that gentleman, but his vast reputation fails to hypnotize us, and such support as he gave has already been the subject of comment in these pages (NATURE, vol xx p 2) He will hardly be comforted to learn that the supposition there made has been amply confirmed of late by Mr Hartert, who informs us (*Cat B Brit Mus* vol xvi p 481) that the British Museum contains five specimens of *Chætura pelagica* from Central America, beside the one before noticed from Mexico —proving that its range is much about what might have been expected Thus all the argument based on Dr. Coues's statement, that this species was "not known to winter anywhere out of the United States, nor is it found anywhere in them at that season," falls to the ground, as we are sure that gentleman will readily admit We allow that it has been very naughty of naturalists if they did prepare this pitfall for Mr Dixon, but that is not our business, and we cannot imagine they did it intentionally It is not unlikely that the Chimney-Swift flew out of shot, or too fast for them to bring it down, but they have at last succeeded in "grassing" their bird, with a result so disastrous to the "Theory" One chance

[1] British Association for the Advancement of Science. Edinburgh, 1892 Address of the President of Section H (NATURE, vol xlvi p 379).

yet remains for our author, for though "unfortunately no direct evidence of torpidity has ever come under" his own observation, the *Dundee Advertiser* of April, 1884, supplies him with another straw at which to grasp—not that the newspaper-writer saw it at all in that light, for he called the bird in question a "wanderer," which term is innocently repeated by Mr Dixon, apparently unconscious that thereby he gives up his case, and drown he must unless some one throws him a life-belt Meanwhile that of the "hibernating" bird is as desperate Deprived by the brutal sceptic of its ancient refuge in the depths of Lapland lakes, or in the crumbling banks of Persian rivers, in the mud walls of Orkney or in Irish dung-heaps, or even in nests of its own building in sea-girt Schleswig-Holstein, the *fin de siècle* Swallow desirous of enjoying torpidity has to betake itself to the security of the Bell Rock Lighthouse, and even there to excite no particular astonishment on the part of the honest men who welcomed it If they had looked upon it as the spirit of Robert Stevenson, or that Abbot of Aberbrothock whose memory was blessed by mediæval mariners, there would have been some excuse for them, but they simply regarded this Swallow as the proverbial one that doesn't make a summer—it was the 12th of March They will, we think, learn with surprise from Mr Dixon that "this bird may probably have spent the winter, dormant, near the lighthouse," while he considers "that we here have the most trustworthy evidence of a positive kind" If this does not indicate hibernation capabilities amongst certain birds, pray to what else can it be attributed?" (p 16) We leave our readers to answer this question as they please, but we fear their answer will not please him They may, however, like to know how the incident was recorded in the Migration Committee's schedule by the matter-of-fact observer —"1884, March 12th One Swallow (Swift) 4 p m. [Wind] S E, strong B[reeze] [Weather] cloudy Arrived much exhausted" No more and no less

Returning to the position whence we started we must express our deliberate conclusion that Mr Dixon, author of so many works as he may be, is no authority on the subject of Migration, which he has left exactly as he found it In the hope he entertains that his volume may form "a basis for more elaborate study and detailed research" we entirely concur On one, and that the most wonderful part of the whole business, the faculty whereby birds are enabled to perform their extended flights with such punctuality and general unerringness that the more one knows of the subject the more one is amazed at it, he is silent, for it would seem that there are even bounds to his imagination, and for this we are thankful

DOMESTIC ELECTRIC LIGHTING

Domestic Electric Lighting, Treated from the Consumer's Point of View By E C De Segundo, Assoc M Inst. C.E. (London H Alabaster, Gatehouse, and Co., 1892)

THE author of this small volume is of opinion that there is at present no literature obtainable to enable the untechnical public to form a judgment as to the suitability of applying electrical energy to meet their various requirements, and he states that at present the extended applications of electricity are largely engrossing attention, but owing to the conflicting views expressed by those ignorant or interested, there is a probability of a feeling of disgust being engendered for all things electrical in the lay mind No doubt there is a good deal of truth in this statement, on the other hand, those who take any interest in this all-important subject will soon learn enough to be able to discern that which is important and worth knowing The volume under notice has been written in order to fill this want in electrical literature, and to teach the consumer of electrical energy something of the source of the light and power he is using

It is admittedly a difficult task to make a technical subject clear to untechnical, though interested, readers, and in this case all the more so, on account of the extreme technicalities of electricity as applied to everyday requirements

The author begins at the very beginning, and in Chapters I and II deals with the lighting of rooms with gas, oil, and electricity, naturally pointing out how very soon the atmosphere is vitiated by the two former illuminants, besides the damage done to paintings, book-bindings, &c When discussing "How shall I light my house best?" the author treats of the efficiency and cost of the different illuminants, and points out that although the electric light may be the more expensive, yet the cost per lamp per hour may be fairly compared with oil or gas, because these illuminants are seldom turned completely out when a room is temporarily empty, whereas the facility of switching on and off an electric lamp must naturally save the current and effect economy

Chapter III consists of a short description of some of the systems on which electric light is produced and supplied Great diversity of opinion exists as to which is the best system on which electric energy should be supplied for public use In London two systems are in vogue, viz, The high pressure alternating current in conjunction with transformers, and the low pressure continuous current system From the consumer's point of view, so long as the high pressure current is not allowed to enter the house, it matters little what are the conditions of distribution, provided a continuous low pressure direct supply or a low pressure alternating current from a transformer station is delivered to him, except, of course, where motors are in use, and then the continuous current is a necessity For installations in the country, separate generating plant is required, and for small installations, where on the average fifteen lamps of 8 c p are in circuit at a time, the author says that the electrical energy can be economically generated by chemical means The primary battery referred to is a modified form of Bunsen, and the cost of producing the light is stated to be one penny per lamp of 8 c.p per hour No doubt such a battery takes the place of engine, dynamo, and accumulators, but it is purely a matter of opinion as to the trouble and skill required to look after these batteries, and, without taking the prime cost into account, a gas or oil engine driving a dynamo and charging accumulators to run these fifteen 8 c p lamps should not cost fifteen pence per hour. A case is known where an Otto domestic gas engine is easily driving seven and sometimes eight 8 c.p lamps, and consuming 24 cubic feet of gas per hour, at a cost of considerably under one penny per lamp, the lamps being run direct off the dynamo.

The progress of private electric lighting is simply astonishing, the gas engine being generally the motor used. Many of these engines are run by the Dowson gas, made on the spot, thus rendering a supply of illuminating gas unnecessary.

The author treats somewhat in detail the cost of electric lighting in a house, but as this largely depends on the type of pendants, brackets, &c., used, the outlay naturally varies considerably. The most serious item in the maintenance of an installation is the breakage of the lamps. The author rejoices that this monopoly of manufacture will soon expire, when competition will place better lamps on the market at half the present cost.

Taken as a whole this little book is interesting and useful. It will certainly help the uninitiated consumer to study intelligently the principles of electric lighting, and render his conception of necessary expenses when installing the light more sensible.

OUR BOOK SHELF

Grasses of the Pacific Slope, including Alaska and the adjacent Islands. Part I. By Dr. Geo. Vasey, Botanist, U.S. Department of Agriculture. 8vo, 56 plates, with descriptions. (Washington: Government Printing Office, 1892.)

THE botanists of the United States Department of Agriculture are working very energetically, and the importance of the herbarium, library, and its publications is increasing year by year. The present work is part of a series of illustrations of the North American grasses, of which we have already noticed two parts, together making one volume, devoted to descriptions and figures of the characteristic species of the South-Western States. The present part, which will constitute half a volume, is devoted to California and the Western States. Dr. Vasey tells us in his introduction that the grasses which are known to grow on the Pacific slope of the United States, including Alaska, number not far from 200 species, which is nearly twice as many as we get in the British Islands. They are all specifically distinct from the grasses growing east of the Mississippi, and also mostly distinct from the grasses of the plains and of the desert, except in that part of California which partakes of the desert flora. A considerable number of the grasses of the mountainous regions of California, Oregon, and Washington reappear in the mountains of Idaho, Montana, and the interior Rockies. The interior of California is a dry region, verging in the extreme south into the desert country, and is deficient in grasses, especially of those species which form a continuous turf. In the present publication fifty of the most interesting species are described and illustrated.

The descriptions are almost wholly the work of Dr. Vasey's assistant, Prof. L. H. Dewey. The illustrations are excellent, and are the work of various artists—F. Muller, W. R. Scholl, T. Holm, and others, and are accompanied by full dissections. The species range under the genera as follows:—Imperata, 1; Panicum, 1; Cenchrus, 1; Phalaris, 2; Hierochloe, 1; Aristida, 1; Stipa, 9; Oryzopsis, 2; Muhlenbergia, 5; Alopecurus, 7; Agrostis, 6; Calamagrostis, 10; Deschampsia, 1; Trisetum, 3; Orcuttia, 2. Only two out of the fifty species are British, *Alopecurus geniculatus* and *Deschampsia cæspitosa*.

J. G. B.

Aids to Experimental Science. By Andrew Gray. (Auckland: Upton and Co., 1892.)

THE chief interest of this little book lies in the fact that it gives a glimpse of the science teaching in one of our colonies. It is a compilation of simple experiments in mechanics, physics, chemistry, physiology and health, and agriculture, to prepare students for what is known as the Class D examination. Naturally, most of the experiments are old ones, but here and there one may gather a new idea. The portion dealing with physiology and health has nothing to do with dissection, but consists of experiments on ventilation, drainage, food stuffs, and the like. An interesting piece of apparatus, devised by Prof. Bickerton for showing the action of the lungs, is described on p. 76. All the experiments are briefly but sufficiently described, and many of them are illustrated.

Science in Arcady. By Grant Allen. (London: Lawrence and Bullen, 1892.)

THIS volume will fully maintain Mr. Grant Allen's reputation as a popular writer on science. The essays of which it consists are written in a bright, lively style, and may be read with pleasure even by original investigators, for the truths with which they deal, if not new, are at least presented from new points of view. Readers who do not profess to know much about any particular branch of science will find in these papers an excellent introduction to some of the more attractive facts and laws of the natural world. The volume includes some archæological essays, which show very effectually that an antiquary has not necessarily much resemblance to Dr. Dryasdust.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Macculloch's Geological Map of Scotland.

IN a recent article in this journal Prof. A. H. Green writes as follows:—

"Macculloch seems to have projected, but never completed, a geological map of the whole of Scotland. The materials collected by him were, however, utilized by the Highland Society in the construction of a general map in 1832."

I am sure that nothing could be farther from the wish of the Oxford Professor than to do an injustice to the memory of one of the greatest of the pioneers in British geology, and he will therefore forgive my calling attention to the following facts, which, judging from a subsequent letter in these pages, would seem not to be generally known.

During the last twenty years of his life Dr. John Macculloch was engaged on a regular survey of Scotland, and in collecting the materials for a geological map of the country. In the earlier part of this period Macculloch seems to have availed himself of the opportunities afforded to him as an official of the Board of Ordnance to carry on his valuable geological explorations. But during the latter part of the period he was regularly employed by Government to complete his geological work, and was paid by the Lords of the Treasury, who in the end published his map.

On July 28, 1834, Macculloch addressed to "His Majesty's Treasury" a series of memoirs respecting the Geological Map of Scotland, which was then completed. In these memoirs he refers to the map as being then in existence, and gives the most minute directions concerning the tints to be employed by the colourists who were to copy the map, in order that it might correspond with his original work. He also expressed his regret that the imperfect topography of the map on which his researches had to be recorded prevented the work from being as accurate as he could have wished at certain points.

Owing to delays in issuing the Government publications—not quite without parallel in more recent times—Macculloch's "Memoirs on the Geological Map of Scotland" did not appear till the year following his death (1836). The date at which the first copies of the map were issued it would probably be difficult to determine, but as to the completion of the map before July 1834,

and its subsequent issue by "the Hydrographer to the King by order of the Lords of the Treasury" there can be no doubt whatever

The first Government Geological Survey undertaken in the British Islands was that of Dr John Macculloch, and the work that he accomplished single-handed was a very remarkable one Several geological maps of Scotland, differing very widely from that of Dr John Macculloch, have been issued and withdrawn during the last fifty years, but any one who will compare the first geological map of Scotland with the latest, also "published with Government authority," will be interested to see how far the work of the early pioneer in Scottish geology has been found to be correct in most of its essential features by those who have come after him

John Macculloch's title to be the author of the first geological map of Scotland is as indisputable as are the similar claims of William Smith and Richard Griffiths with respect to England and Ireland respectively. JOHN W JUDD

16, Cumberland Road, Kew, December 6

Glaciers of Val d'Herens

THE two glaciers of Arolla are interesting, inasmuch as one, the Arolla, is retreating, while the other, Glacier de Zigiorenove, is advancing This has been going on for twelve years, according to the report which appeared in NATURE (vol xlvi p 386), by Dr Forel, dealing with Alpine glaciers and their changes

Having visited these glaciers last summer with the object of observing the effect of their respective movements upon the morainic accumulations in front, I think a brief account may be worth recording

The Arolla glacier occupies the head of the valley, and is fed by the snow from Mont Colon and the fields of nevé extending towards Mont Brulé The Zigiorenove glacier is one mile further down the valley, but does not descend so low as the Arolla glacier by about 300 feet It receives its main supply from the Pigne d'Arolla, a mountain which rises immediately above the glacier, and is conspicuous by its massive snow-cap This glacier is not only nearer to its supply, but descends at a steeper gradient than the Arolla glacier

This may in some measure account for the former advancing while the latter is retreating, or, more correctly speaking, melting backwards I was informed by local guides that the Arolla glacier has been swelling behind for some years, if this be correct, and the seasons remain normal, then, in a short time, this glacier must advance also, in other words, being longer or further away from its feeding ground, the extra supply has not yet had time to reach its extremity Appearances at the end of the glaciers are in themselves quite sufficient to indicate their respective movements, the snout of the Arolla glacier is buried in its own debris, composed of rocks and loam borne upon or concentrated to the surface as the ice melts This debris is being constantly shot down grooves or water courses furrowed in the sloping end or side of the glacier At the bottom of these spout-like grooves conical shaped mounts are formed, one behind another, as the ice melts backwards, resulting in a moundy, zigzag arrangement constantly seen lower down the valley, many miles away from existing glaciers, and can be seen also in many of the higher valleys of North Wales.

The advancing Zigiorenove glacier, instead of being buried in debris, turns up in shell-like flanges, exposing its under surface in its endeavour to climb over, rather than push forward, the loose rocks in front, a part of this loose material only is pushed forward, forming a small bank, which in no place exceeded 5 feet in height, up which the ice mounts with the shell-like flanges projecting beyond, the under part of these projections being fluted into a perfectly symmetrical pattern

In some way the projecting rocks forming the glacier bed produced these convolutions, but whether by cutting, melting, or by the ice crystals flowing round each side, I was unable to determine, but I may state there was no appearance of cutting or grinding which would necessarily leave behind the shavings or ice particles cut out or ground off, and little or no water was present as if from melting. We had much snow for three days, with a total absence of sunshine, the atmosphere at mid-day, when making these observations, registered 38° F Appearances rather suggested the idea that the ice crystals were displaced in a similar manner to water in a rapid river when it meets with obstructing boulders in its bed

Climbing up one of the old lateral moraines, for there are several, the glacier is seen to be encroaching laterally as well as longitudinally, it soon extends to the base of the inner moraine, and then climbs upwards in a similar manner as it advances in front by turning up its edges, carrying upwards a few loose rocks in front, but without materially disturbing the moraine itself Higher up it reaches the top of this moraine, and then rises above it like a wall, having caused the loose rocks it had borne up to roll down into the valley between the inner and outer moraine, with masses of ice broken off the edge of the glacier

As far as I am able to ascertain, by creeping under the flanges the glacier slowly spreads out the bank which it had pushed up in front as it advances into a more even bed to travel over, but my observations were restricted to a few yards owing to the contraction of the sub-glacial space between the ice roof and the floor I was much impressed by the fact that the glacier did little in exerting that force which might be expected from such a power behind, in the way of ploughing through or removing such comparatively trifling obstructions as loose rocks or moraine banks

It is evident from the various ages of moraines that the lower parts of those glaciers have fluctuated considerably during recent times, but the line of demarcation between these minor fluctuations and the period after these lateral valley glaciers had been confluent with the main Valais glacier, and were retreating backwards, is very marked Beyond two miles down the valley from the Zigiorenove glacier no striæ from the trunk glacier could be found, but at this distance it suddenly appears with *fresh glaciated forms*, *precisely the same phenomenon* was noticed in the neighbouring Val d'Anniviers, as if this were the limit of the more recent fluctuations

At the Col de Bertol, 4500 feet above Arolla, or about 11,000 feet above sea level, there are no indications of glaciation, ancient or modern, above the surface of the snow; so it would appear, however much the ice level has varied below, at this dividing ridge it has always remained the same, or, in other words, it has been dispersed by wind or ice movements to lower levels at a rate equal to deposition, when the snow line was low enough to allow the ice to travel down the Val d'Herens, the higher ice streams would simply run down upon its surface, instead of descending as low level glaciers or mountain rivers, as at present

WILLIAM SHERWOOD

Eastbourne House, Sutton Coldfield

Ancient Ice Ages

MESSRS BLANFORD, in their letter (NATURE, p 101) called forth by Dr Wallace's notice of a palæozoic glacial conglomerate in Victoria, Australia, say —"It has become an accepted article of faith amongst most European geologists that no ice-age occurred before the last glacial epoch" There is no doubt that the tendency of opinion has been in that direction, notwithstanding the evidences to the contrary brought forward by Dr. Blanford and others The late Sir Andrew Ramsay was the first, so far back as 1855, to suggest that the Permian conglomerate of Abberley and the Clent hills was an ancient glacial deposit Although this reading was accepted by so cautious a philosopher and critic as Sir Chas Lyell ("Principles," 10th ed, vol i p 223), the idea has languished from disfavour Having devoted a considerable portion of the last twenty years to the study of glacial phenomena, I early this year paid my first visit to the district The best section I saw is an excavation at Abberley in what may be called boulder gravels, and, except for its prevailing red colour, the deposit, *if dropped down on the coast of Wales*, would, in general appearance and arrangement of the materials, be undistinguishable from many of the glacial deposits to be found there Many of the stones have flattened faces, and in general shape resemble glaciated boulders, but the striæ, so far as I could observe in the limited time at my disposal, were not very pronounced Since then I have found a deposit of glaciated gravels on the top of the Screes, Cumberland, 1600 feet above the sea, which on comparison with the specimens brought home from Abberley enables me to understand the latter better The volcanic rocks of the lake district of which these gravels are composed break up into very similar shapes, and are planed and striated in a very similar way to those of Abberley I also brought home from Abberley two specimens of the "paste" which fills up the interstices of the finer gravel

On washing and riddling this clayey matter, well waterworn and smooth gravel was separated from it up to about the size of a bean, and on many of these minute pebbles, with the aid of a microscope of low power, beautifully developed striæ are to be seen, sometimes on more than one face This latter fact appears to have been unnoticed before The conclusion I have come to is that Ramsay had reasonable grounds for his belief in this being a Permian glacial deposit, and think that if he had given more details in his otherwise able paper, geologists would probably have followed him more freely

T MELLARD READE

Park Corner, Blundellsands, December 5

The Earth's Age

As Dr A R Wallace's "Island Life" may be regarded as one of the best authorities on its subject, it appears desirable that any errors in it should be pointed out, lest any of its numerous readers should be misled

In Chapter X (2nd edition, 1892) is an estimate of the earth's age based on the following data —Land area of globe, 57,000,000 square miles, coast line, 100,000 miles, width of shore deposits, 30 miles, hence area of shore deposits, 3,000,000 square miles, hence rate of deposition 19 times as fast as that of mean rate of denudation, which latter is taken to be 1 foot in 3000 years

Thickness of stratified rocks 177,200 feet, hence time required for deposit 28,000,000 years This last result is taken to be approximately the earth's age

It appears to me that Dr Wallace's data warrant no such conclusion, for, in the 28,000,000 years in question, all that would have been deposited would be a thickness of 177,200 feet of rock, over an area of only 3,000,000 square miles, whereas, what has to be accounted for is an area of 57,000,000 square miles (neglecting igneous rocks and sedimentary deposits beneath existing seas) of the same thickness Therefore, so far from Dr Wallace's data leading to 28,000,000 years as the earth's age, they actually lead to a result 19 times as great, viz 532,000,000 years

Sir A Geikie's estimate is (NATURE, vol xlvi, p 322), 100 to 680 million years Personally, I think, the method of taking maximum thicknesses of deposits unsatisfactory, for it assumes that every formation was deposited, with its maximum thickness, over the whole land area of the globe The absurdity of this supposition is obvious The only defence of it is that it is held to make an ample allowance (of unknown amount) for repeated denudation It would, perhaps, be better to ascertain the actual thickness of a great series of successive formations, say in the Colorado Cañon and other regions, and from such data to estimate the total *average* thickness This estimate, of course, would allow nothing for repeated denudation, but would enable one to form an idea of the earth's *minimum* age

BERNARD HOBSON.

Owens College, Manchester, December 5

I AM glad that Mr Hobson has formulated his difficulty as to the measurement of geological time by the comparative rates of denudation and deposition, because it shows that I cannot have explained my views as clearly as I thought I had done, yet on again reading over pp 217–223 of "Island Life," I can hardly understand how he has missed the essential point of the argument Fortunately, there is no dispute as to the data, only as to the conclusions to be logically drawn from them

Mr Hobson says that I account for a deposit of 177,200 feet (the supposed thickness of all the stratified rocks) over an area of 3 000,000 square miles (the estimated area over which at any one epoch stratified rocks are being deposited) in 28,000,000 years (the deduced estimate of known geological time), and then adds: "Whereas, what has to be accounted for is an area of 57,000,000 square miles *of the same thickness*" (my italics) This seems to me a most amazing misconception, for it means that every single formation and every stratum or member of each formation, was deposited to the same average thickness over the whole land surface of the globe (area 57,000,000 square miles)! And this implies that at every successive period, from the Laurentian to the Pliocene, the conditions of denudation and deposition were totally different from what they are now, since at the present time it is demonstrable that the area of deposition of continental debris is only a fraction of the whole continental area It implies further, that during each geological period the whole of the existing land area must have been, either at once or in rapid succession, sunk beneath the sea in order to allow of its being all covered with each successive formation—an amount of repeated upheaval and depression which hardly the most extreme convulsionist of the old school would have postulated I cannot make the matter clearer, and trust that on further consideration Mr Hobson will admit that his objection is invalid

ALFRED R WALLACE

The Colours of the Alkali Metals

IN NATURE (vol xlvii p 55) is a communication by Mr G S Newth, entitled "Note on the Colours of the Alkali Metals."

I write to call attention to my article on "The Colour and Absorption-Spectra of Thin Metallic Films, and of Incandescent Vapours of the Metals, with some observations on Electrical Vitality," published in the *American Chemical Journal* (vol xiv p 185) and reprinted in the *Chemical News* (vol lxvi p 163), which gives the method employed by Mr Newth, as well as other methods for obtaining metals in thin films

In it attention is also called to the fact that the colour of the film of the metal and the colour of the vapour are widely different

Mr Newth, however, succeeded in getting a film from sodium on glass, while I did not, and his success was probably due to the use of a higher vacuum than I employed He also obtained a rubidium film

In my paper I called attention to the similarity in colour of the film by transmitted light and that of the *incandescent* vapour which is very striking in many cases In this respect the film of rubidium as obtained by Mr Newth follows the rule fairly well, but the film which he got from sodium is exceptional, as according to the analogy furnished by other metals it should be yellow The presence of potassium, however, might cause the green colour which he observed, by the combination of yellow and purple

WM L DUDLEY

Vanderbilt University School of Chemistry,
Nashville, Tenn, December 2

Osmotic Pressure

IN an article on osmotic pressure, in NATURE (*ante*, p 103), Mr Rodger very truly remarks that "at present the attitude of the prominent upholders of the new theory [of solutions] is one of indifference as to the exact mechanism of osmotic pressure The numerical agreement between the measurements on solutions and those on gases is regarded as ample justification for considering dissolved substances to be in a pseudo-gaseous condition" Such an indifference is surely to be regretted from any truly scientific point of view, especially as those explanations which have been given of the mechanism of osmotic pressure have been based on the supposition that the dissolved substance is in a *veritable* and not merely *pseudo* gaseous condition There are, however, many reasons for supposing that while the dissolved substance may for many purposes be regarded as analogous to a gas, it must in reality be in a very different condition, and that osmotic pressure is not due to the bombardment of the free molecules of the dissolved substance against a diaphragm through which they cannot pass The impenetrability of the diaphragm to certain molecules can scarcely be attributed to any other cause than that the molecules are too large to pass through the interstices of the former, and it is scarcely conceivable that the molecules of water which do pass through can be much smaller than the molecules of simple salts, which do not pass through, still less that they can be smaller than the single atoms into which these salts are said to be dissociated

A very simple experiment, which I mentioned some time ago in the *Ber d deutsch Chem. Gesell* (24, 3639), appears to settle definitely against the view that osmotic pressure is due to impenetrability to the dissolved substance A solution of propyl alcohol and water was put into a porous pot and immersed in a vessel of water, the water passed through the pot to the solution, and this, according to the usual explanation, would show that the pot was impermeable to the propyl alcohol The same solution was then immersed in a vessel containing propyl alcohol, when the alcohol was found to pass through to the solution, from which we should have to draw the diametrically opposite conclusion that the pot is impermeable to the water The true conclusion obviously is that the pot is impermeable, neither to the alcohol alone, nor to the water alone, but to the solution of these in each other, and that the molecules composing this solu-

tion must be larger than those of either of the two substances when separate, the solution consisting of compounds or hydrates of the two I showed, moreover, in the paper above referred to that the hydrate theory of solutions was quite capable of accounting for and explaining the fact that the dissolved substance may for many purposes be regarded as being in a quasi-gaseous condition in weak solutions, and that calculations based on the idea of its being truly gaseous would yield very nearly correct results

The hydrate theory will also, as I showed, give an explanation of the fact that electrolytes will give abnormally high osmotic pressures, and that the magnitude of these pressures can be calculated from their electric conductivity and the explanation based on this theory also obviates many of the objections to which the idea of dissociation into ions is open More over, the only critical experiment which, as far as I know, has ever been made to test the validity of the dissociation hypothesis, gives an unequivocal answer against it, and in favour of the hydrate theory When, for instance, sulphuric acid is dissolved in excess of water, it is represented by the dissociationists as splitting up into its ions, so that the solution will contain more acting units (ions and molecules) than the acid and water together contained before they were mixed whereas, on the hydrate theory, combination will have occurred, and there will be fewer acting units present The number of acting units may be ascertained by observing the depression produced by the solution on some other solvent, such as acetic acid (that is, by using the very method which the dissociationists use to prove the supposed dissociation of substances), and when this is done it is found that the sulphuric acid solution contains *fewer*, instead of *more*, units than the acid and water separately

Even if the above were the only arguments to be urged, it is evident that although the idea of the dissolved substance being gaseous and often dissociated may be a good working hypothesis for the directing of investigation, it can scarcely be accepted as a true theory of the nature of solutions

SPENCER PICKERING

On a Supposed Law of Metazoan Development

IT is difficult not to feel disappointed that Dr Beard has given only "a preliminary sketch by way of clearing the ground" (NATURE, vol xlvii p 79), in place of "producing the full argument" for a law in the existence of which he has by "observation and reflection" been led to believe For it is not easy to gather from his sketch how he is able to apply a universal law to so varied a series of events and phenomena such as he mentions, and at the same time to point out "the analogy which obtains between the suggested mode of Metazoan development, and the accepted fact of an alternation of generations in the life histories of all plants above the lowest Thallophytes" For in the higher plants the alternation of generations referred to occurs with constancy as regards period of life history, and varies only slightly within the limits of the same group

Dr Beard alludes, I presume, to one form of alternation of generations—that of sexual with asexual generation only, or Metagenesis. This he asserts constitutes a general law in the development of Metazoa.

In a sense this may be true enough If, for instance, we regard the division of each cell as a new asexual generation, then Metagenesis is a very constant phenomenon amongst Metazoa. In this case the life history of a Metazoon consists of a sequence of thousands of asexually produced generations alternating with one sexually produced generation, which gives apparently a stimulus for another run of asexual generations in which polymorphism and division of labour are exhibited in extraordinary complexity and beautiful harmony

But this is not at all what Dr. Beard means. The series of instances which Dr Beard gives, or system of "nursing" as Steenstrup termed it, is at most a series of disconnected phenomena of frequent occurrence, and not a law

Because most Metazoa possess eyes, it is not therefore a law of Metazoan development that eyes should be developed. Diversity in form, number, and time of appearance of eyes, is sufficient to show that the law cannot exist, so also is it in the cases of nursing to which Dr Beard alludes, and on which he bases his argument

It seems to me that no "law" of alternation of generations in Metazoa can be "enunciated" unless there is evidence forth coming of its constant action at corresponding periods in the life histories of all animals of different groups, and in a closely similar manner in individuals of one and the same group. Also a law of such a nature, if it is to be found to act universally amongst Metazoa, must surely have come into action at a very early period in the evolution of Metazoa

Metagenesis is of constant if not universal occurrence in the cycle of life of Protozoa. A long series of generations produced asexually is followed by a generation produced sexually, that is, a generation produced by the conjugation of two individuals, this is followed again by another long series of asexually produced generations, and so on If this is so constant among unicellular organisms of the present day, it is not very unreasonable to suppose it was common among the protozoan ancestors of the Metazoa and of the Plants If we are to find any form of Metagenesis as a *universal phenomenon* in the Metazoa, it must be to the most protozoon-like stages of development of the Metazoon that we should look

There is but one strict meaning to the phrase sexual generation, and that is a fusion of two cells If Metagenesis means anything it means the alternation of a generation resulting from the fusion of two cells, with one or more generations resulting from the division of cells

This we can perhaps find in the protozoon-like stages of Metazoan development, and in a way analogous to the alternation of generations among plants

Spermatozoon and ovum fuse and form the fertilized ovum which is the true sexually produced generation This produces by division a vast number of cells, and if we regard these as a number of generations then Metagenesis is obvious enough But it is no more metazoic—if I may use such a word—to call the whole animal resulting from the segmentation of the fertilized ovum, the sexually produced generation

This generation buds off the immature ovum This is really the "Primitive ovum" of the embryo I see no reason why this may not be regarded as a distinct asexually produced generation—like the formation of the spore of the plant

The immature ovum divides into two cells—first Polar body, and more mature ovum The more mature ovum divides into two cells, namely, second Polar body and mature ovum It does not materially affect the argument whether we should regard these two processes as two separate consecutive asexually produced generations, or as one asexually produced multicellular generation If we take the latter view, then the maturation of the ovum is more analogous to the prothallus stage of the life history of plants

In either case the result is the formation of the mature ovum, comparable to the oosphere of plants

The mature ovum fuses with the mature spermatozoon, and the sexually produced generation recurs, and the cycle of development is completed

I cannot help thinking that if Dr Beard wishes to discover a law of Alternation of Generations applicable to the whole of the Metazoa, he will find a more favourable hunting ground amongst those stages of development at which the several groups of Metazoa approximate, than amongst those stages where they are farthest apart, and also Dr Beard will find the analogy between the supposed Metazoan law and the accepted law of the vegetable kingdom closer than he could ever hope to find it if he continues his present line of search

If the above theory of the cycle of Metazoan life can be considered tenable, we see that both in the Higher Plants and in the Metazoa there are constantly alternating "sporophyte" and "gamophyte" generations, and further, we can find evidence, as we should expect to do, of the origin of such a universal phenomenon in the single celled or protozoan life, where the continuance of the species may be secured in both these ways, namely, by the formation of asexually produced spores, and as a consequence of cell fusion, *i.e* conjugation

RIC ASSHETON

Oxygen for Limelight

THE employment of oxygen for limelight and other purposes has increased enormously since the commercial introduction of the Brin method, by which the gas is separated from atmospheric air by a now well-known chemical process The gas so obtained is practically pure, analysis showing that as now supplied by the Brin companies it contains on an average 95 per cent of oxygen, the remaining five per cent. consisting of inert nitrogen.

The success of this comparatively new industry has been so marked, that, as a natural result, competitors with rival processes have come forward. Some of these met with failure at an early stage of their career, but others are supplying oxygen to the public. This is by no means a state of things to be deplored from the consumer's point of view, if the product from the one source is as good as the other, for benefit generally arises from healthy competition. But when the rival product turns out to be not oxygen, but a half and half mixture of oxygen and air, with a slight excess of the latter, the competition is of a decidedly unhealthy character, and is correspondingly bad for the consumer. I recently obtained a sample of gas from a dealer, which on testing (with a Hempel absorption pipette, charged with metallic copper and ammonia) I found to be a mixture containing only 60.6 of oxygen. I next tested the illuminating value of this highly diluted oxygen with a limelight jet, and for sake of comparison, placed by its side a precisely similar jet supplied with Brin's oxygen, and, as might have been expected, the light given by the former was little more than one-half as intense as that afforded by the latter. With the good oxygen the lime cylinder was quickly pitted, whilst the other showed no symptom of destruction. It is also to be remarked that the consumption of the diluted gas was, for a given period, about one-third more—striving with both jets to get the best possible light—than that of good oxygen. On the same principle a mountaineer at a high altitude will pass more (rarefied) air through his lungs than he will when he is in the valley breathing that which contains the normal quantity of oxygen.

As this matter is of great importance to many workers, I trust that you may be able to find room in your valued publication for these words of necessary caution.

T. C. HEPWORTH

45, St. Augustine's Road, Camden Square, N.W., December 6.

THE STAR OF BETHLEHEM

IN the *Astronomical Journal* of November 26 we find the second of two very interesting articles written by Mr. J. H. Stockwell, bearing on the chronology of certain ancient events. In the introduction the author discusses and sums up some of the more important and historical dates which he has determined by calculations of ancient eclipses. He next refers to the help which may be obtained in the same direction by means of calculations of conjunctions of the planets, and quite appropriately to the present season points out that the appearance of the star of Bethlehem may have been due to the conjunction of the planets Venus and Jupiter, instead of Saturn and Jupiter, as was suggested on incomplete data by Kepler nearly three hundred years ago. We cannot do better than lay this part of Mr. Stockwell's communication before our readers.

"Although the heliocentric conjunctions of the planets occur with a considerable degree of regularity, and are also very easily calculated, the geocentric conjunctions are subject to many inequalities in the periods of their successive occurrences, so that it requires somewhat elaborate computations to determine accurately the character of any geocentric conjunction of two planets which occurred in ancient times. On account of the frequency of planetary conjunctions, and the indefinite manner in which they are usually described, it becomes a matter of very great difficulty to identify any particular conjunction unless it is associated with some other event whose data can be independently determined. A remarkable case of this character is given in the Bible, for Matthew informs us in the days of Herod the King 'there came wise men from the East to Jerusalem saying, "Where is he that is born King of the Jews? for we have seen his star in the East, and are come to worship him."' From the subsequent inquiries and mandates of Herod the King concerning the time when the star appeared, we are led to infer that its appearance took place within two years preceding the death of Herod, and it has been sought to explain the appearance of the star by means of a conjunction of the planets—the Creator employing celestial phenomena to proclaim 'the good tidings of great joy, which shall be to all people.'

"The illustrious Kepler was the first to suggest that the star of the wise men might be explained by means of a conjunction of the planets Jupiter and Saturn, and he even undertook to calculate the times when such conjunctions took place. Much has been said and written on the subject of the 'star of the wise men' during the past few years, but no important contribution to the natural history of the star has been made since the days of Kepler, nearly three hundred years ago. But the supernatural history and functions of such a star have been discussed in a very able and interesting manner by many writers in theological, literary, and semi-scientific periodicals during the past twenty years, and perhaps nothing of interest and importance can now be added to what has already been published on that subject.

"I find, however, that Kepler overlooked one important element of the problem in his calculations, and consequently left the natural history of the problem in an incomplete and unsatisfactory condition. I shall therefore here attempt to complete more fully what Kepler began, and show that the Biblical narrative concerning the 'star in the east' is better satisfied by a conjunction of Venus and Jupiter than by any of the conjunctions computed by Kepler.

"We have already seen that the death of Herod took place early in the year B.C. 4, and if we can now show that there was a very conspicuous conjunction of two bright planets, visible only in the east, within two years preceding that date, the hypothesis that such conjunction was the event referred to in the Biblical narrative will at least be rendered plausible, if not entirely legitimate; and for this purpose I have here undertaken the calculation of all the conjunctions of the planets which took place near that epoch. I shall first enquire whether there was a conjunction of the planets Jupiter and Saturn about that period of time which would satisfy the required conditions. The mean interval between two heliocentric conjunctions of Jupiter and Saturn is 7253.4638 days; and they were in mean conjunction B.C. 6, January 30. Now the time of true heliocentric conjunction may differ from the time of mean heliocentric conjunction by 241 days, on account of the inequalities in their elliptic motions, and by 23 days more by reason of the great inequalities of long period in their mean motions. But the time of geocentric conjunction of Jupiter and Saturn may differ from the time of heliocentric conjunction by 102 days; so that a geocentric conjunction may occur one whole year before or after the time of mean heliocentric conjunction. In the present instance I find that the true heliocentric conjunction took place B.C. 7, September 23, which is 129 days before the mean heliocentric conjunction; and that there were three geocentric conjunctions during the year B.C. 7, which took place as follows:—

"The first conjunction took place June 7, in which Saturn passed 1° 4′ to the south of Jupiter; the second conjunction took place September 18, in which Saturn passed 1° 2′ to the south of Jupiter; and the third conjunction occurred on December 15, in which Saturn passed 1° 8′ to the south of Jupiter.

"In the first conjunction the planets would have an elongation of about 73° to the westward of the sun, and would be seen during four or five hours in the east in the morning. The second conjunction took place near the time of opposition with the sun, and would be visible during the whole night, so that it could not properly be designated as a star in the east any more than a star in the west. In the third conjunction the planets would have an elongation of about 84° to the eastward of the sun, and could therefore appear only as evening stars.

in the west Moreover, Saturn is not an especially bright planet, and consequently no one of these three conjunctions could have been very conspicuous in the heavens The first conjunction was the only one that was visible in the east, but it occurred nearly three years before the death of Herod, it could hardly be said to satisfy the conditions required by the narrative No other conjunctions of Jupiter and Saturn could possibly occur till about twenty years later, so that we may conclude with a light degree of probability that the phenomenon alluded to in the Bible was not occasioned by a conjunction of Jupiter and Saturn Since the planet Mars is a conspicuous object when near its opposition with the sun, it may be well to inquire whether a conjunction of Mars and Jupiter might not occasion the phenomenon referred to But since Mars is conspicuous only near its opposition with the sun, it is evident that any conjunction when in that direction would appear as a star in the west as much as in the east, and consequently it would not fulfil the required conditions There was, however, a conjunction of Mars and Jupiter on March 5, B C 6, but at that the planet's elongation was only 18° to the eastward of the sun, and consequently could have been visible only in the west But Mars was then so far from the earth, and so nearly in conjunction with the sun, that the conjunction would be wholly invisible At the same time Saturn was not very far from Jupiter, and hence it was said there was a triple conjunction of the planets Mars, Jupiter, and Saturn in the spring of B C 6

"It is evident without calculation there could be no conspicuous conjunction of Venus and Mars at any time, because Mars is not a conspicuous planet unless its elongation from the sun be greater than the greatest elongation ever attained by Venus, so that it would be a waste of time and labour to enter into the computations of any such conjunctions

"It now remains to inquire whether the two brightest planets of the solar system, Venus and Jupiter, might not have been in conjunction within a short time before the death of Herod, and constitute the phenomenon alluded to in the biblical narrative, for it was the beautiful phenomenon presented by these two planets when in conjunction last February that suggested this investigation Now the conjunctions of Venus with the sun occur with great regularity at intervals of about 584 days, while those of Jupiter at intervals of 399 days Moreover, it may easily be shown that all geocentric conjunctions of Venus and Jupiter must take place within about 60 days before or after Jupiter's conjunction with the sun Therefore, by tabulating the times of Jupiter's conjunction with the sun, we have only to investigate the longitude of Venus for a period of 60 days before or after that event in order to determine whether a conjunction of those planets will then take place Now I find Jupiter was in near conjunction with the sun B C 6, March 29, while Venus was in conjunction on the preceding November 5, or 144 days earlier than Jupiter Venus was therefore past her greatest western elongation, and was moving towards her superior conjunction, and she would overtake Jupiter on May 8, when their mutual elongations from the sun would be 27° 44′ to the west At that time the heliocentric latitude of Venus and Jupiter were 3° 21′ and 1° 20′ south, while their geocentric latitudes were 1° 40′ and 1° 8′ south respectively It therefore follows that at the time of their geocentric conjunction Jupiter was only 32′, or about the angular breadth of the moon to the northward of Venus, and as they were then to the westward of the sun, they would be visible only as a star in the east a couple of hours before sunrise. These two brightest planets in the sky would therefore at the time of conjunction, B C 6, May 8, be apparently very close together and produce a striking and beautiful appearance The date also at which it took place being about 50 days less than two years before the death of Herod, harmonizes well with the spirit and other conditions of the narrative, for it is probable that the mandate for the slaughter of the children of two years old and under was issued some months before his decease, and the limit of two years would leave an ample margin for any uncertainty as to the time of the appearance of the star as related by the Magi

"There were no other conjunctions of Venus and Jupiter until the year B C 2, or nearly two years after the death of Herod, when there were two conjunctions, one of which occurred on August 31 and the other on October 4 The first of these was invisible on account of being too near the sun, but the second took place when Venus was nearly at her largest elongation to the westward of the sun

"If the preceding calculations, and the references based on them, are correct, it follows that Christ was born as early as May in the year B C 6, and if He was crucified at the time of the paschal full moon, which occurred on a Friday, it must have taken place on April 3, in the year A D 33 And since any given phase of the moon is repeated on the same day of the week, and also within two days of the same time of the year, at intervals of 334 lunations, or 27 years, it follows there was no paschal full moon on a Friday between the years A D. 6 and A D 60, except the one on April 3, A D 33, whence it would seem to follow that Christ was thirty-eight years old at the time of His crucifixion and death, and this would vindicate the sagacity of the Jewish doctors, who had recently affirmed that He (Jesus) was not then fifty (forty) years old"

FUJISAN[1]

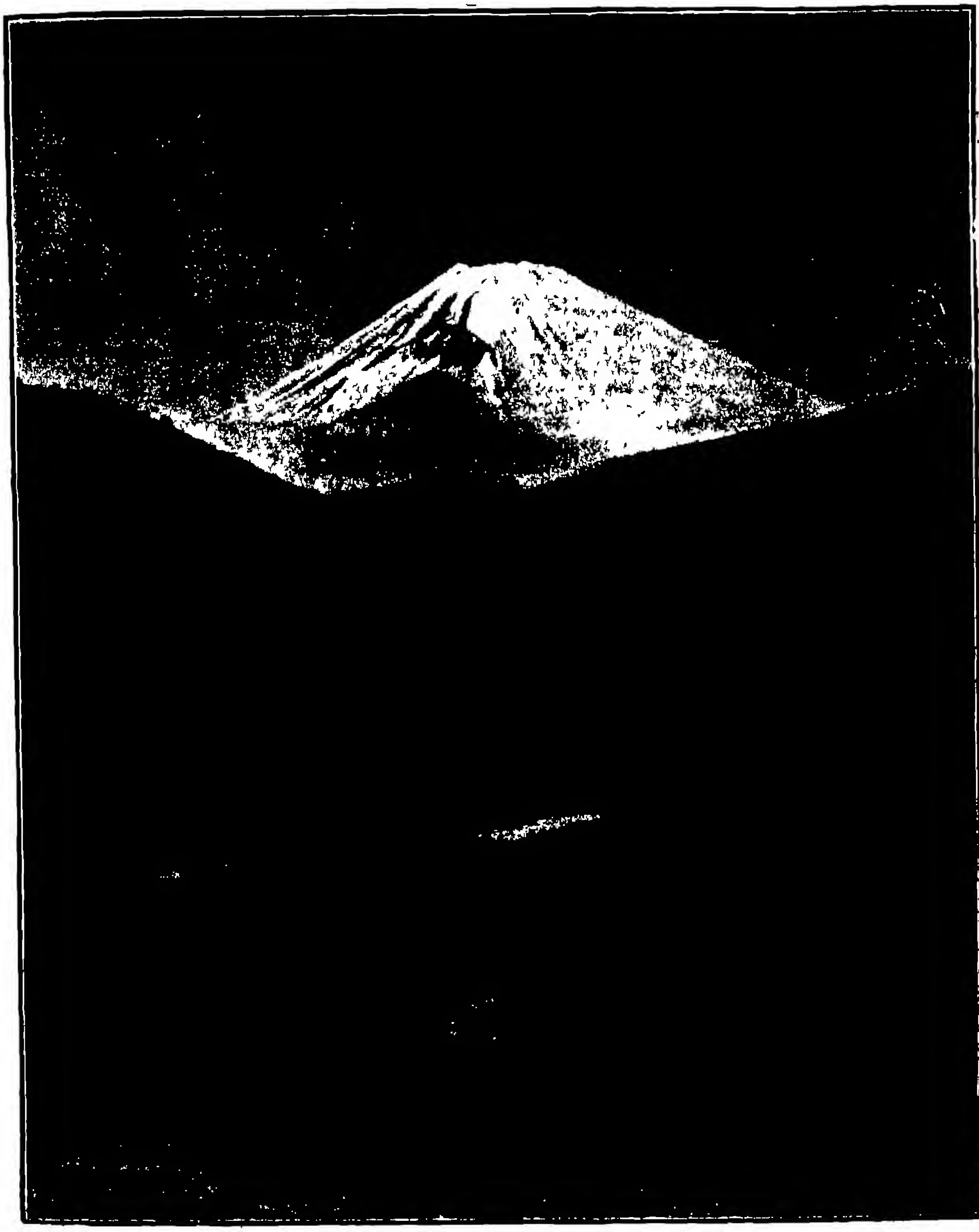
ALL who remember the beautiful plates illustrating the volume on "The Great Earthquake of Japan, 1891," which was issued by the same authors a few months ago, will welcome the first instalment of a work which promises to illustrate, in a manner worthy of the subject, the magnificent volcanic phenomena of Japan The present part contains ten plates, and is devoted to the illustration of the most famous and beautiful of all the Japanese volcanoes—Fujisan The number of parts that the authors will publish will depend partly, we are told, on the encouragement they receive, and partly on the number of photographs that they have been able to secure during the past summer

The photographs in the present part, which are all reproduced as permanent collotypes, 11 inches by 8 inches in size, are exquisite examples of what can be accomplished by this method of illustration, and show that Japan is certainly not behind any country in the world so far as the resources of the publisher go Where all are so excellent, it is difficult to select any particular plate for especial praise, but one of the most remarkable is certainly Plate II, which gives a view over the great cloud-banks as seen from the summit of Fuji Nothing can be more striking than the manner in which the effect of the great fleecy masses of vapour are reproduced, and here nothing whatever is lost from want of colour The plate of greatest scientific interest is perhaps the last, which shows the interior of the crater of Fuji—a great pit 600 to 700 feet deep, with perpendicular walls The sides are built up of rings of variously-coloured rocks, while snow rests in the sheltered hollows The remaining pictures illustrate the sacred mountain as seen from different points of view, the graceful curves of its outline, the variation in the distribution of snow on its flanks, and the

[1] "The Volcanoes of Japan Part I Fujisan" By John Milne, F R S, Professor of Mining and Geology, Imperial University of Japan, and W K Burton, C.E., Professor of Sanitary Engineering, Imperial University of Japan Plates by K. Ogawa. (Yokohama, Shanghai, Hongkong, and Singapore Kelly and Walsh, Limited, 1892)

character of the foreground, giving rise to great diversity in these eight pictures

As an example of these beautiful views, Plate IV —



"Fujisan from above Hakone"—has been reproduced, although necessarily much of the delicacy of the original has been lost in the process by which it has been copied.

"In the foreground, looking like a river, is the Lake o Hakone, at the back of which are hills some 4000 feet high At the lowest gap in these hills is the Otome pass. In the background, overlooking both lake and mountains, is the upper part of Fuji This portion of the mountain is particularly conical, with sides sloping at an angle of

30°, its logarithmic sweep being lost behind the intervening mountains. The almost triangular notch in the snow-cap may possibly represent the scarp that is supposed to have been formed by the great earthquake of 1891, causing a strip of ground in unstable equilibrium to slip downwards." The reader should compare this view with that given in Plate IX., which shows the lake, with the reflection of the mountains behind, and the snow-covered Fuji rising in the background. This plate, and the view, Lake Kawaguchi, given on Plate V., are so delicate and faithful in their portrayal of water and atmospheric effects as to defy reproduction.

No attempt has been made by the authors to produce a scientific treatise, the information contained in the text being of a popular character, and the reader is referred to the Transactions of the Seismological Society of Japan for more detailed information on the subjects treated of. It is nevertheless true that the text published with these plates contains, as the authors claim for it, information not readily obtainable from other sources. The introduction gives a sketch of the volcanic phenomena of the Japan and Kurile Islands, in which we are informed that the number of volcanoes still preserving their form, and with distinct craters, is one hundred, distributed as follows:—In the Kuriles 23, in Yezo 28, in Honshiu 36, and in Kiushiu and the Southern Islands 13. Of these no less than 50 emit steam, while 39 are distinguished by their beautiful and graceful outlines. The number of great eruptions of which there is any published record is 233, the greater frequency, as with earthquakes, having been during the colder months of the year. One line of vents, which is more than 2000 miles long, begins in Kamsatka, passes through the Kuriles, Yezo, and down by Honshiu to the ever-smoking Asama. Here it is joined by a line branching away to the south-west, which runs through the great Fujisan and Oshima, till it reaches the Ladrones, a distance of 1200 miles. The last line begins at, or near, the gigantic crater of Mount Aso, and extends 1300 miles through Formosa to the Philippines. Extremely basic rocks are rare, but so far as observations have gone, it may be said that the lava poured out from the northern vents is more acid in composition than the southern. All are magnetic, and lavas that will turn a compass-needle through 180° are not rare. By their decomposition, the soil of the country is in many places so filled with grains of magnetite, that a magnetized knife passed over the gravel of a garden path will be covered with a brush of this unoxidizable material.

The twelve pages devoted to the description of Fujisan are replete with interesting information. The word Fuji is said (on the authority of the Rev. John Batchelor, of Sapporo) to be a corruption of the Ainu word *Huchi*, which is the name of the "Goddess of Fire." Professor Milne ascended the mountain in 1880, and found that it was not quite extinct, as is usually supposed, for small quantities of steam were detected by him issuing through the ashes on the eastern side of the mountain just outside the lip of the crater. Von Fritsch and Ludecke have shown the lavas composing Fuji to be dolerites, and analyses by several chemists are given in this work. The beautiful and symmetrical outlines of the mountain are well known, but on the south side of the mountain there is an excrescence, at a height of 9000 feet, which was produced by the last great eruption in 1707. The recorded eruptions of the mountain are as follows:—B.C. 301, 294, or 286, and A.D. 799, 802, 864, 937, 1021, 1082, 1329, 1560, 1627, 1649, 1700, and 1707. Professor Milne records the interesting observations made by him with a tromometer or tremor-measure during a stay of five days on the top of Fuji. These observations tend to prove that the great mass of the mountain actually yields to force of wind playing around its summit. The height of Fujisan is proved by various observations to lie between 12,400 and 12,450 feet.

The authors are to be congratulated on the excellence of this first instalment of a work which promises to be one of great scientific value. J. W. J.

THE GALILEO CELEBRATION AT PADUA

THE celebration of the three hundredth anniversary of the day on which Galileo began his labours as a Professor at the University of Padua was even more successful than had been anticipated. Its success was in every way worthy of the large number of scientific men who assembled to do honour to Galileo's memory, and of the great institution with which, as it remembers with veneration and pride, he was so intimately associated.

On December 6 the Rector, Prof. C. J. Ferraris, received in one of the courts of the old University, adorned everywhere with portraits of the most illustrious professors, delegates from the Universities, the polytechnic schools, and Italian and foreign Academies, amounting to nearly a hundred, and amongst them many of those who shed most lustre on contemporary science. The University of Cambridge was represented by Prof. George Howard Darwin, F.R.S., who also represented the Royal Society as Mr. Norman Lockyer, its delegate, had been prevented from attending. The University of Oxford by Prof. E. J. Stone, the Royal College of Physicians, London, by Sir Joseph Fayrer, F.R.S., the Chemical Society and British Association by Prof. Ludwig Mond, F.R.S., the Harvard University, Cambridge, U.S.A., by Prof. William James, and the Princeton University by Prof. Allan Marquand; the University of Lund by Prof. R. A. V. Holmgren, the Astronomical Observatory of Paris by its Director, Prof. F. Tisserand, that of Berlin by Prof. W. Foerster, the Polytechnic Schools of Berlin, Karlsruhe, Monaco, Brunswick, Stuttgart, by Profs. Lampe, Keller, Sohncke, Blasing, Lemcke, the University of Göttingen by Prof. Voigt, that of Budapest by Prof. Lanczy, that of Dorpat by Prof. Schmourlo; that of Lausanne by its Rector, Prof. Favey, the Academy of Paris by Prof. Gariel, the Faculty of Letters at Grenoble by Prof. de Croyals; the General Council of the Faculty at Nancy by Prof. Molk, &c., &c. There were also delegates from the towns of Florence, Pisa, Venice, and representatives from the foremost Italian Universities, Academies, and Technical Schools.

The great academical celebration took place on December 7 in the large hall of the University, in the presence of the Hon. Ferdinando Martini, Minister of Public Instruction, who represented the King of Italy. The ceremony was begun with a discourse prepared for the occasion by the Rector Magnifico, and devoted principally to a cordial expression of thanks to the King and to the Minister who represented him; to the foreign and Italian delegates, and to the ladies of Padua, who had given the University a most beautiful banner, on which were various emblems indicating the history of the University, the genealogical tree of the Galileo family, and the ancient inscription above the door of the University—*Gymnasium omnium disciplinarum*.

Next came the commemoration of Galileo by Prof. Antonio Favaro, who has for nearly fifteen years devoted himself almost exclusively to the study of the life and works of Galileo, and to whom was confided by the Government the care of the national edition of the philosopher's works, under the auspices of the King of Italy. The orator kept his discourse within the limits marked out for him, speaking chiefly of Galileo at Padua. Constrained to leave the University of Pisa, Galileo had been welcomed in that of Padua, where he found the "natural home of his mind," a "theatre worthy of his talents." The conditions at Padua at that time were eminently favourable to Galileo's work, for the Venetian

Senate granted the lecturers the utmost liberty, and experimental methods, which could not be learned from books, had been practised at the University for more than a century Galileo had many opportunities for the development of his genius, both in the lecture-room and in the home, in the preparation of scientific publications, and in the workshops of scientific instrument-makers both in Padua and Venice To Venice he frequently went, attracted thither by the means it afforded him for study, by that grand arsenal which had already been sung by Dante, and which in his reputed Dialogues is spoken of by Galileo with admiration, but above all by the advantages he derived from scientific intercourse with eminent men who resided in the dominion The culminating point of the discourse was naturally reached when the orator had to deal with the invention of the telescope, and with the astronomical discoveries made by means of it, the immediate result of which was the recall of Galileo to Tuscany. This did not aid Galileo in his glorious career, or help to protect him from the attacks which were for a long time made on him by invidious adversaries Even some of his own servants changed at once to implacable and dangerous enemies, and at last he was involved in all the miseries which sprang from the memorable lawsuit. This led the orator to recall the fact that when the clouds assumed their most threatening aspect, the Venetian Republic, forgetting with real magnanimity whatever resentment it might have felt at Galileo's abandonment of his chair at Padua, offered to re-appoint him, and to print at Venice the work which had brought upon him so much trouble He said also that a pleasant memory of Padua must have passed through the mind of the prisoner of the Holy Office, when there came to him his only comfort, the message from the favourite of his childhood, the nun who in Padua had tenderly cared for him during the first ten years of his youth.

After Prof Favaro's oration discourses were delivered by the foreign delegates, Holmgren, Fayrer, Darwin, Tisserand, Lampe, Keller, Foerster, Sohncke, Blasing, Lemcke, Farey, Lanczy, Schmourlo, and by Italian delegates, Nardi-Dei, Mantovani-Orsetti, and Del Lungo Then followed the conferring of University honours, of which seven had been set apart by the Council for seven men of science, one for each nation, all distinguished for their devotion to the studies in which Galileo excelled, viz Schiaparelli, Helmholtz, Thomson, Newcomb, Tisserand, Bredichin, and Gylden The degree of philosophy and letters was given to the Minister Martini; of natural philosophy, and philosophy and letters, to the leading delegates The ceremony was closed by the inauguration of a commemorative tablet in the large hall

Of the other festivals connected with the celebration it would be out of place to speak here, and it will be better to add a list of the publications which have been issued on the occasion The oration read in the Great Hall by Prof Favaro has been published, with the addition of twenty-five facsimiles of documents containing the various decrees of the Senate concerning Galileo, the date of the early prelections given by him at regular intervals, several autographic records of Galileo, chosen in order to give a more exact idea of what are the most precious materials for his biography, the frontispieces of the various publications issued by Galileo, or relating to the time of his sojourn in Padua, the geometric and military compass, the writing presenting the telescope to the Doge, and the first observations of the satellites of Jupiter. A portrait of the great philosopher, from a painting which represents him at the age of forty, taken in 1604, is prefixed.

By favour of the University there have also been published two other works, one containing all the notices of the studies at Padua in 1592, the other proving which was the house inhabited by Galileo and the place in which he made his astronomical observations The ancient Academy of Padua, among whose founders Galileo is numbered, has issued a publication in which are collected several works dedicated to his memory, and the students of the University have sought to perpetuate the remembrance of this festival by the publication of a "unique number," bringing together all the documents relating to the sojourn of Galileo in Padua, collected from all quarters These publications will serve as suitable memorials of a great and most interesting celebration

ANTONIO FAVARO

SIR RICHARD OWEN

IT is with great regret that we record the death of Sir Richard Owen He died on Sunday, after a lingering illness, at Sheen Lodge, Richmond Park, in his eighty-ninth year In publishing his portrait in the series of "Scientific Worthies" (NATURE, vol. xxii p 577) we have already presented an estimate of his work and of his place in the history of science It is only necessary now, therefore, to recall some of the leading facts of his career

He was born at Lancaster on July 20, 1804, and received his early education at the grammar school of his native place Afterwards he matriculated at the University of Edinburgh as a medical student In 1825 he joined the medical school of St Bartholomew's Hospital, London, and in 1826 he took his diploma at the Royal College of Surgeons His professional studies having been completed, he began to practise in Serle Street, Lincoln's Inn Fields, but the bent of his mind was towards purely scientific investigation, and he soon had a good opportunity of exercising his powers Dr Abernethy, with whom he had acted at St Bartholomew's as a dissector, had recognized his ability, and, in accordance with the advice of this famous surgeon, he was invited in 1828 to undertake the task of cataloguing the Hunterian collection at the Royal College of Surgeons The invitation was accepted, and in 1830 the first catalogue of the invertebrate animals in spirits was published In the same year Owen read at the first meeting of the Zoological Society's committee of Science a valuable paper on the anatomy of the orang-utan, and afterwards he made many important contributions to the Society's Transactions and Proceedings He was also well known as a reader of papers before the Medical Society of St. Bartholomew's and the Medical and Chirurgical Society of London. In 1832 appeared his well-known essay on the Pearly Nautilus (*Nautilus Pompilius*), in which he gave most striking proof of his power of interpreting the facts of natural history in a thoroughly philosophical spirit

Before he was thirty years of age Owen had achieved so good a reputation that in 1834 he was appointed to the newly-established chair of comparative anatomy at St Bartholomew's Hospital Two years afterwards he succeeded Sir Charles Bell as professor of anatomy and physiology at the Royal College of Surgeons, and he was elected to the newly-established Hunterian professorship at the Hunterian Museum He also became conservator of the Hunterian Museum on the death of Mr Clift, whose daughter he had married He had gradually been withdrawing from the practice of his profession, and ended by devoting the whole of his time and energy to scientific work

His connection with the Royal College of Surgeons lasted for twenty years, and during this period he achieved results which placed him in the front rank of original investigators. In the article to which we have referred we have already indicated the nature and importance of these results, and need not go over the same ground again It must suffice to mention the completion, in five volumes, of his catalogue of the Hunterian

collection, his "Odontography", his Lectures on Comparative Anatomy and Physiology; his "Archetype and Homologies of the Vertebrate Skeleton", his memoirs on "The Nature of Limbs" and on "Parthenogenesis", his monograph of British fossil reptiles, and his papers on the fossil birds of New Zealand, and on some fossil mammals of Australia In 1856 he was appointed Superintendent of the Department of Natural History in the British Museum How splendidly he fulfilled the duties of this position all the world knows He fought steadily and earnestly to obtain proper accommodation for the magnificent collection placed under his charge, and to him, more than to any one, Great Britain owes the fact that this particular set of her scientific treasures is now so securely preserved and so finely displayed The practical duties of his office were not allowed to interrupt his scientific researches, and year after year he continued to give fresh evidence of the astonishing range of his knowledge and of his remarkable capacity for far-reaching and brilliant generalization Among the writings of this period are his Manual of Palæontology, and his memoirs on the classification and geographical distribution of mammals, on the British fossil reptiles of the Liassic formations, ichthyosaurs and plesiosaurs, on the British fossil cetacea of the Red Rag, on the British fossil reptiles of the Mesozoic formations, pterodactyls, and on the fossil reptiles of South Africa

In 1883 he resigned his official position, but he did not cease to interest himself in the studies in the prosecution of which he had displayed so commanding a genius In 1884 he issued in three volumes his great "History of British Fossil Reptiles," and until a comparatively recent date he submitted to the Royal Society from time to time papers embodying the more important results of his labours.

In the course of his long career Owen did much good service as a member of various Commissions, and it is scarcely necessary to say that honours of many different kinds were conferred upon him About these matters we have given all necessary information in our previous article Owen was very far from being content merely with the collection and classification of facts, he sought also to bring out the ideas in which his facts seemed to him to find their ultimate significance He was unable to adopt the theory of evolution as presented by Darwin, but his researches did much to prepare the way for the general and rapid acceptance of Darwin's hypothesis, since it was felt that there must be some strictly scientific explanation of the affinities by which he had shown vast groups of animal forms to be allied to one another Apart altogether from its speculative aspects, his work is universally acknowledged to be of high and enduring value, and there can be no doubt that he will rank among the strongest and most impressive figures in the intellectual history of the nineteenth century

He desired that his body should be buried beside that of his wife in Ham Churchyard, and his wish is, of course, to be complied with At the funeral, which will take place to-morrow (Friday), there will be representatives of all the learned societies with which he was connected

NOTES.

THE following memorial, numerously signed, has been presented by Sir Henry Roscoe to the Right Hon the Earl Cowper, Chairman of the Royal Commission on the Gresham University:—The undersigned desire hereby respectfully to record their strong opinion that the foundation of a Teaching University for London, without due provision being made for higher Education and original Research, would be unworthy of the Metropolis, and would entail the neglect of an admirable opportunity for promoting the advancement of Science and Learning The signatures cannot fail to command attention The following learned Societies are represented by their Presidents.—The Royal Society, the British Association for the Advancement of Science, the Royal Dublin Society, the Royal Society of Edinburgh, the Iron and Steel Institute, the Physical Society, the Institution of Electrical Engineers, the Institute of Mechanical Engineers, the Chemical Society, the Royal Horticultural Society, the Pharmaceutical Society of Great Britain, and the Institute of Chemistry of Great Britain and Ireland Eton College, Harrow School, Rugby School, and St Paul's School are represented by their head-masters There are also representatives of the University of Oxford, Cambridge, Edinburgh, Glasgow, Aberdeen, and St. Andrews, the Victoria University, the British (Natural History) Museum, the Royal College of Science, London, University College, London, Mason College, Birmingham, Durham College of Science, Firth College, Sheffield, University College, Dundee, University College, Bristol, City and Guilds of London Central Institution the Royal College of Science, Dublin, and the Pharmaceutical Society of Great Britain A special group of signatures consists of the names of a number of Fellows of the Royal Society

SIR JOSEPH LISTER, Sir Henry Roscoe, and Prof. Ray Lankester, will represent the Royal Society at the Pasteur celebration in Paris on the 27th inst Captain Abney has been invited to represent the Society at the 150th anniversary of the American Philosophical Society in May 1893

WE are glad to see that a movement has been started for the purpose of securing that due honour shall be done to the memory of Jean Servais Stas, one of the most illustrious of modern chemists It is proposed that a new edition of his writings shall be issued, his memoirs, notes, and reports being grouped in their proper order, and that a commemorative monument shall also be erected An influential committee, representing science in all parts of the world, has been appointed to take the necessary steps Subscriptions will be received by M. L Errera, 1, Place Stéphanie, Brussels

THE Committee of the International Electrical Exhibition to be held at Milan in 1894 proposes, according to *La Lumière Electrique*, to offer a prize for the most important invention or discovery in the province of electricity, especially in connection with the transmission of energy to a great distance, and its distribution and transformation for industrial uses

SUCCESSFUL experiments have been made in France relative to the introduction of telephones for use in warfare The telephonists are organized in sets of two men, each set being provided with equipment for a mile line The very simple receiving and transmitting apparatus are attached to the military cap, and the wire is on reels in a sort of breast-plate, the whole being so light that a man's ordinary equipment weighs less than six pounds

THE tunnel at Niagara Falls is finished, and the power plant will be in operation by next March It is expected that a current of 45,000 electric horse-power will be transmitted from there to Buffalo, and 30,000 to other points

M. MAURICE MALLET, in *L'Aéronaute*, describes what he claims to be the longest balloon ascent on record. His balloon, "Les Inventions Nouvelles," started from the gasworks of La Villette, Paris, on October 23, and the voyage terminated at Walhen, in Central Germany, at 6 a.m. on the 25th, after a total journey of 36 hours 10 minutes above ground The flight was interrupted several times by the snow which fell in the higher regions of the atmosphere When lower strata were reached, the snow melted, and the balloon regained its ascending power. During one of these descents it was stopped and examined by

a Prussian *gendarme*, who had followed it at a gallop for some distance. The route passed over part of Belgium, the Taunus, and the Odenwald, and the towns of Metz and Frankfurt were recognized in passing

The "Annals of the Harvard College Observatory" contain a discussion by H H Clayton of the cloud observations made at Mr A L Rotch's observatory at Blue Hill, Massachusetts One of the most noticeable facts brought out by the measurements of cloud heights and velocities, which have been conducted with great care, is the difference in height between the same clouds in summer and winter, the clouds, with few exceptions, being lowest in winter The bases of the cumulo nimbus clouds, however, are generally lower in summer, while, at the same time, their tops are higher than in winter The heights of the different clouds were found to maintain an almost constant ratio to each other The mean velocities recorded showed that the entire atmosphere moves twice as fast in winter as in summer The mean velocity of the highest clouds in winter was about 100 miles an hour, the extreme velocity amounted to 230 miles an hour, from which it appears that the upper currents are much more rapid over America than over Europe, which possibly explains the greater velocity of the storms in America As regards the directions of cloud movement, the tables show that from the highest clouds to the earth's surface, the prevailing wind is west, above 4000 metres more than 90 per cent of the observations show the clouds from some point between south west and north-west inclusive In the cirrus and the cumulus regions, and near the earth's surface, the prevailing direction is from a little north of west, but in the intermediate levels, from a little south of west, the excess of the southerly component in these regions being possibly due to the influence of cyclones

The weather during the past week has been generally very dull, and scarcely any rain has fallen over the southern parts of the kingdom Between Friday and Monday there were several depressions to the northward of our islands, passing in an easterly direction, which caused very severe gales and high seas on the coasts of Scotland, the difference on pressure on Sunday between the north and south of our islands being more than an inch During the first part of the period the temperature was unusually high for the season, the maxima exceeding 55° in some parts, and the night minima were occasionally higher than the average daily maxima for the month, subsequently, however, a decided fall occurred, with fog and mist in most parts of England, while in Scotland hail and sleet showers were experienced The *Weekly Weather Report* of the 17th instant shows that for that period the temperature was from 2° to 4° above the mean Rainfall exceeded the mean in the north of Scotland only, and just equalled it in the north of Ireland, in all other parts there was a deficiency Bright sunshine was much less prevalent than during the preceding week, although in most parts of England the amount exceeded the average

Prof Cole writes from Dublin that the afterglow in the west and zenith on Saturday, December 17, was of a superbly brilliant character Mr. R Langton Cole observed that in London on December 15 the whole sky was covered by the glow, which was deeper all round towards the horizon

An interesting lecture on "Water and Water Supply" was delivered last week at the London Institution, by Major L. Flower, of the Sanitary Institute. As an instance of the important part which water played in the economy of nature, he mentioned that if a man weighing 140 lbs were placed under a hydraulic press and squeezed flat, the result would be 105 lbs. of water, and only 35 lbs. of dry residue, which was a fact for conceited people to reflect upon. Major Flower gave some interesting facts about the rainfall of England. It is, of course, highest in mountainous districts, the maximum fall being found in Cumberland, where the record for six years shows an annual rainfall of 165 in The lowest in England is between Biggleswade and Bedford, where it reaches only 20 in London and the east coast average about 25 in Speaking of drinking water, Major Flower said the best way to get it was to bottle it at the fountain head and have it delivered in bottles, which had been done already and might be done to a greater extent in the future

Mr W F Howlett writes to us from Pahiatua, New Zealand —"Can you inform me what is now sold in England as gum arabic? I used to be able to buy a soluble gum, what I get now is the same in appearance, but it will not dissolve It swells up, truly, but will not form a homogeneous filterable solution. It would be a great boon to small buyers if such things were sold under their proper names Am I right in supposing that since the Soudan trouble gum arabic has disappeared from commerce?"

A very interesting report on artesian boring, by Mr J W Boultbee, is included in the volume containing the annual report of the Department of Mines and Agriculture, New South Wales, for the year 1891 Mr Boultbee shows that, as a rule, artesian waters are suitable for irrigation purposes, only those heavily charged with salt or alkaline matters being unsuitable, and he can see no reason why such irrigation should not be an element of immense value, deserving the utmost consideration in connection with the development of that north western portion of the colony, where the fertility and recuperative powers of the soil are so wonderfully illustrated by the growth of feed after rainfall at the proper season The average quantity of water required for the irrigation of grain crops, based upon the experience of other countries, may be roughly estimated at 72,600 cubic feet, or 543,485 gallons per acre One inch of rain would equal 3630 cubic feet, or 22,622 gallons per acre A rainfall of 20 inches would therefore yield 72,600 cubic feet, or 543,485 gallons per acre 640 acres would consequently require 46,464,000 cubic feet, or 347,830,400 gallons upon them as an equivalent to 20 inches of rain When it is considered that the flow per diem from the Native Dog Artesian Bore, 45 miles from Bourke, is approximately 2,000,000 gallons per diem, or 730,000,000 gallons per year, it will be seen that upon the foregoing basis a supply of water equal to a rainfall of 40 inches per annum, per 640 acres is available, or that an area of considerably over 1280 acres can be supplied with water equalling a rainfall of 20 inches per annum.

The Cambridge Local Lectures Syndicate have just issued an announcement of their next Summer Meeting of University Extension students, to be held at Cambridge in August, 1893 The programme is a large and varied one, and a number of well-known lecturers have already promised their services Among the scientific lecturers we notice the names of Sir Robert Ball, Sir H. E Roscoe, Mr Pattison Muir, and several of the best known of the Cambridge Extension lecturers Cambridge has always laid great stress on the importance of providing, as far as possible, practical work in science as well as theoretical teaching It has seldom been found possible to arrange much practical work in connection with the lectures given in the provinces, chiefly on account of the difficulty of finding laboratory accommodation, But students who can spare a fortnight—or, better still, a month—have now the opportunity of coming to Cambridge and seeing, at any rate, something of the resources of the University laboratories Even two or three weeks' work in a well-equipped laboratory may easily be a revelation to a student who has hitherto learnt his (or her) science from books or lectures. The laboratory work has always formed an important and highly appreciated part of the

Cambridge Summer Meetings Next year no less than five practical courses are promised, viz. in physics, chemistry, botany, physiology, and palæontology, thus providing for a considerable variety of taste, and for the accommodation in the laboratories of a fairly large number of scientific students Another feature in the programme is an entire novelty It is proposed to give a series of short courses of lectures on the growth of various sciences—astronomy, physics, chemistry, and geology—to illustrate from different points of view the methods by which discoveries are actually made, and science makes progress These will be accompanied by a short theoretical course on scientific method The sciences selected only cover a small portion of the whole field, and some aspects of scientific method—such as classification—will obviously scarcely be represented The organic sciences generally are left out, and may possibly form the groundwork of a similar scheme on some future occasion The idea of illustrating scientific method by the history of science is a familiar one, and is the basis, for example, of Whewell's great books on "The Philosophy and the History of the Inductive Sciences" Few men, however, possess the encyclopædic knowledge of science which Whewell had, and the progress of science since his day would make such a task as he undertook well nigh impossible for a more modern writer The Cambridge Syndicate do not attempt to find a Whewell, but hand over the history of each science to competent specialists, and hope to give real unity to the whole by the lectures on method, in which the lessons taught by the history of the various sciences will be brought into a focus, and made to lead up to general principles. The experiment is certainly an interesting one, and we shall watch with some interest to see how it succeeds The programme includes also lectures on history, literature, art, and other subjects But we have dwelt only on the science as being of special interest to our readers.

IN the Herz oscillator, as used hitherto, the spark discharge of a Rhumkorff has been produced in air between two balls MM Sarasin and de la Rive lately thought (*Arch. de Sciences*) to place the balls in an insulating liquid, and they find that this gives a more intense effect in the resonator Olive oil does best, oil of turpentine, liquid paraffin, and petroleum were also tried Placed near the oscillator the resonator gives quite a bright spark, and at about 30 ft distance, with a resonator of large diameter, the spark is strong enough to be visible a good way off

ATTEMPTS are being made to create a silk-producing industry in the district of Nicolaieff, in South Russia and, according to the British Vice-Consul at Nicolaieff, the result is not unlikely to be satisfactory He says that the mulberry tree, for the growth of which the soil and climate are well adapted, flourishes wherever it is planted, and that with very little trouble or expense every little plot of ground, now yielding nothing more than a crop of weeds, might in a short time be transformed into a remunerative feeding-ground for the silkworm The matter has been taken in hand by a society, and every encouragement is given to the peasants and poorer classes to take advantage of the opportunities provided for them If seriously followed up, the scheme may, the Vice-Consul thinks, prove a source of revenue to many a poor family, and eventually be the means of establishing a large and flourishing industry

AT a recent meeting of the Trinidad Field Naturalists' Club there was some discussion as to the question whether the bite of the tarantula (Mygale) spider is poisonous. Mr. C W Meaden, writing to the Club's journal on the subject, describes an incident which came under his own observation. Early in the present year he had a gang clearing some land after burning, and on visiting them one afternoon he saw a black tarantula dart from a heap of bush and deliberately bite one of the prisoners on the heel and then scamper away, which it did with safety to itself, although chase was made after it The spider seemed to be in an angry mood at being disturbed in a favourite haunt for food and shelter The bite drew blood, about two or three drops A Trinidad labourer's foot is thick enough almost to resist an auger, yet the spider managed to penetrate, so it may safely be asserted it was in earnest. Immediately the bite was given a shout went up, "The man is bitten by a big black spider—a tarantula!" This made the bitten one almost frantic with fright, and he cried out piteously, "Me God, me go die in gaol, me God," &c Mr Meaden took him to the infirmary, some 300 yards distant, and the sufferer carried his heel in his hand, *i e* hopped all the way. His foot was fomented with hot water, and spirits of ammonia were applied, with the addition of a little liquid ammonia, and he received a dose of ether mixture About two hours afterwards he ate his dinner heartily and slept well at night He complained of no pain in the morning, and went to work as usual There was no local swelling or inflammation, and but little pain at any time Fright was the only ill effect

SOME interesting results in application of cold have been recently recorded Thus M d'Arsonval has found that while with rising temperature, microbes die before soluble ferments, with lowered temperature the opposite occurs The invertine of beer yeast cooled to $-40°$C, does not lose its power, but it is destroyed as a ferment at $-100°$ On the other hand, the yeast itself cooled to $-100°$ is still active M Raoul Pictet has lately observed that at $-150°$ all chemical reaction is suppressed Thus, if sulphuric acid and potash are brought together at this temperature, they do not combine Litmus paper, introduced, keeps its colour. Curiously, it is possible to restore their energy to these inert substances, by passing an electric current, and the current passes readily whatever the substances, at $-150°$ all bodies are good conductors The disappearance of affinity at a low temperature can be utilized to get absolutely pure substances, and M Pictet has thus obtained alcohol, chloroform, ether, and glycerine

SOME good notes on the Shuswap people of British Columbia, read before the Royal Society of Canada by Dr George Dawson, F R S, are now printed in the Society's Transactions, and have also been issued separately In an interesting section on the superstitions of the Shuswaps he notes that they have a singular idea about certain small lizards A man who sees one of these creatures is supposed to be followed by it wherever he may go during the day, till at length, when he is asleep during the following night, it finds him, and entering his body, proceeds to eat out his heart, so that he quickly dies The late Mr Bennett, of Spallumsheen, told Dr Dawson in 1877 that the Indians employed by him in making a ditch for purposes of irrigation, on coming into camp in the evening, would jump several times over the fire in order to lead the possibly pursuing lizard to enter the fire and be destroyed in attempting to cross. He also noticed that they carefully tied up the legs of their trousers when retiring. If while at work during the day they saw one of these little lizards, which appeared to be abundant in that locality, it would be caught in a forked twig, the ends of which were then tied together with a wisp of grass and the butt end of the twig afterwards planted in the soil. Thus treated, the lizard soon died and become a natural mummy. If during the progress of the work any one found and carelessly tossed aside one of these lizards, the Indians would throw down their tools and search diligently until they found it, and secured it in the manner just described. Dr. Dawson thinks that this superstition must be widespread among the Indians, for it was afterwards related to him in identical form by a man of the Nicola River, who further pointed out a small lake, singularly

situated on the summit of a high ridge about a mile and a half south of the mountain named Za-kwās'-ki, as a noted resort—possibly the only place known to the man—of this peculiar animal He described it as being a few inches in length and nearly black Za-kwās'-ki, to which other stories attach, is south of Nicola River, at the source of the Nicoamen River

A COMMON impurity in many seeds which are used as food for live-stock is the seed of corn-cockle (*Agrostemma githargo*) Notably is this the case on the Continent, and especially in Hungary, where the refuse from the machines used in cleaning grain consists chiefly of cockle-seed, and is largely used in feeding swine It appears, as a rule, to have no ill effect upon these animals Upon other animals, however, it sometimes has serious and even fatal effects, especially upon calves and dogs According to Kobert (*Landw Centralblt Provinz Posen*, 19) it would appear that the seeds contain a glucoside—saponin $C_{32}H_{54}O_{18}$,—which acts as a poison either when eaten in the form of cockle-seed or when introduced into the blood Various animals are affected in different degrees, but dogs, cats, and birds soon die when fed upon the seed The poison decomposes the blood, dissolving the red corpuscles, and also destroys the sensitive albuminoid portion of the nerve elements Heating to 50° C. decomposes the saponin, and renders the seed harmless Since this glucoside is found to lie only just below the surface of the seed, Kobert suggests that the seed should be coarsely ground and the outer husk separated, to cook the meal would be a still safer precaution A good deal of cockle-seed comes into the port of Hull, chiefly, it is presumed, amongst grain which has not been screened From such seeds as linseed it is removed by screening before pressing, but it is too often found in the cake which results after the oil is expressed from the linseed A considerable quantity of corn cockle is handled in Hull, whatever its ultimate destination may be, and it sometimes occurs in feeding stuffs in far too large a percentage to be considered as an accidental impurity Its use in admixture (as impurity or otherwise) with other feeding stuffs is strongly to be deprecated so long as there is the slightest risk attending its consumption by any domestic animal Its detection is very easy, the peculiar rough husk of the seed being characteristic, the husk, after clearing with dilute sulphuric acid, and then with caustic soda, and examined under a low power of the microscope, will exhibit dark-red convoluted markings which distinguish it clearly from the husk of any other well-known seed

IT is a well known fact that sea anemones have a sense by which they recognize food. This has been studied recently by Herr Nagel at the Zoological Station in Naples, and he has endeavoured to localize it Among other experiments, a small piece of a sardine was brought carefully to the tentacles of one of these animals, the tentacle first touched, then others, seized the food and surrounded it, and the morsel was swallowed A similar ball of blotting-paper saturated with sea-water, brought near in the same way, was not seized If, however, the ball was soaked in the juice of fish, it was seized with the same energy as the piece of fish, but often liberated again after a time without being swallowed Blotting-paper saturated with sugar acted like the other, but more weakly. If saturated with quinine, it was refused, the tentacles drawing back On the outer surface of the body, as also in the part between the tentacles and the mouth, quinine had no effect, nor had coumarin, vanillin, or picric acid. When a piece of meat was placed in or near the mouth of a widely-open animal, no notice was taken of it, it was only seized when the tentacles were touched Thus the sense of taste seems to be in these alone Cutting the tentacles did not evidently give pain, but these organs appeared sensitive to heat and to touch, so that they appear to be the seat of three senses.

MR JOHN MURRAY has published a fourth edition of Dr W Fream's "Elements of Agriculture" The work was originally issued at the beginning of the present year, and two editions were sold out before the end of January The third edition has for some time been out of print The book has now been thoroughly revised, and enriched with a completely new set of illustrations

A NEW edition of Dr John Casey's "Sequel to the First Six Books of the Elements of Euclid" has been issued as a volume of the Dublin University Press Series The work has been edited by Prof P A E Dowling, by whom it has been carefully revised and considerably enlarged The editor has obtained much valuable aid from Prof Neuberg, of the University of Liège

MESSRS BLACKIE AND SON have issued a second edition, revised and enlarged, of Mr J McGregor-Robertson's "Elementary Text book of Physiology"

A FURTHER communication concerning the nature and properties of hydroxylamine, NH_2OH, is contributed to the *Recueil des travaux chimiques des Pays Bas* by M Lobry de Bruyn, whose isolation of the free base was described in our note of vol xlv p 20. It may be remembered that pure hydroxylamine was found to be a solid substance, crystallizing in colourless thin plates or needles, which are extremely deliquescent So powerful indeed is the affinity of hydroxylamine for water, that the crystals rapidly dissolve when exposed to the air, in the moisture attracted The crystals melt at a temperature of 33°, and the liquid boils at 58° under the reduced pressure of 22 millimetres If the liquid is heated under ordinary atmospheric pressure in contact with the air, it explodes with great violence when a temperature between 60° and 70° is attained, if the experiment is carried out in a vessel from which air is excluded, the liquid may be heated as far as 90° without accident, regular decomposition into gaseous products occurring at this temperature Explosion, however, usually follows at once if this temperature is much exceeded, and generally after a short time if the source of heat is removed as soon as the thermometer has reached 90°, inasmuch as the decomposition which is induced at this temperature is accompanied by evolution of heat. The crystals are without odour They react with considerable violence with the halogen elements, the reaction in the case of chlorine being accompanied by production of flame, the products do not appear to have been investigated as yet beyond ascertaining the presence among them of the halogen acids. Metallic sodium also vigorously attacks hydroxylamine, brilliant incandescence occurring Warm zinc dust reduces it to ammonia so rapidly, that if any considerable quantities are employed a violent explosion follows Highly oxidized compounds, such as potassium permanganate, chromates, bichromates, or chromic acid react with crystals of hydroxylamine, as may be expected, in a most energetic manner, brilliant flame being produced often accompanied by detonation Chlorates, perchlorates and bromates behave similarly in the presence of a drop of sulphuric acid Hydroxylamine liberates iodine from iodic anhydride, and rapidly reduces iodates to iodides. Dehydrated sulphate of copper inflames in contact with the crystals of the base, and powdered nitrate of silver is reduced to metallic silver Addition of trichloride or pentachloride of phosphorus to the crystals likewise brings about ignition Hydrogen peroxide oxidizes hydroxylamine to nitrous acid These reactions, selected from a large number which M. de Bruyn describes, amply demonstrate the remarkable chemical energy with which anhydrous hydroxylamine is endowed. It is interesting to learn that the melted substance is capable of dissolving a considerable volume of ammonia gas. Moreover, carbon dioxide and sulphuretted hydrogen are so soluble in melted hydroxylamine that

viscous liquids are produced which remain liquid even at $-10°$ As regards the preparation of the base, M de Bruyn has now succeeded in obtaining a hundred grams of the pure crystals from a little more than a kilogram of the hydrochloride, by the method described in our previous note above referred to

THE additions to the Zoological Society's Gardens during the past week include a red and yellow macaw (*Ara macao*) from Central America, presented by the Rev T N Talfourd Major, two gold pheasants (*Thaumalea picta* ♀ ♀) from China, an Alpine Chough (*Pyrrhocorax alpinus*), European, purchased

OUR ASTRONOMICAL COLUMN

COMET HOLMES (NOVEMBER 6, 1892) —The following ephemeris, taken from *Astronomische Nachrichten*, No 3131, gives the position for Comet Holmes for the ensuing week —

Berlin, Midnight

1892	R A. (app.). h m s	Decl (app) ° ′	Log r	Log Δ
Dec 23	0 55 44	+34 19 2		
24	56 37	16 0	0 4050	0 3049
25	57 31	12 9		
26	58 27	10 0		
27	0 59 24	7 2		
28	1 0 22	4 5	0 4073	0 3167
29	1 1 21	34 1 9		

M Deslandres, in *Comptes rendus* for December 12 (No 24), informs us that on November 21 he obtained a photograph of this comet between 10h 40m and 11h 20m Paris mean time, showing distinctly "un commencement de dédoublement" Owing to the bad weather no other negatives were taken until December 10, but although the time of exposure was an hour, the comet's impression was not obtained, thus confirming the present eye observations that its intensity is slowly decreasing

COMET BROOKS (NOVEMBER 20, 1892) —The following ephemeris of Comet Brooks is that obtained by Berberich, and varies a little from that given last week, as will be seen by comparing the values for December 22, with those given last week.—

Berlin, Midnight.

1892	R A. h m s.	Decl ° ′	Log Δ	Log r	Br
Dec 22	14 26 9	+42 50 2			
23	14 33 28	44 40 4	9 9211	0 0880	5 59
24	14 41 35	46 34 4			
25	14 50 41	48 31 6	9 9013	0 0861	6 18
26	15 0 55	50 31 4			
27	15 12 26	52 32 9	9 8838	0 0845	6 75
28	15 25 30	54 34 5			
29	15 40 21	56 34 4	9 8694	0 0831	7 26

SWIFT'S COMET —*Knowledge* for December 1 contains three most interesting photographs of Comet Swift, taken by Prof Barnard at the Lick Observatory on April 4, 6, and 7 respectively These photographs, which are obtained from the original negatives after an enlargement of 2¼ times, show what good photographic work can be done even with small instruments when exposures are somewhat lengthened In this case a 6-inch Willard lens of 31 inch focal length was strapped on to the tube of a 6½-inch equatorial, and the exposures given amounted to 60, 65, and 50 minutes The ordinary driving-clock, combined with a slight hand movement at the eye end, were all that was required to compensate for the diurnal and proper motion of the comet The star trails on the plates pointed out then the comet's proper motion Although these photographs were taken at such short intervals the changes recorded are most striking, the pictures bearing very little likeness to one another On this point Prof Barnard says "Had they been drawn by the most competent observer, most astronomers would leave their remarkable differences to the unskilful hand of the artist, for there is absolutely no resemblance among them." The photographs here referred to are from a series taken at Mount Hamilton, and in examining them he mentions that in the case of this comet he has been led to forcibly believe that in a comparatively short period there occurred a rotation of the tail "upon an axis through the nucleus."

ULTRA-VIOLET SPECTRUM IN PROMINENCES —In the current number of the *Memorie della Società Degli Spettroscopisti Italiani*, Prof. G. E Hale communicates a note on some photographs of the ultra-violet region in the spectra of solar prominences On October 15 at 3h 15m a photograph of the spectrum of a metallic prominence was obtained, which contained as many as 74 bright lines in the ultra violet between wave-lengths 3970 and 3630 The photograph, besides displaying all the lines previously recorded by Prof. Hale and M Deslandres, contained 32 additional lines which had not been previously known The following table shows their respective wave-lengths, which are to be regarded yet as only approximate.—

λ	λ	λ
3964	3863	3724 3
3956 9	3850 5	3716 9
3945 2	3813 5	3710·3
3938 1	3774	3699 5
3913 5	3767 1	3683
3965	3758	3681
3895 5	3757	3679 5
3893 8	3749 7	3674 2
3891	3741 7	3662 2
3878 8	3733 3	3647 8
		3632
		3630·8

Besides these lines the photograph shows traces of the lines λ 3807 2, 3802, 3764, 3763, 3758 2, 3709 5, 3707 8, 3676, 3643

EPHEMERIS FOR BODIES MOVING IN THE BIELA ORBIT — In *Astronomical Journal*, No 281, Dr Chandler communicates an ephemeris for the use of those wishing to search for bodies which may be moving in the orbit of Biela's comet The ephemeris is given for every eight days It is based on the orbit obtained by Michez, who calculated the principal perturbations up to 1866 In the present computations Dr Chandler has not taken into account any disturbance that may have been produced by the proximity of the planet Jupiter, or any perturbation that might have ensued from an approach to our earth The values are given up to the end of February, 1893

MADRAS MERIDIAN CIRCLE OBSERVATIONS —The Government of Madras has lately issued the results of observations of the fixed stars, made with the meridian circle during the years 1874–76 During this interval no change whatever was made either in the instrument or in the methods of reduction The volume gives the instrumental corrections for these years, the separate results of observations for each year, with the mean positions of the stars brought up to January 1 of each year, and corrections to the Nautical Almanac stars for the period in question

THE JUBA RIVER

AT the meeting of the Royal Geographical Society on Monday evening, Commander F G Dundas, R N, read a paper describing his ascent of the Juba river This was the first serious attempt to explore the river since Von der Decken's ill-fated expedition in the *Guelph* in August, 1865 The stern-wheel steamer *Kenia*, belonging to the Imperial British East Africa Company, under the command of Captain Dundas, crossed the bar of the Juba on April 25, 1892, an operation of much danger, as the vessel was exposed broadside on to heavy rollers, the depth at high water is only one fathom, and the water swarms with sharks and crocodiles The coast Somalis lined the bank with hostile movements as soon as they saw that the vessel was to go up the river, and detained the expedition for a fortnight, until a message was sent to the head chief, the Sultan of the Ogaden Somalis It was July 3 before amicable arrangements could be made, and the expedition fairly started. The Somalis met with everywhere were very strict Mohammedans, and secluded their women, but a number of Galla slave-girls were seen amongst them There were few villages, Hajowan and Hajaualla opposite each other near the mouth being the only large ones until Munsur, 360 miles, and Bardera, 387 miles from the sea, were reached. The lower reaches of the river were very winding On one occasion Captain Dundas observed a stream flowing parallel to the river he was on, and going across to see it recognized the landmarks as those

he had passed three hours before The Waboni tribe, who live by hunting, and use the bow and arrow, occupied the thick woods of the lower river Above them the curves became more gentle, and the Gusha district was reached, where the people cultivated the land, which was cleared by burning, and for a hundred miles the *Kenia's* furnaces were fired with the dead trees which had been killed, but left unburnt by the fire Cotton is cultivated as well as food plants, and there is a primitive system of weaving Above Bilo, and about 100 miles from the sea, a branch was found to run off from the main river to the south west through very dense forests This is probably the Sheri, which reaches the sea midway between Lamu and Kismayu, the land between this and the Juba mouth being probably of deltaic origin This branch was explored in a boat for twenty miles The dense forests formed a broad belt on both sides on the river, and after steaming for five days through uninhabited woods the *Kenia* suddenly emerged into open country on August 2 The people were of very mixed race, friendly and well supplied with all sorts of food Hills began to appear, and the river grew shallower, until on August 10 the steamer moored to the bank opposite Bardera Here the Sultan forbad a landing, and the people, who numbered about 1200, were hostile, but ultimately peace was arranged, and one of the subordinate sheiks accompanied the *Kenia* to the rapids, where the river sweeps between steep rocky hills 300 to 400 feet high There are three channels in the rapids, but at the time of the visit none was navigable, and the natives reported a waterfall over a ledge of rock about four hours' march further up, in latitude 2°34' N The wreck of the *Guelph* was visited and examined, but the rapid falling of the water made it necessary to hasten back to the sea The climate throughout was found agreeable, and there were few mosquitoes The river does not overflow, so there are no malarial swamps along the banks

BREATH FIGURES[1]

FIFTY years back Prof Karsten, of Berlin, placed a coin upon glass, and by electrifying it made a latent impression, which revealed itself when breathed upon About the same time Mr W R (now Sir W R) Grove made similar impressions with simple paper devices, and fixed them so as to be always visible A discussion of Karsten's results occurs in several places, but I have not been able to find details of his method of performing the experiment During my attempts to repeat it some effects have appeared which seem to be new and worthy of record

After many trials I found the following method the most successful --A glass plate, six inches square, is put on the table for insulation in the middle lies a coin with a strip of tinfoil going from it to the edge of the glass · on this coin lies the glass to be impressed, four or five inches square, and above it a second coin It is essential to polish the glass scrupulously clean and dry with a leather the coins may be used just as they usually are, or chemically cleansed, it makes no difference The tinfoil and the upper coin are connected to the poles of a Wimshurst machine which gives three or four inch sparks The handle is turned for two minutes, during which one-inch sparks must be kept passing at the poles of the machine On taking up the glass one can detect no change with the eye or the microscope, but when either side is breathed upon, a clear frosted picture appears of that side of the coin which had faced it even a sculptor's mark beneath the head may be read For convenience those parts where the breath seems to adhere will be called white, the other parts black In this experiment the more projecting parts of the coin have a black counterpart, but there is a fine gradation of shade to correspond with the depth of cutting in the device; the soft undulations of the head and neck are delicately reproduced

The microscope shows that moisture is really deposited over the whole surface, the size of the minute water granulation increasing as the point of the picture is darker in shade

There seems to be no change produced by the use of coins of different metals.

If sparking is allowed across the glass instead of at the poles of the machine, traces of metal are sometimes deposited beyond the disk of the coin, but not within it

Around the disk is a black ring quarter inch broad. sometimes the milling of the coin causes radial lines across this halo

If carefully protected there appears to be no limit to the permanence of the figures, but commonly they are gradually obscured by the dust gathered up after being often breathed upon some of the early ones, done more than two years back, are still clear and well defined in the detail

It is possible to efface them with some difficulty by rubbing with a leather whilst the glass is moist They are best preserved by laying several together when dry and wrapping them in paper they are not blurred by this contact

It is a curious fact that certain developments take place after a lapse of some weeks or months The dark ring around the disk gradually changes into a series of three or four, black and white alternately, other instances of such a change will be noted below

Let it be noticed that in coin pictures the object is near to, but not in contact with, the glass for in the best specimens the rim of the coin keeps the inner part clear of the surface

Obviously a small condenser is made by the coins it is not essential, at the same time images made by a single coin, put to a single pole, are inferior

The plan which gives the surest and most beautiful results is to place five or six coins, lying in contact side by side in a cross or star, on either side of the glass it is not necessary that each coin should exactly face one on the other side

There has not appeared any distinction between the figures made by positive and negative electricity

When several coins are placed side by side, touching one another, there appear in the spaces between them, which are mostly black, well defined white lines, common tangents to the circular edges of the coins If these are of equal size the lines are straight, otherwise they are curved, concave towards a smaller coin They seem to be traces in that plane of the loci of intersection of equipotential surfaces

Similar effects are obtained when coins and glasses are piled up alternately, and the outer coins are put to the poles of the machine With six glasses and seven coins perfect images have been formed on both sides of each glass. With eight glasses the figures were imperfect, but there is little doubt this could be improved by continued trials as to the amount of electricity applied

If several glasses are superposed and coins are applied to the outer surfaces, there are only the two images at the outside After the electrification there is a strong cohesion between the plates.

It requires some practice to manage the electrification so as to produce the best results There are two forms of failure which present interesting features Sometimes a picture comes out with the outlines dotted instead of being continuous At other times, if the electrification is carried too far, the impression comes out wholly black, but on rubbing the glass when dry with a leather the excess is somehow removed Naturally it is difficult to rub down exactly to the right point, but I have succeeded on several occasions in developing from a blank all the fine detail of elaborate coins.

Here, again, we have another instance of the development by lapse of time, for an over-excited piece of glass usually gives a clear picture after an interval of a day or two

Impressions from stereotype plates have been taken of which the greater part is legible the distinctness usually improves after a few days. In default of a second plate, a piece of tin-foil about the same size should be put on the opposite side of the glass

Sheet and plate glass of various thicknesses have been used without any noticeable change either in the treatment or the results.

I have put an impressed glass on a photographic plate in the dark, but did not get any result on developing my imperfect skill in photographic matters leaves this experiment inconclusive

Probably all polished surfaces may be similarly affected a plate of quartz gives the most perfect images, which retain their freshness longer than those on glass

Mica and gelatine give poorer results · It is not possible to polish the surface to the necessary point without scratching it

On metal surfaces fairly good impressions can be produced if, as Karsten advises, oiled paper is put between the coin and the surface.

In the order of original discovery the figures noticed by Peter Riess should come first. He discusses a breath-track made on

[1] Paper read by Mr. W. B Croft before the Physical Society of London on June 24, 1892.

glass by a feeble electrical discharge, as well as two permanent marks, noticed by Ettrick, which betray a disintegration of the surface.

I have found that when a stronger discharge is employed more complex phenomena of a similar kind are produced. A six inch Wimshurst machine is arranged with extra condensers, as if to pierce a piece of glass. If this is about four inches square the spark will generally go round it. For a day, more or less, there is only a bleared watery track, $\frac{1}{10}$ inch wide, when the glass is breathed upon, but after this time others develop themselves within the first, a fine central black line with two white and two black on either side, the total breadth being the original $\frac{1}{10}$ inch. These breath-lines do not precisely coincide in position with the permanent scars, but the central one is almost the same as a permanent mark, which the microscope shows to be the surface of glass fractured into small squares of considerable regularity; on either side is a grey-blue line always visible, which Riess ascribes to the separation of the potash. After several months I found two blue lines on either side, which I believe were not visible at first. Of course these blue lines may be seen on most Leyden jars, where they have discharged themselves across the glass.

In 1842 Moser, of Konigsberg, produced figures on polished surfaces by placing bodies with unequal surfaces near to them; the action was ascribed to the power of light, and his results were compared with those of Daguerre. Moser says, "We cannot therefore doubt that light acts uniformly on all bodies, and that, moreover, all bodies will depict themselves on others, and it only depends on extraneous circumstances whether or not the images become visible." In general, the multitude of images would make confusion, it can only be freshly polished surfaces that are free to reveal single definite impressions. However great Moser's assumption may be, there are many achievements of modern photography that would be as surprising if they were not so familiar. I have not the means of knowing the precise form of Moser's methods. In the experiments which follow there is usually contact and light pressure, and if they are not wholly analogous, they may for that cause help to generalize the idea. In none of these is electricity applied.

A piece of mica is freshly split, and a coin lightly pressed for thirty seconds on the new surface: a breath image of the coin is left behind. At the same time it may be noticed that the breath causes abundant iridescence over the surface, whilst it is in a fresh state. It is not clear how the electricity of cleavage can have an active agency in the result.

It is familiar to most people that a coin resting for a while on glass will give an outline of the disk, and sometimes faint traces of the inner detail when breathed upon.

An examination-paper, printed on one side, is put between two plates of glass and left for ten hours, either in the dark or the daylight: a small weight will keep the paper in continuous contact, but this is not necessary if thick glass is used. A perfect breath impression of the print is made, not only on the glass which lay against the print, but also on that which faced the blank side of the paper. Of course the latter reads directly, and the former inversely; the print was about one year old, and presumably dry.

More often both impressions are white, sometimes one or other or both are black. At other times the same one may be part white and part black, and they even change while being examined.

During a sharp frost with east winds early in March, 1890, these impressions of all kinds were easy to produce, so as to be quite perfect to the last comma; but in general they are difficult, more especially those from the blank side.

At the best period those from the blank side of the paper were white and very strong; also there were white spots and blotches revealed by the breath. They seemed to correspond with slight variations in the structure of the paper, and suggest an idea that the thickness of the ink or paper makes a minute mechanical indentation on the molecules: the state of these is probably tender and sensitive under certain atmospheric conditions, as happens with steel in times of frost.

The following experiments easily succeed at any time:—Stars and crosses of paper are placed for a few hours beneath a plate of glass: clear white breath-figures of the device will appear. A piece of paper is folded several times each way to form small squares, then spread out and placed under glass: the raised lines of the folds produce white breath-traces, and a letter weight that was above leaves a latent mark of its circular rim.

Some writing is made on paper with ordinary ink and well dried: it will leave a very lasting white breath-image after a few hours' contact. If, with an ivory point, the writing is traced with slight pressure on glass, a black breath image is made at once. Of course this reads directly, and the white one inversely. It is convenient to look through the glass from the other side for inverse impressions, so as to make them read direct.

Plates of glass lie for a few hours on a table-cover worked with sunflowers in silk: they acquire strong white figures from the silk.

In most cases I have warmed the glass, primarily for the sake of cleansing it from moisture, but I have often gone to a heat beyond what this needs, and think that the sensitiveness has been increased thereby.

It is not easy to imagine what leads to the distinction between black and white, different substances act variously in this respect. I have placed various threads for a few hours under a piece of glass, which lay on them with light pressure: wool gives black, silk white, cotton black, copper white. A twist of tinsel and wool gives a line dotted white and black; after a time these traces show signs of developing into multiple lines as in the spark figures.

Two cases have been reported to me where blinds with embossed letters have left a latent image on the window near which they lay; it was revealed in misty weather, and had not been removed by washing. I have not had a chance to see these for myself, but both my informants were accustomed to scientific observation.

A glass which has lain above a picture for some years, but is kept from contact by the mount, will often show on its inner side an outline of the picture, always visible without breath. It seems to be a dust figure easily removed: possibly heat and light have loosened fine paint particles, and these have been drawn up to the glass by the electricity made in rubbing the outer side to clean it. The picture must have been well framed and sealed from external influences; most commonly dust and damp get in and obscure such a delicate effect.

I am not able to suggest simple causes for these varied effects. I am not inclined to think, except in the case of water colours, which is hardly part of the enquiry, that there is a definite material deposit or chemical change; one cannot suppose that imperceptible traces of grease, ineradicable as they may be, would produce complete and delicate outlines. The cleaning off of impressions may at first seem to indicate a deposit, but this renewal of the surface might rather be like smoothing out an indented tin-foil surface: such a view might explain the case where a blank over-electrified disk is developed into fine detail. The electrified figures seem to point to a bombardment, which produces a molecular change, the intensity of electricity bringing about quickly what may also be done by slow persistent action of mechanical pressure. At present it seems as if most of the phenomena cannot be drawn out from the unknown region of molecular agency.

While experimenting I was not within reach of references to former researches, but I have since done my best to find them out, and to indicate all I have learnt in the body of my paper.

Poggendorff, vol. lvii. p. 492; translated in *Archives de l'Electricité*, 1842, p. 647.

Riess' "Electrische Hauchfiguren" in "Repertorium der Physik"; translated in *Archives de l'Electricité*, 1842, p. 591.

Reiss' "Die Lehre von der Reibungs Electricität," vol. ii. pp. 221–224.

Mascart, "*Electricité Statique*," vol. ii. p. 177.

Taylor's "Scientific Memoirs," vol. iii.

SCIENTIFIC SERIALS

American Journal of Science, December.—An experimental comparison of formulæ for total radiation between 15° C. and 110° C., by W. de Conte Stevens. The formulæ given by Dulong and Petit, by Rosetti, Stefan, and Weber, were tested for a comparatively small range of differences by a determination of the heat radiated from an iron disc at a distance of about 30 cm. from a thermopile. The results tended to show that H. F. Weber's formula (*Sitzungsber.*, Berlin, 1888) agrees most closely with experiment. Stefan's formula, according to which the heat emitted in unit of time is proportional to the fourth power of the absolute temperature, is also fairly accurate,

but Dulong and Petit's values are too high, and Rosetti's too low.—Notes on silver, by M. Carey Lea.—Notes on silver chlorides, by the same. Fused silver chloride poured into petroleum and placed in the sunlight without removing it from the liquid, is instantly darkened. From this it appears that the presence of oxygen or moisture is not essential to the darkening of silver chloride in light. The chlorine may be taken up by some other substance.—A remarkable fauna at the base of the Burlington Limestone in north eastern Missouri, by Charles Rollin Keyes.—Glacial pot-holes in California, by H. W. Turner.—The lavas of Mount Ingalls, California, by H. W. Turner.—A method for the quantitative separation of barium from strontium by the action of amyl alcohol on the bromides, by Philip E. Browning. The solubility of barium bromide is about 0.0013 grm. on the oxide in 10 cc. of amyl alcohol, while that of strontium bromide is 0.2 grm. To obtain the bromides, the precipitated and thoroughly washed carbonates of Ba and Sr are treated with hydrobromic acid obtained by the action of dilute sulphuric acid on potassium bromide.—Note on the method for the quantitative separation of strontium from calcium by the action of amyl alcohol on the nitrates, by P. E. Browning. Recent work on this method has shown that the total correction amounts to 0.0006 grm. on the strontium oxide, and 0.0010 on the calcium as sulphate.—Study of the formation of the alloys of tin and iron, with descriptions of some new alloys, by W. P. Headden.—Notes on the Cambrian rocks of Pennsylvania and Maryland from the Susquehanna to the Potomac, by C. D. Walcott.—Volcanic rocks of South Mountain in Pennsylvania and Maryland, by G. H. Williams.

Wiedemann's Annalen der Physik und Chemie, No. 11.—On the behaviour of allotropic silver towards the electric current, by A. Oberbeck.—On the indices of refraction of dilute solutions, by W. Hallwachs.—On capillary constants, by M. Cantor.—On the chemistry of the accumulator, by M. Cantor.—On the fall of potential during discharges, by O. Lehmann. A series of important investigations on discharges between electrodes and in tubes without electrodes.—Expansion of water with the temperature, by K. Scheel.—A method for determining the density of saturated vapours and the expansion of liquids at higher temperatures, by B. Galitzine. This method has the advantage of extreme simplicity combined with accuracy. A small glass tube, about 5 cm. long and a few mm. thick, is closed at one end and drawn out into a capillary at the other. After determining the weight and internal volume of the tube, a small quantity of the substance to be investigated is introduced into it in the liquid state. This is made to boil, and then the tube is sealed by fusing. On raising the temperature, the surface of separation between the liquid and its vapour is displaced, until at a certain temperature all the liquid is converted into saturated vapour. The tube is then cooled until the vapour reappears, when the temperature is again taken. This can be repeated several times, thus giving an accurate value for the density of saturated vapour at a certain temperature. The same process can be used to determine the expansion of the liquid. As the temperature rises, the volume of the liquid will in general increase up to a certain point, when the vaporization becomes more pronounced. This maximum, which can be observed more accurately by drawing out the tube near that point, gives a value for the expansion. For the density at that point is a function of the density at 0° C. and the temperature, and the pressure is that of the saturated vapour at the same temperature. Thus it is only necessary to find the volumes of the liquid and the vapour, and the density of the latter from the previous experiment.—On radiant energy, by B. Galitzine.—Note on the electricity of waterfalls, by J. Elster and H. Geitel.—Apparatus for demonstrating the Wheatstone bridge arrangement, by A. Oberbeck.—Determination of the coefficient of self-induction by means of the electro dynamometer, by O. Troje.

SOCIETIES AND ACADEMIES

LONDON.

Royal Society, December 15.—On some new reptiles from the Elgin Sandstone, by E. T. Newton, communicated by Sir Archibald Geikie, F.R.S.

During the last few years a number of reptilian remains have been obtained from the Elgin Sandstone at Cuttie's Hillock, near Elgin, which are now in the possession of the Elgin Museum and of the Geological Survey. These specimens represent at least eight distinct skeletons, seven of which undoubtedly belong to the Dicynodontia, and one is a singular horned reptile, new to science. All the remains yet found in this quarry are in the condition of hollow moulds, the bones themselves having entirely disappeared. In order, therefore, to render the specimens available for study, it was necessary, in the first place, so to display and preserve these cavities that casts might be taken which would reproduce the form of the original bones. Gutta-percha was found to be the most suitable material for taking these impressions; and in some instances, especially in the case of the skulls, the casts had to be made in several parts and afterwards joined together.

The first specimen described is named *Gordonia Traquairi*; it is the one noticed by Dr. Traquair in 1885, and referred to the Dicynodontia; besides the skull, it includes fragmentary portions of other parts of the skeleton, and is contained in a block of sandstone which has been split open so as to divide the skull almost vertically and longitudinally. The two halves have been so developed that casts made from them exhibit the left side and upper surface, as well as the main parts of the palate and lower jaw. In general appearance this skull resembles those of *Dicynodon* and *Oudenodon*. The nasal openings are double and directed laterally; the orbits are large and look somewhat forwards and upwards. The supra-temporal fossa is large, and bounded above by the prominent parieto squamosal crest, and below by the wide supra temporal bar, which extends downwards posteriorly to form the long pedicle for the articulation of the lower jaw. There is no lower temporal bar. The maxilla is directed downwards and forwards to end in a small tusk. Seen from above, the skull is narrow in the inter-orbital and nasal regions, but wide posteriorly across the temporal bars, although the brain-case itself is very narrow. There is a large pineal fossa in the middle of a spindle shaped area, which area is formed by a pair of parietals posteriorly and a single intercalary bone anteriorly.

The palate is continuous with the base of the skull; the pterygoids on each side send off a distinct process to the quadrate region. Towards the front the mediam part of the united pterygoids arches upwards, and the outer sides descend, forming a deep groove; from the evidence of other specimens it is clear that the palatines, extending inwards, converted this groove into a tube, and thus formed the posterior nares. The ramus of the lower jaw is deep, with a large lateral vacuity, and the two rami are completely united at the symphysis. The back of this skull is not seen, but two other specimens, referable to this same genus, show that the occiput had two post temporal fossæ on each side.

This specimen is distinguished from *Dicynodon* by the presence of two post temporal fossæ on each side of the occiput, by the small size of the maxillary tusk; and probably by the elongated spindle-shaped area enclosing the pineal fossa, and also by the slight ossification of the vertebral centra.

A second and much smaller specimen, provisionally referred to *G. Traquairi*, has, besides the skull, a fore-limb well preserved. The humerus of this shows the usual Anomodont expansion of its extremities; its large deltoid crest is angular, and set obliquely to the distal end.

Three other species are referred to the same genus, namely:—

Gordonia Huxleyana, which is distinguished from *G. Traquairi* by its proportionately wider and more depressed skull, and by the absence of the concavity between the orbits which is present in the latter species. The humerus has the distal extremity oblique to the deltoid crest, which was probably rounded and not angular.

G. Duffiana has the skull even wider than in *G. Huxleyana*, and the portion of a humerus found with this skeleton has the two extremities set nearly at right angles to each other.

G. Juddiana has an elongated skull resembling that of *G. Traquairi*, but the parietal crests are less developed, the bones of the nasal region are much thickened and overlap the nasal apertures, the small tusk is placed a little further back and points more directly downwards, and the pineal fossa is smaller than in either of the other species.

A second generic form is named *Geikia Elginensis*. This is a skull nearly allied to *Ptychognathus*, Owen, but is distinguished by its shorter muzzle and the entire absence of teeth; the upper part of the skull, between the orbits, is also peculiar, forming a deep valley open anteriorly, with a ridge on each side, the anterio

end of which forms a large prominence above and in front of the orbit. The occiput has only one (the lower) post-temporal fossa open on each side. The maxilla is produced into a tooth-like prominence, which occupies a similar position to the tusks of *Gordonia*, but the bone is too thin to have supported a tooth, and in all probability it was covered by a horny beak. The lower jaw has a strong symphysis, a distinct lateral vacuity, and the oral margin, at the foot of each ramus, bears a rugose prominence.

Elginia mirabilis is the name proposed for the skull of a reptile, which, on account of the extreme development of horns and spines, reminds one of the living lizards *Moloch* and *Phrynosoma*. The exterior of this skull is covered in by bony plates, the only apertures being the pair of nostrils, the orbits, and the pineal fossa. The surfaces of the bones are deeply pitted, as in crocodiles and labyrinthodonts. The horns and spines, which vary from ¼ in. to nearly 3 in. in length, are found upon nearly every bone of the exterior. The development of the epiotics, and the arrangement of the external bones, resemble more the Labyrinthodont than the reptilian type of structure; while the palate, on the other hand, conforms more nearly to the Lacertilian type, and, with the exception that the pterygoids are united in front of the pterygoid vacuity, agrees with the palate of *Iguana* and *Sphenodon*. There are four longitudinal ridges along the palate, some of which seem to have carried teeth. The oral margin was armed with a pleurodont dentition, there being on each side about twelve teeth with spatulate crowns, laterally compressed and serrated. With the exception of the smaller number of the teeth, we have here, on a large scale, a repetition of the dentition of *Iguana*. This peculiar skull seems to show affinities with both Labyrinthodonts and Lacertilians, and is unlike any living or fossil form; its nearest, though distant, ally apparently being the *Pareiasaurus* from the Karoo beds of South Africa.

Linnean Society, December 1.—Prof. Stewart, President, in the chair.—A letter was read from the Rev. Leonard Blomefield, expressing his high appreciation of the compliment paid him by the presentation of the illuminated address which had been signed by the Fellows present at the last meeting of the Society and forwarded to him.—Messrs. H. and J. Groves exhibited specimens of several Irish *Characeæ* collected during the past summer. *Nitella tenuissima* from Westmeath and Galway had not been previously recorded from Ireland, and a large form of *N. gracilis* from two lakes in Wicklow had been only once previously met with. Referring to the former, Mr. H. Groves remarked that although it might be expected to occur in all the peat districts it had only been found in two widely separated localities in England, namely, in the Cambridgeshire Fens and in Anglesea.—Mr. A. Lister made some remarks on the nuclei of Mycetozoa, exhibiting some preparations under the microscope.—Mr. E. Cambridge Phillips forwarded for exhibition a hybrid between red and black grouse, which had been shot in August near Brecon.—Mr. J. E. Harting exhibited and made remarks on some coleopterous larvæ which had been vomited by a child at Tintern, and had been forwarded by the medical attendant, Dr. J. Taylor Brown, for identification. The precise species had not been determined, but was considered to be allied to *Blaps mortisaga*. Mr. Harting drew attention to the fact that cases of voiding coleopterous larvæ were mentioned by Kirby and Spence (7th ed. p. 71), and by the late Dr. Spencer Cobbold in his work on parasites (1879, p. 269).—Mr. D. Morris exhibited some tubers of *Calathea allouia*, eaten as potatoes in Trinidad, where it is known as Tapee Nambour. Apparently a corruption from the French *topinambour* (artichoke).—A communication was read from Mr. J. H. Hart, of the Botanic Gardens, Trinidad, on *Œcodoma cephalotes* and the fungi it cultivates.—Prof. F. Jeffry Bell contributed a short paper on a small collection of Crinoids from the Sahul Bank, North Australia, some of which were new, and Mr. Edgar Smith communicated descriptions of some new land shells from Borneo.—The meeting adjourned to December 15.

Physical Society, December 9.—Mr. Walter Baily, Vice-President, in the chair.—The Chairman announced that an extra meeting would be held on January 13, 1893.—Prof. S. P. Thompson's communication on Japanese magic mirrors was postponed.—Mr. W. B. Croft read a paper on the spectra of various orders of colours in Newton's scale. After referring to the definition of the *order* of colours by reference to the retardation in wave-lengths, produced by different thicknesses of selenite between crossed polarizer and analyzer, the author went on to say that several books on optics implied that the number of bands in the spectra of these colours was the same as the order of the colour. On obtaining selenites of the first four orders of red from Messrs. Steeg and Reuter, he found that the first three orders gave one dark band each, and that of the fourth order three dark bands. Further experiments showed that the thicknesses of the selenites were in the proper proportions required to give the first four orders of red. The numbers of bands, the author explained, depended on the numerical possibilities of wave-length within the visible spectrum—that is, whether a multiple of the wave-length of one visible wave can be another multiple of a different wave. For example, taking the visible spectrum as extending from A (0·000760) to H (0·000394) and the wave-length of the line E in the green as 0·000527, it was shown that the first order of red was due to extinction of green by a thickness of crystal proportional to 1 × 0·000527, and would give one band in the green. For the second order, the thickness of crystal was proportional to 2 × 0·000527, viz. 0·001054, and this number was no other integral multiple of any other wave-length between A and H; consequently there could only be one band. Similarly it was shown that the third order of red could only have one band or possibly produce a shortening of the spectrum. With the fourth order of red three bands were obtainable, for 4 × 0·000527 = 3 × 0·000703 and = 5 × 0·000422. Three bands were therefore possible near F, A, G, respectively. At the conclusion of his paper, Mr. Croft directed attention to a very simple form of diffraction apparatus, by which most of the ordinary diffraction phenomena could be well seen, and which also served for spectrum observations. Mr. H. Miers pointed out that in Lewis Wright's "Practical Optics" a chart showing the bands corresponding to the first four orders of red was given. So far as he was aware, the subject was not fully discussed in the book. In reply, Mr. Croft said he had noticed Mr. Wright's chart, but believed the text implied that the number of bands should be the same as the order of the colour. Tyndall made definite statements to that effect.—Dr. W. E. Sumpner read a paper on the diffusion of light. The influence of diffusion in increasing the illumination of rooms and open spaces, had not, in the author's opinion, been sufficiently appreciated. Being impressed with the great importance of the subject, he was led to make determinations of the co-efficients of reflection, absorption, and transmission of diffusing surfaces. To give precision to terms sometimes vaguely used, several definitions were proposed. *Reflecting power* was defined as the ratio of the amount of light reflected from a surface to the total amount of light incident upon it; *illumination* of a surface, as the amount of incident light per unit of surface; *unit quantity* of light as the flux of radiation across unit area of a sphere of unit radius at whose centre a unit light is placed; and *brightness* as the candle-power per unit area in the direction normal to the surface. Denoting these quantities by η, I, Q and B respectively, and assuming the cosine law of diffusion (*i.e.* the candle-power in any direction is proportional to the cosine of the angle between the direction and the normal to the surface) it was shown that $\pi B = \eta I$, and that the average illumination (I′) of the walls of a room is related to the illumination (I) due to the direct action of the lights as expressed by the formula $I' = \frac{I}{1 - \eta}$. If the reflecting power of the walls, &c., be 50 per cent., $\eta = \frac{1}{2}$, and $I' = 2I$, whilst if $\eta = 0{\cdot}8$, a number approximately true for white surfaces, then $I' = 5I$. The illumination due to the walls may, therefore, be far more important than that due to the direct rays from the lights. When the surfaces consist of portions of different reflecting power, the average reflecting power may be found from the equation $\eta = \frac{\eta_1 A_1 + \eta_2 A_2 + \&c.}{A}$, A being the total surface, and A_1, A_2, &c., the areas of surfaces whose reflecting powers are η_1, η_2, &c., respectively. This law is shown to be quite accurate for spherical enclosures. In measuring reflecting power, the surface was attached to a large screen of black velvet placed perpendicular to a 3 metre photometer bench. Two lights were used, one a Methven 2-candle standard placed at the end of the bench remote from the reflecting surface, and the other, a glow lamp of about 20 candle power, was attached to a slider which also carried a Lummer-Brodhun photometer. The glow lamp served to illuminate the reflecting surface, but the photometer was screened from its direct rays. The formulæ used in reducing the observations are worked out in the paper

and tables of results given Absorbing power was determined by measuring the candle-power of a glow lamp, first when uncovered, and then when surrounded by a cylinder of the substance under test It was found to be of great importance to distinguish between apparent and real absorption, for reflection from the surfaces of the cylinders increases the internal illumination The true absorption coefficient (α) is given by $\alpha = (1 - \eta)\dfrac{k_0 - k_1}{k_0}$, where η is the reflecting power and k_1 and k_0 the candle-powers with and without the envelope of material under test In determining transmitting power, the Methven standard and photometer were placed on one side of the surface and the glow lamp on the other Difficulties were experienced from the fact that some materials such as tracing paper, transmit part of the light directly (like transparent substances), and another part by diffusions according to the cosine law Methods for discriminating between the different parts were therefore devised both in the reflection and transmission experiments, and consistent results subsequently obtained Tables and curves showing the close agreement of calculated and observed values, are included in the paper An abstract of some of the tables of numbers is given below —

Material	Percentage reflecting power η	Percentage absorption α	Percentage Transmission τ	$\eta + \alpha + \tau$
Blotting paper	82	13·8	9·2	105·0
Cartridge paper	80	12·2	11·2	103·4
Tracing cloth	35	15·0	54·4	104·4
Tracing paper	22	7·0	76·0	105·0
Ordinary mirror	82			
Ordinary foolscap	50 to 70			
Tissue paper (one thickness	40			
Tissue paper (two thicknesses	55			
Yellow wall-paper	40			
Blue paper	25			
Dark brown paper	13			
Yellow painted wall	20			
Black cloth	12			
Black velvet	0·4			
Arc lamp globes—		(apparent)		
Light opal	—	15		
Dense opal	—	39		
Ground glass	—	42		

Theoretically the sum of the reflecting, absorbing and transmitting powers should be unity, but from the above table it will be noticed that they exceed 100 per cent, by amounts greater than can be accounted for by experimental error This discrepancy, the author thought, might be attributed to the law of cosines not being exactly fulfilled Mr A P Trotter said he had been interested in the subject of diffusion for many years with a view to obviating the glare of arc lamps Some experiments he made on reflecting power gave unsatisfactory results, owing, as he now saw, to his not taking the solid angles subtended by the reflecting surfaces into account. The reflecting power of substances was of great importance in the illumination of rooms, in one case measured by Dr. Sumpner and himself, two thirds of the total illumination was due to the walls It would greatly simplify measurement of reflecting power if some substance could be adopted as a standard Referring to the cosine law, he said he had found it true, except when the angles of incidence approached 90° In cases where considerable total reflection took place the apparent brightness near the normal direction was greatly in excess of that in other directions. These points he illustrated by polar curves. He had also considered what should be the nature of a roughened or grooved surface to give the cosine law of diffusion. No simple geometrical form of corrugations, &c., seemed to fulfil the required conditions. Dr. Hoffert said the high numbers given for the reflecting powers of substances were very interesting. Most people had noticed the effect of laying a white table cloth in an ordinary room. He had also observed that wall papers of the same pattern, but slightly different in colour, had very different effects in producing increased illumination, and wished to know if the influence of small differences in colour and texture on diffusing power, had been investigated Mr Blakesley defended the cosine law, and suggested that the summation of the powers exceeding unity might be due to the fact that the enclosure reflected heat as well as light, thus raising the temperature and increasing the efficiency of the radiant Mr Addenbrooke said the importance of the subject was impressed on him when he passed through America three years ago and noticed the crude manner in which electric lighting was there carried out If using good reflecting surfaces increased the illumination of a room 50 per cent, it was like reducing the cost of electricity from 8*d* to 4*d* per unit He could hardly conceive any subject of more practical importance than the one before the meeting Dr C V Burton did not understand why the cosine law should be objected to, for it was possible that no surface was perfectly diffusive The effect of reflection from walls, &c, say in illuminating a book would not, he thought, be so great as would appear from the numbers given, for one usually read near a light, and the reflected light falling on the book was only a small part of the whole, on account of the greater distances of the walls Another member pointed out that in experiments such as those described, it was very important to screen the photometer and surfaces from all radiation other than that under test He rather doubted whether any surface reflected as well as mirrors White surfaces might appear to do so, but this was probably because the eye would overestimate it, owing to the superiority of white in aiding distinct vision Dr Sumpner in reply said he had, as stated in the paper, used white blotting paper as a standard of reflecting power and found it very convenient His most careful measurements had been made on whitish surfaces and not on coloured ones Where one colour, say red, preponderates in a room, the average light would be much redder than that emitted by the source owing to the other colours being absorbed In considering illumination as related to distinct vision, it was necessary to take account of the eye itself, for the pupil contracted in strong lights and opened in feeble ones This subject he hoped to treat fully in a subsequent paper

Entomological Society, December 7 —Frederick DuCane Godman, F R S, President, in the chair —The President announced the death, on December 2, of Mr Henry T Stainton, F R S, an ex President and ex Secretary of the Society —Mr Jenner Weir exhibited a species of Acræa from Sierra Leone, which Mr Roland Trimen, F R S, who had examined the specimen, considered to be a remarkable variety of *Telchinia encedon*, Linn It was a very close mimic of *Limnas alcippus*, the usual West African form of *Limnas chrysippus* The upper wings of the specimen were rufous and the lower white, as in the model, and the resemblance in other respects was heightened by the almost total suppression of the black spots in the disc of the upper wings, characteristic of the usual markings of *T encedon* —Mr F J Hanbury exhibited a remarkable variety of *Lycæna adonis*, caught in Kent this year, with only one large spot on the under side of each upper wing, and the spots on the lower wings entirely replaced by suffused white patches He also exhibited two specimens of *Noctua xanthographa* of a remarkably pale brownish grey colour, approaching a dirty white, obtained in Essex, in 1891, and a variety of *Acronycta rumicis*, also taken in Essex, with a dark hind margin to the fore wings.—Mr H J Elwes exhibited a living specimen of a species of *Conocephalus*, a genus of *Locustidæ*, several species of which, Mr McLachlan stated, had been found alive in hothouses in this country —Dr T A Chapman exhibited immature specimens of *Tæniocampa gracilis*, *T. gothica*, *T populeti*, *T. munda*, *T instabilis* and *T. leucographa*, which had been taken out of their cocoons in the autumn, with the object of showing the then state of development of the imagos —Mr F W Frohawk exhibited a living specimen of the larva of *Carterocephalus palæmon* (*Hesperia paniscus*) hybernating on a species of grass which he believed to be *Bromus asper* The Rev Canon Fowler and Mr H Goss expressed their interest at seeing the larva of this local species, the imagos of which they had respectively collected in certain woods in Lincolnshire and Northamptonshire. Mr Goss stated that the food-plants of the species were supposed to be *Plantago major* and *Cynosurus cristatus*, but that the larva might possibly feed on *Bromus asper* —Mr C G Barrett exhibited a long series of remarkable melanic varieties of *Boarmia repandata*, bred

by Mr A E Hall from larvæ collected near Sheffield —Mr W Farren exhibited four varieties of *Papilio machaon* from Wicken Fen, also a series of two or three species of *Nepticula* pinned on pith with the "minutien Nadeln," for the purpose of showing these pins —Canon Fowler exhibited specimens of *Xyleborus perforans*, Woll which had been devastating the sugar canes in the West Indies —Mr E B Poulton, F R S, showed, by means of the oxy-hydrogen lantern, slides of various larvæ and pupæ, in illustration of his paper, read at the October meeting, entitled, "Further experiments upon the colour-relation between certain lepidopterous larvæ and their surroundings" He stated that he believed that nineteen out of twenty larvæ of *Geometridæ* possessed the power of colour adjustment Mr F Merrifield, the Rev J Seymour St John, and Mr Jacoby took part in the discussion which ensued —Mr F. Merrifield read a paper entitled, "The effects of temperature on the colouring of *Pieris napi*, *Vanessa atalanta*, *Chrysophanus phlæas* and *Ephyra punctata*," and exhibited many specimens thus affected Mr Poulton, Dr F A Dixey, Mr. Elwes, and Mr Jenner Weir took part in the discussion which ensued —Mr Kenneth J Morton communicated a paper entitled, "Notes on *Hydroptilidæ* belonging to the European Fauna, with descriptions of new species"—Dr T A Chapman read a paper entitled, "On some neglected points in the structure of the pupa of Heterocerous Lepidoptera, and their probable value in classification, with some associated observations on larval prolegs" Mr Poulton, Mr Tutt, Mr Hampson, and Mr Gahan took part in the discussion which ensued —Mr J Cosmo-Melvill communicated a paper entitled, "Description of a new species of butterfly of the genus *Calinaga*, from Siam"—Mr W L Distant communicated a paper entitled, "Descriptions of new genera and species of Neotropical *Rhynchota*."

PARIS.

Academy of Sciences, December 12.—M d'Abbadie in the chair —On certain asymptotic solutions of differential equations, by M Emile Picard —Description of a new electric furnace, by M Henri Moissan The furnace consists of two bricks of quicklime one upon the other, the lower one of which is provided with a longitudinal groove which carries the two electrodes, and between them is a small cavity serving as crucible, which contains a layer of several centimetres of the substance to be experimented upon The latter may also be contained in a small carbon crucible The highest temperature worked with was 3000° C, produced by a current of 450 amperes and 70 volts consuming 50 horse power In the neighbourhood of 2500°, lime, strontia and magnesia crystallized in a few minutes At 3000° the quicklime composing the furnace began to run like water. At the same temperature the carbon rapidly reduced the oxide of calcium to the metallic state The oxides of nickel, cobalt, manganese, and chromium were reduced in a few seconds at 2500°, and a button of uranium weighing 120 gr was obtained from the oxide in ten minutes at 3000° —Action of a high temperature on metallic oxides, by M Henri Moissan In all the experiments, the simple elevation of temperature produced the crystallization of all the metallic oxides experimented upon —On the existence of the diamond in meteoric iron of the Cañon Diablo, by M. C Friedel A careful analysis has placed beyond doubt the existence of diamond in a portion of the Arizona meteorite presented to the Ecole des Mines It occurs in small grains or a fine powder disseminated through the iron.—On the laws of expansion of fluids at constant volume, coefficients of pressure, by E H Amagat —On the means of diminishing the pathogenic power of fermented beet-root pulp, by M Arloing —On the employment of free balloons for meteorological observations at very great heights, by M Ch Renard —Photographic observations of Holmes's comet, by M. H Deslandres —On the locus of the mean distances of a point of an ordinary epicycloid, and of the successive centres of curvature which correspond to it, by M G Fouret —On ordinary linear differential equations, by M. Jules Cels.—On the common cause of the evaporation and surface tension of liquids, by M G van der Mensbrugghe —On the relation between the velocity of light and the size of the molecules of refracting liquids, by M P Joubin. From a comparison of a large number of substances the following law is deduced. The refraction is proportional to the square root of the quotient of the weight of the molecule by the number of constituent atoms (mean weight of the atom) —On the anomalous propagation of the light waves of Newton's rings, by M Ch. Fabry.—On transparent diffusing globes, by M. Frédureau.—On a relation between molecular heat and the dielectric constant, by M Runolfsson —On the employment of guard-ring condensers and absolute electrometers, by M P Curie —On the density of oxide of carbon and the atomic weight of carbon, by M A Leduc.—Critical reduction of Stas's fundamental determinations on potassium chlorate, by M G Hinrichs.—On a chloro iodide of carbon, by M A Besson —Action of anhydrous hydrofluoric acid on the alcohols, by M Maurice Meslans —Action of sulphuric acid on citrene, by MM G Bouchardat and J Lafont —Analysis of sulphate of quinine and quantitative determination of quinine in presence of the other cinchona alkaloids, by M L Barthe —On the assimilation of the omasum to the abomasum of the Ruminants from the point of view of the formation of their mucous membrane, by M J A Cordier —On the differential osteological characters of rabbits and hares, comparison with leporides, by M F X Lesbre —Remarks on the preceding communication, by M Milne Edwards —Myxosporidia of the bile duct of fishes, new species, by M P Thélohan —Method for ensuring the conservation of vitality in plants brought from distant tropical regions, by M Maxime Cornu —On the difference of transmissibility of pressures across ligneous, herbaceous, and succulent plants, by M Gaston Bonnier —On the structure of the *Gleicheniaceæ*, by M Georges Poirault —Salivary secretion and electric excitation, by M N Wedensky —Action of the extract of cows' blood on animals affected with glanders, by M A Babes —The blizzard of December 6 and 7, 1892, by M Ch V Zenger

BOOKS and SERIALS RECEIVED

BOOKS —The Elements of Graphic Statics L M Hoskins (Macmillan) —Qualitative Analysis Tables and the Reactions of certain Organic Substances Dr E A Letts (Belfast, Mayne and Boyd) —Lord Rosse on the Gospel Modernized by F L. Garbett (W Reeves) —An Atlas of Astronomy Sir R S Ball (Philip).—Pioneers of Science Prof O Lodge (Macmillan).—Collected Mathematical Papers of Prof A Cayley Vol V (Camb Univ Press) — British Journal Photographic Almanac, 1893 (Greenwood) —A Manual of Bacteriology Dr G M Sternberg (New York, Wood) —La Terre Les Mers et Les Continents F Priem (Paris, J B Baillière)

SERIALS —L Anthropologie, Tom 3, No 5 (Paris, Masson) —Economic Journal December (Macmillan and Co) —Journal of the Chemical Society, December (Gurney and Jackson)

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THURSDAY, DECEMBER 29, 1892

GORE'S "VISIBLE UNIVERSE"

The Visible Universe By J Ellard Gore, F R A S (London Crosby Lockwood and Son, 1893)

THE object of this book is "not to propound any new hypothesis, but simply to explain and discuss theories which have been supported by well-known astronomers and other men of science" as to the "evolution of the Solar System," and to give a popular account of the "construction of the Universe *as we see it*, and its probable development from pre-existent matter"

Mr Gore has already acquired considerable success as a popular writer on astronomical subjects, and the scheme of the present volume is, as we might expect, a very good one The first three chapters are devoted to a popular account of the hypotheses of Kant and Laplace, the principal objections that have been urged against them, and the modifications and additions suggested by recent research In subsequent chapters such subjects as the fuel of the sun, the luminiferous ether, the constitution of matter, celestial chemistry, and the meteoritic hypothesis are dealt with Mr Gore then reaches the purely descriptive portion of his subject, and gives excellent chapters on the Milky Way, and on "the latest results respecting the distribution of stars and nebulæ and their relative motions" Various theories of the construction of the Universe are then discussed, and in a final chapter the idea of infinite space and a finite universe is developed

Although the general scheme of the book is excellent, the execution falls in many places far short of its promise and our expectations When Mr Gore confines himself to the historical and descriptive his work is, on the whole, well done, but in discussing theories he has in several cases obviously ventured out of his depth, and has consequently spoiled what would otherwise have been a valuable addition to popular astronomical literature

For his chapters on the Nebular Hypothesis and Faye's theory of the formation of the solar system Mr Gore has largely availed himself of M Wolf's "Les Hypothèses Cosmogoniques" He has also introduced extensive quotations from "the late Mr Jacob Ennis," but in considering Ennis as an authority, Mr Gore is probably alone Mr Ennis was, on his own admission, not a mathematician, and certainly did not by "his own discoveries," place the nebular hypothesis on a firm mathematical basis. He proved Mars could not have satellites; that the heat of the sun was entirely due to chemical combination; that Sirius has twelve planetary attendants, and made several other equally important discoveries *His* mathematical demonstration of the truth of the nebular hypothesis is about as sound as the well-known proofs that the earth's surface is flat. Mr Gore would have done well to have omitted the quotations from Ennis, and to have filled the space with a fuller account of the recent mathematical investigations of the nebular hypothesis, especially those of Prof. G H Darwin.

Quoting freely from Young and Sir William Thomson, Mr Gore is fairly safe in his chapter on the fuel of the sun, but he is in error in stating that "the meteoric theory of the sun's heat must be abandoned" It is true that the larger portion of the solar heat is believed to be due to shrinkage, but it is generally conceded that a considerable fraction has its origin in falls of meteoric matter into the sun A glaring case of the misuse of a scientific term occurs in this chapter (p 52), where Mr Gore is responsible for the statement that "the theory generally held by astronomers ascribes the heat of the sun to shrinkage of its *mass* caused by gravitation" Mr Gore surely meant volume

The chapter on celestial chemistry is meagre and unsatisfactory It seems incredible that the application of photography to spectroscopic work is not even mentioned, and that no allusion is made to the Draper catalogue of photographic stellar spectra, to Rowland's photographic map of the solar spectrum, or to any of the recent photographic work Mr Gore is also in error in this chapter when he states (p 79) that although the great nebula in Andromeda "has never been resolved into stars the evidence of the spectroscope shows it is not gaseous" Bright bands have been seen in the spectrum by Backhouse Fowler, and myself, and these have been identified as probably due to carbon radiation

The Meteoritic Hypothesis is dealt with in considerable detail, and here Mr Gore is most seriously in error He gives what is professedly "a review of the principal facts and arguments advanced by Lockyer," and carefully enumerates all the objections that have been urged by "his opponents," ending the account with the opinion that "on the whole, therefore, we seem bound to conclude that the weight of evidence is against the truth of the Meteoritic Hypothesis." The chapter bears internal evidence that Mr Gore began his consideration of this hypothesis with the opinion which he enunciates as his final judgment, already formed

The summary of Prof Lockyer's book has not been made with the care that should have been bestowed upon it There are at least two misquotations, on p 91, the substitution of "periastron" for "perihelion" makes nonsense of what is otherwise an important paragraph, and on p 113 the omission of the word "other" considerably modifies the meaning of the passage quoted

There are several errors due to hasty compilation, observations and theories being attributed to Prof Lockyer in cases where be only quotes the observations and adopts the theories. On p 92 Mr Gore says "he (Lockyer) also finds line absorption in Comet Wells and the great September comet of 1882" This is misleading, the observations of absorption having been made by Copeland, Maunder, and Vogel On p 93 we find the "theory that the light of comets is due to collisions between the component meteorites" attributed to Prof Lockyer The theory is due to Reichenbach, Tait, and Sir William Thomson, Prof Lockyer's contribution being the demonstration that spectroscopic observations lead to and support the hypothesis The results of Tait's calculations given on pp. 227–229 of the "Meteoritic Hypothesis" are also attributed to Lockyer on p 93 of Mr Gore's book On p 95 we read, "the spectra of the true nebulæ consist of a very faint continuous spectrum crossed by one, two, three, or four bright lines" Lockyer gives seventeen bright lines in his table Mr Gore's footnote that "the complete hydrogen series of lines were

photographed by Dr Huggins in 1890," in the great nebula in Orion is also a mistake

Mr Gore has evidently failed to appreciate the importance of several portions of Prof Lockyer's book, and has consequently omitted to mention them in his summary Thus the observations of meteoritic glows recorded on pp 49-51 of the "Meteoritic Hypothesis" are entirely passed over In these experiments it was found that on slowly warming meteorites in a vacuum tube through which electric discharges were passing, the spectrum of hydrogen was first developed, then carbon was added, and the first line due to any metal was the 500 line which is the characteristic nebular line Further heating gave the 495 line and then the B magnesium lines These experiments, omitted in Mr Gore's summary, are an effective answer to the objections of Messrs Liveing and Dewar given on p. 116 of this book, for we have here the 500 line developed in presence of hydrogen, and at a lower temperature than the B lines

Mr. Gore believes that "one of the crucial tests of the meteoritic hypothesis" is the question of the identity of the 500 nebular line with the magnesium fluting at this wave-length He says (p 86) that "it is on the identity of this fluting (or rather its brightest edge) with the chief line in the spectrum of the nebulæ that the meteoritic hypothesis mainly depends," and from pp 118-121 it is obvious that he thinks the evidence conclusively against the hypothesis on this point

In the first case the identity of the 500 nebular line with magnesium is not essential to the meteoritic hypothesis, although the latest observations have strongly supported the case for the identity The main point is whether the 500 nebular line is due to high or to low temperature, and whether nebulæ are high or low temperature phenomena. Previous to the publication of Prof Lockyer's book all cosmical bodies were believed to be cooling The nebulæ were considered to be the hottest of all bodies, and on losing heat were supposed to pass into stars of the Sirian type Further loss of heat converted them into stars of the solar type, and by still further loss they became red stars with banded spectra before reaching final extinction This hypothesis was supplemented by Dr Croll, who suggested that nebulæ were formed by the complete and almost instantaneous volatilisation of these dark bodies on collision, the heat generated by impact being sufficient for the purpose Lockyer's hypothesis supposes nebulæ to be loose swarms of colliding meteorites Condensation of these swarms by gravitation increases the number of collisions, and as the temperature rises we get *stars* with bright lines in their spectra. Further increase of temperature gives red stars of Secchi's III class, which pass with still rising temperature into stars with fine absorption lines in their spectra, and so on until the Sirian type is reached, in which we have the highest temperature. Collisions have now ceased and the process of cooling begins, the stars passing into the solar type, then into red stars of Secchi's IV class, and to final extinction.

The lines in the spectra of nebulæ and bright line stars according to this theory may be due to three causes (*a*) Radiating vapours filling the interspaces between the meteorites; the lines of hydrogen and the bands of carbon being due to these (*b*) *Low temperature* lines of metals, due to grazing collisions of meteorites (*c*) High temperature lines of metals, due to direct collisions It is essential to the theory that low temperature lines o metals should be found in nebulæ spectra, and the low temperature origin of the 500 line seems clearly established Its chemical origin is of quite secondary importance That it is due to low temperature is shown by the experiments on meteoritic glows which Mr Gore omits, by its presence in comets away from the sun, as observed by Huggins in 1866 and 1867 (this being the only line present), by Vogel in Coggia's comet, and Konkoly in the great September comet of 1882, and also by the fact that it persists in all temporary stars as the temperature falls and is the last line to disappear Until these facts are explained away the foundation of the meteoritic hypothesis remains unshaken Mr Gore seems unaware that this main point is now generally admitted, for although the low temperature origin of nebulæ was denied by Dr Huggins as late as 1889, it was adopted in his Address to the British Association at Cardiff in 1892

There is early evidence in the book that Mr Gore has entirely failed to grasp this essential point of the hypothesis On p 41, discussing Croll's impact theory of the formation of nebulæ, he says, "according to Prof Lockyer the temperature of the original solar nebula was as high as that of the sun at present" Mr Gore would have done well to have noted that on p 528 of his book Prof Lockyer explicitly states that "the temperature of the most prominent radiating vapours in nebulæ is about that of the Bunsen burner"

Mr. Gore's misconception of the theory and the spirit in which he approached its discussion are also shown on p 101, where he says, "All these conclusions rest, of course, on the supposed coincidence of certain lines in the spectra of comets, nebulæ, and stars, with bright lines and flutings, a coincidence which has been disputed by other observers Relying, however, on the accuracy of his experiments, Lockyer proposes a new grouping of cosmical bodies He supposes some of these bodies to be increasing in temperature, while others—like our own sun—are cooling" To this he adds a footnote, "Lockyer's curve rests on this assumption, but it should be stated that some astronomers doubt that the sun is really cooling" We should be glad to know who these "astronomers" are Mr Gore himself is evidently not of their number, for he distinctly recognizes the sun as a cooling body in his chapter on the fuel of the sun, and specially mentions it as such on pp 42 and 53. It is possible that Mr Gore has misunderstood the apparently paradoxical fact that a body, in changing from a gas to a liquid, may rise in temperature while losing heat, but that will not justify the loose style which leaves it to be understood by the general reader that Lockyer's curve rests solely on his experiments, and the "assumption" that the sun is cooling, and that this fact is doubted by some astronomers We are quite aware that Mr Gore's expression will bear other interpretations, but this is the idea conveyed to several readers to whom we have shown the book.

Returning to the question of the coincidence of the 500 nebular line with magnesium, the evidence recorded by Mr Gore is in favour of, rather than against, the identity.

His facts are —Huggins finds the wave-length in the Orion nebula as 5004·75, the magnesium fluting being 5006·5, a difference of 1·75. At the same time, Huggins finds very little, if any, sensible motion in the line of sight. Mr. Keeler finds as a mean from 10 nebulæ 5005·68, magnesium being, according to his measurement, 5006·36, a difference of ·68. These latter observations completely invalidate Huggins's evidence on this point, especially as Mr. Keeler recognizes a motion of recession for the Orion nebula of 10·7 miles per second.

Mr. Gore ought to have recorded the fact that in Keeler's observations the comparisons for different nebulæ gave the magnesium sometimes more refrangible and sometimes less refrangible than the nebular line. Later observations of Keeler, "corrected for the earth's orbital motion and the sun's motion," give the nebular line a wave-length of 5005·93, *i.e.* only ·43 from the magnesium. Assuming Keeler's latest results as perfectly correct, and placing his position at Charing Cross, while representing the position found for this line by Dr. Huggins in 1868 at St. Paul's Cathedral, we find Dr. Huggins's limiting positions in 1889 as the extreme east and extreme west ends of Green Park, his 1890 position in the middle of Green Park, while the magnesium fluting will be at Cecil Street. When we consider that a motion in the line of sight of less than twenty miles per second will make the nebular line and the magnesium fluting absolutely coincident, that the rate of the sun's motion in space is estimated but not absolutely known, that these measurements are probably the most difficult of all astronomical observations, and that every increase of power and accuracy has brought the lines closer together, we are certainly *not* justified in stating that the "weight of evidence" is "against the truth of the hypothesis." The differences in recorded wave-lengths of well-known solar lines by experienced observers are in many cases greater than the difference in question here.

Mr. Gore regards the dispersion used by Prof. Lockyer as insufficient, and yet he records that sixteen prisms were used by Lockyer in some of his observations of the coincidence of the nebular line with magnesium, so that his dispersion was actually greater than that used by Dr. Huggins, and two-thirds that of Mr. Keeler, whose dispersion equalled twenty-four prisms.

The objections to that portion of the meteoritic hypothesis which deals with the meteoritic origin of the lines in the auroral spectrum do not in any way affect the main hypothesis. That this subject is unimportant is distinctly recognized by Prof. Lockyer, "Meteoritic Hypothesis," p. 97, where he claims that "certainly the coincidence is such as to justify us in regarding meteoritic dust as the origin of the spectrum *until a better and more probable origin is demonstrated*."

We are told (p. 122) that Mr. Monck objects to Lockyer's hypothesis, because it contains no explanation of "why all the planets and asteroids and the great majority of the satellites revolve in the same direction, why the orbits of the larger bodies of the system deviate so little from the circle and why they are so nearly in the same plane." This was asked in 1890, and yet Prof. G. H. Darwin had in 1888 shown that a swarm of meteorites which, on the meteoritic hypothesis would form a nebula, may be considered as a gas, and therefore any answer that the nebular hypothesis can give to these questions will also apply to the meteoritic hypothesis.

Such puerile suggestions as that the meteorites used by Prof. Lockyer "*may have been*" of terrestrial origin: "that meteor clouds dense enough to produce the requisite amount of light by their collisions would also be dense enough to intercept *a great part of it* again on its way to the earth" (the italics are ours); and objections based on Mr. Monck's interpretation of Prof. Newton's calculations, and on opinions to which Mr. Monck "*inclines*" as to the origin of certain comets, are evidence that Mr. Gore has not hesitated to avail himself of anything that in any way seems to disagree with the meteoritic hypothesis. The whole of the "objections" of the "opponents" of Prof. Lockyer recorded by Mr. Gore are on matters of secondary importance, and have been insisted upon by him owing to his complete misconception of the theory. As a guide to the meteoritic hypothesis his chapter is misleading, and utterly valueless either as exposition or as criticism.

After his account of the meteoritic hypothesis Mr. Gore abruptly turns to a comparison of the various drawings that have been made of the Milky Way, and gives an interesting and valuable summary of the present state of our knowledge as to star distribution and movement and the construction of the Universe. For this portion of the book we have nothing but praise. It is carefully written and copiously illustrated. Mr. Gore has evidently taken the word "visible" in its widest possible sense, for he includes not only things visible to the retina of the eye, but those visible to the retina of the camera; and six excellent reproductions of photographs of nebulæ and stars clearly demonstrate the superiority of the latter for astronomical purposes. It is probable that the use of photography in the preparation of complete charts of the Milky Way will throw much new light upon many of the points discussed in this portion of the book, and may profoundly modify many of the views at present held; but in presenting a clear and concise account of the present state of our knowledge Mr. Gore has made a valuable addition to the literature of the subject. An appendix, in which are given various calculations and tables involved in the discussion of several points raised in the book, and a useful index, complete the volume.

A. TAYLOR.

THE IRON MANUFACTURE IN AMERICA

On the American Iron Trade and its Progress during Sixteen Years. By Sir Lowthian Bell, F.R.S. (Edinburgh and London: Ballantyne, Hanson, and Co.)

IT is impossible, in the limited space at our disposal, adequately to review this remarkable book, in which no branch of a very comprehensive subject appears to have escaped the author's close attention.

So full of detail and so exhaustive of the subject-matter are the various sections into which the work is divided, that we can do little more than glance at the numerous subdivisions.

The first section, dealing with international trade, dis-

cusses at length the American policy of protection Comparison is made of American exports as affected by British free trade Then follows a series of short articles on various subjects—the Anglo-American, imports of tinplates from this country, imports and exports of both countries, America as consumer and as exporter, and other important matters By way of illustration copious tables are adduced with the author's deductions therefrom, and these will well reward the closest attention.

Section 2 deals with the relative cost of the necessaries of life in various mining and metallurgical localities —

"In the United States the manufacturers are enriched at the expense of the agriculturist and of other consumers. Some time before the abolition of protective duties in the United Kingdom years of scanty harvests entailed a great amount of misery among the labouring population of these islands, and at all times the landed interest by the protection granted to it by law, imposed a burthen upon industry generally This relation between land and industry is now, as we have seen, reversed in the United States, by which, according to our views, the manufacturers are enriched at the expense of the agriculturists and of other consumers

"Circumstances have greatly changed since the repeal of the corn laws, and the general introduction of free trade in the British Isles, for we have a people, the largest food importers in the world, obtaining their supplies 3000 miles from where they are grown, frequently at prices as favourable as those charged in the cities of America itself"

Sir Lowthian Bell appears to grasp fully a difficult situation, and gives a fair summary of the relative economic position of the two countries, and though his views will hardly be endorsed in their entirety by Americans, the present statement of them cannot fail to strengthen the movement now in progress towards a modification of the existing fiscal policy

It is somewhat out of our province here to comment upon the protective policy so ardently advocated in America, but we are of opinion that had iron manufacturers in the States adopted, even partially, our policy of free competition, they and their *employés* would now have been in a stronger position, and would have had a better prospect of successfully competing with us It is possible that the very natural desire to foster the home industry has carried them a little too far

In the next section the assemblage of materials on American is compared with that on British railways in an exhaustive manner

Section 5 treats of the iron ores of the States, and is fully illustrated with maps, topographic and geological, together with the coal fields The quantities raised at different periods are given, and show that in ten years the production of ore has been fully doubled This is followed by a detailed account of the mines and costs of working Pages 96-104 contain some interesting speculative matter on the genesis of iron ores, the cost of raising ore, together with chemical analyses, is compared with that of Great Britain and other countries. The importance of having iron free from phosphorus is shown It is noted that iron ore suitable for the Bessemer acid process has been imported In 1880 only 27 35 per cent of native ore was deemed suitable and raised for this purpose

Treating of raw material in the States, the writer gives a vivid picture of the boundless wealth of both ore and fuel existing within a limited area In the great Lake district there is a wide strip of country over 1000 miles long, where ore is found, and this is insignificant when compared with the immense resources of fuel The origin of natural gas, petroleum, and its uses receive attention —"natural gas is not a suitable form of fuel for the blast furnace"

Section 9, on the manufacture of coke, is interesting At the outset coke is defined and compared with its analogues—anthracite or native coke The losses necessarily entailed in the manufacture of coke are discussed, together with modes of minimizing them It is shown that it is impossible to utilise the gases evolved in coking or heating coal in the blast furnace, and how slowly this was realized in early practice

Here the author's ripe experience comes into play The *rationale* of coking is tersely put, together with the methods dealing with the utilization and recovery of the ammonia, tar, &c, the products of the destructive distillation of coal, "or coking," with special appliances adapted for this purpose The comparative merits of hard and soft coke in the blast furnace are discussed Commercial details are appended, which speak for themselves, and which appear accurate

From the section on the manufacture of pig iron it may be gathered that the gigantic methods of procedure, and the enormous energy diplayed in the business of the American iron manufacture, leave the average cautious Englishman in the rear There is, however, the reverse side for consideration it is questionable whether even the magnificent results before us have not been purchased at too great a cost Enormous quantities of iron have without doubt been turned out, such as would never have been dreamt of here, but it would seem that authorities are not yet in agreement as to the relative merit of English and American practice So far our American cousins appear satisfied, pointing triumphantly to the saving of both time and material accruing from their present practice At the Edgar Thompson Works (page 170) one of the furnaces ran 2462 tons of iron in one week, and showed an average make of 2813 tons per week with an expenditure of only 16 80 cwts of coke per ton of iron One needs, however, only to take Sir L Bell's elaborate demonstration of the laws which govern the consumption of fuel in the blast furnace, and its utilization for the reduction of the ore, to see clearly that the above production is scarcely in the domain of practical work, carried out under ordinary conditions with average ores and fuel. Also (p 162) he remarks, if Great Britain fails to offer striking examples such as are described by Mr. Potter and Mr Gayley, yet, all things considered, a more uniform as well as loftier pitch of excellence in British furnace work can be proved

Our space does not admit of a complete statement of Sir L. Bell's proofs, shortly, he first tabulates the work done at Middlesbrough with that of the Pittsburg blast furnace, and absolutely demonstrates that the large makes are not altogether due to superior practice. A perusal of the tabular statement given satisfactorily accounts for the larger consumption of fuel in the English furnace.

The poorer ore of Cleveland consumes 3 48 cwt of coke, as against only 1 42 cwt in the richer ore used at Pittsburg for the future of the slag

The quantity of slag determines the fuel required for its consumption, and here is the chief difference in the amount of fuel required, amounting to 2 06 cwts The Clarence furnace consumed 19 99 cwt of coke per ton of iron, the Pittsburg furnace consumed 16 80, difference 3 19, and deducting 2 06 from 19 99 cwt = 17 93, showing an excess of 1 13 against the English furnace This is practically the only margin we have for economy in the other sources of waste tabulated in Sir L Bell's comparison of heat distribution

A positive saving is effected of only 1 13 cwt, and reasons are given showing that, all things considered, this may be counterbalanced by the increased expenses incurred in American practice As instance pp 172-174 there are now four furnaces in action at the Clarence works performing duty well after 17½ years' service, as against the hard-driven furnaces in America with lining worn out, and useless in one-sixth of the period

The limitation is well defined in the following words, pp 182-183 —

"As one who has been fifty years at blast furnaces, I am greatly impressed with the pitch of excellence to which the Americans have brought this useful invention

"While saying so much I have not in my mind the enormous makes

"In respect to this we must remember that neither in materials nor in labour can we look for any economy in this country

"On the subject of large makes I must admit that I failed to shake the belief of my friend, Mr E C. Patter, that there is a great advantage in tasking the endurance of the furnace to the extent of reducing it to a wreck about every three years

"I cannot say I am quite a convert to his creed, but recent experience, and the unswerving conviction of my American friends, have raised in my mind the disposition to make a trial of Cleveland ironstone, on what I have thought a questionable mode of action"

The question of heat intensity, or actual temperature, which must vary with the rate at which the fuel or coke is consumed, has not been mooted, and we admit there is no positive reason why it should

Yet it is evident that a certain fuel—coke, for instance —may be so burnt as only to give a heat intensity barely sufficing for the fusion of lead On the other hand, it may be so manipulated, *i e* rapidly consumed by a quick draught or forced blast "as to attain a heat intensity (temperature) sufficing for the fusion of pig iron."

Working with high pressure blast and driving in a large volume of air (87 15 cwts. Clarence, as against 71 20 cwts. Pittsburg, see p. 172), the heat intensity must be greater in the latter instance, and must, "according to the law of heat exchanges," result in the more rapid economic fusion of iron in the hearth, also intensifying the usual chemical reactions. This seems worth consideration; temperature is an important factor—in saying this it must not be inferred that the estimation of the calorics which a given fuel evolves, and their distribution, must be set aside; on the contrary, they remain the fundamental basis of any study bearing on the economic uses of fuel Finally, one gathers on the whole that American practice is not universally superior to ours, and competent authorities are as a rule inclined to a compromise In other words we might graft or partially adapt their practice to ours, so reaping the benefits of both, for something may be urged in favour of either system

JOHN PARRY

A COUNTY FAUNA

The Fauna and Flora of Gloucestershire By Charles A Witchell and W Bishop Strugnell (Stroud James, 1892)

IT would really be almost difficult to discuss this book in a serious spirit were it not that the publication of so ambitious a work as the Natural History of a County must always be regarded as a serious undertaking The reader who has struggled through the volume will lay it down with a sigh—not of regret at leaving it, but at the thought that time has been wasted in its compilation

A glance at the index is almost enough to condemn the book, without making any attempt at further acquaintance Among nearly a score of errors in spelling, *subuteo, oesalon, tinninculus*, occur as three consecutive words Nor is this carelessness by any means confined to the index Such blemishes disfigure the book from beginning to end; and when, among a host of errors, we find such mistakes as *haliotidæ* and *helliborus*, we can hardly ascribe all the blame to the printer The compilers usually give us "Cotteswold," but in the introduction the name is spelt "Cotswold," and there are pages on which both forms occur—in one case only a line apart

A more serious fault is the want of balance in the work. The space allotted to birds occupies eighty-two pages, while the chapter on ants takes up nearly twenty, and that on wasps and bees close upon fifty pages We may say at once that the two latter are so good, and stand out in such marked contrast to the rest of the work that, in spite of their disproportionate length, we hardly grudge a line of the room they occupy Perhaps, however, it is the length of these papers which makes one of the writers on mosses omit "many other interesting species," for want of space Another contributor calls his list of fungi "short and very imperfect" If the list is as complete as it is possible to make it, no one can fairly complain of its shortness; but surely it is scarcely worth while to print an avowedly imperfect list in what professes to be a County Flora

The fauna opens with a brief account of the bats, a mere list of names, among which we look in vain for any evidence of observation. The notices of the quadrupeds contain some interesting particulars, but they present little that is new In the article on the badger a good deal of information is given on the authority of a gentleman who appears to think no observations but his own are worthy of credence One of his own observations is thus worded: "Any one who has caught badgers at night knows only too well that it is certain death to a dog

which is good enough to hold it in the open to follow it into an open drain large enough for the dog to reach it." Other people who have hunted badgers have found that an extremely small terrier is quite able to turn a badger from its earth, and that although the dog may be hurt, even seriously, by its formidable antagonist, the contest does not by any means mean "certain death" to it.

The chapter on birds bears evidence of having been put together in the most casual manner Various contributors have sent in notes as to whether, in their experience, birds were rare or not, and these appear to have been printed without any attempt at summarizing The result is that the whinchat is described in one line as "common," and in the next as "occasionally seen" The marsh tit is "rare," and also "generally distributed" The cirl bunting is in one line called "rare" and "by no means rare" The coot is "rare" (!) and "frequently met with" The woodcock, according to one observer, "has been seen" If it were clear that such remarks applied to different parts of the county, there might be some sense in printing them. As they stand, they are useless and bewildering One contributor is surprised at the occurrence of the gannet just outside the limits of the county, because "they generally inhabit the Bass Rock"! They certainly do, and "there's milestones on the Dover road" But perhaps there is nothing in the whole chapter which quite comes up to what we read about two starlings that one of the contributors watched "fighting furiously each bird trying to force its bill into that of the other *He was informed that the purpose of each bird was by this means to render the opponent insensible, so as to be more easily destroyed*"

In the article on reptiles occur these remarkable words —"The slowworm is habitually 'slow,' but we know of no reptile or quadruped which, in proportion to its size, can move more rapidly"

There are several errors in spelling in the list of land and fresh-water shells, and it is rather misleading to give "Downs, under stones," for the habitat of the species here called *Bacutus*, without adding "near the sea."

Helianthemum polifolium is given as a Gloucestershire plant It would be interesting to know if this is correct The localities usually given are in Somerset and Devon

Among the illustrations are some interesting figures of famous trees; but it seems hardly worth while to have inserted such a very ordinary-looking plate as that of the common crayfish

Allusion has already been made to two chapters the excellence of which is all the more marked by contrast with the grandiloquent flights and the trivial details of much of this unfortunate volume Rev W F White's paper on ants contains, as might be expected, accounts of many interesting and original observations Mr Vincent Perkins's excellent chapter on wasps and bees, again, is extremely good, though the writer deals only with the neighbourhood of Wotton-under-Edge That so imperfect, and, as far as much of its contents goes, we are afraid we must say untrustworthy, a book should ever have been published is matter for regret The real "Fauna and Flora of the County of Gloucester" yet remains to be written.

OUR BOOK SHELF

The Chemistry of Life and Health "University Extension Manuals" By C W Kimmins, M A, D Sc., Staff Lecturer in Chemistry, Cambridge University Extension Scheme (London Methuen and Co, 1892)

THIS little book is well adapted to secure the aim of the author, which is "to give sufficient information on the particular portions of the sciences involved to enable readers to appreciate fully the fundamental principles of hygiene" There can be no doubt of the importance, one might truly say, the national importance, of the spread of sound knowledge regarding the laws of health Such sound knowledge cannot be attained except it be built upon a well-laid foundation of chemistry and physiology To lay the foundation, and rear the structure, in a little book of 160 pages is almost impossible Dr Kimmins has, wisely, omitted much, but what he retains is of fundamental importance, his facts are clearly enunciated and systematically arranged A careful study of this book, especially when it is supplemented, as it is meant to be, by a course of lectures, cannot fail to be most useful The book is written for ordinary people, not for professional students, the teaching is sound and clear The first chapter, on the principles of chemistry, is the least satisfactory in the book, but in this chapter the author has attempted, what is surely unattainable, to give an elementary knowledge of the features of chemical action, the use of chemical symbols, and the molecular and atomic theory, in sixteen small pages As an introduction to the study of the application of chemical facts and principles to the conditions of healthy life, the book is to be thoroughly recommended

Naked-Eye Botany, with Illustrations and Floral Problems By F E Kitchener, M A Pp 182 and fifty-two woodcuts in the text (London, Percival and Co, 1892)

ON turning over the pages of this book one wonders why "Naked-Eye Botany" was chosen for the title, because, although a small book, it has some reference at least to a great many things that cannot be seen with the naked eye It is something in the way of Prof D Oliver's "Lessons in Elementary Botany," but one misses the Professor in it. On p 7 we are introduced to stomata, and physiological processes are described in some detail Nevertheless it contains much useful matter, and with a little revision and better selections would make a very good first book For example, the chickweed is chosen for the first lesson But the flowers of this plant are so small and the number of parts in the various floral whorls is so variable that it is not a good subject to begin with The "problems," or questions, also at the end of each chapter are too wide-reaching Referring to *Aspidium Filix-mas*, we are told that the "production of the fertilized seed, more correctly called oosphere, from the prothallus, can scarcely be made out with the naked eye." Saying nothing about the name given to the fertilized body, we must protest that "scarcely" is not the word to qualify the observation

Perhaps it is too much to ask that the headmaster of a "high school" should be acquainted with even remotely recent discoveries in physiological botany, but it would not be unreasonable to ask him to use the text-books of specialists It is now some years since the reproduction of *Lycopodium* was fully described, yet Mr. Kitchener still teaches that the spores are of two sorts

The Great World's Farm, some account of Nature's Crops and how they are Grown By Selina Gaye (London Seeley, 1893.)

THIS is a delightful book, pleasantly written, full of information, and on the whole remarkably free from those errors, generally the results of misunderstanding, which

are the sins that do so easily beset writers on popular science The volume, which contains some excellent illustrations, deals with "pioneer labourers," "soil-makers," "soil-carriers," "soil-binders," "field-labourers," "guests welcome and unwelcome," "nature's militia," and so forth We do not propose to tell who or what the labourers, the guests, or the militia are. We advise those of our readers who are interested in the transactions of the Great World's Farm to get the volume and ascertain for themselves

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

Measurement of Distances of Binary Stars

SOME years ago I communicated to a few astronomers a plan for measuring the distance which separates us from some of the binary stars, believing, as I did, that by using the diameters of their paths as a basis, determinations of distance could be made which are impossible with the means at present in use

This basis could, I hoped, be calculated by first ascertaining the velocities with which the stars are moving in their paths, in a somewhat similar manner to that employed for measuring the motions of stars with the spectroscope, except that instead of making a comparison with a hydrogen flame, the spectra of the two stars should be compared by photographing them together The width of any double lines, which may show themselves (the one line belonging to the spectrum of the receding star, and the other to the advancing one) would be a measure of their velocities expressed in miles. Applying this information to the known period of revolution of the system, its diameter can also be expressed in miles, and this would enable one to estimate the distance from the earth if the angle between the two stars were known This suggestion has already borne fruit, the relative velocity of some rapid, but as yet inseparable, binaries having recently been determined

The answers received to my suggestions were discouraging, but since then instruments have been improved, and I trust that you will think the matter of sufficient importance to be brought before the notice of your numerous astronomical readers Should any of them be able to make the necessary determination, a foundation-stone will have been laid, not only for obtaining a true idea of perhaps undreamt of stellar distances, but also of the masses of binary stars, and possibly a connection may ultimately be traced between them and the adjoining ones

The two most brilliant binary stars are α Centauri and α Geminorum, and as in both these cases the paths are elongated ellipses, and the stars near their extremities, efforts should be directed towards determining their distances as suggested above C E STROMEYER.

Strawberry Hill, November 16

Remarkable Weapons of Defence

THE following extract from a letter from such a careful observer as Mr E E. Green is of such general and special interest as to require publication

Mr R J Pocock informs me that the Acaroid is almost certainly *Holothyrus coccinella*, Gerv , a species that appears to be common in Mauritius, and that in the lateral membranous area between the carapace and the cephalothoracic limbs is a distinct orifice which was regarded by Dr Thorell as of respiratory import, but in connection with Mr Green's interesting discovery of the existence of offensive glands in this animal it is necessary to bear in mind the possibility of its being the outlet of these organs.

The mite has such a hard integument, that being taken into the mouths of the lizards and birds that would probably prey upon it in the situations it frequents, would probably do it little or no damage if it were speedily rejected. G F. HAMPSON.

THE accompanying insects—apparently Orobatid mites—were found by me in the district of Tallawakelle, Ceylon (alt 4600 ft), under stones and rocks in damp, shady situations. It was only by accident that I became aware of their remarkable weapons of defence—an exceedingly pungent secretion.

About five hours after handling one of these insects I accidentally touched my tongue with my finger Immediately an extraordinarily pungent, galvanic sensation or taste commenced rapidly to spread over my mouth, quickly reaching my throat Rinsing my mouth and gargling with hot water failed to arrest the progress of the sensation, which was accompanied with excessive salivation The unpleasantness lasted for several hours, and then died away without any further consequences. I also unconsciously rubbed my face, at the angle of the eye, with the same finger, after which a rather pleasant warmth spread over that part of my face, and was distinctly perceptible the following morning

I could not for some time trace the cause of this effect I at first put it down to the agency of a fungus that I had been carrying, but a further experiment negatived this idea I afterwards tested the insect, and found it to be the real agent The experiment was repeated at my suggestion, by a medical friend—Dr. R J Drummond—who can testify to the result He described the sensation as somewhat like that produced by the strongest menthol We both noticed that it had a numbing effect upon the mucous membrane of the mouth

It is evident that this property must be a very efficient protection to the insect The rapidity with which the secretion acts would cause it to be very quickly ejected if picked up by either a bird or a lizard—the only enemies that would be likely to attack it E ERNEST GREEN.

Eton, Pundulorja, November

A Suggestion

AS very shortly now NATURE will reach its jubilee volume, I hope you will permit me, as an uninterrupted subscriber for nearly twenty years, to offer a suggestion with regard to that occasion

As the volumes of NATURE contain original contributions, observations, and notes in all branches of science, more varied and valuable than are to be found in any other scientific periodical publication in existence, there is not a worker, in whatever branch he may be engaged, that does not find it necessary to be continually referring to its pages, but, unfortunately, through lack of a general handy index, he discovers what he wants only after the expenditure of a very great deal of time and worry

I write, therefore, not only in my own name, but (by request in a private way) in that of a large number of fellow-workers in the subjects in which I am myself specially interested—biology, palæontology, anthropology, geography—to suggest that you should celebrate the jubilee of NATURE by conferring on your readers the immense boon of a classified index to its contents

During some investigations I was making in 1876 7 I so felt the need of a collected index that I went to the trouble of compiling for myself one, up to that date, classified according to sciences, subdivided again according to the sections of each, which in subsequent work saved me weeks of time and trouble. To my regret, this MS got lost or destroyed, and there is nothing in connection with NATURE that I, and I am certain every other worker, would now hail with greater satisfaction than the announcement that the means of reaching with expedition and precision the treasures at present so deeply buried in your (nearly) fifty priceless volumes, will be ced within our reach with its jubilee volume OLD SUBSCRIBER.

Superstitions of the Shuswaps of British Columbia.

REFERRING to the above, as recorded by Dr George Dawson, F R S , in the Transactions of the Royal Society of Canada, and included in your Notes of last issue, in which attention is called to the belief among the Shuswaps and some other North American races, that small lizards enter the bodies of men, pursuing them, and devouring their hearts, I was at once struck with the almost exact resemblance of this belief to one very generally prevailing in Ireland, as regards common water Newts, which go by the name of Man eaters (pronounced Man-aters) This I can testify to from personal knowledge, but it has been accidentally confirmed by an experiment which I hope I may be pardoned for referring to. Where I reside are three Irish servants, to whom I caused to be shown a drawing of the Water Newt, and with the request that I might be told its

name, and anything ~~k~~ they knew about it One of these, a Galway woman, spea_ng Irish better than English, gave me the name in her langu ge (which I won't attempt to transcribe, for it was a very long one), and also said that the animals were well known to jump down people's throats to their certain destruction C Bushe

Athenæum, December 24.

The Great Ice Age

There is in the Astronomical theory of the Ice Age a point of some importance, not mentioned by Sir Robert Ball in his interesting work on this subject, to which I invite the reader's attention I mean *the slowness with which the difference between the length of summer and that of winter is varying in the neighbourhood of its maximum*

To compute this difference and its mean value, we put

a = the mean distance of the earth from the sun,
e = the eccentricity of the earth's orbit,
ω = the longitude of the perihelion of the earth's orbit,
T = the length of the year in mean solar days,
Δ = the difference between the lengths of the two seasons in mean solar days,
η = the mean value of this difference during the interval between the two dates, corresponding to $\omega = \omega_1$ and $\omega = \omega_2 > \omega_1$

Then, the eccentricity remaining always extremely small, the difference between the areas of the two segments in which the line of the equinoxes divides the earth's orbit, may be put—and with sufficient accuracy,

$$= 2ae \quad 2a \sin \omega = 4a^2 e \sin \omega$$

Hence, we find, by Kepler's first law,

$$\frac{\Delta}{1} = \frac{4a^2 e \sin \omega}{\pi a^2 \sqrt{(1 - e^2)}},$$

and consequently, by neglecting the third and higher powers of e,

$$\Delta = \frac{4\mathrm{T}e \sin \omega}{\pi}$$

Observing that the eccentricity remains sensibly constant for a period of time, which is doubtless to be reckoned by many tens of thousands of years, we obtain, by means of the formula just found,

$$\eta = \frac{4\mathrm{T}e}{\pi}\int_{\omega_1}^{\omega_2} \sin \omega d\omega \quad \int_{\omega_1}^{\omega_2} d\omega$$

$$= \frac{4\mathrm{T}e}{\pi} \frac{\cos \omega_1 - \cos \omega_2}{\omega_2 - \omega_1}$$

Finally, by substituting the numerical values of our constants, we shall have the following formulæ for computing Δ and η —

$$\Delta = 465 e \sin \omega,$$

$$\eta = \frac{465 e (\cos \omega_1 - \cos \omega_2)}{\omega_2 - \omega_1},$$

positive values designating that in the Northern Hemisphere and negative values that in the Southern Hemisphere the summer exceeds the winter.

From the first formula we deduce that, for a given eccentricity, the disparity in the lengths of the seasons shall be as great as possible when the line of the equinoxes is perpendicular to the axis major of the orbit Now, putting e = 0, 071, the maximum eccentricity, the values of Δ and η for a few values of ω are as follows —

ω	Δ	$\omega_2 - \omega_1$	η
°		to	
90	33		
85 or 95	33	95 – 85	33
80 or 100	32½	100 – 80	33
75 or 105	32	105 – 75	32½
70 or 110	31	110 – 70	32
65 or 115	30	115 – 65	32
60 or 120	28	120 – 60	31½
55 or 125	27	125 – 55	31
50 or 130	25	130 – 50	30
45 or 135	23	135 – 45	29½

If we remember that the longitude of the perihelion increases in about twenty-one thousand years from 0° to 360°, then, it will be seen by inspecting these results that, for example, during the interval between the two dates corresponding to ω = 65° and ω = 115°, *i e* during a period of nearly three thousand years, the mean difference between summer and winter will be thirty two days, and that during this period the difference itself will never sink below thirty days N L W A Gravelaar

Deventer, Netherlands, December 17

Aggressive Mimicry

In his last letter Mr Poulton observes that I am one of "four recent writers" who have made use of the collections in the Natural History Museum and the Museum of the Royal College of Surgeons, for the purpose of illustrating the phenomena of mimicry between *Volucella* and *Bombex* This is the case, but I should like to add that the species which I have depicted are not *V bombylans* and *B muscorum* (the questionable resemblance of which in nature, and the erroneous labelling of which in the "show cases," constitute the grounds of Mr Bateson's somewhat "aggressive" criticism on other "recent writers"), but *V bombylans* and *B lapidarius*, where the fact of resemblance can admit of no doubt (' Darwin and After Darwin," p. 329) Indeed, Mr Bateson fully recognizes the close similarity in appearance between these two species, and, as I refrained from giving the hypothetical explanation of it to which he objects, I avoided all the issues which have since been raised in the Nature correspondence

Madeira, December 15 George J Romanes

Artificially Incubated Eggs

I have been repeatedly informed by poultry-growers and market men that hens raised from artificially incubated eggs were much less fertile than those produced in the natural way My information has been derived from persons who did not even know each other It occurs to me that if true it is a curious matter and worthy of some attention

W Whitman Bailey

Brown University Herbarium, Providence, R I
December 10

THE PROPOSED UNIVERSITY FOR LONDON

A general meeting of the Association for Promoting a Professorial University for London was held on Wednesday, December 21, when a report, which we print below, was presented by the Executive Committee We would call the attention of our readers to the penultimate paragraph of this report, which indicates the existence of an agreement, on matters of principle between the Senate of the University of London and the Association

The last general meeting of members of the Association was held on June 14, 1892, when the Executive Committee presented for approval a series of proposals for the organization of a University in London These proposals were adopted as the formal expression of the objects of the Association

Since that meeting the efforts of the Committee have been directed to the furtherance of the principles embodied in the above-mentioned proposals—by endeavouring to obtain the adhesion of literary and scientific men, and of other persons interested in the matter, by organizing a body of evidence to be presented to the Gresham University Commission, and by such other means as have suggested themselves from time to time

Immediately after the last general meeting, Prof. Huxley became a member of the Association, and consented to accept the office of president. Sir Henry Roscoe and the Master of University College, Oxford, consented to become vice presidents; and the first of these gentlemen has since been an active member of the Executive Committee.

The number of members of the Association is now one hundred and fifty

Evidence in support of the principles of the Association has been given before the Gresham University Commission by the following gentlemen.—Prof. Ayrton, Mr F V. Dickins, Prof. G C Foster, Principal Heath, Prof.

Henrici, Prof Huxley, Prof Ray Lankester, Prof Henry Nettleship, Prof Pearson, Sir H Roscoe, Prof. Rucker, Dr Russell, Prof T E. Thorpe, Prof Unwin, Dr Waller, Dr Windle, Prof Weldon.

During the month of November the Committee were informed that a Committee of the Senate of London University had drawn up a series of resolutions, to be submitted to the Royal Commission Your Committee therefore requested the Vice-Chancellor to allow its members to address the Committee of the University Senate in support of the proposals of the Association The Vice Chancellor replied by inviting the Executive Committee of the Association to attend a meeting of the University Committee on Wednesday, December 7 At this meeting the objects of the Association were explained by the President, Sir Henry Roscoe, and Prof Weldon, and the Vice-Chancellor in reply made an important statement, to the effect that the resolutions which were put forward by the Committee of the Senate were intended to be understood in such a manner as to render them perfectly consistent with the programme of the Association. The resolutions proposed by the University Committee, and since adopted by the whole Senate, are as follows —

The Senate having reason to believe that a distinct expression of opinion may be useful to the Commissioners at the present stage of the inquiry, desire to recall to their attention the fact that during last year the Senate approved a Scheme for a Reconstitution of the University which provided for the constitution of Faculties consisting of teachers and of Boards of Studies in each Faculty, and for the election of members of the Senate by the Faculties, and that the Scheme further proposed to confer on the University power to hold real property and to accept grants, gifts, devises, and legacies for the purposes of the University, including the establishment of Professorships and Scholarships, whether attached or not to any particular College, and the furtherance of regular liberal education and of original research

The Senate now desire to state that, if in accordance with the decision of the Commissioners, the Senate is prepared, in order to promote the efficiency of the University, and with a view to its reorganization as a Teaching University in and for London, without curtailment of the functions which it now discharges—

(a) To establish and incorporate with the University Faculties in Arts, Science, Laws, and Medicine, and Boards of Studies acting thereunder

(b) To provide for the incorporation with the University of Teaching Institutions of the higher rank

(c) To utilize, with their consent, existing organizations for higher culture, and subject to such utilization to institute and maintain Professorships and Lectureships, whether for academical or other purposes, and generally to assume such functions as may be required for the furtherance and superintendence of a regular liberal education, and for the promotion of original research

(d) To accept and administer fees and such other funds, public or private, as may be necessary, and may be granted or given for the purposes of the reorganized University

(e) To provide for the adequate representation of the Professoriate on the Senate.

The Committee regret that Prof. Pearson, whose energy and enthusiasm have been of such essential service to the Association, has felt obliged to retire from the office of Secretary His place has been taken by Prof. Weldon

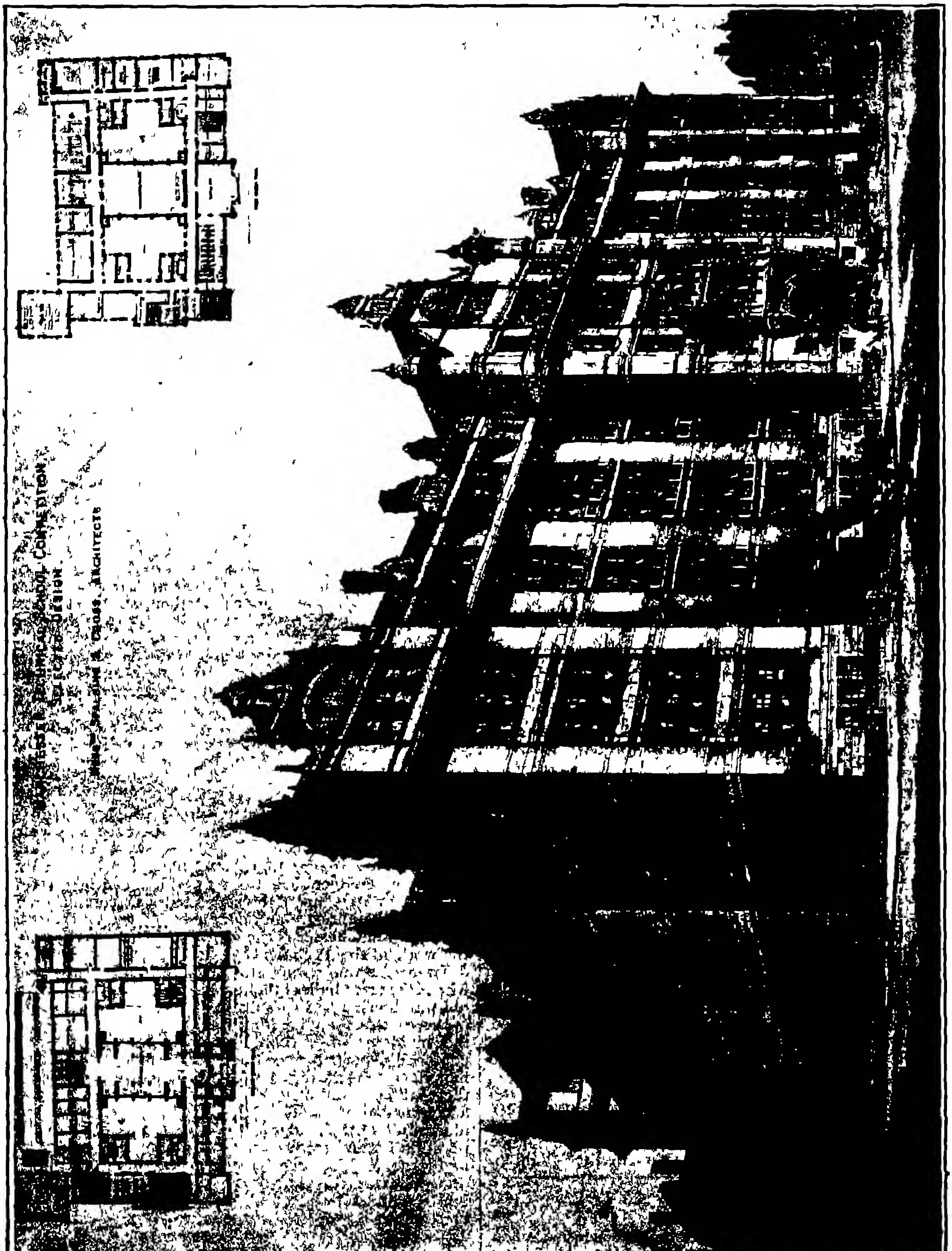
THE MANCHESTER MUNICIPAL TECHNICAL SCHOOL.

IN his interesting address on technical education, when distributing the prizes of the Manchester Municipal Technical School, on the 19th inst, Mr. Balfour pointed out that the occasion was an important one, not only in the history of technical instruction in Manchester, in the history of the Corporation of that city, but also in the commercial and manufacturing history of Manchester itself, since this was the first public occasion of the distribution of prizes to the scholars of the Technical School and the School of Art since these schools were taken over by the municipality, and supported out of the public funds of the city The fact that the Corporation of the northern metropolis has taken possession of the School of Art and of the flourishing Technical School, founded a few years ago on the site of the old Mechanics' Institution, is one which may well claim the attention of the leading statesmen of our time, and Mr Balfour has done good service to this great educational movement by thus placing prominently before the country the part which our municipal authorities are now playing in the matter Fully alive to the revolution which these changes are bringing about in our educational system, Mr Balfour, speaking to the teachers and students, insisted that there is now thrown upon them something more than personal responsibility, something more than the desire for self-advancement They are concerned, he said, in a national work, and ought to look at it from a national point of view, and it is this public aspect of the question which justifies and more than justifies the Corporation for having taken up this great work and for having created the greatest technical school at present existing in England, but which, great as it is, is still in its infancy, and will yet show developments which will astonish those who are now devoting their time to it in so public-spirited a fashion.

Then spoke Mr Councillor Hoy, the chairman of the Technical Education Committee of the Corporation, and in thanking Mr Balfour for his "thoughtful and charming address" added that it was only nine months since these schools were handed over to the Corporation, that they had to master the whole machinery of the education, to arrange all the details of the transfer, but that in addition they had plunged right away into the necessary steps for erecting a new and enlarged school

So it is evident that the men of Manchester do not allow the grass to grow under their feet They know that the business they have undertaken is a big one, and they, like good business men, are prepared boldly to meet the necessities of their position. How boldly and how completely they propose to do so will be seen when we learn what are the proposals which they have made for carrying on their work, for making the necessary preparations, for giving the highest and most complete technical training which can be given in all those matters upon the satisfactory accomplishment of which, the industry and commerce of the vast district of which Manchester is the centre depends At present the work of the Technical School is carried on in three different buildings, one the old Mechanics Institution where the great bulk of the teaching is done, another in an old warehouse fitted to suit the wants, as far as may be, of the electrical engineering department, and a third in the buildings of a school where a very completely-equipped department for the scientific study of the cotton manufacture is arranged Needless to say that none of these three buildings provide sufficient or adequate accommodation for the proper practical teaching and illustration of their subjects, and no sooner had the Corporation Committee become acquainted with what they had to do, and the means placed at their disposal for doing it, than they made up their minds that a new building must be erected fully representative of the present needs, and with room, if possible, for future developments

But before committing themselves to plans or estimates, this committee wisely determined to see with their own



eyes what was doing and had been done elsewhere They visited the English schools, such as they are, and, more important, they went abroad and inspected the well-known technical schools on the continent, and on their return they issued an interesting report containing not only an account of what they saw and learnt, but the conclusions they drew as to how far their Manchester school should be modelled on foreign lines This journey of inspection gave the members of the committee a new and enlarged view of their duties, and they returned home with the determination that if they could not approach the size of such buildings as the Zurich Polytechnicum or the Technical High School of Charlottenburg, at any rate they would put up a school which should be as complete in its parts as any similar institution abroad and capable of doing for their centre work equally useful and of exerting an equally beneficial influence on their population as any of the foreign schools Some captious critics were loud in their condemnation of such a way of spending public money as that of sending a number of Manchester men on an educational tour abroad In fact, no money could be or has been more judiciously or more economically spent Without a knowledge from personal observation of what is doing elsewhere, these gentlemen could not possibly have carried out their business to a successful issue, with such a knowledge they can and will do it

Fortunately for Manchester, the necessity for technical training of the people was long ago preached by one of her most distinguished sons, the late Sir Joseph Whitworth, and his legatees, knowing his views, presented a site for the school of 5000 square yards, situated in the centre of the city, and well placed as regards light and air On this site the Corporation have decided to build a spacious, not to say magnificent, school, a perspective view of which is found on the opposite page The whole of the site, including 770 yards in addition given by the Corporation, is to be covered by buildings, and in it ample accommodation will be found for the work carried on in the present temporary premises This will include engineering, mechanical, electrical, civil and sanitary, the chemical industries, the cotton manufacture, spinning and weaving, the building trades, dyeing and calico printing, metallurgy, letterpress and lithographic printing, and other minor industries, industrial art and design, and the subjects classed under the heads of commercial and economical instruction. And in addition to these proper accommodation for the teaching of the pure sciences, mathematics, foreign languages, to say nothing of manual instruction and gymnastics All these matters require means of giving practical instruction, not only lecture rooms, but laboratories, workshops, and museums, so the problem of satisfying all their needs is a complicated one, but one which the committee are determined to do their best to carry out The size of the proposed building called forth a large number of competing designs from some of the first architects of the day, and the first premium was awarded by the Committee, assisted by Mr Waterhouse, R.A, to Messrs Spalding and Cross, of London Their design is in Renaissance style of the early French period, and the internal arrangements are made with the view of giving as much light as possible The material is red brick with terra cotta facings, it is roofed with green Whitland Abbey slates. The building will be fireproof throughout, and the flooring covered with wood blocks, except in the case of the dyehouse and laboratories, where impervious paving is needed One great desideratum in such a building is proper ventilation; this will be arranged on the plenum or plus pressure system, the air being pumped throughout the building by fans worked by electricity, and the lighting will also be electrical. The building is six stories high, none of the rooms will be lower than 15 feet clear, and averaging from 25 to 30 feet in depth. The class rooms, lecture theatres, drawing and designing offices, laboratories, library, workshops and administrative department, as well as the students' and lecturers' rooms, are all lighted from the face of the building with wide continuous corridors all round each floor, lit from internal areas, and each department will be as far as possible separate and self-contained The total available floor-space exceeds 150,000 square feet exclusive of the corridors The main entrance hall is 85 by 50 feet, and it is to be utilized as an industrial museum, on the first floor is a public lecture hall 30 feet high, and of the above dimensions On the third floor is the chemical laboratory arranged for 80 working benches Two independent staircases, as well as a spacious passenger lift give access to the different floors, and extra exits are provided in case of fire The basement, which is only seven feet below the ground line, is to be fitted with heavy machinery and other apparatus used in industrial operations on a considerable scale Here we find the electrical and mechanical workshops and testing machinery, rooms for purposes in which stability is necessary, experimental steam engine, dynamo, and secondary battery rooms, spinning and weaving machinery for cotton and silk, rooms for bleaching, dyeing, and finishing; plumbers', bricksetters', and masons' workshops, shops for repairs, and construction of new apparatus, &c The upper stories contain the laboratories, general and special, lecture rooms, drawing offices, gymnasium, library, and students' reading and common rooms

The following is the space allotted on the various floors for the several departments —

		Sq feet.
1	Administration, Museum, Lecture Hall, Library, Reading Room, Gymnasium, and other offices	26 837
2	Mechanical Engineering	18,266
3	Applied Physics and Electrical Engineering	13,666
4	Textile Trades	19,211
5	Applied Chemistry, Dyeing, &c, Metallurgy	29,232
6	Building Trades	10,922
7	Letterpress and Lithographic Printing	2,798
8	Industrial Design	13,453
9	Commercial Subjects	11,844
10.	Domestic Economy Subjects	6,461
	Total	152,690

As if to indicate the determination to make the utmost of their building, the Committee have asked Sir Howard Grubb to design a small astronomical and meteorological observatory on the roof! This in the centre of smoky Manchester, but experts say that even here much useful work can be done.

The estimated cost of the building, including fittings, apparatus, and machinery is about £125 000; towards this sum the Committee have available £14,000 balance of profit from the Jubilee Exhibition; £5000 promised by the Whitworth trustees; and the property belonging to the old schools estimated at £31,000. The remainder of the sum, about £75,000, the Corporation will borrow for a period of thirty years on the security of the 1d rate This great school will be governed by a Committee of thirty-six persons, twenty-four of whom are members of the City Council, twelve being chosen from the public interested in the progress of Industrial and Commercial Education

Enough has been said to give the reader an idea of the scale and completeness of the proposed Municipal School To work this properly will cost nearly £10,000 per annum. The fees will be low, but nevertheless will bring in a goodly sum, and the funds available from the Local Taxation (Customs and Excise) Act of 1890—commonly termed the beer money—will provide the remainder Such a school, holding as it will do an intermediate position, between the Board Schools on the one hand, and highest University Education as given in the Owens

College on the other, cannot fail to exert a most important influence on the future development of trade and manufactures in Lancashire. What Manchester is doing in this magnificent way, other towns, notably Birmingham, Salford, Stockport, Oldham, Bolton, and others, are also doing, it is true on a smaller scale, but still in a manner sufficient for their needs. How long will it be before London moves? H. E. ROSCOE

THE MONT BLANC OBSERVATORY[1]

THE project of establishing a meteorological and astronomical observatory on the summit of Mont Blanc has, under the care of M. J. Janssen, of the Meudon Observatory, made considerable progress during this year's summer months. It has been decided to use the snow itself as a foundation on which to rest the building. That this can be done with security was shown by some experiments carried out at Meudon last winter. A miniature mountain was made of snow pressed to the same density as that which is found on Mont Blanc at a depth of one or two metres below the surface. This being

made level at the top, discs of lead 35 cm. in diameter, and weighing each about 30 kgr., were placed on the snow, one upon the other. After twelve of these had been piled up, with an aggregate weight of 360 kgr., they were removed and the depth of the impression measured. It was not more then 7 or 8 mm. Thus a structure measuring 10 m. by 5 m. might safely weigh 187,000 kgr. without sinking into the snow more than a few centimetres.

The summit of Mont Blanc is formed by a very narrow edge of rock 100 m. long, running from west to east, and covered by snow which is thicker on the French than on the Italian side. The level of this snow has not shown any important oscillations throughout a number of years. To obviate the disturbing effects of the storms which frequently rage round the summit, the building is constructed in the shape of a truncated pyramid, the lower floor being sunk into the snow. The rectangular base measures 10 m. by 5 m. The upper floor, which will be devoted to the observations, is covered with a flat roof, towards which ascent is made by a spiral staircase leading from the basement upwards through the whole building, and above the flat roof to a small platform destined for meteorological observations.

The whole observatory has double walls to protect the observers against the cold. The windows and doors are also double, and provided on the outside with shutters closing hermetically. The floor is made of double planks, and furnished with trap-doors giving access to the snow supporting the observatory, and to the screw-jacks placed in position for adjusting the level of the building in case the snow should yield. The building will be provided with heating apparatus and all the furniture necessary to make habitation at such an altitude possible.

Up to the present the observatory has been transported in parts to Chamounix. On the Grands-Mulets a cottage has been erected for the use of the workmen and for storing the things destined for the observatory.

On the Grand Rocher Rouge another cottage has been built, only 300 m. below the summit, in which the workers and observers can, if necessary, take refuge. Three-quarters of the materials for the observatory have been transported to the Grands-Mulets (3000 m.) and the rest to the Rocher Rouge (4500 m.).

Next year the erection on the summit will be carried out. An astronomical dome, which is to complete the observatory, will also be taken in hand. The work done up to now has been carried out under great difficulties, owing to the fact that everything had to be carried by hand. But no accident has, so far, marred the success.

Dr. Capus, who accompanied M. Bonvalot in his well-known expedition to the Pamir, has promised his assistance for certain observations. But the observatory will be international, and open to all observers who wish to work there. E. E. F. d'A.

M. PASTEUR'S SEVENTIETH BIRTHDAY

FRENCHMEN may be cordially congratulated on the enthusiasm with which the seventieth birthday of M. Pasteur was celebrated on Tuesday. It afforded a most striking illustration of the way in which they appreciate the services rendered by men of science. But the celebration was not, of course, one in which only the countrymen of M. Pasteur were interested; representatives of science from many different parts of the world were present to do honour to the illustrious investigator.

The ceremony took place in the great amphitheatre of the Sorbonne, which was crowded by a brilliant assembly including many of the foremost men of the day, not merely in science but in politics and literature. M. Carnot was present, and among those who supported him was M. Dupuy, the Minister of Public Instruction. M. Pasteur entered the amphitheatre leaning upon the arm of his son and upon that of the President of the Republic. All who were present rose to their feet and greeted the hero of the day with loud cheers. M. Pasteur, who was much affected by this reception, took his place beside his colleagues of the Institute and a row of Ambassadors and Ministers.

The proceedings were opened by M. Bertrand, perpetual secretary of the Academy of Science, who acted as chairman. At his request an address was delivered by the Minister of Public Instruction, who spoke eloquently of the great qualities displayed by M. Pasteur during his splendid career, and of the benefits conferred on man-

[1] Janssen, Comptes rendus, November 28.

kind by his labours. After the Minister came M d'Abbadie, the President of the Academy, who, expressing the congratulations of the Institute, presented to M Pasteur the large gold medal which had been struck in commemoration of the day The medal bears on the obverse a likeness of M Pasteur, while on the reverse is the following inscription "To Pasteur, on his seventieth birthday, from grateful science and humanity, Dec 27, 1892" M Bertrand also spoke, and both his speech and that of M d'Abbadie were cordially applauded. Sir Joseph Lister, one of the delegates sent by the Royal Society, was warmly greeted He read in French the following address —

"M Pasteur, the great honour has been accorded me of offering you the homage of medicine and surgery There is certainly not in the entire world a single person to whom medical science is more indebted than to you Your researches on fermentation have thrown a flood of light which has illuminated the gloomy shadows of surgery, and changed the treatment of wounds from a matter of doubtful and too often disastrous empiricism into a scientific art, certain and beneficent Owing to you, surgery has undergone a complete revolution It has been stripped of its terrors, and its efficiency has been almost unlimitedly enlarged But medicine owes as much to your profound and philosophic studies as does surgery You have raised the veil which had for centuries covered infectious diseases You have discovered and proved their microbic nature, and, thanks to your initiative, and in many cases to your own special labour, there are already a host of these destructive disorders of which we now completely know the causes 'Felix qui potuit rerum cognoscere causas' This knowledge has already perfected in a surprising way the diagnosis of certain plagues of the human race, and has marked out the course which must be followed in their prophylactic and curative treatment In this way your fine discoveries of the attenuation and reinforcement of virus and of preventive inoculations serve, and will serve as a lode-star As a brilliant illustration, I may note your studies of rabies. Their originality was so striking that, with the exception of certain ignorant people, everybody now recognizes the greatness of that which you have accomplished against this terrible malady You have furnished a diagnosis which immediately dispels the anguish of uncertainty which formerly haunted him who had been bitten by a dog mistakenly supposed to be suffering from rabies If this were your only claim on humanity, you would deserve its eternal gratitude But, by your marvellous system of inoculation against rabies, you have discovered how to follow the poison after its entry into the system, and to conquer it there M Pasteur, infectious maladies constitute, as you know, the great majority of the maladies which afflict the human race You can therefore understand that medicine and surgery are eager on this great occasion to offer you the profound homage of their admiration and of their gratitude"

Among other addresses was a striking speech by the Mayor of Dôle, M Pasteur's birthplace After the presentation of gifts by foreign delegates, M Pasteur rose and spoke a few words, which, according to the Paris correspondent of the *Times*, were "broken by sobs" A speech was then read for him by his son. In this speech, as reported in the *Times*, M Pasteur said, after referring to M Carnot's presence —"In the midst of this brilliant scene my first thought turns with melancholy to the recollection of so many scientific men who have known nothing but trials. In the past they had to struggle against the prejudices which stifled their ideas. These prejudices overcome, they encountered obstacles and difficulties of all kinds. Even a few years ago, before the public authorities and the Municipal Council had provided science with splendid buildings, a man whom I loved and admired, Claude Bernard, had for a laboratory, a few steps from here nothing but a low damp cellar Perhaps it was there he was struck by the malady which carried him off When I heard of the reception intended for me, his memory rose first of all to my mind I hail that great memory It seems that you have desired by an ingenious and delicate idea to make my entire life pass before my eyes One of my Jura countrymen, the Mayor of Dôle, has brought me a photograph of the humble house where my father and mother lived under such difficulties The presence of all the pupils of the Polytechnic School reminds me of the glowing enthusiasm with which I first entered on the pursuit of science The representatives of the Faculty of Lille recall for me my first studies on crystallography and fermentations, which opened quite a new world to me What hopes filled me when I discovered that there were laws behind so many obscure phenomena! You have witnessed, my dear colleagues, by what a series of deductions I have been enabled as a disciple of the experimental method to arrive at physiological results If I have sometimes disturbed our academies by somewhat livelier discussions, it is because I was passionately defending truth

"You, lastly, delegates of foreign nations, who have come so far to give France a proof of sympathy, you afford me the most profound gratification which can be experienced by a man who invincibly believes that science and peace will triumph over ignorance and war, that peoples come to an agreement not to destroy, but to build up, and that the future will belong to those who have done most for suffering humanity I appeal to you, my dear Lister, and to you all, illustrious representatives of science, medicine, and surgery Young men, trust those certain and powerful methods, only the first secrets of which we yet know And all of you, whatever your career, do not allow yourselves to be infected by vilifying and barren scepticism, do not allow yourselves to be discouraged by the gloom of certain hours which pass over a nation Live in the serene peace of laboratories and libraries Consider first of all, 'What have I done for my education?' and then, as you advance, 'What have I done for my country?' until the moment when you will perhaps have the immense happiness of thinking that you have contributed in some way to the progress and welfare of mankind But whether your efforts are more or less favoured in life you must, on nearing the grand goal, be entitled to say, 'I have done what I could' I express to you my profound emotion and warm gratitude Just as, on the back of this medal, the great artist Roty has concealed under roses the date of birth which weighs so heavily on my life, so you have desired, my dear colleagues, to give my old age the spectacle which could most delight it—that of these eager and loving young men"

This closed the ceremony M Carnot, before quitting the building, walked over to M Pasteur and embraced him The celebration was one of which France has good reason to be proud, and Englishmen may well regret that such a demonstration, common to governors and governed, would in this country be impossible

NOTES

THIS week the American Society of Naturalists has been holding at Princeton, N.J, its eleventh annual meeting, the chair being occupied by Prof Henry F Osborn, Columbia College, New York On Tuesday a lecture was to be delivered by Dr. C Hart Merriam on the Diak Valley Expedition (illustrated) On Wednesday, after the transaction of general business, the following reports on marine biological laboratories were to be read:—The Sea Isle Laboratory, by Prof J A Rider, University of Pennsylvania, a marine station in Jamaica, by

Prof E A Andrews, Johns Hopkins University, the marine laboratories of Europe, by Dr D Bashford Dean, Columbia College, and the outlook for a marine observatory at Woods Holl, by Prof C O Whitman, University of Chicago In the evening the annual dinner of the society was to be held, and the president's address was to be delivered The following are the principal arrangements for to-day (Thursday) —A paper is to be read by Dr C W. Stiles, Agricultural Bureau, Washington, on the endowment of the American table at Naples, and reports are to be read on botanical explorations in Florida, by Prof. W P Wilson, University of Pennsylvania, the summer work of the U S Fish Commission Schooner *Grampus*, by Prof William Libbey, Junr, Princeton College, and expeditions of the American Museum of Natural History into New Mexico, Wyoming, and Dakota, by Dr J L Wortman, American Museum Natural History Then will come the annual discussion, the subject being, What were the former areas and relations of the American Continent, as determined by faunal and floral distribution? The following papers will be read — Introduction, and evidences from past and present distribution of mammals, by Prof W B Scott, Princeton College, evidence from past and present distribution of reptiles, by Dr George Baur, University of Chicago, evidence from the distribution of birds, by Prof J A Allen, American Museum of Natural History, and evidence from the distribution of plants, by Dr N L Britton, Columbia College Special meetings have been held by the American Societies of Anatomists, Morphologists, and Physiologists

WE learn, from the *Oesterreichische Botanische Zeitschrift*, of the death, at Vienna, of the veteran palæontologist, Dr D Stur, Director of the Imperial Geological Institute in that city, and author of several finely illustrated works on palæo-phytology

DR VOLKENS, Privatdocent at the University of Berlin, and Dr Lent are about to start for East Africa, where they propose to carry on scientific investigations The former has received a grant from the Prussian Academy of Sciences, and will devote himself especially to botanical study Dr. Lent has received aid from the German Colonial Society, and will give especial attention to geology

DR F BUCHANAN WHITE has presented his fine collection of lepidoptera to the Museum of the Perthshire Society of Natural Science, which is in process of being greatly enlarged The collection contains twelve thousand specimens, which have been collected by Dr White in many parts of Europe, though mainly in Great Britain and largely in Perthshire Many are type specimens, which have been described and figured by the collector in his numerous descriptive papers, and several represent species that have now become extinct

DURING the latter part of last week an area of low pressure lay to the south-westward of our islands, causing south-easterly gales on our western coasts. This disturbance, however, although it advanced from off the Atlantic, remained comparatively stationary for two or three days, during which time the weather continued fine and dry over England At the close of the week the low pressure area gave place to an area of high barometer readings, which gradually spread over the United Kingdom from the continent, bringing dry weather and severe frost, with fog in many places The thermometer in the shade fell to 9° in Leicestershire, and to 17° in London in the night of the 26th, and in many places the day temperature continued much below the freezing point during both Monday and Tuesday At this time the anticyclone had become thoroughly established, and the area of cold was increasing both in size and intensity, although the conditions in the extreme north indicated a possible change The *Weekly Weather Report* for the period ending the 24th inst shows that temperature was above the mean in all districts, being as much as 5° or 6° over Ireland During the early part of the week the night minima were very high for the time of year Rainfall was less than the mean in all districts, the deficiency being most considerable in Scotland and in the south-west of England Bright sunshine was also very deficient, in Scotland and Ireland there was only from 2 to 3 per cent of the possible amount

THE Weather Bureau of the U.S Department of Agriculture has published some valuable "Observations and Experiments on the Fluctuations in the Level and Rate of Movement of Ground-water on the Wisconsin Agricultural Experiment Station Farm, and at Whitewater, Wisconsin," by Franklin H King The author holds that a careful and detailed study of the movements of ground-water ought to supply very important knowledge bearing upon the contamination of drinking waters and the spreading of certain classes of contagious diseases, and thus help to place the water supply for both urban and rural purposes under better sanitary conditions Every advance which is made towards the increase of yield per acre necessarily means an increased demand for water, so that market gardeners even in Wisconsin and Illinois, where both the annual and summer rainfall is relatively large, are turning their attention, Mr King says, to the question as to the best means for providing irrigation A rapid and economical advance in this direction demands, he thinks, a much more thorough knowledge of the movements of underground water than we at present possess He also urges that in the utilization of natural subirrigation, and in the reclaiming of swamp lands for agricultural purposes, there is imminent need for new knowledge in the same direction Mr King does not overrate the importance of his own researches He regards them simply as preliminary studies

H HABENICHT, of Gotha, has contributed a paper to *Ausland* (No 49) on the frequency of icebergs in the Gulf Stream and variations of climate, based upon the reports of icebergs published since 1883 in the pilot charts of the North Atlantic Ocean. He gives a table showing the number of bergs reported in each year in the Gulf Stream, with a summary of the temperature conditions experienced in Europe during each of the four seasons. The number of icebergs varied considerably in different years, from ten in the year 1888 to 674 in the year 1890 The table shows some unmistakable coincidences between the frequency of the bergs and the character of subsequent weather about six months afterwards The extremely low minimum of iceberg frequency in 1888 was followed by the warmest year of the series, all the seasons of 1889 were warm over Europe There was another less marked minimum of icebergs in 1889, and this was followed by a relatively warm year in 1890 The remarkable maximum of bergs in 1890 was followed in 1891 by the coldest winter that had occurred for twenty years, and the cold winter was followed by an abnormally cold spring and summer. The table also shows that the coincidences are more marked with iceberg maxima than with minima. Two of the latter in two successive years were followed by only one warm summer, while in the case of the maxima the decrease of temperature occurred in the next year.

MR D T MACDOUGAL contributes to *Science*, December 2, an interesting account of some explorations recently made by a botanical expedition in Idaho. The work of the expedition was planned by Dr G Z. Vasey, chief botanist of the U S. Department of Agriculture. The results are summarised thus:— The basins of Lakes Coeur d'Alene and Pend d'Oreille and of the Clearwater and Palouse rivers were explored, the botanically unknown area in Central Idaho now being limited on the south by the Snake River basin, on the west by the Snake River

and the basin explored. About 25,000 specimens of dried plants were collected, representing nearly 1000 species, many of them undescribed forms. Valuable facts concerning general distribution of plants were obtained, since the area explored is one where the Rocky Mountain flora meets and intermingles with the Pacific coast flora in a very interesting manner, while the opportunity afforded by numerous mountain slopes for the furthering of some problems of vertical distribution was not neglected.

AN important paper on fossil mammals of the Wahsatch and Wind River Beds, by H. F. Osborn and J. L. Wortman, has been issued as a bulletin by the American Museum of Natural History, and has also been published separately. It includes a plate and eighteen figures in the text, and is devoted principally to a description of a collection made by Dr. Wortman during the summer of 1891. The authors claim that many new facts of great interest are brought out by the material in the collection. In a preliminary note it is stated that the department of mammalian palæontology in the American Museum of Natural History was established in May, 1891, and that the purpose of the trustees is to procure a representative collection of the American fossil mammals from the successive geological horizons of the West for purposes of exhibition, study and publication. The staff consists of Prof. H. F. Osborn, of Columbia College, Curator, and of Dr. J. L. Wortman, assistant in Palæontology. Mr. Charles Earle and Mr. O. A. Peterson are also engaged as assistants, and Mr. Rudolph Weber as draughtsman. The collections are to be made readily accessible to students, and exhibited as rapidly as they can be put together and mounted. A list of such duplicate specimens as are available for purposes of exchange is to be prepared. A series of casts of the best preserved types is also in preparation for exchange.

LAST week we printed an account of the ceremonies connected with the Tercentenary of Galileo at Padua. In addition to what was then stated we may say that after Prof. Favaro's oration the delegates were invited to present the addresses of which they were the bearers, whereupon, the English delegation having by lot been placed first in order of precedence, at the request of his colleagues, Profs. Darwin and Stone of Cambridge and Oxford, Sir Joseph Fayrer spoke first, on presenting the addresses of the Royal College of Physicians of London and the University of Edinburgh, with which he was entrusted. He spoke in Italian to the following effect:—

"Profondamente commosso all'onore accordatomi dal Reale Collegio dei Medici di Londra, ed anche dall Università di Edinburgo, nel nominarmi il loro delegato, io mi presento davanti a questa insegne adunanza, per far onore alla memoria di uno dei più grandi uomini e dei più illustri sapienti del mondo, e per render omaggio da parte del detto Collegio, così bene come dell' illustre centro di scienza e di filosofia in Scozia, all' inclito scienzato, nonche a felicitare di cuore colla massima riverenza, questo antico seggio di scienza e di filosofia in così lieta e fausta occasione, nella quale si commemorano le scoperte gloriose del celebre e rinomato filosofo, col nome del quale e intimamente collegata la sua storia passata ed anche la sua rinomanza attuale. La scienza di tutto il mondo è senza dubbio in questo luogo ora rappresentata. Da ogni parte sono venuti messaggi di simpatia, ma da nessuno forse, con maggiore premura e zelo che dei compatrioti di Harvey e Newton. Questi, impugnando la facciola caduta dalla mano morta di Galileo, la innalzò e la sostenne per illuminare le tenebre e dischiarare di vera luce i luoghi finallora oscuri anche al gran filosofo stesso, l'altro avendo terminato i suoi studi ed essendo laureato in questa università, divenne dipoi, come socio del Collegio di Londra, famoso per le sue scoperte sulla circolazione del sangue. I suoi studi anatomici che fece a Padova svilupparono in lui quel genio al quale il mondo intero è debitore. Signori miei, non è solo allo scopritore del termometro, e, come si può dire, all' inventore del telescopio; non è neppure all' astronomo famoso che ha stabilito il sistema eliocentrico, ed ha quasi anticipato le scoperte di Kepler, e che ha dimostrato i satelliti di Giove, le fasi del pianeta Venere, i movimenti diurni e mensili della luna e le macchie solari, non è infine all' autore del 'Saggiatore,' del 'Sidereus Nuncius' e del 'Dialogo dei due Massimi sistemi del Mondo,'—ma e piuttosto al fondatore della filosofia sperimentale che noi rendiamo adesso omaggio ed onore. Egli, osando, pensare ed investigari da se stesso, rigettando gli assiomi degli antichi sistemi di filosofia, anche quello di Aristotile stesso, e rifiutando gl' insegnamenti della teologia dogmatica, stabilì il sistema del libero esame, affermando che la scoperta della verità dev' essere il primo motivo, e che si deve cercarla per via di sperimenti e non sull' altrui autorità, e che la verità è unica, tanto in respetto alle scienze divine come alle umane. Ardisco dire che nessun migliore tributo si può fare al gran maestro adesso commemorato, che questa riconoscenza festiva dopo trecento anni, dell' assiduo e instancabile lavoro che ha rovesciato non soltanto il sistema Tolomaico, ma ha dato un nuovo impulso vitale ad ogni ricerca scientifica e filosofica. Signori, con queste poche parole ho tentato d'esprimere i sentimenti dell' illustre Collegio e dell' inclita Università dei quali io sono il modesto interprete, e ho l'onore di sommettere queste indirizzi, e con esse, i voti più sinceri dei miei colleghi per la prosperità futura di questa venerabile Università, la quale, molto avanti a Galileo è stata un primo centro della vita intellettuale in Europa, e che anche adesso e famosa per la sua propria eccellenza e pei suoi rapporti col gran savio di cui si può dire, come ha detto Dante di Aristotile

'Tutti l'ammiron, tutti onor gli fanno.'"

PROF. DARWIN of Cambridge followed Sir Joseph Fayrer with an interesting and eloquent address, also in Italian. He was succeeded by other delegates. We may note that every attention was shown to the foreign delegates, and the great success of the commemoration was courteously assigned by the University authorities in large measure to the sympathy and interest evinced by other nations. It is satisfactory that no inconsiderable share of this was attributed to the English; their addresses being delivered in Italian evidently afforded much pleasure.

THE *Mediterranean Naturalist*, noting the fact that new and spacious buildings are about to take the place of the old biological station at Cette, expresses regret that no institution of this kind has yet been established in connection with the Maltese Islands. It points out that the marine fauna and flora of Maltese waters offer themselves as a rich and practically untouched field of research, the careful working out of which would be attended with scientific and economic results of the greatest importance.

THE same journal mentions that a petition is to be presented to the Governor of Malta praying that the Maltese fisheries may be more efficiently protected. At present considerable latitude is allowed both as regards the methods practised and as regards the times at which the fishing is carried on. "This," says our contemporary, "is not as it should be. No other food supply can take the place of fish, and the fisheries of the islands under adequate protection and judicious management will always be an unfailing and increasing source of wealth."

THE Department of Public Instruction in New South Wales has published in its Technical Education Series (No. 10) the first part of what promises to be a most valuable "Bibliography of Australian Economic Botany," by J. H. Maiden, curator of the Technological Museum, Sydney. Much information on the properties and uses of Australian plants, and on the products obtained from them is embodied in books of travel, in exhibition literature, pamphlets, proceedings of learned societies, professional journals, and newspapers. It is the author's object to render this scattered information convenient for reference.

A GERMAN translation, by Count Goertz Wrisberg, of Dr. W. Fream's "Elements of Agriculture," has been published by

Paul Parey, of Berlin, under the title of "Landwirtschaft in England"

THE current number of Wundt's *Philosophische Studien* contains two experimental articles—both dealing with problems of psychological optics The first (A Kirschmann, "Beitraege zur Kenntniss der Farbenblindheit") gives an account of a number of interesting cases of colour blindness, together with criticisms of existing theories A unique case is that of an inherited, unilateral (left) blindness to the qualities violet, green and yellow In the second (E B Titchener, "Ueber binoculare Wirkungen monocularer Reize") an attempt is made to show that stimulation of one retina is followed by an excitation process in the other The psychophysical results are supported by recent physiological discovery

THE following are the arrangements at the Royal Institution for the Friday evening meetings before Easter, 1893 —Friday, January 20, Prof Dewar, F R S, liquid atmospheric air, Friday, January 27, Francis Galton, F R S, the just-perceptible difference, Friday, February 3, Alexander Siemens theory and practice in electrical science (with experimental illustrations), Friday, February 10, Prof Charles Stewart, some associated organisms, Friday, February 17, Prof A H Church, F R S, turacin, a remarkable animal pigment containing copper, Friday, February 24, Edward Hopkinson, electrical railways, Friday, March 3, George Simonds, sculpture considered apart from archæology, Friday, March 10, Sir Herbert Maxwell, early myth and late romance, and Friday, March 17, William James Russell, F R S, ancient Egyptian pigments On Friday, March 24, a discourse will be delivered by Lord Rayleigh On March 31 and April 7 (the Fridays in Passion and Easter Weeks) there will be no evening meetings

THE following are the arrangements for lectures at the Royal Victoria Hall in January —January 3, Mr Charles E Reade on a trip through India, with anecdotes of the mutiny, January 10, Mr A. Hilliard Atteridge on some old Belgian towns, January 17, Prof Carlton Lambert on the romance of the stars, January 24, Dr Dallinger on spiders, their work and their wisdom

THE fermentative changes which the leaves of the tobacco plant are made to undergo before they are worked up and finally handed over to the public, are of the greatest importance in determining the quality of any particular tobacco It was formerly supposed that the alteration in its condition thus brought about was due to purely chemical changes induced by the process of "sweating" which the leaf undergoes, but some interesting experiments made recently go to show that these important results are effected by special micro-organisms. In a paper read before the German Botanical Society, Suchsland gives an account of some investigations which he has been conducting on the bacteria found in different kinds of tobacco He has examined fermented tobacco from all parts of the world, and found large numbers of micro-organisms, although but few varieties, mostly only two or three different species in any particular brand and but rarely micrococcus forms But what is of especial interest is the discovery that pure cultures of bacteria obtained from one kind of tobacco and inoculated on to another kind, generated in the latter a taste and aroma recalling the taste and aroma of the original tobacco from which the pure cultures had been in the first instance procured Thus it may be possible in the future to raise the quality of German tobacco, not, as heretofore, so much by careful culture and judicious selection of varieties, which has so far proved unsuccessful, but by inoculating pure cultures of bacteria found in some of the fine foreign tobaccos on to our own raw material, whereby similar fermentative changes may be induced and the quality correspondingly improved The further results promised by Suchsland will be looked for with much interest In connection with the above experiments on the "transplantation," so to speak, of micro organisms, it is interesting to note some results obtained lately by Nathan (*Die Bedeutung der Hefenreinzucht fur die Obstweinbereitung*) The amount of alcohol present in such wines as cider, currant wine, etc., is generally from 3 to 4 per cent This small proportion is possibly in part due to the necessarily large dilution of the fruit with water, which considerably reduces the nitrogenous constituents of the "must," and also to the fact that the yeast, according to Hansen mostly present on sweet fruits is the *Saccharomyces apiculatus*, which only possesses a feeble fermentative power Experiments were made to see whether, by increasing the nitrogenous constituents of the "must," and introducing a pure cultivation of a vigorous wine yeast, the yield of alcohol would be greater It was found that by adding a small amount of nitrogenous material, such as 0 15 gram ammonium chloride, and 5 cubic centimetres of wine yeast per litre to the "apple-must" (which was the fruit selected) 2 per cent more alcohol was obtained, and not only was this the case, but this cider possessed a finer and more vinous taste than that untreated, or which had only received an additional supply of ammonium chloride without the wine yeast Kosutany in a paper published in the *Landw Versuchsstationen*, 1892, has recorded the results of his investigations on the behaviour of certain species of wine yeast He states that not only is the percentage of alcohol yielded very different with particular yeasts, but that also the taste, smell, and bouquet of the wine inoculated with special cultures were distinctly different according to the variety of yeast employed It is hoped that, as in the case of tobacco so with wine, it may be possible to raise the quality by the judicious transplanting of bacteria obtained from finer brands

THE additions to the Zoological Society's Gardens during the past week include a —— Squirrel (*Sciurus* ——) from China, presented by Mr Julius Neumann, a Crowned Hawk Eagle (*Spizaetus coronatus*) from South Africa, presented by Mr T H Mills, a Macaque Monkey (*Macacus cynomolgus* ♀) from India, deposited, three Sulphury Tyrants (*Pitangus sulphuratus*) from South America, six common Widgeons (*Mareca penelope*, 3 ♂, 3 ♀), four common Pintails (*Dafila acuta*, 2 ♂, 2 ♀), two Pintailed Sand Grouse (*Pterocles alchata*, ♂ ♀) European, purchased.

OUR ASTRONOMICAL COLUMN

JUPITER'S FIFTH SATELLITE.—Mr A A Common, in a letter to the *Times* for December 28, writes with respect to the fifth satellite of Jupiter :—

"This extremely difficult telescopic object discovered by Prof Barnard last September at the Lick Observatory has been looked for with the 5ft reflector on several occasions On October 18 and on December 13 it was pretty certainly seen, by me on the first occasion, and by Mr Albert Taylor on the second. The last two evenings (Sunday and Monday) have been very fine, and on each, between five and six o'clock, the satellite has been seen with certainty by Mr Taylor and in glimpses by me.

"The brightness seems less than that assigned to it by Prof Barnard, but this may be due to the very much better sky they enjoy at Mount Hamilton, the glare from Jupiter would be with them very much less, so that they would have the planet on a much darker background, and it would appear brighter than it does here

"I have not heard of any other observations having been made out of America."

COMET BROOKS (NOVEMBER 20, 1892) —*Edinburgh Circular*, No 36, gives the ephemeris of this comet, from which the following extract is made This comet, according to Ber-

berich's computations, will soon commence to decrease in brightness

Berlin, Midnight.

1892–93.	R A h m s.	Decl ° ′	Log r	Log Δ	Br
Dec 30	15 57 15	58 31 0			
31	16 16 30	60 21 3	0 0820	9 8589	7 66
Jan 1	16 38 18	62 1 9			
2	17 2 46	63 29 7	0 0812	9 8530	7 89
3	17 29 49	64 41 7			
4	17 59 0	65 34 5	0 0807	9 8521	7 95
5	18 29 40	66 5 4			

COMET HOLMES (NOVEMBER 6, 1892) —The following is a continuation of the ephemeris of this comet for the present week —

Berlin, Midnight.

1892–3	R A (app) h m s	Decl (app) ° ′	Log r	Log Δ
Dec 30	1 2 22	+33 59 5		
31	3 24	57 2		
Jan 1	4 27	55 1	0 4096	0 3284
2	5 31	53 1		
3	6 36	51 3		
4	7 42	49 6		
5	1 8 50	33 47 9	0 4119	0 3400

THE MARKINGS ON MARS —In No 25 of the Publications of the Astronomical Society of the Pacific, Mr Schaeberle has a preliminary note on the question as to whether the darker and the brighter areas on Mars are water and land or *vice versâ* Having observed the planet from June 11 up to the present time he has been led to the conclusion opposite to that of Schiaparelli, Flammarion, and other observers, and considers that after all the dark portions should be considered as land and the bright as water. In raising such a question as this Mr Schaeberle has been very reserved, for should his opinion receive due attention, as of course it should do, and be corroborated, the planet's surface will be looked upon in quite a different light than formerly In this note he sets forth a few of his reasons for coming to such a conclusion, and it may interest many of our readers if we state some of them briefly If the dark markings be taken as land, would not the irregular gradations of shade be more naturally expected than if we consider them as fixed surface features? "Light reflected from a spherical surface of water in a slight state of agitation would vary uniformly in intensity At opposition, the centre of the planet would, for a water surface, appear brightest Observations show that within a certain distance from the edge of Mars there is a gradual increase in the steady lustre of the brighter areas towards the centre of the planet" Assuming these dark areas to be water, then they should thus be least dark near the centre, which is somewhat contrary to observation With reference to the "canals," he says that they on this hypothesis "correspond to the ridges of mountains which are almost wholly immersed in water," while with regard to their observed doubling he remarks that they can be explained as "representing parallel ridges of which our own earth furnishes examples" As a concluding argument he takes an observed terrestrial observation, the view of the lower end of San Francisco Bay from Mount Hamilton, San Francisco being fifty miles away At all hours of the day, he says, "the surface of San Francisco Bay (as seen from the top of Mount Hamilton) is much *brighter* than the neighbouring valley and mountains at the same distance" He further adds that the line of sight makes an angle of more than 87° with the normal to the surface of the bay, while the observer's position "varies all the way from being nearly in a direct line between the bay and the sun to the position in which the sun is nearly in the direction of the bay"

THE LICK OBSERVATORY —Miss Milicent W Shinn is the writer of a very interesting pamphlet on the history of the Lick Astronomical Department of the University of California In these few pages she brings together much with regard to the early events connected with the founding of the giant refractor that is not generally known. For instance, it is curious to read how Mr Lick wished to be immortalized by leaving bequests for costly statues of himself and his family, and when urging that such statues would be preserved for all time, was answered by Mr. Staples that "more likely we shall get into a war with Russia or somebody, and they will come round here with warships and smash the statues to pieces in bombarding the city" Mr Lick was so struck by this, that he asked, "What shall I do with the money, then?" How this question was answered is now well known, and astronomical science was presented with the finest object-glass that was ever made

Mr Lick's deed prescribed that the Observatory should be "made useful in promoting science," and up to the present these words have been carried out to the letter The big telescope has not been preserved for one side of astronomical science, but has dived into all branches, as every astronomer is aware Not only have minute double stars been observed and measured, but the spectroscope has been employed, from which excellent results have been published, while lunar photographs, equalling, if not excelling, those that had been previously obtained have brought to light much to set us thinking about Jupiter's fifth moon is perhaps the latest arrival of which we have heard, and this, following just 300 years after Galileo's discovery, would alone render the Observatory famous That the Lick Astronomical Department, during the few years of its existence, has done an immense amount of good work, especially when one takes into account the comparatively small staff on hand, cannot be denied, and we hope the day will come when the number of such telescopes will be increased, for the ever-opening fields of research point out how necessary they are

WASHINGTON MAGNETIC OBSERVATIONS —The United States Naval Observatory has quite recently published their magnetic observations that were made during the past year, prepared on the same plan as that for 1889–90 The observations for 1891, as Mr Hoogewerff (who was in charge for the greater part of the year) informs us, are better than those of former years, owing to the fact that the reductions took place at no very distant dates from the observations, the experience thus gained helping to correct and guard against conditions which might have tended to give rise to errors The introduction contains a description of the buildings, methods of observing, together with the personnel during the year, concluding with a description of the tabular results The tabular results, as usual, show the mean hourly readings for the elements for each month, Table I containing the mean values for the four years 1888–91

Simultaneous with this volume was also issued the meteorological observations and results for the year 1888

GEOGRAPHICAL NOTES.

A SPECIAL number of the *Mouvement Géographique* is devoted to a series of important despatches from M Alexandre Delcommune, chief of the Lomami expedition of the Katanga Company Entering the Lomami from the Congo, the party left the river on May 13, 1891, and explored the entirely untraversed territory between its upper valley river and that of the Sankuru as far as 8° S Thence they turned eastward and reached Lake Kassali on the Lualaba, and struck south through Garenganze's country to Bunkeia Making a circuit through Katanga and westward, they found the Lualaba near its source, and following it for 200 kilometres, discovered a grand gorge at Nzole, where the river flowed in a succession of wild cataracts between cliffs nearly a thousand feet high, and not more than forty yards apart From the rapids they returned to Bunkeia, travelled north eastward over the plateau, crossing the Luapula at its outflow from Lake Moero, and ultimately reached Lake Tanganyika The difficulties overcome were very great, and the sufferings of the caravan have rarely been surpassed even in the grimmest records of African travel

AMONGST the English travellers who have recently arrived in London are Mr. Selous, the famous South African hunter, and Mr Conway, who has probably climbed higher than any other European in the Karakoram range Both gentlemen will read papers to the Royal Geographical Society early next year

THE arrangements for the Royal Geographical Society's evening meetings after Christmas are unusually varied Mr Hose will describe his journey up the Burram river in Sarawak to Mount Dulit, at the first meeting in January The second meeting will be devoted to the Island of Yezo, when Prof Milne and Mr. Savage Landor will read papers Papers by Captain Bower and the American traveller Mr Rockhill, on Tibet, will be given later, and Lieutenant Peary will personally describe

his experiences in the north of Greenland In March Prof Bonny will lecture on the action of ice in producing geographical forms, and there will be other papers dealing with the scientific basis of geography

THE death of Cardinal Lavigerie on November 24 removed one of the most powerful personages who have recently influenced the geography of Africa. It is very largely on account of his labours that the French Roman Catholic missions have played so conspicuous a part in combating the slave trade, and to him also is due the formation of a much-needed Belgian Anti slavery Society

THE British Government having decided to relieve the East African Company from the responsibility of occupying Uganda, an Imperial commission, under the charge of Sir Gerald Portal, will set out from Mombasa as soon as it can be got ready to take over the administration of the country Another fact of some interest is the revival by Mr Cecil Rhodes of the idea of exploring Africa by telegraph He proposes to lay down a line from the Cape to Uganda, and ultimately to extend it to Egypt In a few months the South African Company's wires will have reached the mission station of Blantyre north of the Zambesi, and there are no serious physical difficulties in continuing the line to the head waters of the Nile The effect on the exploration of Africa will be enormous, not the least important result being the possibility of arriving at the true longitudes of places in the interior of the continent

DEW AND FROST

A PAMPHLET recording some interesting "Observations on Dew and Frost," by the Hon R Russell, has just been published by Mr Edward Stanford We reprint Mr Russell's "Summary of Results" —

The observations were begun with the object of verifying the commonly received theory of dew, and with a strong feeling that the results obtained by Col. Badgeley, described in the *Proceedings of the Royal Meteorological Society* for April, 1891, opposed as they were in some measure to the accepted teaching on the subject, would not be corroborated When, after exposing inverted glass tumblers and pans on grass and bare earth in the summer of 1891, dew was often found in surprising amount in the interior, I attributed the deposit to vaporous air which might have entered under the rim and parted with its moisture in the calm of the inclosed space But when it was found that a tumbler pressed down into dry earth, and other vessels admitting little air from outside, were considerably bedewed in the interior, and when, further, similar vessels inverted on earthenware or metal plates were found to be very slightly or not at all bedewed inside, it became more probable that the vapour condensed in the interior of vessels over grass and garden earth had proceeded from the earth beneath Next, it was found that china plates, admitting a flow of air between their lower surfaces and the ground, were more heavily bedewed on their lower than on their upper surfaces, and that a cylinder of glass was most bedewed on the lower outer and upper inner surfaces. These observations confirmed the suspicion that the dew on the inside of the hollow vessels was derived from the ground It was for a long time a matter of doubt and difficulty that vessels inverted over dry, dusty earth and dry turf were found copiously bedewed within on the morning following exposure On many mornings the amount of dew in the interior increased in some proportion to the precautions taken to exclude free air, and it seemed highly improbable that moist air penetrated, without depositing on its way much of its moisture, either through the dusty earth banked round the edges of the vessel, and exposed to the sky, or else through the dusty covering of earth below the vessel from lower layers

In December, 1891, during hard frost and very fine weather, with calm or very light airs, the ground being frozen hard, leaves of bushes, ferns, &c., were seen to be frosted both on their upper and lower sides, though much less on the lower sides facing the bare ground than on the upper sides facing the open sky Where thick fern grew between the observed leaves and the ground, there was no rime on the lower sides of the overhanging ferns or leaves This seemed to show that the rime on the lower sides of ferns was due to exhalation from the ground, for the interruption of radiant heat from the earth by dry litter would rather favour than reduce the frosting of the under sides. Live leaves on bushes, and dead leaves on the ground, were whitened with frost on their upper sides, and had a thin film or coat of transparent ice on their lower sides Leaves and sticks on the ground were less frosted on the sides facing the ground than on the top Thick planks between a few inches and one foot above the ground were about a third as much frosted on the lower as on the upper sides Considering that the upper side of a plank 1 inch thick would fall to a considerably lower temperature by radiation than the lower side, it may be supposed that the deposition would have been largest on the lower side if they had been at the same temperature That much frost came from the air independently of the ground, was shown by the white roofs 12 feet above the surface of the earth. On the other hand the grass was much more heavily frosted Moreover, tumblers inverted and pressed down on dry, hard, bare earth, on sand, and on hard turf, were moderately frosted inside, besides being thickly frosted outside The indications, on the whole, seemed to resemble those of the previous June, but the vapour condensation attributable to exhalation from the earth bore a much smaller proportion to the total deposit than in the case of dew on interior surfaces observed in summer

Boards, tiles, and stones (sandstone) in heaps were frosted on the top, and especially in cracks and indentations of the top surface, but not in the interstices between the separate pieces Stones on the ground were sometimes not frosted at all on the top, but much on the parts against the sandy earth, and where bedded in the ground

Further experiments in May and in the summer months of 1892 gave strong confirmation of the evidence that much dew and frost are caused by exhalation of vapour from the earth, even in dry weather

The facts that—

(1) A large quantity of dew was invariably found on clear nights in the interior of closed vessels over grass and sand

(2) Very little or no dew was found in the interior of vessels inverted over plates on the ground

(3) More dew was found on the lower side of a square, slightly raised, china plate over grass or sand than on the lower side of a similar plate placed upon the first

(4) The lower sides of stones, slates, and paper on grass or sand, were much more dewed than the upper sides The flat wooden back of the minimum thermometer on clear evenings when lying on earth, sand, or grass was almost invariably wet before the upper surface

(5) The lower side of plates of glass, 1 or 2 in above grass, were as much or more bedewed than the upper sides.

(6) Leaves of bushes, leaves lying on the ground, and blades of grass were about equally bedewed on both sides

(7) The interior of closed vessels inverted on the grass and covered with two other inverted vessels of badly-conducting substance was thickly bedewed, and the grass in the three circular inclosures also thickly bedewed

(8) The deposit of dew on the interior of closed vessels inverted over dry garden earth was much less than over sand or turf, although the powdery condition of the earth in the morning showed that no deposit from the air had taken place on its surface during the night

(9) Usually a greater amount of dew was deposited in the interior of vessels when the earth was moist at a little depth below the surface than when the earth was at its driest.

(10) The temperature of the space under a glass plate or other object suspended near the surface of the ground was higher than that of the upper surface of the object, and, nevertheless, a cloudy film was produced first on the lower surface,—amounted to a proof that a large part of the dew formed is derived from vapour from the earth

Moreover, the large difference often observed between the quantity of dew deposited in the interior of a vessel inclosing a plant, and the quantity of an empty vessel, proved that much dew may be derived from the earth through plants

Drinking glasses inverted over grassy turf, and over turf close by, from which the grass was removed, showed a similar excess of deposit on the glasses inclosing grass. More vapour was condensed on plates suspended over grass than over bare earth. In these cases the conditions are somewhat artificial, and the grass, which was covered by a suspended plate or inclosed by a glass, would be warmer than if the exposure to the sky were free, but the disturbance thus caused would tell as much against as in favour of deposition on the interior surface. It may be objected that the air in and above the grass would be colder, owing to the radiating grass, than over the bared spot, and that

therefore more dew would be deposited from the air, but this objection would scarcely be valid where a small plant was inclosed on bare earth and the deposition on the interior of the glass compared with that on a glass not inclosing a plant

Recent investigations have proved the evaporation from plants to be very large, and since evaporation proceeds by night as well as by day, there can be no reason why a moderate proportion of the dew deposited on the surface of blades of grass and on leaves of plants generally should not be derived from the vapour which they exhale The fact that an equal quantity of dew is deposited on glass, china, painted wood, &c., exposed to the sky to that deposited on grass, may seem to minimize the influence of plant exhalation, but we must remember that the whole of the stratum of air near the ground is rendered more vaporous by these exhalations, and that therefore the dew point is sooner reached on the surface of any body exposed to the sky in the midst of vegetation than on bare open ground Moreover, the thickness of the substance prevents earth heat from much affecting the upper surface The effect of grass in promoting dew formation is owing—(1) To its radiative power cooling its surface below the dew point (2) To the consequent cooling of the stratum of air in and over the grass to a point much below that of the air a few feet higher (3) To the obstruction offered by the grass to any light air or breeze on a nearly calm night, and the consequent settling down, without much disturbance, of a cold heavy stratum (4) To the prevention by the grassy covering of the drying up process by sun and wind which takes place on bare ground, and to the moist earth which therefore exists under grass near the surface even in dry weather (5) To the exhalation of vapour from the grass

The realization of these causes explained what was always, previous to these observations, a difficulty to me, the almost entire absence of dew on heather and dry fern in the summer Even after heavy dews, heather was invariably found perfectly dry In fine, calm winter weather, with white frost, heather may be a good deal whitened, and the frost is then derived largely from the open air Wood, being a good radiator and bad conductor, is heavily bedewed and frosted

Stones, whether of sandy composition and appearance, or of close grain like flint, pebbles, and slate, are not often visibly bedewed or frosted on the top on clear nights. On their surfaces, touching or very close to the ground, they are heavily bedewed and frosted A moderate radiative power, their usual situation removed from grass and vegetation, and in the case of the close grained stones, a conductive power greater than that of leaves, grass, and wood, though less than that of metals, prevent the deposition of much atmospheric moisture on their exposed sides But when air highly charged with vapour impinges on them in a confined space, as on their lower sides, condensation readily takes place, just as it will take place when any substance, even polished metal, is held above the spout of a kettle of boiling water It is apparent that since stones act as condensors to the vapour constantly arising from the earth, and since the heat of the sun and temperature of the air by day only slightly raise the temperature of the earth immediately beneath a large stone, while the radiation of heat from the stone and low air temperature of the night cause the lower side of the stone to be very cold at night, a rather large amount of moisture must be deposited on its lower surface in every twenty-four hours, and the ground on which it rests must in our climate remain always very moist The space between the stone and the ground consequently becomes the abode of many insects which live well in damp and darkness

Occasional observation of the distribution of dew, without careful comparison with the state of the weather, gives an impression of capriciousness which only continuous records comprising various conditions can remove.

Deposition is generally favoured by a humid air, and therefore in this country by southwesterly and westerly winds, which bring over the land the vapour derived from evaporation of the Atlantic Ocean. A smaller fall of temperature by radiation brings about condensation, and there is less tendency in any deposit to evaporate than in a drier air Radiation may produce a greater fall of temperature in dry air, but the distance from the dew-point is commonly too wide to compensate greater humidity with greater cooling

Calm is also very favourable to dew-formation. It allows parcels of vapour in the air to remain sufficiently long in contact with cold radiating substances to become greatly cooled, and so to become condensed upon them, and it prevents the dispersion of the stratum of air near the ground, which is continually cooling by contact and radiation Thus dew goes on forming while the air falls lower and lower beyond its original dew point, and while by a very gentle movement an interchange is kept up between the warmer air touching the ground beneath the grass, and the cold air on the surface of the grass, and between differently cooled layers and portions of air above it If the air is very humid, a very slight air or breeze is favourable to heavy deposition. On ordinary clear nights, calm and light airs allow the reduction of the lowest stratum of air to the dew point, and there is no liability to evaporation of the minute deposited particles by portions of air above the dew point being driven against them When the air is rather dry, as often happens at night in dry summer weather, and in winter frosts, calm is frequently a necessary condition for the deposit and appearance of dew and white frost The deposit may be observed to take place on the cessation of wind, and again, the change from calm to wind soon dries off the dew which has already formed On other occasions, when there is a gentle air or breeze, dew and frost are deposited only in sheltered places, as on the most sheltered slopes of fields, on banks sloping to leeward, on leaves on the lee side of bushes and trees, on the lee side of mole-hills, posts, railings, and other objects Hollows, depressions, and cracks, in paper, glass, stones, tiles, wood, and leaves, are more bedewed than flat surfaces from the same reason,—the reduction below the dew-point of air less diluted than that which is more free by currents of higher temperature and greater dryness With a fresh west wind in a clear night, the raised and ribbed parts of leaves, &c, may be thickly bedewed and frosted, but the hollows and folds scarcely if at all less, and the sides of buds, thorns, &c, are more frosted than the points The wind is, in fact, often sufficiently removed from the dew point to prevent deposition or continuance of moisture on all parts which are fully exposed to it Not even free radiation to a clear sky then avails to plant frost growths upon the object whose temperature is being perpetually supplied by the forcible impact of warmer air

Free radiation or exposed situation is, on the whole, perhaps the most effectual cause of dew on very many nights in the year In a level country those parts of a field which are least sheltered by trees and hedges gather most dew and frost on calm nights Similarly, those parts of any flat substance, such as a sheet of glass or paper, which have the most uninterrupted exposure to the sky are most bedewed The tops of bushes, posts, railings, inverted drinking glasses, pans, &c, are on calm nights, and sometimes breezy nights, more bedewed than the sides Greater cold by greater radiation in these cases produces greater deposition from the cooled air which comes in contact with the freely radiating surfaces It must be remarked, however, that radiation from fine points, such as the tips of sharp thorns, is often not sufficient to counteract in air which is not very humid the effect of the continual impact of air above the dew-point and higher in temperature Close to the ground the case is different, for there the temperature of the low stratum of air is lower, and usually about the dew-point, there is little movement, and vapour from the ground increases humidity, but even in this situation the points of grasses, &c., are often less bedewed than the sides.

That free radiation is by no means necessary for the formation of heavy dew on grass is proved by the experiments detailed above, made during the summer of 1892 The grass was found heavily bedewed in dry weather within three enclosures of earthenware by which radiation was arrested

Since grass covered by hollow vessels, and the interior of hollow vessels themselves, are thickly covered with dew, it would seem likely that the grass under overhanging trees would be as thickly bedewed as the exposed grass in a field, and that the under sides of the overhanging leaves would also be wetted This is not the case. And there are differences in the two situations sufficient to account for the absence of dew under leafy trees In the first place, on a calm night, the air under a tree is warmer than in the open owing to radiation from the ground being arrested Secondly, whatever vapour escapes from the earth is unable to condense on the grass which covers it, the grass being but little colder than the air and vapour Thirdly, and herein lies the chief difference, the air under the tree moves freely and is above the dew-point, since the earth and other objects which it touches are warmer than the grass and air outside. If the air were confined in a small space, the increments of vapour issuing from the earth, and the gradual cooling of the grass under the tree and of the tree itself, might cause deposition, but air which has parted with much of its moisture outside is

constantly mixing with a considerable body of air already warmed under the sheltering canopy. Thus all objects under the tree remain above or not much below the dew point of the air which touches them. Yet, on a calm night, long grass and other substances a little raised above the ground are sometimes heavily bedewed, though largely hindered by overhanging branches from losing their heat by radiation. They often remain nearly dry till the morning hours, and then reach a temperature below the dew-point. The absence of dew under trees and bushes is, within limits, roughly proportional to the area of ground covered. A large surface of dry ground slowly parting with its heat during the night has a powerful effect in preventing condensation. Small bushes on a humid clear night are often much bedewed even on their lower leaves. On the night of October 5, 1892, both sides of the leaves of bushes in all sheltered situations were found thickly bedewed, but where leaves were either exposed to the slight breeze which was blowing, or near the wall of the house on which the sun had shone, they were dry. The warm, dry wall of a house acts a part similar to that of the earth under a tree in radiating warmth to neighbouring objects, and in warming the air by contact. The vapour emerging from earth sheltered by foliage several feet above it has time to mix well with air before coming in contact with solid objects. In the hollow vessels, and even in the space between a raised plate of glass and the earth, the vapour which rises from the earth has no time to become equally distributed in the air before meeting with substances colder than itself; in the closed vessels the initial amount of vapour is augmented so as to produce constant saturation. Objects, such as drinking glasses, raised several feet above the grass, were seldom much bedewed, and often quite dry.

The increase of pasture-land in England must have a considerable effect in increasing cold by radiation, and in diminishing the amount of vapour in the air at night by deposition on grass. The sensible moisture at night must be increased near the ground, the dew point being quickly reached on a clear night over grass.

The large quantity of dew found on plates and other objects over sandy ground, dry to a depth of several inches, proves the possibility of a large emanation of noxious vapours from soil containing decaying organic matter below a covering of sand. The ague of parts of East Anglia and of sandy malarious districts may be thus accounted for.

Houses built on sandy ground over a damp subsoil may be considered as scarcely more wholesome than if built on the damp soil itself.

In late summer and early autumn the high temperature of the soil in comparison with the temperature of the surface and of the air near the ground at night, must have a powerful effect in the production of vaporous exhalations. The heavy rains which so often occur in October, the wettest month of the year, must co-operate with a falling air temperature in driving out air from the pores of the earth.

In nearly all the conclusions of Wells, as stated in his admirable "Essay on Dew," my observations lead me to concur. He found that calm is favourable to the precipitation of dew; that if, in the course of the night, the weather, from being calm and serene, became windy and cloudy, not only did dew cease to form, but that which had formed either disappeared or diminished considerably; that if the clouds were high and the weather calm, dew sometimes formed to no very inconsiderable extent; that dew often forms on shaded grass even several hours before sunset, and continues to form after sunrise; that, if the weather be favourable, more dew forms a little before, and, in shaded places, a little after sunrise, than at any other time; that on substances elevated a few feet above the ground it forms much later in the evening, but continues to form as long after the rising of the sun as upon the ground; that dew is more abundant shortly after rain than during a long tract of dry weather; that dew is always very copious on those clear and calm nights which are followed by misty or foggy mornings, and also on clear mornings after cloudy nights, and generally after hot days; that more dew was formed between midnight and sunrise than between sunset and midnight, owing doubtless "to the cold of the atmosphere being greater in the latter than in the prior part of the night;" that whatever diminishes the view of the sky diminishes the quantity of dew; that a substance placed on a raised board of some extent acquired more dew on a very still night than a similar substance lying on grass; that bright metals attract dew much less powerfully than other bodies, that a metal which has been purposely moistened will often become dry though similarly exposed with bodies which are attracting dew, and that wool laid upon a metal acquires much less dew than an equal quantity laid upon grass in the immediate vicinity; that a metal plate on grass always became moist on the lower side during the night, though the upper side was often very dry, but that if the plate was elevated several feet in the air, the condition of both sides was always the same, whether dry or moist; that wool on a raised board was commonly colder than on the grass on very still nights, and that the leeward side of the board was colder than the windward; that bare gravel and garden mould were very much warmer after sunset than neighbouring grass; that on dewy nights the temperature of the earth half an inch or an inch beneath its surface was much warmer than the grass upon it, and than the air; that metal covering grass was only slightly colder than the grass covered, and this again colder than the earth; that metal thus exposed was warmer than air 4 feet above it, and much warmer than neighbouring grass; that the variety in the quantities of dew, formed upon bodies of the same kind in different situations, was occasioned by the diversity of temperature existing among them; and that on nights favourable to the production of dew, only a very small part of what occurs is owing to vapour rising from the earth.

The last of these conclusions Wells supported by the observation that the dew on the grass increased considerably about sunset, the same time at which dew began to show itself on the raised board, and by the reflection that, "though bodies situated on the ground after they have been made sufficiently cold by radiation to condense the vapour of the atmosphere will be able to retain the moisture which they acquire by condensing the vapour of the earth; yet, before this happens, the rising vapour must have been greatly diminished by the surface of the ground having become much colder." He adduced the fact that substances on the raised board attracted rather more dew throughout the night than substances lying on the grass. He admitted that all the dew on calm, cloudy nights might be attributed to condensation of the earth's vapour, since on such nights the raised board was dry.

But if the grass was moist on these calm, cloudy nights, and the moisture were owing to earth-vapour, it is only reasonable to infer that a very much larger quantity was owing to earth vapour on clear nights when radiation was comparatively free. Moreover, the fact that substances on the raised board became wetter than substances on the grass may be attributed to the non conducting wood intercepting the warmth radiated from the ground, and thus allowing a substance on the upper surface of the board to become colder than a substance on the grass. And with regard to the "rising vapour" being greatly diminished by the surface of the ground having become colder, it does not appear that such diminution actually occurs, owing possibly to the influence of the high temperature of the preceding day reaching the moist earth at a little depth below the surface about the same time. I have found the deposition of earth vapour to proceed at a rapid rate after sunrise over grass.

Wells explains with much ingenuity the reason why leaves of trees often remain dry throughout the night, while those of grass are covered with dew. But he does not, I think, attach sufficient weight to the fact which he mentions among others, that the air near the ground is near one of its sources of moisture, while the tops of trees are removed from that source. The air is both damper and colder near the ground; a stratum of cooled air rests upon warm earth emitting vapour. The tops of trees are pervaded by air which is drier and warmer, and the leaves do not allow air to rest long enough on their cooled surfaces to part with sufficient heat in order that condensation may ensue.

I have found that when the air is clear and not humid, radiation into space is often not sufficient to cause visible dew or frost except in sheltered calm places, and in the same condition of air deposition takes place more on broad surfaces than on thin shoots, threads, and points, and more on the faces than on the edges of leaves. It appears necessary that a certain stability of temperature below that of the air, and a certain protection from re-absorption by the drier portions of air which pass over, should be attained in order that dew and frost may accumulate. When, on the other hand, the air is very moist, with a tendency to mist or fog, a very large condensation takes place on exposed objects, and especially on those which are at some height above the ground, such as the branches and twigs of trees. Points, thorns, spiders' webs, and other thin filaments are then heavily bedewed. Mist or fog often follows.

When some mist has formed on such a night, there is a heavy

precipitation on trees, &c., which is increased by wind, and large drops of rain on to the ground beneath them. This condition seems best explained by Aitken's discoveries showing the possibility of a super-saturation of air when the number of dust-particles is unusually small in a mass of air which is humid and cooled to saturation. The dust particles from their minuteness, and from their inability to fall below the temperature of the air owing to the cloud canopy above, do not condense much of the vapour, and consequently any solid object of the same or slightly lower temperature brings about precipitation from the passing air, which may possibly be super-saturated. A slight fall of temperature in the air, or sometimes an increase of dust particles, then produces fog. A dry fog may thus result from cold causing condensation on a very large number of dust-particles which are radiating heat rather freely, and a damp mist from partial condensation from super-saturated air on a comparatively small number of dust particles not radiating freely owing to a clouded sky.

These considerations explain why a dry fog is densest in London and a wet mist densest in the country. A dry fog is the work of cold radiating particles, a wet mist is the work of cold air mixing with warm. "In a fog," says Angus Rankin,[1] "the watery vapour in condensing has more particles to condense on, and consequently the particles of fog are smaller, and on meeting with an object with a higher temperature, instead of wetting it the object dries them up by parting with some of its heat. On the other hand, in a mist, the particles of dust, being few, have more water condensed on each, and so are larger and do not readily evaporate with small increments of heat." Yet in a damp mist the addition of a large number of dust particles, as in a town by day, scarcely increases the density of the mist. In fact, the wet mist is less dense in London than in the country, owing to the higher temperature and lower humidity of the air. Dry or radiation fogs, which cling to the ground, are the most dense in smoky places.

In fogs with frost in winter, such as have occurred several times in the last few years, I have always found the windward side of objects to be much more heavily frosted than the leeward, and the rime to attach itself most to points and edges. Trees have thus become laden with rime, even so as to break down branches; iron points of railings, splinters of wood, wires, and blades of grass have borne spikes and fern-like growths an inch or more long, and heather and fern in hollows have been whitened as if with a fall of snow. In weather of this kind it is difficult to say what is dew or frost proper, and what is deposited moisture from super-saturated air and from fog. On the same night a white frost may present the characteristics of fog-deposition in a valley and of clear condensation on a neighbouring hill.

Dew and frost are in fine the result of many causes which inter-operate in a complex manner. The importance of the laws of gases of the multitude of fine adaptations in the relations of vapour, air, water, earth, and plants; the importance, too, of the thermal receptivity of boundless space, gives an interest to this branch of meteorology which is second only to its beauty.

ARBORESCENT FROST PATTERNS

PROF. MELDOLA'S account of Arborescent Frost Patterns has excited a good deal of interest, and we have received many letters on the subject, some of which we have already published. To-day we give reproductions of photographs we have received from Mr. J. Maclear, Cranleigh. Fig. 1 represents a photograph of a facsimile tracing of a "Nature print" of an ice crystallite taken by Mr. A. Anderson on a still and sunny early morning in January 1887, after a not very severe frost. The sunshine had just dried the rest of the frost off the flagstone, and left this mud and ice-crystallization, which he promptly secured on soft paper by means of a soft pad-pressure, and thus got a perfect Nature printed impression. The original (now unfortunately lost) showed an appearance of vegetable (moss) growth, even more strikingly than in this tracing from it.

With regard to Fig. 2 Mr. Maclear writes:—"The melting ice under the dabbing pad formed a natural pigment with the mud on the flagstone, the rest of the flagstones being perfectly dry already by the early morning sunshine."

Prof. Meldola sends us the following interesting letter which he has received from Corbridge on Tyne:—

"I was much interested by your note in NATURE the other day, anent the frost markings of a vegetable pattern. I have seen just the same forms several times in the north, but it is I think the least common of the patterns usually met with. I write, however, to call your attention to Figs. 1 and 7 of Plate

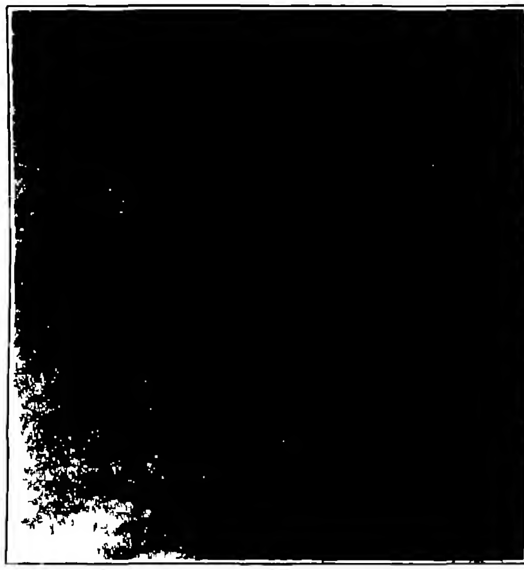


FIG. 1.—Ice crystallite, "Nature printed" by A. Anderson, January 1887. Facsimile tracing by J. Maclear, January 1887. Size of crystal 14¼ inches × 13¾ inches.

vii, illustrating the article on Meteorology in the "Encyclopædia Metropolitana" (1845, vol. i. of plates, vol. v. of text). These figures are very like yours and some of the others given with them are also very interesting. I have often shown my students when out in the fields in cold weather how exactly the mud

FIG. 2.—Photograph from the original "Nature print," made by Mr. A. Anderson, of an ice crystallite, January 1887. Size of crystal, 10½ inches × 7 inches.

cum frost markings of the common feathery volute type imitate the so called *Cauda galli* fossil fucoid (?) which is one of the most abundant objects on the surface of the carboniferous limestone courses about here. As far as form goes they are identical, and there is no structure to be discovered in the fossil markings.

"Corbridge-on-Tyne, December 16. G. A. LEBOUR."

PROF. SOLLAS writes to us:—The correspondence on this subject that has lately appeared in your columns (particularly Prof. Bonney's reference), leads me to anticipate a communication I hope shortly to present to the Royal Dublin Society on the growth of crystals. The arborescent forms assumed by ice are merely a special case of a very general problem—that of the

[1] *Journal of the Scottish Meteorological Society.* Third Series. No. viii.

forms assumed by crystals under different conditions Petrologists have long been familiar with the tendency of crystals developing in a viscid medium to excessive growth in one or more directions Felspar is a familiar instance, the lath-like forms which it frequently assumes being due to elongation along one axis (x), the length of prisms measured along this axis often exceeding by ten times that along the axis y or z The cause of this need not now be discussed, it will be sufficient to add that the phenomenon is not special to felspar, but is of quite general occurrence With this tendency is connected the origin of curvilinear forms We may consider the molecules forming the growing face of a long prism, the spheres of influence of these lie half within and half without the substance of the crystal. Considering this influence as attractive (directly or indirectly), we may say that the attraction of the molecules leading to further deposition is one half their total attraction If now from the face we pass to the edge between two faces at right angles, only one-quarter of the sphere will be immersed, and the attraction may be spoken of as three quarters of the whole, while if from the edge we pass to a corner, only one-eighth is immersed, and the attraction becomes seven eighths From this it follows that growth should be more rapid at the edges than over the surface of the face, and still more rapid at the corners In accordance with this we find young growing prisms in a viscid medium increasing so rapidly at the edges as to leave a space in and about the axis filled with the medium in a non-crystalline state Indeed, a viscid medium is not necessary, hollow prisms are of common occurrence whenever crystallization takes place with rapidity Further, in quite embryonic crystallites, Vogelsang figures elongated prism like forms, in which the four corners are produced parallel to the long axis into processes resembling spines There is an additional reason pointed out to me by Prof Fitzgerald why growth should be more rapid at the edges and corners than over the general surface, and that is that these parts are more exposed to molecular bombardment

If crystals are more readily built up along edges and corners, we should expect them to be more readily unbuilt in these regions, and this is in accordance with observation, the zonal felspars of igneous rocks, in the formation of which intervals of solution have alternated with periods of growth, usually present, in the outlines of each resulting envelope, rounded corners

The influence of corners is well seen in some glassy rocks where small prisms of felspar (andesite) may be observed, with five or six slenderer but longer prisms springing from a corner in radiate divergence

From this it is but a step to curvilinear growth Let a prism tend to rapid rectilinear growth, and any check immediately in front will lead to a forward growth from a corner in a slightly different direction, even the competition of molecules for this centre of attraction may by overcrowding bring about this result, and thus both branching and curvilinear forms may arise This is beautifully exemplified in the spherulites of many igneous rocks, where we find in the centre of a radiately crystallized sphere a long prism of felspar serving as a nucleus, and from the *ends* of this slender, almost linear, prisms diverge towards a spherical surface which by repeated branching and associated curving they everywhere reach, leaving about the sides of the nucleus a spherical space almost devoid of crystal structure The whole arrangement in median longitudinal section presents a remarkable resemblance to the lines of force as shown by iron-filings about a bar magnet

Evidently in rapid crystallization with a tendency to linear growth, divergence may be repeated at such frequent intervals as to produce forms which to the unaided eye appear to be continuous curves.

SOCIETIES AND ACADEMIES.

LONDON

Mathematical Society, December 8.—Mr A B Kempe, F R S, President, in the chair —The following communications were made —On a theorem in differentiation, and its application to spherical harmonics, by Dr Hobson.—On Cauchy's condensation test for the convergency of series, by Prof M J M Hill Cauchy's condensation test for the convergency of series is as follows —If $f(n)$ be positive for all values of n, and constantly decrease as n increases, then the series $\Sigma f(n)$ and $\Sigma a^n f(a^n)$ are both convergent or both divergent, where a is any positive integer not less than 2 There is a clear reason why a cannot be unity, for then $\Sigma a^n f(a^n) = \Sigma f(1)$, which is always infinite It is proved in Chrystal's "Algebra" that the theorem is also true if a have any positive fractional value not less than 2, see part 2, chapter xxvi, § 6, cor 1 The proof there given when a lies between the consecutive positive integers p and $p+1$ is based on Cauchy's proof for the two cases $a = p$ and $a = p + 1$ But this proof will not apply when $1 < a < 2$, because Cauchy's proof will not apply when $a = 1$ Yet it does not seem possible to assign a reason for excluding values of a between 1 and 2, for Cauchy's method appears to depend on this—viz that for increasing values of n the expression $f(a^n)$ occupies more and more advanced positions amongst the terms of the series $\Sigma f(n)$, but this is possible if $1 < a < 2$, as well as when $a > 2$ If $a \overline{\overline{<}} 1$, then this is no longer true The problem then considered in this paper is so to recast the proof for fractional values of a as not to exclude the case $1 < a < 2$ The complete theorem will then stand thus —If $f(n)$ be positive for all values of n, and constantly decrease as n increases, then the series $\Sigma f(n)$ and $\Sigma a^n f(a^n)$ are both convergent or both divergent if $a > 1$ The demonstration depends on the following theorems

I If $\Sigma a^n f(a^n)$ be convergent, then—

$$\sum_{n=1}^{n=\infty} f(n) < f(1) + \quad + f(t_s)$$
$$+ (a - 1 + a^{-s}) \left[\sum_{n=1}^{n=\infty} a^n f(a^n) - \sum_{n=1}^{n=s-1} a^n f(a^n) \right]$$

where s is any integer so large that

$$a^{s+1} - a^s > 1,$$

and t_s is the greatest integer in a^s, a being greater than 1

II (A) If $\Sigma a^n f(a^n)$ be divergent, and if $a^n f(a^n)$ diminish as n increases beyond a certain value, then

$$\sum_{n=1}^{n=\infty} f(n) > f(1) + \quad + f(t_s)$$
$$+ (1 - a^{-1} - a^{-s-1}) \left(\sum_{n=1}^{n=\infty} a^n f(a^n) - \sum_{n=1}^{n=s} a^n f(a^n) \right]$$

II (B) If $\Sigma a^n f(a^n)$ be divergent, and if $a^n f(a^n)$ do not diminish as n increases beyond a certain value, then—

$$\sum_{n=1}^{n=\infty} f(n) > \sum_{n=1}^{n=s} f(n) + \sum_{n=s+1}^{n=\infty} An^{-1},$$

where s is an integer taken large enough, and A is some finite quantity —Additional note on secondary Tucker circles, by Mr J Griffiths —Notes on determinants, by Mr J E Campbell In accordance with the late Prof Smith's notation, a determinant of the p^{th} class may be written

$$| a_{ijk} \quad |$$

The fact that a determinant of the second class (an ordinary determinant) is not altered if the vertical columns be written horizontally is expressed by the identity

$$| a_{ij} | = | a_{ji} |$$

For determinants of higher class it is known that any of the suffixes can be interchanged, except the first, and if the class be even, the first suffix can also be interchanged with any other, but for determinants of odd class this is not true By considering a cubic determinant as an ordinary determinant in alternate numbers, the author tries to explain this essential distinction between determinants of odd and even classes If the element $a_{pqr} = - a_{qpr}$, and $a_{ppr} = 0$, the determinant is called skew symmetrical It is easily seen that skew symmetrical determinants of even class and odd degree vanish identically This is analogous to the well known theorem in ordinary determinants, but there is no corresponding analogue to the theorem that skew symmetrical determinants of the second class and even

degree are perfect squares The reasoning which establishes these propositions does not apply to skew symmetrical determinants of odd class. By a different method it is shown that they vanish identically whether the class be even or odd It is next shown that if we form any determinant of even class $2p$ from $2p$ ordinary determinants, in a manner analogous to that in the rule for the multiplication of two ordinary determinants, the determinant so formed is the product of the $2p$ determinants, and if any determinant of odd class $2p + 1$ is formed from $2p + 1$ ordinary determinants, the determinant so formed is the product of the last $2p$ of these ordinary determinants into the first taken, with all its signs positive A somewhat similar result is shown to hold for determinants of alternate numbers As an application, let

$$z = \frac{a_1}{(x - \alpha_1)(y - \beta_1)} + \cdots + \frac{a_n}{(x - \alpha_n)(y - \beta_n)},$$

and let (p, q) denote

$$\frac{d^{p+q}z}{|\underline{p}\,|\underline{q}\,dx^p\,dy^q}$$

By multiplying the arrays

$$\left\|\begin{matrix} \dfrac{a_1}{x - \alpha_1} \\ \dfrac{a_1}{(x - \alpha_1)^2} \end{matrix}\right\| \qquad \left\|\begin{matrix} \dfrac{1}{y - \beta_1} \\ \dfrac{1}{(y - \beta_1)^2} \end{matrix}\right\|$$

we get

$$\begin{vmatrix} (0, 0), & (0, 1), \\ (1, 0), & (1, 1) \end{vmatrix} = \Sigma \frac{a_p a_q (\alpha_p - \alpha_q)(\beta_p - \beta_q)}{(x - \alpha_p)^2 (x - \beta_p)^2 (x - \alpha_q)^2 (y - \beta_q)^2}$$

Suppose, now, $n = 1$, we get that the primitive of

$$\begin{vmatrix} (00) & (01) \\ (10), & (11) \end{vmatrix} \text{ is } z = \frac{a_1}{(x - \alpha_1)(y - \beta_1)}$$

Similarly, by multiplying,

$$\left\|\begin{matrix} \dfrac{a_1}{(x - \alpha_1)} \\ \dfrac{a_1}{(x - \alpha_1)^2} \\ \dfrac{a_1}{(x - \alpha_1)^3} \end{matrix} \quad \cdot \quad \cdot \right\| \qquad \left\|\begin{matrix} \dfrac{1}{y - \beta_1} \\ \dfrac{1}{(y - \beta_1)^2} \\ \dfrac{1}{(y - \beta_1)^3} \end{matrix} \quad \cdot \right\|$$

we get that the primitive of

$$\begin{vmatrix} (00), & (01), & (02) \\ (10), & (11), & (12) \\ (20), & (21), & (22) \end{vmatrix} = 0,$$

is

$$z = \frac{a_1}{(x - \alpha_1)(y - \beta_1)} + \frac{a_2}{(x - \alpha_2)(y - \beta_2)}.$$

Similar primitives are obtained for differential equations, which are in the form of determinants of higher class A further application is obtained by taking powers of different invariantive symbols, of which (123) is the simplest for the ternary quantic The resulting invariants are seen to be determinants of some even class —A geometrical note, by Mr R Tucker —The President (Major MacMahon, F R S, in the chair) made an impromptu communication of a problem, the solution of which he thought would be subsidiary to the sought-for solution of the "stamp folding" problem

Linnean Society, December 15 —Prof Stewart, President, in the chair —The President announced the recent death of Mr H T Stainton, a Fellow and former Vice President of the Society, and of European reputation amongst entomologists, by whom his loss would be widely felt —Mr. D Morris exhibited a series of botanical photographs from the west coast of Africa, and gave some interesting details about the appearance and mode of growth of some of the more remarkable forest trees and plants of that region —The Secretary exhibited a large collection of photographs of Lichens, very neatly mounted and labelled, which had been recently presented to the Society by Prof Arnold, of Munich —On behalf of Mr George Swainson, of St Annes-on-Sea, Lancashire, Mr A R. Hammond exhibited an aquatic dipterous larva, belonging probably to the genus *Dixa*, of which by means of the oxyhydrogen lantern, with microscopic attachment, a good figure was projected on the screen. He referred to the different views which prevailed concerning the dorsal and ventral aspects of this larva, and pointed out that the tail plates possessed features which in allied forms were characteristic not so much of the larval as of the pupal stage —A paper was then read by Dr Maxwell T Masters, F R S, on the classification and geographical distribution of the *Taxaceæ* and *Coniferæ*, his remarks being illustrated by a specially prepared map, lent by Mr C B Clarke, and by specimens of the fruit and leaves of some of the more notable forms —Mr George Brook followed with a paper on the affinities of *Madrepora*, and here again, by means of the oxyhydrogen lantern, an excellent series of coral sections was projected, which illustrated very clearly the author's remarks on comparative structure —A short note on the abnormal form of the lens in the eyes of an albino rat, by Prof R J Anderson, was read on his behalf by the Secretary The meeting then adjourned to January 19, 1893

Zoological Society, December 6 —Dr St George Mivart, F R S, Vice-president, in the chair —The Secretary read a report on the additions that had been made to the Society's menagerie during the month of November 1892 —Dr Hickson read a paper entitled "A Revision of the Genera of the *Alcyonaria Stolonifera*, with a description of one new genus and several new species" The author commenced by stating the grounds upon which it might be considered desirable to retain the suborder Stolonifera, and criticized the views of those who place these Alcyonarians in the suborder Alcyonida Of the genera that had already been proposed only four could now be retained, namely, *Tubipora*, *Clavularia*, *Cornularia*, and *Sympodium*, and the author proposed to add one more, namely, *Stereosoma* The genera *Sarcodictyon*, *Rhizoxenia*, *Cornulariella*, *Anthelia*, and *Gymnosarca* must be abandoned, and the species incorporated in the other genera. A description was then given of the new genus *Stereosoma*, a form found on the coast of North Celebes, distinguished from all other Stolonifera by certain characters of its tentacles and by the absolute non retractability of its polypes Several new species of *Clavularia* were then described from North Celebes, Diego Garcia, and Australia This was followed by a summary of all the species of the genus known to science —Mr F E Beddard, F R S, read a description of the convolutions of the cerebral hemispheres in certain rodents. The paper referred chiefly to *Dasyprocta Cœlogenys*, *Lagostomus*, *Hydrochœrus*, and *Dolichotis*, being the genera of rodents in which the brains show the greatest development of convolutions —A communication was read from Prof Collett, containing a description of a new monkey from S E Sumatra, for which he proposed the name *Semnopithecus thomasi* —Mr H J Elwes read the second portion of an account of the butterflies collected by Mr W Doherty in the Naga and Karen Hills and in Perak

PARIS

Academy of Sciences, December 19.—Annual Public Meeting —The President, M d'Abbadie, gave a brief survey of the life and work of those lost to the Academy by death during the year Among these were the following members M D D A Richet, distinguished for his medical discoveries, M de Quatrefages de Bréau, the naturalist; M Jurien de la Graviere, Vice Admiral under the Empire, M Pierre Ossian Bonnet, geometrician; Admiral Mouchez, late Director of the Paris Observatory Foreign Associate Sir G B Airy *Académicien libre* M Lalanne Correspondents MM Gilbert, Abria and Adams The prizes were awarded as follows: The Grand Prize of the mathematical sciences to M Hadamard for his solution of the problem of determining the number of primary numbers inferior to a given quantity One Prix Bordin to M Gabriel Koenigs for his solution of a problem concerning geodesic lines, another to M Humbert for his work on hyper-elliptic surfaces The Prix Poncelet to the builders of the Forth Bridge, Sir John Fowler, and Sir Benjamin Baker, the Extra Prize of 6000 francs to M Hédouin for his work on the Channel currents; the Prix Montyon to M N J Raffard, civil engineer, the Prix Plumez to M Augustin Normand, for his geometry of ships In Astronomy, the Prix Lalande was doubled, and awarded to Mr Barnard and Mr Max Wolf; the Prix Damoiseau to M Radau for his work on lunar inequalities of long period caused by planets, the Prix Valz to M. Puiseux for his researches on the *equatorial coudé* and other instruments; the Prix Janssen to M. Tacchini for his solar work Statistics: The Prix Montyon to MM M

Bastié and J Dardignac for works on the population of France and hygienic statistics respectively. Chemistry The Prix Jecker to M Bouchardat for his researches on the terebene carbon compounds Mineralogy The Prix Vaillant to M Lacroix for his work on the application of optical characters to the determination of rocks and mineral species Botany - The Prix Desmazières to M Pierre Viala for his "Maladies de la Vigne", the Prix Montagne—1000 francs to M l'Abbé Hue, and 500 francs to Dr F Xavier Gillot for their mycological researches, the Prix de la Fons Mélicocq to M Masclef for his "Botanic Geography of Northern France" Medicine and Surgery Prix Montyon—one to MM Farabœuf and Varnier for work on obstetric medicine, another to M Javal for ophthalmometry, a third to M Lucas Championnière for his work on hernia, the Prix Barbier was shared between M Laborde ("Death by Chloroform") and MM Cadéac and Albin Meunier ("Alcoholism," &c), the Prix Bellion to Dr Theodore Cotel for his work on "The Education of the Senses", the Prix Lallemand was shared between M Binet ("Les Altérations de la Personnalité") and M Durand ("Les Origines Animales de l'Homme") Physiology the Prix Montyon to M Hedon (diabetes) and M Cornevin (breeding of domestic animals), the Prix Pourat to M H Roger for his researches on the inhibitory power of the nervous shock Physical Geography the Prix Gay to M. Moureaux (distribution of magnetic elements in France) General Prizes Prix Montyon, for improvements in unhealthy industries, to M L Guéroult (crystal cutting), the Prix Delalande Guérineau, to M Georges Rolland for his work on the Algerian Sahara, the Prix Jérôme Ponti, to M Le Chatelier for his researches on dissociation and chemical equilibrium, the Prix Leconte (50,000 frcs) to M Villemin for his demonstration of the specific nature and the transmissibility of tuberculosis The *Comptes rendus* contains a complete list of the prizes to be awarded in the next few years

BERLIN

Physical Society November 18 —Prof Du Bois Reymond, President, in the chair —Prof Neesen gave an account of experiments made with a view to the photographic recording of the oscillation of projectiles He employed hollow projectiles in whose interior was placed a sensitive plate, illuminated by sunlight through a small opening During its rotatory flight the ray of light described curves on the plate from whose position, taken in conjunction with that of the sun, the oscillation of the axis and point of the projectile would be calculated The results obtained showed that both the axis and point perform oscillatory movements during the flight which are very different from those usually believed to take place In order to study these more accurately, Prof Neesen is busy with the construction of some arrangement which may admit of the introduction into the projectiles of sensitive plates which shall not participate in the rotatory motion

December 2 —Prof Du Bois Reymond, President, in the chair —Dr Du Bois gave an account of experiments made by Mr Shea in Berlin on the refraction of light in metals, and in connection with this referred to a theoretical treatise which he had recently published on the same subject in conjunction with Dr Rubens

Physiological Society, November 25 —Prof Du Bois Reymond, President, in the chair —Dr Treitel gave an account of observations he had made on two snails enclosed in air-tight glass vessels. Dr Ad Baginski gave an account of a very fatal epidemic among rabbits in the same hutch, in which a post-mortem examination of the dead and also showed a serious affection of the liver and intestinal mucous membrane. The liver was filled with cysts of various sizes, in which, together with coccidia, some very remarkable growths were found, which led to very marked changes of the epithelial cells —Dr Rawitz made a short preliminary statement of observations on Annulata made during his stay at the biological station of Rovigno, on the coast of the Adriatic. While one species was found to be extremely sensitive to light, and to draw in its tentacles at once when shaded, another closely related species was quite unresponsive, while, on the other hand, it reacted immediately to the slightest touch The first species was much less sensitive to touch.

AMSTERDAM

Royal Academy of Sciences, October 29.—Prof. van de Sande Bakhuyzen in the chair. —Prof Engelmann spoke (1) on the influence of central and reflected irritation of the nervus opticus on the movement of the cones of the retina, and (2) on the theory of the contraction of muscles —Prof. Schoute proved the following theorem —If $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ is the equation of a given ellipse, E, and $f_n(x,y)$ contains the terms of the nth order of the equation of a curve C^n with reference to the same axes The sum A of the eccentric anomalies a_k of the $2n$ points S_k common to E and C^n is determined by the relation

$$e^{iA} = \frac{f(a, ib)}{f(a, -ib)}.$$

He indicated several peculiar cases of this general theorem —Prof Kamerlingh Onnes communicated some measurements, by Mr Leeman, relating to Kerr's phenomenon when reflection takes place at the pole of a cobalt magnet The constancy of the difference of phase S, discovered by Dr Sissingh was confirmed The measurements agree with the theory of Goldhammer, contrary to that of Drude Mr Leeman finds a magneto optic dispersion in S

November 26 —Prof van de Sande Bakhuyzen in the chair —Prof Schoute continued his communication of October 29, on a general theorem in the theory of plane curves, and corrects a theorem of Laguerre —Prof Lorentz dealt with the relative motion of the earth and the luminiferous aether —Prof Kamerlingh Onnes spoke of measures on the relation of spark length and difference of potential made by Dr Borgesius at Groningen with a double bifilar electrometer of his own construction The differences hitherto found are explained by a correction for pressure and temperature having been omitted Discharge between two concentric cylinders depends, as Gaugain stated, on the density of the inner one only Provoking glow discharge on the inner one of two concentric cylinders proves successful in maintaining constant high potentials

CONTENTS.

From a photograph by Werner & Son, Dublin

Arch. Geikie

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THURSDAY, JANUARY 5, 1893

SCIENTIFIC WORTHIES

XXVIII.—SIR ARCHIBALD GEIKIE

SOME MONTHS ago the British Association for the Advancement of Science was holding its annual meeting at Edinburgh under the presidency of Sir Archibald Geikie, F.R.S., Director-General of the Geological Survey of the United Kingdom.

It may well be said that a more appropriate choice could hardly have been made by the Council of the learned Association. Not only is Sir Archibald a thorough Scot, born and educated in Scotland, where he fulfilled for many years the most important duties as a member of the geological staff, and later as a professor in the University of Edinburgh, but, having long been engaged in the supervision of the Scottish Survey, he mapped with his own hand many hundreds of square miles of country, and through the entire scenery of Scotland there is not a single point with the peculiarities of which he did not make himself thoroughly familiar. His knowledge of the ground is not at all restricted to geological relations. In Sir Archibald the qualities of the geologist are combined with those of the enthusiastic lover of landscape, and his able pencil excels in drawing original sketches in which the outlines, peculiar shades, and, one might say, the general spirit of the scenery are fixed with the most striking accuracy. Obviously, therefore he was the right man to be placed at the head of the Edinburgh meeting, which many prominent foreign investigators attended in the hope of afterwards travelling, both as tourists and as men of science, through the most interesting fields of the Highlands. Nobody could have been better fitted to introduce them to the country. When putting Sir Archibald in the chair at Edinburgh, the British Association not only did due justice to one of the most distinguished sons of "modern Athens," it also took the best course to secure from foreign guests the fullest recognition of the various merits of Scotland.

Sir Archibald Geikie was born at Edinburgh in 1838. We learn from a notice in the *Mining Journal* that he was educated at the Royal High School and at the Edinburgh University. When he was only twenty years old he became an assistant on the Geological Survey for Scotland, and proved so able that in 1867, when the Scottish branch of the Survey was made a separate establishment, Sir Roderick Murchison deemed he could not do better than confer the directorial powers on the young assistant whom he had appreciated at work. Four years later, the chair of Geology and Mineralogy at the University having been founded by Sir Roderick with a concurrent endowment by the Crown, Archibald Geikie was invested with the new professorship, which he resigned only at the beginning of 1881, when he was appointed to succeed Sir Andrew C. Ramsay as Director-General of the Geological Survey of the United Kingdom, and Director of the Museum of Practical Geology in Jermyn Street.

That the new Director had not disappointed the hopes he had excited, appeared with sufficient clearness when, some time ago, the Queen conferred on him the honour of knighthood. Now it is our duty to note the chief features of his activity, and to state what personal part Sir Archibald Geikie has played in the recent progress of science. It is scarcely necessary to say that his geological achievements are too important to be conveniently reviewed in a few lines. Nevertheless we shall try to give a general idea of the prominent results to which his name must be attached.

Early appointed, as he was, as an officer of Scotland's Survey, he had, from the beginning, to deal with the most puzzling problems involved in the stratigraphy of the Highlands. The case was a very difficult one, and gave rise to much controversy between Sir Roderick Murchison and many other geologists, among whom it will be sufficient to quote the respected name of Nicol. As in the Highlands gneisses and ordinary crystalline schists were seen resting, with apparent conformity, on Silurian strata, it had been admitted by Murchison that the sequence was a normal one. Therefore the crystalline schists had to be regarded, in spite of their Archæan appearance, as metamorphosed Silurian deposits. Such an assumption had a considerable bearing on other geological problems, as it rendered highly probable the theory that the so-called primitive gneisses were altered sediments, and had nothing to do with the early crust of the molten globe.

That Sir Archibald should at first have taken his Director's side is not at all surprising. But he was never quite satisfied, and his love of truth led him, as soon as he was in a position to do so, to undertake a detailed review of the facts. Since the discovery of Silurian fossils in the rocks of N.W. Sutherland, it had been recognized that the key to the structure of the Scottish Highlands was to be searched for in that region. Accordingly, in the years 1883 and 1884, MM. Peach and Horne were entrusted with a careful study of the Durness and Enboll districts. They were very far from being directed to obtain means of justifying the old survey. "It was a special injunction to the officers" (we quote Geikie's own words) "to divest themselves of any prepossession in favour of published views, and to map the actual facts in entire disregard of theory."

From the work ably carried on by the distinguished surveyors, and verified on the spot by the Director-General, it appeared clearly that Murchison had been deceived by prodigious terrestrial disturbances, of which, at the time, nobody could have formed an idea. Over immense reversed faults, termed *thrust planes* by Geikie and his officers, the older rocks on the upthrow side had been, as it were, pushed horizontally forward, covering much younger sediments, and the displacement attained the almost incredible distance of more than ten miles. Sometimes an outlier of the displaced ground was found capping a hill, while the remainder had been swept away by erosion, and the strangeness of the case led the observer to write, "One almost refuses to believe that the little outlier at the summit does not lie normally on the rocks below it, but on a nearly horizontal fault."

Disturbances of that kind had already been noticed in some coal-basins, as, for example, on the southern limit of the French and Belgian coal-field, where similar outliers had been termed by M. Gosselet "lambeaux de

poussée" But they occurred on a much smaller scale, and there was no reason why the phenomena should be considered otherwise than as quite exceptional To recognize the generality of that class of stratigraphical accidents was a conquest of a high order, not only for Scottish geology, but for all countries where the work of orogenetic disturbances has for a long time suffered from the agencies of erosion The Highlands of Scotland belong to that part of the old European continent which in earlier Palæozoic times emerged from the sea Near the end of the Silurian period it was subjected to enormous pressure, which resulted in folding and breaking the whole border of the dry land, raising in the air a series of high mountainous ridges, the Caledonian chain of M. Suess. But millions of years have since passed over the land, and the continued action of atmospheric powers has left but a very small part of the original mass It is extremely difficult, therefore, to restore the broken continuity, and through the quiet appearance of the now planed ground, the geologist is everywhere bound to search after the scattered signs of previous plication and fracture This is now the task to be fulfilled by the detailed Survey, and every stratigraphical difficulty has to be treated in the newly-acquired light

A few years after that discovery had been made in Scotland, Prof Marcel Bertrand made in Southern France quite similar observations, showing that very limited patches of older formations, which had been till then regarded as remnants of ancient islets, projecting out of younger geological seas, were nothing else than outliers of reversed folds, the remainder of which had disappeared under the action of rain and rivers

In this manner the correction of a long accepted error has led to stratigraphical conclusions of the highest import. In the meantime these gigantic displacements showed themselves accompanied by intense modifications of the rocks, so that Geikie was entitled to write "In exchange for this abandoned belief, we are presented with startling new evidence of regional metamorphism on a colossal scale, and are admitted some way into the secret of the processes whereby it has been produced"

This is not the only occasion on which Sir Archibald has given proof of his readiness to admit frankly and decidedly the correction of opinions which have long been held Some years ago, when the Lower Cambrian fauna had been detected by the officers of the Survey much below the Durness limestone of the Highlands, in a series of strata which rests unconformably on the Torridon sandstone, he was the first to announce the fact before the Geological Society. The "Precambrian," which he had till then been rather reluctant to recognize, has now taken its place in the scale of divisions Moreover, he has created a new name, that of "Dalradian," for the long strip of Precambrian deposits which extends from Donegal to the centre and south-west of Scotland.

As one of the most characteristic formations in Scotland is the Old Red Sandstone, we cannot be surprised that Sir Archibald has devoted much care to the description of the peculiarities of that interesting group of strata. After a long and detailed study of the whole ground, he has summed up his views in some important memoirs, published in the Transactions of the Royal Society of Edinburgh. There he has called again to life the old and long-extinct lakes, where the grits and conglomerates of the Old Red were piled up through the disintegration of surrounding formations, namely, Lake Orcadie, Lake Caledonia, Lake Cheviot, Welsh Lake, and Lake of Lorne, each of them being a separate basin, where the work of sedimentation has been many times interrupted by volcanic outbursts, while in the adjacent and more quiet seas there were accumulated the marine deposits of Devonshire

But the chief work of Sir Archibald seems to be his exhaustive review of the volcanic history of the British Isles. While his brother, Dr James Geikie, the author of "The Great Ice Age," has done excellent service by deciphering the marks of former ice action on the soil of the United Kingdom, Sir Archibald has been particularly attracted by the work of fire, *i e* by the records of that volcanic activity, the evidence of which is so deeply impressed on the scenery of the Hebrides, of Wales, and other districts of Great Britain

The British Isles are now a very quiet ground, where explosive activity and projection of stones seem to be restricted to electoral periods, and although Scotland has been from time to time shaken by minor earthquakes, no human eye has ever seen there any volcanic outburst. Nevertheless, during Tertiary times, immense sheets of lava were poured out in the north-west of the country. To discern the site of the centres of eruption, and determine the old chimneys, the remnants of which give a glimpse into the lowest parts of ascending lavas; to discriminate the volcanic *necks*, the intrusive sheets and dykes, the bedded lavas and the tuffs—this was the first part of the task undertaken by Sir Archibald But it was not enough for him to re-ascend in the past to the beginning of the Tertiary period Not only in the Old Red of Scotland, but in the very heart of the oldest formations known in England and Wales, there were numerous evidences of previous volcanic activity To use Geikie's words "Placed on the edge of a continent and the margin of a great ocean-basin, the site of Britain has lain along that critical border-zone where volcanic energy is more active and continuous"

The chief outlines of that marvellous story, which was hardly suspected some years ago, were recently traced in Geikie's presidential addresses to the Geological Society of London, a work which has been qualified by Mr Iddings, the distinguished American petrographer, as "one of the most important contributions to the history of volcanic action." Nevertheless, it is only a preliminary paper, and in the same manner as he already has devoted a special memoir to the volcanic outbursts of Tertiary times, Sir Archibald promises to publish in a short time a detailed account of the Palæozoic eruptions.

In order to become competent for such an undertaking, the author had prepared himself without sparing time, labour, or trouble Having travelled over much of Europe, from the north of Norway to the Lipari Islands, he was anxious to learn from personal observation the broad features of that American continent, the geological construction of which seems to have been conceived on a much larger scale than that of Europe Therefore in 1878 he rambled over many hundreds of miles in Western America, from the Archæan fields of Canada to the huge volcanic plateaux of Oregon and

Idaho, where a country as large as France and Great Britain combined has been flooded with a continuous sheet of basalt But stratigraphical studies were only part of the necessary initiation Sir Archibald had been one of the first field-geologists in England to perceive the importance of microscopic investigation as an adjunct to field work He might well have left the care of that special study to some officer in the Survey, but he wished to make himself master of the subject. Connected by personal friendship with Zirkel, Renard, and other eminent petrographers, he gave to that branch of the Survey such a vigorous impulse, that upwards of 5000 slices of British rocks were soon prepared and classed in the collections of the museum in Jermyn Street, and if he can now rely with full confidence on his distinguished professional officer, Mr Harris Teall, for any determination of rocks, he himself has won all necessary competence in that department of science, which has been so much enlarged during the last twenty years

An undertaking so ably provided for could not but prove successful It is not, of course, our purpose to give an account of the results arrived at The "History of Volcanic Action in the Area of the British Isles," as it was presented in the presidential addresses for the years 1891 and 1892, is so much condensed that it must be read *in extenso* by every one who takes interest in the matter We would only call attention to the final summary, where some important and far-reaching conclusions are deduced from the observed facts One of them is that British volcanoes have been active in sinking rather than in rising areas, to which it is added that the earlier eruptions of each period were generally more basic, while the later intrusions were more acid

When presenting "a connected narrative of ascertained knowledge regarding the successive epochs of volcanic energy in this country," Sir Archibald did more than write an important chapter of British geology It may be said that he definitively settled the long-controverted question, whether there has been any essential difference or not between the display of volcanic activity at various geological periods Not very long ago some scientific schools—above all, on the Continent—showed the greatest reluctance to admit that true volcanoes could have existed during the Palæozoic era When they were told of Cambrian lavas and felspathic ashes, of Silurian tuffs, especially of Precambrian felsites, they could not restrain a strong feeling of incredulity Against old granitic or porphyritic eruptions they had nothing to object; but the volcanic *facies* appeared to them a privilege restricted to recent geological times To this the present writer might bear personal testimony, as he found his "way of Damas" only when he was fortunate enough to ramble over North Wales, and gather with his own hands pieces of vesicular lava embedded in the tuffs of the Snowdon, or boulders of true felsite lying at the base of the Cambrian series at Llanberis

Not only has Sir Archibald, in common with his countrymen, always escaped that kind of misconception, but he will have contributed more effectively than any other to place the matter in the true light. Thanks to the cliffs of Scotland, he has been able to trace the roots of old volcanoes, to show true volcanic bombs entombed in sediments, and to mark the site round which vast piles of lavas and tuffs, 5000 or 6000 feet in thickness, had been heaped up Likewise, in his previous paper on Tertiary volcanoes, he had established by indisputable sketches that the granitic rocks of the islands of Mull and Skye were ejected during the earlier part of the Tertiary period, and that they belong to the central mass of intrusions, the lateral veins of which have taken the form of granophyres

There is another kind of useful geological work which Sir Archibald has a right to be credited with, we allude to the restoration of the most friendly relations between the official Survey and the Geological Society of London For many years those relations had been maintained at a rather low temperature, both independent geologists and Government's surveyors showed, as it were, more inclination to mutual and severe criticism than to brotherly co-operation This period of misunderstanding is now well over Thanks to the present Director, the Geological Society has more than once received the early flower of the capital results obtained by the Survey, and the recent Presidentship of Sir Archibald has solemnly sanctioned the return of a harmony which will prove of great benefit to the advancement of geological science in England

This is a very brief and imperfect account of the chief work accomplished by the field-geologist, a work which would have been sufficient for the whole of a man's life But we have now to consider in Sir Archibald the master who has been engaged in important educational duties When he was appointed in 1871 to the chair of Geology at Edinburgh he had the whole work of that department to organize, a task which may be wearisome, but which involves great benefit for a man of labour, as he must face every difficulty, and obtain day by day a clear and personal idea of all that is required for teaching To that we are indebted for the undisputed superiority which Sir Archibald has displayed in his "Text-book," as well as in his other educational writings, such as the "Class-Book," a very model of clearness, whereby it has been once more demonstrated that those only are qualified for writing elementary books, who are in the fullest possession of the whole matter Likewise he is the author of small books or "primers" on physical geology and geography, of which some hundreds of thousands of copies have been sold, and which have been translated into most European languages as well as into some Asiatic tongues This exceptional success will be easily understood if we remember that in Sir Archibald's works the traditional barrenness of geology is always smoothed and adorned by a deep and intense feeling for nature Nobody has done more than he to associate geological science with the appreciation of scenery In numberless writings he has undertaken to explain the origin of existing topographical features Among others reference may be made to the volume on "The Scenery of Scotland viewed in connection with its Physical Geology," first published in 1869, of which a new edition appeared in 1887, also to "Geographical Evolution," in the Proceedings of the Royal Geographical Society for 1879, and "On the Origin of the Scenery of the British Isles," published in NATURE (vol. xxix pp 347, 396, 419, 442)

Nevertheless, whatever might have been the attainments of the geologist and of the teacher, they would not have been sufficient to secure universal recognition, had not Sir Archibald been provided in addition with the best powers as a writer From the beginning he was strongly convinced of the importance of cultivating the literary element in scientific exposition, not only in order to make science interesting and intelligible to those outside the circle of actual workers, as he did in writing "Geological Sketches at Home and Abroad," but because he did not admit the right of a man of science to appear before the public without putting on the "nuptial dress" Every one who knows Sir Archibald will readily admit that in doing so he is not impelled by a desire for personal display He is essentially a man of thought as well as of action "*Res non verba*" might well serve him as motto, and whoever has seen his silent but piercing attention in listening to some scientific controversy would never be tempted to suspect him of a wish to search after resounding manifestations But he has too much of the artist's temper to neglect correctness and elegance in the utterance of his thoughts And since nothing in the world is less common than the union of scientific insight and acuteness with a vivid appreciation of nature and a delicate feeling for style, it is not strange that Sir Archibald's fame has passed far beyond the circle of professional men The portrait will be duly completed when it is added that no one could have a better renown for frankness, fair dealing, and perfect trustworthiness in every relation of life

It is highly gratifying for England that the recognition of such achievements has not been left to future times, and that the present generation has not failed in the duty of rewarding so much continuous and fruitful labour He was admitted to the Roya Society before reaching the age of thirty, a most unusual honour, he has been Vice-President, and was recently elected Foreign Secretary, of that Society Since 1890 an Associate of the Berlin Academy, elected by the Royal Society of Sciences at Göttingen, after the death of Studer, the Nestor of Swiss geologists, enrolled among the members of the Imperial Leopold-Caroline German Academy, of the Imperial Society of Naturalists of Moscow, &c, &c, he was chosen in 1891 as a correspondent by the French Academy of Sciences, and in the same year he was made a knight An honorary LL D of the Universities of St Andrews and Edinburgh, he has received the Murchison medal of the Geological Society of London, and twice the MacDougal Brisbane Gold Medal of the Royal Society of Edinburgh has been conferred on him, in recognition of the zeal and skill displayed in explaining the geological peculiarities of his mother-land He is now at the summit of his career, and not so heavily laden with years but that we may express for him the wish *ad multos annos* Let us hope that he will long remain at the head of the distinguished staff to which he has given so profitable an impulse, and continue to serve as a comforting example for those who refuse to acknowledge any other means of genuine success than constant labour and faithfulness to duty

A. DE LAPPARENT

SHAKING THE FOUNDATIONS OF SCIENCE[1]

TO judge by the columns of the daily press, we must expect to find a large number of enterprising company-promoters coming forward shortly to urge, in Parliament and elsewhere, that leave may be given them to confer lasting benefits upon Londoners The good they propose to do comes in the shape of underground intercommunication Locomotives of the ordinary construction, it would seem, are not to be employed, but instead of them cable traction or electric energy in some shape or another On these points, however, we must speak with caution, for we are told that an absence of definite statements and programmes is one of the main features of the pronouncements so far issued

On two previous occasions it has been our duty to draw attention to a scheme, intended to provide more ready means of intercommunication between different parts of London, which threatens to inflict serious damage upon the property of the nation

It so happens that one of the schemes to which reference was made in the opening paragraph is a rehabilitation and expansion of that very project against which we protested on the previous occasion The attempt, which has already once been thwarted, to render the study of the sciences involving exact measurement impossible at South Kensington, is again to be repeated, and it is necessary to warn the public that an enterprise undertaken nominally for their interests, which are, or the moment, regarded as identical with those of the company promoter, will strike a fatal blow at the utility of institutions on which many thousands of pounds of money, public and other, have already been spent, and on which it is in contemplation to spend many thousands more Our protest on the former occasion was based on scientific grounds. There were others strongly urged from other points of view, and as a result of the opposition the scheme was withdrawn for a time

In the shape it now assumes it is still more objectionable, as the scope is now a more ambitious one

Our objection was simply to the route to be followed. In London we have only one locality where telescopes are nightly used by teachers and students, we have only one institution the function of which is limited to physical and chemical teaching and research, where delicate measurements are essential, and form part of the routine work, we have only one institution, the function of which is to teach applied science in the most efficient manner—that is, by teaching in which experiment and observation, and of extreme delicacy, must go hand in hand with the *viva voce* exposition of the professor of each branch of applied science

The contemplated railway proposes to sweep all these away Astronomical Observatories, the various Laboratories of the Royal College of Science, and of the City and Guilds Institute, are not to be considered the least in the world This is practically what it comes to, for we doubt whether either teacher or taught will care to remain in a locality where neither valid experiments nor observations are possible

[1] Continued from vol. xlvi. p 148.

We need not waste time in considering whether some means could not be found to continue to take astronomical photographs of say an hour's exposure, or to use chemical balances of the greatest delicacy, with a railway or tramway of any kind running intermittently within twenty yards of the laboratory in which the work is supposed to be carried on, and it is also clear that the result would be disastrous if the traffic were carried on at any practicable depth.

Last year a joint Committee of the Houses of Lords and Commons fully considered the question as to the principles on which future extensions of what may be called omnibus traffic should be carried on, and they came to the conclusion that electric and cable railways constructed at a considerable depth below the surface would probably be the most convenient means for uniting the various parts of the metropolis more closely.

Some people have attempted to read into this part of the Committee's report that given a cable or electric railway *there will be no shaking!* And it has been suggested that all such opposition as we have expressed above should disappear. This of course is the view of the company-promoter, but it will commend itself to no one else. In fact there are special objections to an electric railway in addition to those earthquakes more or less mitigated which are associated with any system of traction.

No evidence was laid before the Committee as to some of the disadvantages which are incidental to the use of electricity. It is true that these disadvantages are not such as to interfere with the further extension of electrical railways, but they are of sufficient importance to be considered in deciding on the routes which the railways shall follow. Experiments made some little time ago in the neighbourhood of the South London Electrical Railway proved that the electrical disturbances were so great that it was doubtful whether ordinary higher students' work could be carried on within a quarter of a mile.

A quarter of a mile! And the proposed railway, or electric way, or cable way, or tramway is to run within twenty yards of electrical and magnetic laboratories. "*Rien n'est sacré pour un sapeur!*" an evil hidden in the ground ceases to be one.

It must not be forgotten that the interests at stake are not only those of the higher sciences and research. It might, perhaps, be argued that as the instruments used for investigation become more sensitive, and as the necessity for accuracy increases, it may be necessary that researches of a special character should be carried out in places specially selected for their freedom from all external disturbance. A serious damage will, however, be done to our large towns if it becomes necessary for every middle-class youth who wants to master more than the elements of science to become a boarder at a country college. It is frequently complained that there is an increasing separation between class and class, those who are able to do so leaving the towns for the more distant suburbs. It would be a thousand pities if the higher education were also, even in part, to be banished from our great centres of population.

It may be urged by the promoters of the company that it will be easy for them or the Government to plant the Royal College of Science elsewhere, but if the buildings of the College are notoriously inadequate, it was clearly stated at the time when the proposal to place a collection of pictures on the site reserved for science made it necessary to explain the future policy of the Department of Science and Art, that the collections and the laboratories attached to them were in the future to be housed on the plot close to the present site.

But as stated before, it is not necessary only to base our case upon the injury which would certainly be done to the Royal College of Science; it must be remembered that hard by is the City and Guilds Central Institution, in which extensive and costly laboratories, built by the munificence of the City Companies, have during the last few years been filled with students, many of whom are engaged in advanced studies.

Every argument which applies to the one case holds good in the other. The work of the City Companies and the interests of these institutions are endangered in the same way, and for the same reasons, as those of the Government College over the way.

On the previous occasion, when it was proposed to bring a railway at the back of the Central Institution, the Professors there, with the sanction of the City and Guilds of London Institute, opposed the scheme. We understand that the Professors have again made a representation to the Institute which in all probability will result in steps being taken to prevent the construction of any railway or tramway which would interfere with the work carried out in the Physical Department of the Central Institution.

In both these institutions it is as important that the apparatus should be used without let or hindrance from external disturbances, as say, that the reading-room in the British Museum should not be rendered uninhabitable by a nuisance produced either by private individuals or by some company in the neighbourhood.

On these grounds we protest in the name of science against a railway of any kind in Exhibition Road.

If there is one district in the metropolis which ought to be thus secured, it is the neighbourhood of the great national scientific school and its associated collections.

And here a word about these Science Collections. There are philistines among us who think that the collections would do very well without the schools, as the schools could do very well without either higher teaching or research.

There is no doubt a certain advantage to be gained by collecting types of all sorts of apparatus, exhibiting them appropriately labelled in glass cases, through which the public may gaze with, it is to be feared, somewhat indiscriminate admiration; but it must always be recollected that the nation is proud of the British Museum and Art Galleries, not merely because they play a useful part in educating the crowds who visit them, but also because they are centres to which students resort from all parts, not only of the United Kingdom, but of the civilized world, not to gaze at the collections but to *use* them. In like manner a national collection of scientific apparatus should be brought together, not merely to be stared at, but to be used. By an arrangement more logical than those to which our haphazard English

customs too frequently lead, this second object is at present attained

It is almost ludicrous that at the very moment when a Royal Commission is sitting to determine the constitution of a new University for London, Parliament should be asked to sanction a Bill which, if it serves as a precedent, may make the teaching of some of the most important sciences impossible within the metropolitan area Indeed, in this danger we find a new confirmation of the importance of the policy which we have often urged upon those who are directly interested in the constitution of the future University

Science teaching in Exhibition Road is threatened to-day It may be threatened somewhere else to-morrow It will be impossible for a number of competing colleges to defeat the railway engineers, or to preserve intact for scientific research a number of buildings planted upon sites selected without reference to the new danger which has arisen They will be attacked in detail, and beaten one by one How immensely in this, as in many other matters, would their position be strengthened if they were able to speak with one voice in support of a plan decided on in common, and defended together If the hoped-for University of the future already existed, if it spoke with the prestige of the existing University of London, combined with that of the consolidated teaching staffs of the London Colleges, if the support of a Government Department could be asked to aid a University which, like the British Museum, commanded universal respect and support, then it might be possible to obtain a ready hearing for opinions given with all the weight of a great institution of which the country would be justly proud Till the union is effected, which alone will make science in London able to meet its enemies in the gate, we must struggle as best we can to prevent irreparable mischief

We can only hope that the Vice-President of the Council, who is known to have the interests of the higher education at heart, will not allow a railway, electrical or other, to injure the teaching institutions clustered round the magnificent collections of apparatus in his charge

SOUND AND MUSIC

Sound and Music By the Rev J A Zahm, C S C, Professor of Physics in the University of Notre Dame Large octavo, 452 pages (Chicago A C McClurg and Company, 1892)

THIS handsomely got-up and lavishly illustrated volume is, the author informs us, a largely expanded transcript of a course of lectures delivered by him, in 1891 "in the Catholic University of America, at Washington, D C" Its "main purpose is to give musicians and general readers an exact knowledge, based on experiment, of the principles of acoustics, and to present at the same time a brief exposition of the physical basis of musical harmony" A clear intimation is given at the outset (p 18) of the predominant *rôle* which experiment is to play in the acoustical portion of the undertaking. Had Prof Zahm not had at his disposal "all the more delicate and important instruments" of research and verification, in the theory of sound, constructed by Dr Koenig of Paris, he would "not have attempted to give the present lectures on sound" before such an audience as that which actually attended them With Dr Koenig's apparatus around him, however, he had assured means of "entertaining" his hearers, and of "illustrating in a way that would otherwise be impossible the most salient facts and phenomena of sound" The late Isaac Todhunter has deprecated the systematic repetition of perfectly established experiments, on the ground that their results ought to be believed on the statements of a tutor—"probably a clergyman of mature knowledge, recognised ability, and blameless character"—to suspect whom was in itself irrational[1] Prof Zahm's practice pushes to a great length a view directly opposed to that enunciated—with obvious humorous exaggeration—by the well known Cambridge private tutor Not content with a single experiment decisive of each successive issue presented, he performs a whole series bringing into action all the resources of his superbly found collection of acoustical apparatus It is no detraction from the clear and interesting manner in which these formidably numerous experiments are set forth, to say that the amount of space necessarily devoted to explaining the mechanism of the apparatus used gives to parts of Prof Zahm's volume somewhat of the look of an acoustical instrument-maker's illustrated catalogue Subject, however, to this defect, if defect it be, the lectures are decidedly pleasant and attractive reading The illustrations, too, are thoroughly clear and beautifully executed, so that our author may be fairly congratulated on success in 'entertaining'—the word is his own—his hearers and readers His object, to give to general readers an "exact knowledge" of the principles of acoustics, has also been in a fair measure attained, but subject to certain not inconsiderable deductions In describing the processes and results of experiment Prof Zahm is clear and thoroughgoing in expounding the parts of acoustical theory which must be mastered if the facts thus obtained are to be understood in their mutual relations, he is often vague and superficial Thus the nature of wave motion, the formation of stationary undulations, the composition of small vibratory movements—matters of crucial importance to any connected comprehension of Acoustics—receive from him no effective elucidation Nay, he is even chargeable with having, by the misuse of a technical term of perfectly settled meaning, written in a way likely to confuse his readers' ideas on these very matters On p 46 he calls certain points in a series of progressive waves "NODAL points where there is no motion," thus confusing two things which ought to be most carefully distinguished from each other, a point of *momentary* rest in a *progressive wave*, and one of *permanent* rest in a *stationary undulation* The usage which restricts 'node' to this latter meaning is so well established that such use of it as the above is quite inexcusable, especially in an author who himself elsewhere, p 146 &c., employs it in its ordinary signification The same indifference to accuracy of expression recurs in this volume with a frequency not creditable to a professor of an exact science Thus on p 50 the return movement of a prong of a tuning fork is said

[1] "The Conflict of Studies," p 17

to 'pull' air particles apart. On p. 52 we are told that the motions of particles of a water wave "are always at right angles to the direction of the wave itself." On p. 68 the author corrects this statement, but in doing so, takes occasion to speak of a plane "in," instead of 'passing through' the line of progression. On p. 380 he describes harmonic partial-tones as "modifying the quality of their fundamental," though he obviously means the quality of the compound sound due to the fundamental and other partial-tones combined. On p. 387 it is said that the "ratios of frequencies" which characterize particular sounds "are called intervals," and that by dividing one note by another we obtain the intervals between them. Language of this kind is, indeed, hardly misleading, but it is certainly very slipshod.

Before passing from the more generally acoustical, to the more specially musical portion of Prof. Zahm's volume, it is proper to point out one important respect in which it has the advantage over most, or possibly all, the manuals on the same subject which have preceded it. This merit consists in giving a somewhat full account of elaborate experimental researches on beats, combination-tones and quality conducted by Dr. Koenig, the results of which are to a considerable extent at variance with conclusions previously announced by Prof. Helmholtz. In the opinion of our author, Dr. Koenig is "one who, not excepting even the eminent German philosopher just mentioned (Helmholtz), has contributed more than any other person to the advancement of the science of acoustics" (p. 17). A more balanced judgment, while placing great reliance on Dr. Koenig's experimental skill and on the superlative excellence of the apparatus constructed by him, would probably attribute to Helmholtz's opinion a preponderant weight in interpreting and correlating the results of experiment. Be that, however, as it may, Prof. Zahm has done excellent service by popularizing the work so laboriously performed, and so modestly placed on record, by the eminent instrument-maker to whom no one who has put his hand to acoustical work can fail to be under considerable practical obligations.

The specifically musical are decidedly the least meritorious parts of our author's performance. The looseness of phraseology already complained of is here at its worst. On p. 166 we are told that a 'comma,' ($\frac{81}{80}$) is "the smallest interval used in music." A beginner might easily take this to mean that notes differing by only that interval were actually heard consecutively in a musical phrase—of course an absurd supposition. Very misleading, again, is the statement on p. 388 that tones, like major and minor tones, that differ from each other only by a comma "are considered in music to have the same value." The only rational meaning to be got out of it seems to be that *in the equally tempered scale* the distinction between major and minor tones is obliterated. On p. 389 the notes of the diatonic scale, and their relations, in respect to rapidity of vibration "to one another," are set out, and it is added that all but the second and the seventh of the intervals thus indicated are consonant. The essential piece of information, that it is not the intervals formed by these notes with "one another," but with *the tonic*, that are in question, is withheld, and so the reader is left free to suppose *e.g.* that the tritone, F—B, is a consonance. On p. 390 the 'inversion' of intervals is mentioned without any explanation of its meaning.

Attention may well be called to a process of reasoning which occurs on pp. 388-390. Prof. Zahm abruptly introduces (p. 388) calculation by "frequency ratios", assumes, without attempt at proof, that addition of two semitones is performed by squaring the ratio $\frac{16}{15}$, and then remarks (p. 390) "From the foregoing we observe that the sum of two intervals is obtained by multiplying, not by adding their ratios together." An *assumption* in a *particular case* is thus made to do duty as a *general demonstration*.

On p. 396 we read that "so perfectly does the interval of the fifth answer the requirements of the ear that even unpractised singers find it quite natural to take a fifth to a chorus that does not quite suit the pitch of their voice." If, as this passage appears to suggest, practised singers in America find it still more natural to accompany melodies in consecutive fifths, wonderful effects may surely be expected from the choruses to be heard at the Chicago exhibition.

On p. 429 our author describes a diagram by Helmholtz as concerned with the transposition of an interval by an octave, whereas what it really deals with is the enlargement of the interval in question by the addition to it of an octave. On p. 430 he writes down, *as constituents of the chromatic scale of C*, the notes E♯, F♭, B♯ and C♭.

On p. 441, he tells us that in listening to such violin players as Joachim, Wilhelmj, and others "one can always hear distinctly the *Tartini*, or beat-tones, that add such richness and volume to violin music."

To gauge the amount of truth contained in this remark it suffices to bear in mind that in the case of most major, and of all minor consonant chords, Tartini's tones cause a *decided dissonance*. Players who made them 'always distinctly audible' would soon be reduced to permanent inaudibility themselves.

Prof. Zahm's volume is creditably free from misprints; the following have, however, been noted:

P. 23, l. 16 'period' for 'periods.'
P. 68, l. 21 'amplitude' for 'amplitudes.'
P. 90, l. 8 'Ajugari' for 'Agujari.'
P. 142, in diagram, B_4♯ for B_4.
P. 152, in diagram I, D♯ for B.
P. 388, ll. 11 and 12, G for F.

GERLAND'S ETHNOLOGICAL ATLAS

Atlas der Volkerkunde. (Berghaus' Physikalischer Atlas, Abth. vii.). Bearbeitet von Dr. Georg Gerland, Professor a. d. Universitat in Strassburg. (Gotha: Perthes, 1892.)

ANTHROPOLOGY owes much to Prof. Gerland, whose completion of the two last volumes of the late Prof. Waitz's "Anthropologie der Naturvolker" is a monument of that co-ordinated knowledge of fact which is the source of sound principle. His new "Atlas of Ethnology," while forming part of the great Physical Atlas of Berghaus, may be obtained and used as a separate work by anthro-

pologists, to whom it will be of great service in methodizing the vast and growing information with which they have to deal This application of graphical method, it is true, has difficulties which even the greatest skill cannot altogether overcome, but Prof Gerland may well be content with his success in making evident at a glance the characteristics of mankind, seen from many points of view Their distribution over the earth, as thus made evident, may often lead straight on into theories of origin The fifteen plates contain nearly fifty maps, each suggesting a principle, or showing where there is room for one

Plate I. represents on two planiglobes the classification of human races as to skin and hair Prof Gerland does not even combine these two characteristics, and points out in his introductory remarks that any attempt to map out man into defined physical races is impossible, for such division does not exist in nature Anthropologists of course know this, but care is not always taken to make it clear that race-types are not so much complete realities as statistical abstractions from partial realities, the various measurable characters of skull, limbs, complexion, hair-form, &c , combining and blending too intricately for absolute definition I was struck by meeting lately in a popular book with a confident mention of the four distinct Aryan race-types, and it occurred to me that it would bring the statement down to its bearings to put one of Prof Gerland's planiglobes before the author, desiring him to define and map out these varieties of mankind Even in Gerland's broad general distinctions of complexion and hair, an anthropologist not thoroughly special on the anatomical side may find novelty and difficulty The opinion that all native Americans are similar as to race is here strongly and probably with reason modified by the native Brazilians being separated on the complexion-map from other peoples of North and South America, and placed to match the Tartars and Chinese What amount of evidence there is for placing the Berbers of North Africa under the same map-colour seems not so clear, but it is to be noticed that the same tint includes several more or less distinct grades in Broca's scale An attempt is even made to separate the friz-haired negroids into classes according to the arrangement of their corkscrew-tufts of hair on the skin Plate III , in two maps, classifies man according to his religious beliefs and customs, and here the prevalence of special rites offers instructive generalizations Thus the American line which limits the smoking of tobacco as a religious ceremony, indicates the spread of this peculiar rite from some religious centre over an enormous area No doubt it is rooted in nature, from the fact that its narcotic ecstasy brought the priest into direct visionary contact with the spirit-world But none the less, it proves the religions of savage tribes, separated by great distances on the map, to be bound together by historical connexion Not less remarkable is the compactness of the districts of Eastern Asia and the opposite Continent of America, where masks are used, apparently originally with religious significance Here again it is evident that we have to do not merely with independent growth from the human mind, but in some way with historical transmission It must be remembered in using these maps, that they bind their author only to fact, and not to theoretical interpretation This same plate maps out the immense districts whose natives have a myth of a deluge, the upheaving of the earth, &c , but it cannot distinguish in North and South America, for instance, between regions where deluge-myths are old, and those where they were introduced by the Jesuits a few generations ago Plate IV , mapping out regions liable to special diseases, as malarious fevers, pestilence, cholera, yaws, &c , contains in a condensed form a vast collection of knowledge, bearing on anthropological arguments as to the relation of race to physical constitution, and thus opening into one of the great problems of the history of man Plate V classes out the varieties of human food, clothing, dwellings and occupations Plate VI and onward map out the distribution of nations and tribes at different periods as known to history, Plate XIV being devoted to the distribution of languages over the world

Anthropologists who keep this atlas at hand as a help in their work will by practice find out its merits and defects The representation of the geographical distribution of arts and customs has long been a feature of the Pitt-Rivers Museum, where so far as possible each series, illustrating development and transmission of culture, is accompanied by a small world map coloured to show the parts of the world it occupies It is of course impossible to Prof Gerland to work in such detail, involving as it would do hundreds of separate charts He has to indicate his distributions on a moderate number of plates and mostly uses planiglobes, a projection which, after being neglected for generations, will, in its improved modern arrangement, certainly come into more general favour On these, by ingenious devices of tinted patches and streaks, combined with lines and dots, he succeeds in giving a more general survey of man and civilization than our students have ever had in their hands before EDWARD B TYLOR

OUR BOOK SHELF

Castorologia, or, The History and Traditions of the Canadian Beaver By Horace Martin, F Z S (London. Stanford, 1892)

"BEAVER" was once the most important fur in the world In former days the pelt of this Rodent was the standard by which all barter in the Dominion of Canada was regulated, and "beaver" passed as current coin throughout the whole of North America Even now the quantity of beaver skins brought to England is considerable Mr Poland, in his "Fur bearing Animals," tells us that upwards of 63,000 beaver skins were sold by the Hudson's Bay Company in 1891 But "beaver hats" formerly required a much larger supply than this, and in 1743 it is said that 127,000 beaver-skins were imported into La Rochelle alone Our "top" hats are now made of silk, and beaver has become a fur of second-rate importance

Besides the fur of the beaver many other points of interest attached to this animal will be found discussed more or less completely in Mr Martin's volume Long before its fur was required for hats *castoreum* or castorin—a substance found in two large glands, situated near the base of the beaver's tail—was a much-valued specific in medicine, as spoken of by Hippocrates and Pliny. Even at the present time its use is by no means abandoned, and the "crude article" is "still sold at our drugstores" at prices varying "from eight to ten dollars a

pound" But in past centuries castoreum was considered a sovereign remedy for every kind of disease Many amusing details on this part of the subject are given by Mr. Martin, mostly extracted from the "Castorologia" of Johannes Francus, published in 1685 The wisdom of Solomon himself is attributed by this learned author to the virtues of the beaver To acquire it, it is only necessary "to wear a hat of beaver's skin, to rub the head and spine with that animal's oil, and to take twice a year the weight of a gold crown piece of castoreum"

At the end of his volume Mr Martin places a short account by Mr C V Riley, the well known American entomologist, of *Platypsillus castoris*, a parasite on the beaver, and one of the most remarkable among the many extraordinary forms of parasitic insects Mr Riley correctly refers this creature to the coleoptera, although other naturalists, and, amongst others, its discoverer, Ritsema, have expressed different views on this point He omits, however, to refer to the excellent account of *Platypsillus castoris*, written by the late John Leconte, and published in the Proceedings of the Zoological Society of London for 1872 Dr Leconte has here shown that it is necessary to make a special family (Platypsillidæ) for the reception of this curious parasite, but that it must be unquestionably referred to the coleoptera

On account of these and other peculiarities the beaver is unquestionably an animal of great general interest, and Mr Martin has done well to devote a volume to what is evidently his favourite theme There is, we must allow, little, if anything, original in it, and the statements on scientific points cannot always be implicitly depended upon But the author has brought together a large amount of information on the subject, and his book is "popularly written" and "fully illustrated," though we cannot quite agree to his claims to have produced an "exhaustive monograph"

An Atlas of Astronomy By Sir Robert Stawell Ball, LL.D, F R S (London George Philip and Son, 1892)

A NEW book by Sir Robert Ball is always a matter of interest, but the present one naturally lacks the usual characteristics It is described as "a series of 72 plates with introduction and index" In addition to monthly and general maps of the stars, the atlas reproduces pictures of the sun, moon, planets, and comets, and contains diagrams illustrating their motions and dimensions As the book is chiefly meant to be a companion to more general works, the introductory matter is purposely brief, but still it has several features of interest Special attention may be drawn to the excellent description of a simple graphical method of determining the orbit of a binary star

To the serious student who may possess a small telescope the new atlas will be very useful Here he may learn how to determine the positions of sun spots, how to find the places occupied by the various planets, and what objects are most likely to be within reach of his instrument. Those interested in selenography will derive much assistance from the twelve plates showing the moon at different phases, which have been specially drawn by Mr Eiger, each being accompanied by an index map One can only wonder, however, that some of the recent excellent photographs of the moon have not been pressed into the service

The star maps, on the whole, are excellent, and our only complaint is of the excessive density of the Milky Way, which, in some parts of the maps, is almost sufficient to obliterate the names and numbers of the stars The monthly maps will be particularly useful to those who are just learning the constellations, a new feature being a belt indicating the track of the planets

Spectroscopic astronomy is entirely omitted, the author being of opinion that this great branch of work can only receive justice in a separate atlas In this we heartily agree, and trust that such an atlas will soon be forthcoming

The author's large following of readers will no doubt welcome the new comer, but we must express regret that astronomical photographs are not more fully represented It would be interesting, for example, to reproduce a series of photographs of typical nebulæ, all of which, we believe, are now available A plate showing the advantages of photography in the delineation of stars would also add to the interest of the atlas

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

Vector Analysis

I FANCIED that, in reply to the voluminous letters of Prof Willard Gibbs (NATURE, xliii 511, xliv 79), I had said in a few words all that is requisite (if, indeed anything *be* requisite) to show the necessary impotence, as well as the inevitable unwieldiness, of every system of (so-called) *Vector Analysis* which does not recognize as its most important feature the product (or the quotient) of two vectors — *i e* a Quaternion

A recent perusal of the first four pages of a memoir by Mr O Heaviside (*Phil Trans* 1892) —for so far only could I go —has dispelled the illusion For he calls the correspondence just spoken of a "rather one sided discussion" —a truly Delphic delivery —cleared up, however, by what follows it I particularly desired to read the memoir (which the Author had kindly sent me) as I hoped to learn from it something new in Electrodynamics But, on the fifth page, I met the check-taker as it were —and found that I must pay before I could go further I found that I should not only have to unlearn Quaternions (in whose disfavour much is said) but also to learn a new and most uncouth parody of notations long familiar to me, so I had to relinquish the attempt In the last of the four pages of my progress, I had found that Mr Heaviside (though, as above stated, he has a system of his own) is an admirer of Prof Gibbs' system, to such an extent at least that he thinks "his treatment of the linear vector operator specially deserving of notice" There I was content to leave the matter

But Mr Heaviside has just published (*Electrician*, 9/12/92) an elaborate attack on Quaternions, of a kind which is calculated to do real injury to beginners In answer to his remarks, in which he continues to point to me as the persistent advocate of a system which all right-minded physicists should avoid, I would simply refer him (and his readers, if there be such) to a brief Address which I gave a short time ago to the Physical Society of Edinburgh University (*Phil Mag* Jan. 1890) One or two sentences, alone, I will quote here :—

"if we can find a language which secures, to an unparalleled extent, compactness and elegance, and at the same time is transcendently expressive—bearing its full meaning on its face—it is surely foolish, at least, not to make habitual use of it"

"For (Hamilton) the most complex trains of formulæ, of the most artificial kind, had no secrets —he was one of the very few who could afford to dispense with simplifications yet, when he had tried quaternions, he threw over all other methods in their favour, devoting almost exclusively to their development the last twenty years of an exceedingly active life"

The main object, however, of my present letter, is to call attention to a paper by Dr Knott, recently read before the Royal Society of Edinburgh Dr Knott has actually had the courage to *read* the pamphlets of Gibbs and Heaviside, and, after an arduous journey through these trackless jungles, has emerged a more resolute supporter of Quaternions than when he entered. He has revealed the (from me at least) hitherto hidden mysteries of the Dyadic, and of Prof Gibbs' strange symbols Pot, Lap, Max, New, &c. The first turns out to be only the linear and vector function ; and the others are merely more or less distressing symptoms characteristic of imperfect digestion or assimilation of ∇. And when, at my request, Dr. Knott

translated into intelligible form the various terms of one of the less formidable formulæ of Mr Heaviside's memoir, I was surprized to find two old and very unpretending friends masquerading in one person like a pantomime Blunderbore In one of his Avatars the monster contains, besides the enclosing brackets, no fewer than 24 letters, 12 suffixes, 3 points, and 5 signs! When he next appears he has still the brackets to hold him together, but although he has now only 18 letters, he makes up his full tale of 44 (or 46) symbols, for he has 9 suffixes, 3 indices, 3 points, 5 signs, and 3 *pairs* of parentheses! I used to know him as compounded of 14 separate marks only, viz — $V^2\nabla\sigma + 2S\nabla\nabla_1 S\sigma\sigma_1$, but, unless I had required to dissect him, I should never have put him in anything resembling his new guise

Dr Knott's paper is, throughout, interesting and instructive —it is a complete exposure of the pretensions and defects of the (so-called) Vector Systems "Wer diesen Schleier hebt soll Wahrheit schauen!" I find it difficult to decide whether the impression its revelations have left on me is that of mere amused disappointment, or of mingled astonishment and pity

P G TAIT

Edinburgh, 24/12/92

Measurement of Distances of Binary Stars

WITH reference to Mr. C E Stromeyer's letter on the above subject, which appeared on p 199, it may be of interest to point out that his plan of determining the distance of a binary star is by no means a new one

The method was, I think, first suggested by Mr Fox Talbot at the Edinburgh meeting of the British Association in 1871, but the mere idea was sufficiently obvious as soon as the possibility of determining velocities by the spectroscope had been demonstrated by Dr Huggins

The first discussion of the geometrical conditions of the problem was given by Prof C Niven in the *Monthly Notices*, vol xxxiv No 7, where he exhibits the relation connecting the parallax, the relative velocity, and the elements of the orbit of a double star, and computes the value of the product (πV) of the parallax and velocity for a small number of binary systems

In a paper published in the Proceedings of the Royal Irish Academy for May, 1886, I examined the same question from a slightly different point of view, being at the time unaware of Prof Niven's paper, and was led to similar results An epitome of this paper was published in your Astronomical Column, vol xxxiv p 206 From the results obtained it appeared that, all things considered, γ Coronæ Australis and α Centauri were the most likely binaries to yield to this method of eliciting the secret of their parallax, while α-Geminorum, one of the stars selected by Mr Stromeyer, was shown to be most unfavourable on account of the situation of its orbit

In the *Monthly Notices* for March, 1890, I again drew attention to the subject in view of the accuracy of the results obtained by the photographic method in the hands of Prof Pickering and Prof Vogel In this paper I gave an extended list of binaries with the usual geometrical and dynamical elements, and in addition the two elements A and B on which the relative velocity depends I also gave the greatest value which πV can attain in each case and the velocity to be expected in the case of those stars whose parallaxes had been determined

Again in Mr J E Gore's valuable catalogue of Binary Star Orbits, published in the Proceedings of the Royal Irish Academy for June, 1890, columns 18 and 19 are devoted to the constants A and B computed from my formulæ (which I may say ought more properly to be called Prof Niven's formulæ on account of the priority of his paper) for eighty-one different orbits

The subject has also been discussed by Miss Clerke in "The System of the Stars," pp 199-201, where references to most of the original publications will be found

I may perhaps add that the inverse problem of determining the elements of the orbit from spectroscopic observations alone has also been investigated by me in the *Monthly Notices*, vol li, No. 5, where I have deduced the principal elements of the orbit of β Aurigæ, a spectroscopic double which no telescope can divide

I have been disappointed that astronomers engaged on spectroscopic determinations of stellar velocities have not devoted more attention to observations of already known binaries, which appear to me to offer a promising field of work, and have often regretted that at this observatory we have not the means of undertaking the investigation, and if Mr Stromeyer's letter has no other effect than to bring the subject once more forward it will have done good service, but I should like to point out that the second of the stars selected by him ought on no account to be taken as a test of the feasibility of the method, since the accurate discussion of the conditions shows that unless this is an exceptionally remote system the velocity must be very small indeed For instance, assuming Johnson's parallax, viz 0″ 20, the relative velocity of the components amounted last year to only 0 6 miles per second.

In the northern hemisphere the most favourably situated binaries are 70 Ophiuchi, ξ Ursæ Majoris, and, if Peters' orbit represents the real motion of the pair, 61 Cygni, while for the southern hemisphere special attention ought to be directed to α Centauri and γ Coronæ Australis

In Mr Gore's Catalogue, referred to above, will be found all the materials for determining when to observe any known binary most favourably in this respect, and for deducing its parallax from the measures obtained, and it ought to be borne in mind before letting the subject sink back once more into oblivion, that, other things being equal, this method is most likely to succeed in the case of the most distant systems, where the parallax is so small that the ordinary trigonometrical method necessarily fails us, and that when the micrometer, the heliometer, and the stellar photograph break down, the spectroscope will sound the further depths with ever increasing facility

Dunsink Observatory, co Dublin ARTHUR A RAMBAUT
December 30

December Meteors (Geminids)

THESE meteors were moderately abundant on the night of December 12, which appears to have been a very favourable one in regard to weather The chief radiant point was observed in the normal position very close to α Geminorum, and there was a strong contemporary shower from a centre east of β Geminorum

At 10h 10m December 12, a fireball estimated to be twice as brilliant as Venus was observed by Mr Booth at Leeds It moved rather slowly from $150°+43°$ to $188°+41°$, and divided into two pieces at the finish

Mr Wm Burrows, of Small Lane, Ormskirk, writes to me with reference to a meteorite which he observed to fall at a later hour on the same night He says the time was 6 52 a.m (December 13), and refers to the phenomenon as follows:— "Seeing the meteor was coming to the earth I crossed the road to where it appeared to be falling, and it fell about two yards from me When it struck the earth it made a noise like the report of a gun, it also went black instantly While descending it had a tail of fire about a foot long It is 1¾ inch in diameter one way, and 1¼ inch another, and one inch thick"

Mr Burrows sends drawings of the object, and it being still in his possession it is hoped the matter may be suitably investigated Should it prove a veritable meteorite one interesting circumstance in connection with it will be that its descent took place concurrently with the shower of Geminids

It is significant that December 9–13 constitutes a well-defined ærolitic epoch, rendered memorable by the fall at Wold Cottage, Thwing, Yorkshire, on December 13, 1795, and by many others, such as that at Massing, Bavaria, December 13, 1803, at Weston, Connecticut, U S.A, December 14, 1807, at Wiborg, Finland, December 13, 1813, at Ausson, France, December 9, 1858, at Baudong, Java, December 10, 1871, &c

Bristol, January 1 W F DENNING

The Earth's Age

As Dr Wallace (NATURE, p 175) trusts "that on further consideration" I shall "admit that" my "objection is invalid," it is evident that I have failed to make clear to him my argument showing that his data do not warrant his conclusion

He overlooks the fact that a thickness of 177,200 feet of sedimentary rocks is, standing alone, a perfectly indefinite quantity, to make it definite it must have a definite area.

As he mentions no area for it we are justified in assuming that he means the land area of the globe, whereas his calculation is made as though area were not of the essence of the problem, in short, as if the formation of a pile of sediment 177,200 feet thick, of no matter what area, were the problem

In Sir A Geikie's calculation and all other similar ones with which I am acquainted, the thickness of the sedimentary rocks is tacitly assumed to be their thickness all over the land area of the globe

Dr Wallace's calculation leads to the absurd result that continents are growing nineteen times as fast as materials are produced to supply their growth

Leaving the question of the conclusions to which Dr Wallace's data logically lead, I may say that I am not responsible, and do not hold him to be responsible, for the absurd theory as to the thickness of sedimentary rocks on which they are based

In order to arrive at a scientifically accurate result, what we require to know is the present actual thickness in every part of the world, plus all the thickness which has previously existed in, but since been denuded away from, every area The existing thickness in geologically explored areas can perhaps be ascertained within certain limits of error from geological maps and memoirs For instance where the surface consists of Torridon Sandstone overlying Archæan gneiss of igneous origin, the thickness of sedimentary rock is that of the Torridon Sandstone only, if we assume that the gneiss there is part of the metamorphosed original crust of the earth, for the existence of which Rosenbusch has recently argued

It is easily demonstrable, first, that in many places the existing thickness of each formation, where undenuded, is far from being the maximum thickness, and, secondly, from the thinning out in some directions, or merging, near the old shoreline, into conglomerates, that some formations were never deposited over certain areas, indeed, the very existence of a sedimentary deposit necessarily implies that of land undergoing denudation and not receiving deposit, although it may well be doubted whether the land area was always nineteen times the area receiving deposit

Reasoning from the deposits preserved as to those removed by denudation, it is highly improbable that any considerable area ever received either the complete series of deposits, or on the average anything like the maximum thickness of the deposits it actually received In addition to this, some formations usually considered to be successive may be really contemporaneous, so that the figures representing maximum thicknesses usually taken in calculating the earth's age are probably far above the truth for the purpose in question

The immense labour involved in calculating the existing thickness of sedimentary rocks in each area, and the thickness which there is any reasonable ground for supposing to have been at any time denuded from that area, as well as the uncertainty of the results, has probably deterred geologists from attempting the task, especially as large areas are very imperfectly known BERNARD HOBSON

Tapton Elms, Sheffield, December 24

THE first part of Mr Hobson's letter alone requires notice from me, as the latter part characterizes as absurd the views of those eminent geologists who have estimated the total thickness of the sedimentary rocks, and seems to assume that such writers as the late Dr Croll and Sir Andrew Ramsay overlooked the very obvious considerations he sets forth

As regards myself, he reiterates the statement that when geologists have estimated the total thickness of the sedimentary rocks at 177,200 feet, they mean that this amount of sediment has covered the whole land surface of the globe, that, for example, the coal measures, the lias, the chalk, the greensand, the London clay, &c, &c, were each deposited over the whole of the continents, since it is by adding together the thicknesses of these and all other strata that the figure 177,200 feet (equal to 33 miles) has been obtained

Mr Hobson concludes with what he seems to think is a *reductio ad absurdum* —"Dr Wallace's calculation leads to the absurd result that continents are growing nineteen times as fast as materials are produced to supply their growth"

But the apparent absurdity arises from the absence of any definition of the "growth of continents," and also from supposing that the growth of continents is the problem under discussion The question is, as to the growth in thickness, of sedimentary deposits such as those which form the geological series These deposits are each laid down on an area very much smaller than the whole surface of the continent from the denudation of which they are formed They are therefore necessarily very much thicker than the average thickness of the denuded layer and the ratio of the area of denudation to the area of deposition which I have estimated at 19 to 1, gives their proportionate thickness If Mr Hobson still maintains that he is right, he can only prove it by adducing *evidence* that every component of the series of sedimentary rocks has once covered the whole land surface of the globe, not by assuming that it has done so, and characterizing the teaching of all geologists to the contrary as absurd ALFRED R WALLACE

Ancient Ice Ages

MR READE in his letter (NATURE, p 174) refers to the striations on the pebbles forming the conglomerates at Abberley and the Clent Hills

Following the late Sir Andrew Ramsay, he considers the deposits to be of glacial origin, but goes further than that distinguished geologist in citing them as proof of a former ice age

It is but reasonable to suppose that *glaciers* existed in past ages in places where the conditions—such as high altitude and abundant precipitation—were favourable

Before, however, the existence of a former *glacial period* can be established, we must have evidence of contemporaneous deposits of undoubtedly glacial origin, and extending over wide spread areas—say half a hemisphere J LOMAS

University College, Liverpool, December 31

Printing Mathematics

THE use of the solidus in printing fractions has been advocated by authorities of such weight that it seems almost a heresy to call it into question Yet I venture to think that there is a good deal to be said against it In such matters the course preferred by mathematical writers and their printers is apt to take precedence over that which is most convenient for the great body of those who will read their work. It is tacitly assumed by those who prefer this notation that the getting of mathematical formulæ into line with ordinary printing is an unmixed advantage No doubt it is easier to set up the work in type thus, but with the consequent rapidity and cheapness of printing the advantage ends Most people will agree that it is much pleasanter to read a mathematical book in which the letterpress is well spaced, so that the formulæ stand out clearly from the explanatory language, than one in which the two run together in an unbroken stream just as a book divided into paragraphs is more readable than one which is not The old style is more restful to the mind and eye and one can more readily pick out the salient features of the demonstration

Another aspect of the question seems to me more important In making any calculation mentally it is much easier to visualize fractions, more especially if complicated, as written in the ordinary way than as written with the new fashioned notation The component parts of the mental picture are imagined as spread over a plane instead of being arranged along a line, and can be thought of separately with less confusion From a similar point of view it will be admitted that it is inconvenient to write mathematical expressions in one form and to print them in another

Then, again, I doubt whether the assumption that the solidus notation conduces to accuracy is justified No doubt the printer makes fewer original errors, but whereas with the old notation his frequent glaring errors are more readily detected by the proof-reader (or, if missed by him, by the ordinary reader), with the new notation the misplacement or omission of a solidus is, from the simplicity of the error, likely to be overlooked. In general, no one will be the poorer if a little more trouble is taken with the printing, and a little more paper is used for the book

The symbol / has advantages over its equivalent , and to its restricted use, such as is made by Sir G Stokes, one can hardly object, it matters little how such expressions as a/b or dy/dx are printed But it is the thin end of the wedge, and one is under a debt of gratitude to Mr Cassie for showing, in your issue of November 3, to what it may lead May it be a long time before we have to learn to substitute for the harmless expression, $\frac{b^{\frac{1}{2}}}{c(d+e)^3}$ its newest equivalent, $\{b \backslash 1/2\}/\{c\{d+e\} \backslash 3\}!$ I trust that no one will interpret the final note of exclamation as a factorial symbol M J JACKSON

D I Sind College, Karachi, November 23

The Teaching of Botany

I do not think there is at present any book in English giving practical instructions for experiments in Physiological Botany There is, however, an excellent book of this kind in German, Dr W Detmer's "Das pflanzen physiologische Praktikum," published by Gustav Fischer, Jena, 1888 This, no doubt, contains all that your correspondent "A H" (NATURE, *ante*, p 151) requires, though it is perhaps somewhat more advanced than is necessary for school teaching D H SCOTT

Old Palace, Richmond, Surrey

THE ORIGIN OF THE YEAR[1]

IV

THE reformation of the Egyptian calendar, to be gathered, as I suggested in my last article, from the decree of Tanis, is not, however, the point to which reference is generally made in connection with the decree The attempt recorded by it to get rid of the vague year is generally dwelt on

Although the system of reckoning which was based on the vague year had advantages with which it has not been sufficiently credited, undoubtedly it had its drawbacks

The tetramenes, with their special symbolism of flood, seed, and harvest time, had apparently all meant each in turn, however, the meanings of the signs were changed, the "winter season" occurred in this way in the height of summer, the "sowing time" when the whole land was inundated, and there was no land to plant, and so on Each festival, too, swept through the year Still, it is quite certain that information was given by the priests each year in advance, so that agriculture did not suffer, for if this had not been done, the system, instead of dying hard, as it did, would have been abolished thousands of years before

Before I proceed to state shortly what happened with regard to the fixing of the year, it will be convenient here to state a suggestion that has occurred to me, on astronomical grounds, with regard to the initial change of gn

It is to be noted that in the old tables of the months, instead of Sirius leading the year, we have Teχi with the two eathers of Amen In later times this is changed to Sirius

I believe it is generally acknowledged that the month tables at the Ramesseum is the oldest one we have, there is a variant at Edfu They both run as follows, and no doubt they had their origin when a 1st Thoth coincided with an heliacal rising and Nile flood

Egyptian month	Tropical month	Ramesseum	Edfu
Thoth	June–July	Teχi	Teχ
Phaophi	July–Aug	Ptah (Ptah-res-aneb-f)	Ptah (Menχ)
Athyr	Aug–Sep	Hathor	?
Choiak	Sep–Oct	Paχt	Kehek
Tybi	Oct–Nov	Min	Set but
Mechir	Nov–Dec	Jackal (rekh-ur)	Hippopotamus (rekhur)
Phamenoth	Dec–Jan	,, (rekh-netches)	Hippopotamus (rekh netches)
Pharmuthi	Jan–Feb	Rennuti	Renen
Pachon	Feb–Mar	χensu	χensu
Payni	Mar.–Ap	Horus (χonti)	Horus (Hor-χent χati)
Epiphi	Ap–May	Âpet	Âpet
Mesori	May–June	Horus (Hor m-χut)	Horus (Hor-ra-m-χut)

I am informed that Teχi, in the above month-list, has some relation to Thoth In the early month-list the goddess is represented with the two feathers of Amen, and in this early stage I fancy we can recognize her as Amen-t, but in later copies of the table the symbol is changed to that of *Sirius* This, then, looks like a change of cult depending upon the introduction of a new star—that is, a star indicating by its heliacal rising the Nile rise after the one first used had become useless for such a purpose

I have said that the Ramesseum month list is probably the oldest one we have It is considered by some to date only from Ramses II, and to indicate a fixed year, such, however, is not Krall's opinion[1] He writes —

"The latest investigations of Dumichen show that the calendar of Medinet Abu is only a copy of the original composed under Ramses II about 120 years before

"But the true original of the calendar of Medinet-Abu does not even date from the time of Ramses II It is known to every Egyptologist how little the time of the Ramessids produced what was truly original, how much just this time restricted itself to a reproduction of the traditions of previous generations In the calendar of Medinet-Abu we have (p 48) not a fixed year instituted under Ramses II, but the normal year of the old time, the vague year, as it was, to use Dschewhari's words quoted above (p 852), in the first year of its institution, the year as it was before the Egyptians had made two unwelcome observations First, that the year of 365 days did not correspond to the reality, but shifted by one day in four years with regard to the seasons, secondly—which of course took a much longer time—that the rising of Sirius ceased to coincide with the beginning of the Nile flood

"We are led to the same conclusion by a consideration of the festivals given in the calendar of Medinet-Abu They are almost without exception the festivals which we have found in our previous investigation of the calendars of Esne and Edfu to be attached to the same days. We know already the Uaga festival of the 17th and 18th Thoth, the festival of Hermes of the 19th Thoth, the great feast of Amen beginning on the 19th Paophi, the Osiris festivals of the last decade of Choiak, and that of the coronation of Horus on the 1st Tybi

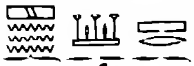
"Festivals somehow differing from the ancient traditions, and general usage are unknown in the calendar of Medinet-Abu, and it is just such festivals which have enabled us to trace fixed years in the calendars of Edfu and Esne

"We are as little justified in considering the mythologico-astronomical representations and inscriptions on the graves of the time of the Ramessids as founded on a fixed year, as we can do this in the case of the Medinet-Abu calendar In this the astronomical element of the calendar is quite overgrown by the mythological Not only was the daily and yearly course of the sun a most important event for the Egyptian astronomer, but the priest also had in his sacred books many mythological records concerning the god Râ, which had to be taken into account in these representations The mythological ideas dated from the oldest periods of Egyptian history, we shall, therefore, be obliged for their explanation not to remain in the 13th or 14th century before Christ, but to ascend into previous centuries, *I should think about the middle of the fourth millennium before Christ, that is the time at which the true original of the Medinet-Abu calendar was framed* Further we must in these mythological and astronomical representations not overlook the fact that we cannot expect them to show mathematical accuracy—that, on the contrary, if that is a consideration, we must proceed with the greatest caution We know now how inexact were the representations and texts of tombs, especially where the Egyptian artist could suppose that no human eye would inspect his work, we also know how often representations stop short for want of room, and how much the contents were mutilated for the sake of symmetry"

[1] Continued from p. 35

[1] *Op cit* p 48.

There is also, as I have indicated, temple evidence that Sirius was not the first star utilized as a herald of sunrise We have then this possibility to explain the variation from the true meaning of the signs in Ramessid times



Pre-Sirian Text: Thoth, Phaophi, Athyr, Choiak | Tybi, Mechir, Phamenoth, Pharmuthi | Pachons, Payni | Epiphi, Mesori

Sirian, 3192 B C: Thoth, Phaophi, Athyr, Choiak, Tybi, Mechir, Phamenoth, Pharmuthi, Pachons, Payni, Epiphi, Mesori

And it may be gathered from this that the Calendar was reorganized[1] when the Sirius worship came in and that the change effected in 619 B C brought the hieroglyphic signs back to their natural meaning and first use

Before I pass on it may be convenient in connection with the above month-tables to refer in the briefest way to the mythology relating to the yearly movement of the sun, in order to show that when this question is considered at all, if it helps us with regard to the mythology connected with the rising and setting of stars, it will as assuredly help us with regard to the mythology of the various changes which occur throughout the year

We have, as we have seen, in the Egyptian year really the prototype of our own The Egyptians, thousands of years ago, had an almost perfect year containing twelve months, but instead of four seasons they had three, the time of the sowing, the time of the harvest, and the time of the inundation Unfortunately, at various times in Egyptian history, the symbols for the tetramenes seem to have got changed

The above-given inscriptions show that they had a distinct symbolism for each of the months Gods or goddesses are given for ten months out of the twelve, and where we have not these, we have the hippopotamus (or the pig) and the jackal, two circumpolar constellations I think there is no question that we are dealing here with these constellations, though the figures have been supposed to represent something quite different

There are also myths and symbols of the twelve changes during the twelve hours of the day, the sun being figured as a child at rising, as an old man when setting in the evening These ideas were also transferred to the annual motion of the sun In Macrobius, as quoted by Krall, we find the statement that the Egyptians compared the yearly course of the sun also with the phases of human life

Little child	=	Winter solstice
Young man	=	Spring equinox
Bearded man	=	Summer solstice
Old man	=	Autumnal equinox

With the day of the summer solstice the sun reaches the greatest northern rising amplitude, and at the winter solstice its greatest southern amplitude. By the solstices the year is divided into two approximately equal parts, during the one the points of rising move southwards, during the other northwards

This phenomenon, it is stated, was symbolized by the two eyes of Rā, the so-called Utchats, which look in different directions They appear as representing the sun in the two halves of the year

We have next to discuss the fixed year, to which the Egyptian chronologists were finally driven in later Egyptian times

The decree of Tanis was the true precursor of the Julian correction of the calendar In consequence of this correction *we* now add a day every four years to the end of February The decree regulated the addition, by the Egyptians, of a day every four years by adding a day to the epacts, which were thus 6 every four years instead of being always 5 as they had been before

In fact it replaced the vague year by the sacred year long known to the priests

But if everything had gone on then as the priests of Tanis imagined, the Egyptian new year's day, *if* determined by the heliacal rising of Sirius, would not always afterwards have been the 1st of Payni, although the solstice and Nile flood would have been due at Memphis about the 1st of Pachons, and this is, perhaps, one among the reasons why the decree was to a large extent ignored

Hence, for some years after the date of the decree of Tanis there were at least three years in force the new fixed year, the new vague year, reckoning from Pachons, and the old vague year, reckoning from Thoth

But after some years another attempt was made to get rid of all this confusion The time was 23 B C, 216 years after the decree of Tanis, and the place was Alexandria Hence the new fixed year introduced is termed the Alexandrine year

This new attempt obviously implied that the first one had failed, and the fact that the vague year was continued in the interval is sufficiently demonstrated by the fact that the new year was $2\frac{1}{4}$ – 54 days *en retard* In the year of Tanis it is stated that the 1st Pachons, the new New Year's Day, the real beginning of the flood, fell on the 19th of June (Gregorian), the summer solstice, and hence the 1st of Thoth fell on the 22nd of October (Gregorian) In the Alexandrine year the 22nd of October is represented by the 29th of August, and the 19th of June by the 20th of April

It is noteworthy that in the Alexandrine year the heliacal rising of Sirius on the 23rd of July (Julian) falls on the 29th of Epiphi, nearly the same date as that to which I first drew attention in the inscriptions of the date of Thotmes and Pepi This, however, it is now clearly seen, is a pure accident, due to the break of continuity before the Tanis year, and the *slip* between that and the Alexandrine one It is important to mention this, because it has been thought that somehow the "Alexandrine year" was in use in Pepi's time !

It would seem that the Alexandrine revision was final, and that the year was truly fixed, and from that time to this it has remained so, and must in the future for ever remain so It must never be forgotten that we owe this perfection to the Egyptians

One of the chief uses of the Egyptian calendar that has come down to us was the arrangement and dating of the chief feasts throughout the year in the different temples

The fact that the two great complete feast calendars of Edfu and Esne refer to the only fixed years evidenced by records, those of Tanis and Alexandria, one of which was established over 200 years after the other, is of inestimable value for the investigation of the calendar and chronology of ancient Egypt

In an excellent work of Brugsch, "Three Festival Calendars from the Temple of Apollinopolis Magna (Edfu) in Upper Egypt," we have two calendars which we can refer to fixed years, and can date with the greatest accuracy In the case of one of these, that of Esne, this is universally recognized, as to the other, that of Apollinopolis Magna, we are indebted to the researches of Krall, who points out, however, that "it is only when the province of Egyptian mythology has been dealt with in all directions, that we can undertake a successful explanation of the festival catalogues Even externally they show the greatest eccentricities, which are not diminished but increased on a closer investigation"

[1] Goodwin has already asked, "Does the Smith Papyrus refer to some rectification of the Calendar made in the 4th Dynasty, similar to that made in Europe from the old to the new style," quoted by Riel, 'Sonnen und Sirius-Jahr," p. 361

About some points, however, there is no question The summer solstice is attached in the Edfu calendar to the 6th Pachons, according to Krall, while the beginning of the flood is noted on the 1st of that month In the Esne calendar, the 26th Payni is New Year's Day We read —"26th Payni, New Year's Day, Feast of the Revelation of Kahi in the Temple To dress the crocodiles, as in the month of Mechir, day 8"

Peculiar to the Esne calendar, according to Krall, is the mentioning of the "New Year's Festival of the Ancestors" on the 9th of Thoth, to the Edfu calendar, publication No 1 of Brugsch, the festival "of the offering of the first of the harvested fruits, after the precept of King Amenemha I.," on the 1st Epiphi, and "the celebration of the feast of the great conflagration" on the 9th of Mechir In feast calendar No 1, the reference to the peculiar Feast of Set, is also remarkable, this was celebrated twice, first in the first days of Thoth (? 9th ?), then, as it appears, in Pachons (10th) This feast is well known to have been first mentioned under the old Pharaoh Pepi Merinrā

It is a question whether in the new year of the ancestors and the feasts of Set, all occurring about the 9th Thoth and Pachons, we have not Memphis Festivals which gave way to Theban ones, for so far as I can make out the flood takes about nine days to pass from Thebes to Memphis, so that in Theban time the arrival of the flood at Memphis would occur on 9th or 10th Thoth There is no difficulty about the second dating in Pachons, for as we have seen this followed on the reconstruction of the calendar

It is also worthy of note that the feast of the "Great Conflagration" took place very near the Spring Equinox

It is well to dwell for a moment on the Edfu inscriptions to see if we can learn from them whether they bear out or not the views brought forward with regard to this reconstruction

As we have seen it is now acknowledged that the temple inscriptions at Edfu (which are stated to have been cut between 117 and 81 B C) are based upon the fixed year of Tanis, hence we should expect that the rising of Sirius would be referred to on 1 Payni, and this is so But here, as in the other temples, we get double dates referring to the old calendars, and we find the "wounding of Set" referred to on the 1st Epiphi and the rising of Sirius referred to under 1 Mesori Now this means, if the old vague year is referred to, as it most probably is, that

$$\begin{array}{l} 5 \text{ Epacts} \\ 30 \text{ Mesori} \\ \hline 35 \times 4 = 140 \text{ years} \end{array}$$

had elapsed since the beginning of a Sothic cycle, when the calendar coincidences were determined, which were afterwards inscribed on the temple walls We have, then, 140 years to subtract from the beginning of the cycle in 270 B C This gives us 130 B C, and it will be seen that this agrees as closely as can be expected with my view, whereas the inscription has no meaning at all if we take the date given by Censorinus

I quote from Krall[2] another inscription common to Edfu and Esne, which seems to have astronomical significance

"1 Phamenot Festival of the suspension of the sky by Ptah, by the side of the god Harschaf, the master of Heracleopolis Magna (A1) Festival of Ptah Feast of the suspension of the sky (Es)

"Under the 1st Phamenot, Plutarch, de Iside ac Osiride c. 43, b, notices the ἔμβασις Ὀσίριδος εἰς τὴν σελήνην These are festivals connected with the celebration of the winter solstice, and the filling of the Uza-eye on the 30th Mechir Perhaps the old year, which the Egyptians introduced into the Nile valley at the time of their immigration, and which had only 360 days, commenced with the winter solstice Thus we should have in the 'festival of the suspension of the sky,' by the ancient god Ptah—venerated as creator of the world—a remnant of the time when the winter solstice marked the beginning of the year, and also the creation"

The reconstruction of the calendar naturally enhanced the importance of the month Pachons, this comes out very clearly from the inscriptions translated by Brugsch On this point Krall remarks —

"It is therefore quite right that the month Pachons, *which took the place of the old Thoth by the decree of Tanis*, should play a prominent part in the feast calendars of the days of the Ptolemies, and the first period of the Empire in general, but especially in the *Edfu* calendar, which refers to the *Tanitic* year The first five days of Pachons are dedicated in our calendar to the celebration of the subjection of the enemies by Horus, we at once remember the above mentioned (p 7) record of Edfu of the nature of a mythological calendar, describing the advent of the Nile flood On the 6th of Pachons—remember the great importance of the sixes in the Ptolemaican records—the solstice is then celebrated The Uza-eye is then filled, a mythical act which we have in another place referred to the celebration of the solstice, and "everything is performed which is ordained" in the book "on the Divine Birth"

Next let us turn to Esne The inscriptions here are stated to be based on the Alexandrian year, but we not only find 1st Thoth given as New Year's Day, but 26 Payni given as the beginning of the Nile flood

Now I have already stated that the Alexandrine year was practically a fixing of the vague Tanis year; that is, a year beginning on 1st Pachons in 239 B C

If we assume the date of the calendar coincidences recorded at Esne to have been 15 B C (we know it was after 23 B C and at the end of the Roman dominion), we have as before, seeing that, if the vague Tanis year had really continued, it would have swept forward with regard to the Nile flood,

$$\begin{array}{l} \text{Pachons } 30 \\ \text{Payni } \ \ 26 \\ \hline 56 \times 4 = 224 \text{ years after } 239 \text{ B C} \end{array}$$

This double dating, then, proves the continuation of the vague year of Tanis if the date 15 B C of the inscription is about right

Can we go further and find a trace of the old cycle beginning 270 B C? In this case we should have the rising of Sirius

$$\begin{array}{r} 270 \\ -\ 15 \\ \hline 4)255 \text{ years} \\ \hline 64 = \text{say } 5 \text{ Epacts and } 2 \text{ months} \end{array}$$

This would give us 1 Epiphi Is this mentioned in the Esne calendar? Yes, it is, "1 Epiphi To perform the precepts of the book on the second divine birth of the child Kahi"

Now the 26th Payni, the new New's Year Day, is associated with the "revelation of Kahi," so it is not impossible that "the second divine birth" may have some dim reference to the feast

It is not necessary to pursue this intricate subject further in this place, so intricate is it that, although the suggestions I have ventured to make on astronomical grounds seem consistent with the available facts, they are suggestions only, and a long labour on the part of Egyptologists will be needed before we can be said to be on firm ground

J. NORMAN LOCKYER.

[1] On the 7th Epiphi of the 10th year of Ptolemy III the ceremony of the stretching of the cord took place Dümichen, Aeg Z 2, 1872, p 41

[2] Op cit, p 37

PROPOSED HANDBOOK TO THE BRITISH MARINE FAUNA

THE admirable monographs issued under the auspices of the Ray Society, and in Van Voorst's series, by such well-known authorities as Forbes and Hanley, Alder and Hancock, M'Intosh, Allman, Hincks, Brady, Norman, and others, are amongst the most creditable and useful productions of British Zoology, and all naturalists must devoutly trust that there are still others of a like classical nature to follow, and that, for example, Prof M'Intosh will soon be able to complete his long-expected work on the British Polychæta

But many Marine zoologists feel that, quite apart from such exhaustive and expensive monographs, and only aspiring to occupy a very much humbler position, there is pressing need of a "pocket" or seaside "Invertebrate Fauna," which could be used in much the same way as the botanists' "Field Flora" It has been suggested to me more than once during the last few years that I would be doing useful work in compiling such a book, and as no one else seems ready or willing to do so, I feel inclined to make the attempt Some material has already been accumulated for the purpose, but before going further I wish to lay my views before my fellow zoologists, in the hope that they will be kind enough to criticize the scheme and give me the benefit of their advice

The only existing work of the kind is Gosse's well-known, and, so far as it goes, very excellent little "Manual of Marine Zoology," but that book does not really meet the present want, as not only is the date of publication 1855-6, since when the number of genera and species has probably been something like doubled, but also Gosse merely gives the names of the species, while the book I think of would, in order to be of any real use, require to aim at giving a brief but sufficient diagnosis and figure of every British species I would adopt as "British" the area defined by Canon Norman's British Association Committee in 1887

Probably the most convenient form of publication would be some four to six small volumes, each dealing with one or two of the large groups This would allow of the groups being published as they were ready, not necessarily in zoological order, and would also be convenient for the use of those interested in one set of animals

There would be definitions—perhaps with occasional analytical tables or keys—of orders, families, &c, down to and including genera Under each genus would be given all sufficiently defined species with a brief description of each either in tabular form or in series, as seems most suitable in each case, and with an indication of size, range, and habitat Many species might be described very briefly in terms of preceding species, the differences merely being pointed out By simplicity of language, avoidance of unnecessary repetition, and use of contractions it might be hoped that each species could be confined on an average to a couple of lines

Illustrations would be either in the form of numerous small outline figures on thin paper plates inserted as near as possible to the pages where the descriptions occur, or as small groups of cuts (as in "Gosse") in the text There would be a figure of the whole animal in each important genus, or small family, and the figures of the species would represent the diagnostic points only, *e g* in the zoophytes there would be a figure in the genus *Plumularia* of an entire colony, or shoot, while the species *pinnata*, *setacea*, *catharina*, &c, would be represented each by a small figure showing the pinnæ, calycles, or nematophores as the case required

I shall now give a few examples, taken from different groups, of the method in which the genera and species might be treated, in order that specialists may have the opportunity of judging and criticizing

I From Cœlenterata —Genus ANTENNULARIA
Stems simple or branched, pinnæ verticillate, nematophores along the stems gonothecæ axillary, unilateral

A antennina, L, stems clustered, usually simple, hydrothecæ separated by 2 joints 6 to 9 in high Gen distr deep w

A ramosa, Lamk, stems single, usually branched, hydrothecæ separated by 1 joint only 6 to 9 in high Gen distr deep w

II From Crustacea —Family MAIIDÆ

HYAS Carapace tuberculous, no spines, branches of rostrum not divaricated, second joint of antenna dilated, no teeth beneath last joint of walking legs

H araneus, L, carapace not contracted behind post-orbital process 3 in Common, shallow

H coarctatus, Leach, carapace contracted behind post-orbital process 1 in Gen distr shallow

PISA Carapace may be tuberculous, with strong postero-lateral spine branches of rostrum divaricated at extremity, second joint of antenna slender, terminal joint of walking legs toothed beneath

P tetraodon, Leach, carapace with small tubercles, antero lateral margin with 4 spines 2 in Rare, S coast

P gibbsii, Leach, carapace with large rounded elevations, but no tubercles, no spines on antero lateral margin Rare, deep w, S coast

MAIA Carapace covered with numerous sharp spines, branches of rostrum strongly divaricated, no teeth beneath terminal joint of walking legs

M squinado, Latr 10 in long S and W coasts of England

III From Tunicata —Family MOLGULIDÆ

EUGYRA Branchial sac with no folds

E glutinans Möll, circular area on side free from sand ½ in Shallow w, gen distr

E globosa, Hanc, entirely covered with sand ½ in

PERA Branch s with 5 folds each side

P hancocki, Hrdn, matted fibres at poster end ½ in Irish Sea, 20 fms

MOLGULA Branch s with 6 or 7 folds each side

M inconspicua A & H, 6 folds, sandy, dors lam entire, no pap on stigmata ¼ in

M impura, Hel, 6 folds, sandy, small papillæ on edges of stigmata 1 in W of Ireland, shallow

M simplex, A & H, few hairs, little or no sand, 6 folds, anus fringed, dors tub horse shoe, aperture to left ½ ¾ in

M tubifera, Örst, 6 folds, anus fringed, dors tub horse-shoe, dors lam toothed, sandy 1 in E coast

M ampulloides, v Ben, 6 folds, anus fringed, dors tub horse shoe, 3 bars on fold, dors lam entire 1 in E coast, shallow

M socialis, Ald, 6 folds, anus fringed, dors tub horse-shoe, 4 bars on fold, dors lam entire, sandy, gregarious ½ in shallow w S coast

M holtiana, Hrdn, 6 folds, dors tub serpentif, hairs but little sand on test ¾ in W of Ireland, 10 fms

M occulta, Kupf, 7 folds, dors tub horse shoe, dors lam toothed, whole body sandy 1 in Shallow w S and W coasts

M oculata, Forb, 7 folds, siphonal region alone free from sand, and retractile between folds of test 1 in Gen distr Shallow w

M cephiformis, Hrdn, 7 folds, globular, not attached, no sand ¾ in S coast, shallow w

M citrina, A & H, 7 folds, attached by left side, no sand ¼–½ in under st, litt E and W coasts

CTENICELLA, as MOLGULA, but branchial and atrial lobes laciniated

C complanata, A & H, 6 folds on left, 7 on right, depressed attached, sandy, ¼ in

In conclusion, I need scarcely say that I shall be very grateful for suggestions, and, if the work is carried on, for any information from specialists about less known species, and the discrimination of allied forms, and for specimens, and also for references to any descriptions which might be likely to escape my notice

W A HERDMAN

NOTES

IN consequence of the unavoidable absence abroad of the new President of the Institution of Electrical Engineers, Mr W H Preece, F R S, on the 12th inst, he will deliver his inaugural address on the 26th inst.

A PUBLIC meeting, arranged by the Technical Instruction Committee of the Essex County Council, will be held in the Shire Hall, Chelmsford, on Friday afternoon, January 13, at 4.30 p m, Lord Rayleigh in the chair. An address will be given by Sir Henry E Roscoe on technical instruction in agricultural counties, with especial reference to science teaching Afterwards a discussion will take place

DR PERCY RENDALL, F Z S, has accepted an appointment as Resident Medical Officer to the Sheba Gold-mining Company in the Barberton District of the Transvaal He will reside at Eureka City, at an elevation of 5000 feet above the sea level Dr. Rendall made a good collection of birds during his recent residence at Bathurst on the Gambia, of which he has given an account in the *Ibis* for last year (*Ibis*, 1892, p 215) He has also made many valuable donations to the Zoological Society's Menagerie, amongst which is the unique example of the Nagor Antelope (*Cervicapra redunca*), presented by him in June, 1890 Of this scarce animal there is, we believe, no example in the British Museum Dr Rendall's new appointment will give him many opportunities of extending our zoological knowledge of a little known district

LORD WALSINGHAM, who has devoted much of his attention to the micro-lepidoptera, has filled the vacancy on the staff of the *Entomologists' Monthly Magazine* occasioned by the death of Mr Stainton

LAST week a preliminary meeting was held at the house of Sir James Paget to consider what steps should be taken with regard to a memorial of Sir Richard Owen It was decided that a committee should be formed to make the necessary preparations The following, among others, have consented to serve as members —The Presidents of the Royal Colleges of Physicians and Surgeons and of most of the scientific societies, the Duke of Teck, Lord Playfair, Prof Huxley, Sir Joseph Hooker, Sir Henry Acland, Sir John Evans, Dr Michael Foster, Mr Sclater, Sir W Savory, Mr. Hulke, Sir Joseph Fayrer, Sir Edward Fry, Dr Günther, Mr Carruthers and Dr H Woodward Sir William Flower will act as treasurer, and a general meeting will shortly be called. It has been suggested that the memorial should be a marble statue, to be placed in the hall of the Natural History Museum

PROF WESTWOOD, who died on Monday at the age of eighty-seven, will be greatly missed at Oxford To most people he is known chiefly as a writer on the archæology and palæography of art, but he was equally eminent as an entomologist He was one of the founders of the Entomological Society, and received one of the Royal Society's gold medals for his entomological researches.

WE regret to record the death of General Axel Wilhelmovitch Gadolin, an old member of the Russian Academy of Sciences. He was born of Finnish parents on July 10, 1828, received his education in the Finnish Corps of Cadets, and till his death remained in the Russian Artillery, devoting his leisure time to mineralogical, and especially to mathematical, researches into the molecular forces which act in the formation of crystals One of his earlier works, published in the *Verhandlungen der Mineralogischen Gesellschaft zu St. Petersburg*, was on some minerals from Pitkäranta. His chief work, published in 1867, was his "Deduction of all the Systems of Crystals and their Derivates from a Unique Principle" A deep impression was produced upon the members of the Russian Mineralogical Society by Gadolin's first communication upon this subject. The lucidity with which he deduced all systems of crystallization from fundamental principles of equilibrium of molecular forces, and the simplicity of the exposition of his researches, entirely based upon high mathematical analysis, reminded his hearers of some of the best pages of Laplace's writings The work soon became widely known in a German translation A paper on the resistance of the walls of a gun to the pressure of gunpowder gases also deserves mention, as, in addition to the formerly known formulæ of highest resistance of cylinders, he gave a new formula of minimal resistance Later on his method was used with great success by Klebsch, in his well-known "Theorie der Elasticität fester Körper," for deducing some general equations of equilibrium of solid bodies

THE last issue of the *Izvestia* of the East Siberian Geographical Society (vol xxiii 3) contains an obituary notice by V Obrutcheff, of I D Chersky, who died in the far north east of Siberia, during his expedition to the Kolyma river, after having given many years of his life to the active geological exploration of Siberia He began his work in 1872 at Omsk, where he made most valuable discoveries of post-tertiary mammals During the next two years he explored the Tunka and Kitoi Alps, but his rich materials were lost during the great conflagration at Irkutsk in 1879 In 1875 and 1876 he explored the Nijneudinsk caves, making again remarkable finds of quaternary mammals, and then he gave fully five years to the study of the stores of Lake Baikal, embodying the results of his extensive researches in a map (6 7 miles to the inch), and in vol xii of the *Memoirs* of the East Siberian Society, and vol xv of the *Memoirs* of the Russian Geographical Society In 1882 and 1883 he explored the Lower Tunguska, and again made rich finds of fossil mammals The next five years he spent at the Academy of St Petersburg, preparing the part of Ritter's "Asia" which is devoted to Lake Baikal, and working out the rich materials collected by another lamented Polish explorer of East Siberia, Czekanowski He also worked out the collections brought in from the New Siberia Islands by MM Bunge and Toll, and came to such interesting and new conclusions as to the recent geological history of Arctic Siberia, that the Academy of Sciences sent him out in 1891, at the head of a new expedition to the Kolyma region There he died, in the midst of his promising work

THE twentieth annual dinner of the old students of the Royal School of Mines will be held at the Holborn Restaurant, on Tuesday, January 10, at 7 o'clock The chair will be taken by Mr W Gowland, late of the Imperial Mint, Osaka, Japan

MR G T ATKINSON has been appointed Professor of Cryptogamic Botany at Cornell University, Ithaca, State of New York, in the place of Prof W R Dudley, who has gone to the Leland Stanford University, Paolo Alto, California.

AT the next public meeting of the French Academy, in December 1893, forty-five prizes will be awarded for the best work tending to the advancement of the various branches of science Of these, the following are, by the terms of the bequests, open to competitors of all nationalities The Prix Lalande will be awarded for the most intereresting observation, or the memoir or work most useful for the progress of Astronomy Its value is 540 francs The Prix Valz, of 460 francs, is offered under the same conditions. Three prizes of 10,000 francs each, bequeathed by M. L. La Caze, will be awarded annually for the best contributions to Physiology, Physics, and Chemistry respectively The Prix Tchihatchef, of 3000 francs, is offered annually to naturalists who have distinguished themselves most in the exploration of the continent of Asia or the adjacent Isles.

excluding better known regions such as British India, Siberia proper, Asia Minor, and Syria. The explorations must have some object connected with Natural Science, physical or mathematical, and will not be awarded for archæological or ethnographic work. All these prizes will be awarded in December 1893. Works for competition to be sent in to the *Sécrétariat* before June 1. The Prix Leconte, of 50,000 francs, for the most important scientific discovery, will be awarded in 1895.

THE Royal Academy of Sciences of Turin, in accordance with the will of Dr. Cesare Alessandro Bressa, and in conformity with the programme published December 7, 1876, announces that the term for competition for scientific works and discoveries in the years 1889–92, to which only Italian authors and inventors were entitled, was closed on December 31, 1892. The ninth Bressa prize will be given to the scientific author or inventor, whatever be his nationality, who during the years 1891–94, "according to the judgment of the Royal Academy of Sciences of Turin, shall have made the most important and useful discovery, or published the most valuable work on physical and experimental science, natural history, mathematics, chemistry, physiology and pathology, as well as geology, history, geography and statistics." The term will be closed at the end of December 1894. The sum fixed for the prize, income tax being deducted, is 10,416 francs. Any one who proposes to compete must declare his intention within the time above mentioned, by means of a letter addressed to the President of the Academy, and send the work he wishes to be considered. The work must be printed. Works which do not obtain the prize will be returned to the authors, when asked for within six months from the adjudication of the prize. None of the national members, resident or not resident, of the Turin Academy can obtain the prize. The Academy gives the prize to the scientific man considered most worthy of it, even if he has not competed.

MESSRS. MACMILLAN AND CO. hope to publish early in the spring the second volume of Dr. Arthur Gamgee's Treatise on Physiological Chemistry. This volume, which deals with the Digestive Processes, will be followed at no long interval by an enlarged and revised edition of the first volume, which originally appeared in 1880.

THE United States Government is inviting the various European Governments to send delegates to an International Conference of Meteorologists, to be held at Washington. The following is said to be proposed as a provisional programme of topics to be discussed by the Conference:—(*a*) The organization of additional meteorological work for the benefit of agriculture. (*b*) The extension to all ports frequented by commerce of the benefits of systematic storm and weather signals, and the introduction of a uniform system of storm warnings throughout the world. (*c*) The co-operation of all nations in the publication of a daily chart of the weather over all the habited lands and frequented oceans for the study of the atmosphere as a whole, and as preparatory to the eventual possibility of predicting important changes several days in advance. (*d*) The equable apportionment of stations, publications, and expenses among the nations, and the suggestion of practical methods by which to secure observations from those countries that are not represented in this Conference. (*e*) The encouragement by the respective Governments of special scientific investigations looking to the advancement of meteorology. Such other matters as the delegates may think advisable to submit for discussion, or for future report, will also be considered.

DURING the past week the sharp frost has continued almost uninterruptedly over these islands, with the exception of a partial thaw on Friday and Saturday, caused by a disturbance in the west spreading to the eastward. The greatest increase of temperature occurred in the north and west, but in the south-east of England the day readings were only slightly above the freezing-point. There was a complete change in the type of weather at the close of the week; a large anticyclone had formed over Scandinavia, and the air over nearly the whole of Europe was intensely cold, the minimum in the shade at Haparanda on Sunday registering 72° below the freezing-point, and the barometer on subsequent days rose to 31 inches and upwards in these islands. These conditions were accompanied by cold easterly gales in the south west of England, while a heavy fall of snow was experienced in the south-eastern districts. On the coast of Kent the shade minimum fell to 11° during Monday night. The *Weekly Weather Report* issued on December 31 shows that the temperature of that period was much below the mean, amounting to 9° or 10° over the greater part of England, and to 12° in the Midland counties. Very little rain fell during the week; the deficiency of rainfall in the south-western district of England for the last year amounts to 10·8 inches, or more than 25 per cent. below the average of the 25 years 1866–90. A good deal of fog was experienced at the inland stations during the week.

SOME very interesting entomological notes from the Eastern Archipelago are given by Mr. J. J. Walker in the January number of the *Entomologists' Monthly Magazine*. Incidentally Mr. Walker mentions that Dr. Wallace's residence in these islands, after a lapse of more than thirty years, is not forgotten, and that the Dutch translation of the "Malay Archipelago" is "as highly appreciated in the lands of which he gives so vivid a picture as the original work is at home."

AT the Physikalisch-Technische Reichsanstalt, Berlin, copies of standard mercury resistances are being constructed in which the mercury does not require renewal (*Wiedemann's Annalen*). They consist of U-shaped tubes filled with mercury in a vacuum and then sealed by fusion. Into each of the ends are fused three thin platinum wires connecting with the main current, the secondary circuit, and the galvanometer respectively. Since the connections are rigidly joined to the glass, it is possible to employ platinum wires as thin as 0·3 mm., so that there is no danger of heat being conducted into the mercury from without. The copy, mounted in a perforated brass box with an ebonite lid, is immersed in petroleum contained in another brass box, so that the binding screws are covered. This box is again surrounded during the experiment with a mixture of fine ice and water. The resistance is thus taken at a temperature which can easily be obtained, and which is uniform throughout the containing vessel.

AN apparatus for demonstrating the difference of potential at the poles of a galvanic cell has been constructed by Messrs. Elster and Geitel, of Wolfenbuttel (*Zeitschr. fur Phys. und Chem. Unterricht*). It is a modification of Thomson's water dropping influence machine. Two insulated metallic vessels can be filled with water by pressing a rubber ball communicating with a three-necked jar. The jets enter the vessels through two metal rings. One of these rings is connected with the positive pole of the cell. The jet on passing through becomes negatively charged, and the charge is communicated to the vessel and through a wire to the second ring, which acts by induction on the other jet. A strong positive charge is soon accumulated on the outside of the second vessel, and can be exhibited by a gold leaf or aluminium foil electroscope.

IN 1869 it was decided, in France, to give a medal and pension of 250 francs to every old soldier of the Republic and the Empire who could show two years of service, or two campaigns, or a wound. An interesting statistical record of these "médaillés de Sainte Hélène" as of "a generation which is disappearing," is given by M. Turquan in the *Revue Scientifique*. The first list, in 1870, comprised 43,592 names; and these men

must have almost exclusively served under the Empire. They are now reduced to 27. The oldest, Vivien by name, a Lyons man, is now 106. When 13 he was with Bonaparte in Egypt, fought in 22 campaigns, and was one of the Imperial Guard at Waterloo. The youngest is 92, and served in the navy. The mean age of the 27 survivors is 97 or 98 years. The annual number of deaths in this body of men reached a maximum of 6456 in 1872, since which year it has been gradually diminishing. The proportional mortality rose, in general, till 1889, but in the years since there has been a marked fall, testifying to the exceptional vitality of those late survivors. M. Turquan calculates that this remnant will have wholly disappeared by the end of the century. Going back to 1815, he estimates the generation to which the men belong at about 300,000, with a mean age of 25 years, and that 500,000 births between 1785 and 1795 would concur to its formation. From figures relating to the Napoleonic wars he comes to the grim conclusion that one man in five of those born between the years just named was destined to die in war. It is, he says, to the immense losses of men during the ten years of war of the Empire that the present generations owe their low birth rate.

MR. J. R. S. CLIFFORD offers some interesting observations in the January number of *Nature Notes*—the Selborne Society's magazine—on the Death's head moth and bees. Last July a friend of his at Gravesend found one of these huge moths trying to gain access to a hive, having evidently been drawn to the spot by the odour of the honey. This disposes of doubts which have been suggested as to the old statements about this moth's habit of entering hives when it has a chance. The construction of modern hives keeps it out, but "where old style hives are used, the moth can and does enter, and occasionally one has been found dead within a hive, the bees, being unable to remove so bulky an insect, having taken the precaution to embalm its body with what is called *propolis*." According to Mr. Clifford, some Continental bee keepers have discovered that "the bees are aware they are liable to the intrusions of this big moth," and when the bees are "located in the old fashioned hive, the insects erect a kind of fortification at the portal. This is constructed with a narrow passage and a bend, past which the Death's head could not possibly make its way, and which it has no jaws to bite through."

WE learn from the *Agricultural Journal*, issued by the Department of Agriculture at Cape Colony, that much attention is being given there to questions connected with the fruit export trade. The department is in correspondence with the steamship companies with a view to securing every possible encouragement to the trade, which is expected to be taken up on a considerable scale this year. Replying to inquiries on the subject, the Castle Mail Packets Company announce that they will give every publicity to the rates of freight to be charged and the stowage arrangements, &c. The Company will also concede a somewhat lower rate for the less remunerative fruits carried in the cool chambers, and will reserve a cool and well ventilated part of the vessel for conveyance of fruit as ordinary cargo. Careful instructions have been issued to captains of the Company's vessels in regard to the stowage and carriage of fruit.

DR. THEODORE MAXWELL has issued a useful catalogue of Russian medical dissertations and other works he has collected and presented to the Royal College of Surgeons of England. In order that the dissertations may be of service to students who do not read Russian, he has indicated the nature of each work in English, and has given references to such abstracts in the *Lancet* or elsewhere as he has himself made or happens to be acquainted with.

AN excellent "Child Life Almanack" for 1893, by A. M. Clive Bayley, has been published by Messrs. G. Philip and Son. It is issued as an extra number of "Child Life," and the object, as the author explains, is to provide teachers with suggestions both for lessons to be prepared and observations to be made. Teachers who may wish to give "seasonable" lessons will find many most useful hints as to what really goes on in nature during the various periods of the year.

MR. JOHN BROWNING, optical and physical instrument maker, has issued an illustrated catalogue of magic, dissolving view, and optical lanterns, lime light apparatus, and slides.

THE extraordinary diversity in the temperature at which different micro organisms flourish and multiply, has from time to time been the subject of some interesting investigations by Fischer, Globig, and others. Thus Fischer isolated fourteen different species of bacteria from the sea water in Kiel harbour, and from soil in the town itself. These he was actually able to cultivate successfully at the freezing temperature (0° C.) as well as at from 15° to 20° C. Globig, on the other hand, studied the behaviour of micro organisms at high temperatures and separated out no less than thirty varieties from garden soil which would grow at 60° C. Some of these were even able to develop at 70° C., whilst the majority refused to grow at all below 50° C., some still more fastidious individuals objected to any temperature below 60° C., and others again required a temperature of between 54° and 68° C. One bacillus, however, was discovered more catholic in its taste in this respect, for whilst growing at 68° C. it managed to develop also at from 15° to 20° C. Some fresh contributions on the growth of micro organisms at low temperatures have recently been made by Forster of Amsterdam ("*Ueber die Entwickelung von Bakterien bei niederen Temperaturen*"). As far back as 1887 Forster described a phosphorescent bacillus obtained from sea-water which was found not only capable of growing, but of producing the phenomenon of phosphorescence at 0° C. In further researches made by this investigator in conjunction with Bleekrode, it is stated that, although not many different species were found by them to develop at 0° C., yet immense numbers of individual bacteria belonging to this category were detected in very various media. Thus one cubic centimetre of milk as sent into the market contained 1000 such micro-organisms, whilst in a single gram of garden soil as many as 140,000 were found. Large numbers of such bacteria were also present in sea water obtained from the North Sea, and they were also found on the surface of fresh water fish as well as in their alimentary tract. It is well known that to successfully preserve meat and other articles of food it is necessary to employ a much lower temperature than 0° C., and experience has further shown that this is best done when the atmosphere is deprived of all moisture, as is accomplished by the compression and subsequent expansion of the air in enclosed spaces. Haddocks imported from Norway and thus artificially frozen were examined by Forster for bacteria. These fish were first killed and then exposed to a temperature of from 20° to 40° below 0° C. until they became perfectly hard and stiffly frozen, when they were removed to a cold chamber in which the temperature varied from 8° to 15° below 0° C. In spite of the extremely low temperature to which these fish had been subjected, on examining them when still hard frozen, a considerable number of bacteria were found in the abdominal cavity which had been opened when the fish was killed. It is obvious that during the interval which elapsed between the killing of the fish and their transference to the freezing chamber, bacteria must have been able to gain access, but had not had time to multiply to any considerable extent before the fish was frozen. Forster points out, what is sufficiently apparent, that the packing of samples of water in ice when sent from a distance

for bacteriological examination to prevent the multiplication of the micro organisms present, is really of very little if any use at all Thus it was already shown several years ago by Percy Frankland that the bacteria in filtered Thames water were able to multiply extensively, even when preserved for some days in a refrigerator

THE additions to the Zoological Society's Gardens during the past week include a Bittern (*Botaurus stellaris*), European, presented by Lord Ilchester, F Z S , two Hamsters (*Cricetus frumentarius*), British, presented by Miss Pugh , two Alligators (*Alligators mississippiensis*), from Florida, presented by Master Williams , a Common Snipe (*Gallinago cœlestis*), British, purchased

OUR ASTRONOMICAL COLUMN

COMET HOLMES (NOVEMBER 6, 1892) —The following is a continuation of Herr Berberich's ephemeris of this comet, the places being for Berlin, midnight —

		R A (h m s)	Decl (° ′)	Log r	Log Δ
Jan	5	1 8 50	33 47 9	0 4119	0 3400
	6	9 59	46 4		
	7	11 8	45 0		
	8	12 18	43 7		
	9	13 30	42 6	0 4143	0 3516

The comet is now near to and south following β Andromedæ Reports from various Observatories state that the comet is now very dim

COMET BROOKS (NOVEMBER 20, 1892) —This comet is now travelling very quickly The ephemeris for Berlin, midnight, is continued below —

		R A (h m s)	Decl (° ′)	Log r	Log Δ	Br
Jan]	5	18 29 40	+66 5 4	0 0805	9 8562	7 82
	6	19 0 49	13 6			
	7	19 31 22	65 59 2			
	8	20 0 22	24 6	0 0806	9 8651	7 49
	9	20 27 8	64 32 4			
	10	20 51 19	+63 26 0	0 0811	9 8781	7 01

The unit of brightness is taken as that at midnight on November 21

The track of the comet lies near the pole of the ecliptic, in the constellation Draco

THE SPECTRUM OF COMET HOLMES —The spectrum of the comet appears to have been continuous without any trace of bright bands At South Kensington it appeared to have its brightest part near the chief carbon fluting (λ 517), but there was nothing which could be described as a line or fluting As might be expected, there was a brighter continuous spectrum from the nucleus The same result was obtained by Mr Campbell at the Lick Observatory, and by Prof Keeler at the Allegheny Observatory The latter observer remarks that the spectrum is just what we should expect if the comet shines entirely by reflected sunlight

THE RECENT OPPOSITION OF MARS —In the December number of *Astronomy and Astro Physics*, Prof W H Pickering summarizes the conclusions derived from the observations of Mars at Arequipa as follows (1) That the polar caps are clearly distinct in appearance from the cloud formations, and are not to be confounded with them (2) That clouds undoubtedly exist upon the planet, differing, however, in some respects from those upon the earth, chiefly as regards their density and whiteness (3) There are two permanently dark regions upon the planet, which under favourable circumstances appear blue, and are presumably due to water (4) Certain other portions of the surface of the planet are undoubtedly subject to gradual changes of colour, not to be explained by clouds (5) Excepting the two very dark regions referred to above, all of the shaded regions upon the planet have at times a greenish tint At other times they appear absolutely colourless Clearly marked green regions are sometimes seen near the poles (6) Numerous so-called canals exist upon the planet, substantially as drawn by Prof Schiaparelli Some of them are only a few miles in breadth No striking instances of duplication have been seen at this opposition. (7) Through the shaded regions run certain curved branching dark lines They are too wide for rivers, but may indicate their courses (8) Scattered over the surface of the planet, chiefly on the side opposite to the two seas, we have found a large number of minute black points They occur almost without exception at the junctions of the canals with one another and with the shaded portions of the planet They range from thirty to one hundred miles in diameter, and in some cases are smaller than the canals in which they are situated Over forty of them have been discovered, and for convenience we have termed them lakes

The heights of some of the clouds were found to be not less than twenty miles, and indirect observations have led to the conclusion that the density of the atmosphere of the planet is less than that at the surface of the earth, but probably not as much as ten times less

Prof Pickering is of opinion that the opposition of 1894 will be quite as valuable to observers as that of 1892, the distance being but little greater, while the planet will be much farther north, and there is less likelihood of the surface being so much obscured by clouds as during the recent opposition

GEOGRAPHICAL NOTES

AN interesting illustration of the rapid development of South Africa is given by the recent appointment of a magistrate to reside near Lake Ngami to protect the interests of white traders, and enforce the laws restricting the sale of liquor and ammunition to the natives

THE January number of the *Geographical Journal*, the new form of the Proceedings of the Royal Geographical Society, contains a paper and map of some importance by Mr A P Harper, descriptive of the central part of the Southern Alps of New Zealand Government surveyors have been sent for several seasons to map out the glaciers, and an effort is being made by thoroughly exploring and mapping the region to make it the Switzerland of the southern hemisphere in the estimation of tourists, as it is already by virtue of its fine mountain systems

AN important paper on the physical conditions of the waters of the English Channel is published by Mr H N Dickson in the new number of the *Scottish Geographical Magazine* He shows how the ebb and flow of the tides in the Channel is affected by the characteristic form of the main feature of the coast line, viz bays with the western side running nearly from south to north, turning at a sharp angle, and lying open to the east The circulation of the water and its temperature were found to be largely determined by these conditions

MR COLES gave a successful lecture to young people in the hall of the University of London, on Friday last, covering the first half of his subject, "All the World Over," in a very interesting way Anecdotes of personal adventure combined with exceptionally fine limelight views of scenery to give a vivid impression of the regions touched upon The second and last juvenile lecture, under the authority of the Royal Geographical Society, will be given on Friday, January 6, at 4 p m

THE Royal Scottish Geographical Society announces a course of educational lectures in continuation of those delivered by Prof J Geikie and Dr H R Mill last year The new course will be on the Geographical Distribution of Animals, by Mr J Arthur Thomson, who is at present delivering the Thomson Lectures at Aberdeen The Society has also provided two special lectures to young people, by Prof C G Knott, on Life in Japan, and by Mr Graham Kerr on his recent travels in South America

WE understand that a book of travel in Madagascar and Africa, by Mrs Colvile, F R G S , describing the observations of the authoress on a recent extensive tour, will shortly be published by Messrs Blackwood

MR. J W. GREGORY, assistant in the Geological Department of the British Museum, has joined as naturalist the sporting expedition of Lieutenant Villiers and others, which is on the point of starting up the Juba From Bardera, the head of navigation, the party will traverse unknown regions to Lake Rudolf, and from there attempt to cross in a north-easterly direction, through the Galla country and Somaliland to Berbera on the Gulf of Aden

THE INTERNATIONAL ZOOLOGICAL CONGRESS AT MOSCOW

THE International Zoological Congress held its second session in Moscow during the month of August last, and with most commendable zeal the committee, to whose care the editing and publishing of the memoirs read were committed, now publish the first part of the volume of its Proceedings This part is printed in royal octavo size, and contains 350 pages, with several illustrations. All the memoirs are in French, thirteen out of the total thirty having been translated from, it is presumed, Russian In the first section—that of questions concerning biology and systematic and faunistic zoology from a general standpoint—there are three papers J de Kennel replies to the queries of Prof L Cosmovici (1) On a definite arrangement of the animal kingdom in "Phyla", (2) is there a type "Vermes"? (3) on a uniform terminology of the secretory organs of worms Ch Girard on some points of nomenclature J de Bédriaga on introduced species, and on hybrids, reptilian and amphibian In Section II—the same subjects from a special standpoint—there are twelve papers —P N Boutchinsky, on the Black Sea fauna, refers to a report on invertebrates of the Bay of Sebastopol by Péréiaslavtzeva, who records 639 forms found He describes three zones (1) from the surface to a depth of 175 feet, (2) from 175 to 280 feet in depth, with a minimum temperature of 6–7° C, and (3) from 280 to 700 feet, with a slightly higher temperature than in the previous zone, 8–9° C From a depth of 700 feet the water contains a quantity, more or less large, of sulphureted hydrogen, the quantity notably increasing with the depth T J Van-Beneden gives a note on the living and extinct Cetacea of the same sea. Gr Kojevnikov gives an account of the fauna of the eastern Baltic based on many recent explorations Dr J de Bedriaga treats of European and circum mediterranean vipers C Grévé has a paper on the geographical distribution of the Carnivores, and T Richard, one on the geographical distribution of the Cladocerous crustacea H de Jhéring makes some observations on insects' nests made of clay Prof A Brandt gives a classification of animal variations according to their causation Prof A Milne Edwards and E L Bouvier give a most interesting account of the varieties and distribution of *Parapagurus pilosimanus*, S I Smith A table with the comparative measurements of forty two specimens, is appended *P abyssorum* and var *scaber*, are reduced to the first named species F Vejdovsky describes *Thuricola gruberi*, n sp, and *Monodontophrya longissime*, gen et sp nov, the former from a stream near Bodenbach, the latter in the alimentary tract and body cavity of *Rhynchelmis limosella*, Holm In a short note Dr J de Bédriaga calls attention to some differences between *Chalcidis simonyi*, Steind, and *C viridanus*, which forms Boulenger and Steindacher have proposed to unite, and thinks that *Molge luschani*, Steind, neither belongs to Molge nor to Salamander, but to a European and American genus, not however named by him

The third section contains eight papers on histology and embryology N Kholodovski, contributions to a mesoderm and metamere theory A Pitzine, note on the formation of the germ of the peripheric nervous system V Roudnev, note on the development of the cardiac endothelium in Amphibians Mme O Tikhomirova, on the development of *Chrysopa perla* Fr Vejdovsky, on the segmentation of the ovum and the formation of the blastoderm in the Pseudoscorpiones, and on a rudimentary organ in the same N Koulaguine, contribution towards the history of the parasitic hymenoptera. A Tikhomirov, value of embryological research for classification. Section IV, physiology —C Khvorostansky, on the luminosity of animals from the White Sea

In Section V, devoted to morphology and comparative anatomy, L. Cosmovici writes as to the purport of the "aquiferous system," "segmentary organs," "excretory organs," and "nephridia." H de Jhéring, on the presence or absence of an excretory apparatus in the genital organs of the metazoa P Mitrophanov, note on the metameric significance of the cranial nerves N Nassonov, on the position of the Strepsiptera in the animal system, according to the facts of post embryonal development and of anatomy A O. Kovalevsky, on the excretory organs of the terrestrial Arthropods N. Zograf, on the origin and parentage of the Arthropods, more especially the tracheal bearing forms.

A BOTANIST'S VACATION IN THE HAWAIIAN ISLANDS

THE new number of the American *Botanical Gazette* (vol xvii, No 12) contains the first part of a paper by Prof D H Campbell, describing his experiences during a vacation spent last summer in the Hawaiian Islands We reprint the following passage —

On awakening upon the seventh day out, and looking through the port hole of my state-room, I saw that we were sailing near land Rugged barren looking hills were seen, and, going upon deck, I learned that this was Oahu, the island upon which Honolulu is situated As we skirted the shore at a distance, I soon spied a grove of unmistakable cocoa palms, the first hint of the tropical vegetation to which I was soon to be introduced Beyond was the bold promontory of Di mond Head, an extinct volcanic crater, forming a great bowl with rugged sides, right at the water's edge Beyond this, and bounded partly by it, is the bay upon whose shores stands the city Back of it rose abruptly a chain of mountains, in places about three thousand feet above sea level, and furrowed by deep valleys, whose walls, as well as the cloud capped summits of the hills, were covered with the most wonderfully verdant vegetation Never before had I realized the possibilities of green Blue greens, yellow greens, gray greens, and positive greens, with all degrees of these and others that are indescribable, combined to form what Whistler would term a symphony in green

As if to vie with the colours of the mountains, the sea exhibited an equally wonderful variety of tints. Outside the harbour is a coral reef, and within this the water is of the pale green common to shallow ocean water, but outside it deepens very rapidly into the vivid blue of the open ocean From a distance the line is clearly seen, but, as the observer approaches shore, the water changes from deep blue through every shade of blue and green until the pale green of the water within the harbour is reached

As we approached land numbers of the queer outrigger canoes of the natives were met, and from the wharf boys jumped into the water and swam about the ship in the hope of persuading some of the passengers to throw over to them coins, which they were very skilful in diving for

On the way to the hotel a few gardens were passed, and in them everything was strange By far the most striking thing was the superb *Poinciana regia* Although I had never seen this before I recognized it in an instant from a description of Charles Kingsley's, read long ago Surely in the whole vegetable kingdom there is no more splendid plant A spreading flat topped tree, perhaps thirty feet high, with feathery green, acacia like foliage and immense flat clusters of big flaming scarlet flowers that almost completely hide the leaves so that the tree looks like an immense bouquet They were in their prime about the time of my arrival in Honolulu, and continued to flower more or less for the next six weeks Pretty much everything in Honolulu, except the cocoanuts and an occasional haw tree (*Paritium tiliaceum*) is planted, but people seem to vie with each other in seeing how many different kinds of plants they can grow, and the result is that the place is like one great botanical garden. To Dr Hillebrand this is said to be largely due, as he was one of the first to introduce foreign ornamental plants, and his place, which is kept much as it was at the time he left the islands, was a very remarkable collection of useful and ornamental plants from the warm regions of almost the whole globe

Probably the first thing that strikes the traveller from the cooler regions is the great variety and number of palms Of these the beautiful royal palm (*Oreodoxa regia*) is easily first With its smooth columnar trunk, looking as if it had been turned, encircled with regular ring-shaped leaf-scars, and its crown of plumy green leaves, it well deserves its name. Other characteristic palms are various species of betel palms (Areca), wine palm (Caryota), sugar palm (Arenga), and a great variety of fan-palms of different genera. None is more beautiful than a thrifty young cocoa palm, but unfortunately it is very subject in the Hawaiian Islands to the ravages of some insect which eats the leaves and often renders them brown and unsightly Indeed, it is almost impossible to find a specimen which is not more or less disfigured by this pest. The trunk of the cocoanut tree is usually more or less crooked, and in old specimens much too tall

for its thickness, so that the old trees look top heavy. The date palm flourishes in Honolulu, where it is quite dry, but does not do so well in the wetter parts of the islands.

On studying the other trees, one is struck at once by the great preponderance of Leguminosæ, especially Cæsalpineæ and Mimoseæ. All about the town, and growing very rapidly, is the algaroba (*Prosopis juliflora*), a very graceful tree of rapid growth, with fine bipinnate leaves and sweetish yellow pods, which animals are very fond of, and which are used extensively for fodder. Add to this that the tree now forms the principal supply of fuel for Honolulu and we can realize its full value. Other leguminous trees that are planted are the monkey pod (*Pithecolobium samang*), tamarind, various species of Bauhinia and Cathartocarpus. One species of the latter with great drooping bunches of golden yellow flowers and enormous cylindrical pods three or four feet long, rivals the Poinciana when in full flower.

Mingled with these are a great number of shrubs and trees with showy flowers or leaves, most of them more or less familiar to the stranger, either from pictures or from green-house specimens. Several species of Musa are grown, and when sheltered from the wind are most beautiful; but ordinarily the leaves are torn into rags by the wind. The tall and graceful *M. sapientium* has been largely supplanted by the much less beatiful Chinese banana, *M. Cavendishii*, which is short and stumpy in growth, but enormously prolific. The related traveller's tree (*Ravenala Madagascariensis*), is a common and striking feature of many Hawaiian gardens. Of the many showy flowering shrubs, the beautiful *Hibiscus Rosa-Sinensis* is one of the commonest, and is used extensively for hedges. One of the most striking hedges in the city, however, is the famous one at Puna Hou college, which is 500 feet long and composed of night-blooming cereus. I was not fortunate enough to see this when it was in full flower, but I saw a photograph of it when it was estimated that there were about 8000 flowers at one time.

Of the fruit trees ordinarily grown, the following may be mentioned. The mango is a very handsome tree with dense dark green foliage and masses of yellow and reddish fruit on long hanging stalks. The bread fruit tree is common, both cultivated and wild, and is a very beautiful tree of moderate size, with leaves looking like immense fig-leaves, and the fruit like a large osage orange. I saw no ripe fruit, and so had not an opportunity of testing its quality. Guavas of different varieties are extremely common, both wild and cultivated, and the various fruits of the whole citrus tribe grow well. The few specimens of temperate fruits were, for the most part, much inferior to those of the United States. Of the fruits that did not strike my fancy, at least at first, was the alligator pear (*Persea gratissima*), a big green or purple pear-shaped fruit with an immense single seed. The pulp is somewhat waxy in consistence and very oily. It is eaten as a salad, and very much relished by the islanders, but the taste is acquired. The curious papaya (*Carica papaya*) is another fruit which did not appeal to my palate. Its big orange fruit, not unlike a melon in appearance when cut open, has a peculiar "squashy" flavour that suggested it having been kept a day too long.

Many showy climbers are planted, some of which, like Stephanotis, Thunbergia and Allamanda are superb; but there is one that is particularly obnoxious in colour, Bougainvillea, whose magenta floral bracts are an offence to the eye, forming a cataract of raw colour. It looks, as some one observed, as if it had just come from a chemical bath.

As soon as one gets fairly away from the city, it is at once seen that all the luxuriant vegetation is strange. Along the seashore is a plain gradually rising into low hills, both almost destitute of trees, except here and there a few cocoa palms along the shore. Of the strictly littoral plants among the most conspicuous is the curious *Ipomœa pes capræ*, with deeply two cleft leaves and purplish pink flowers. In the fertile lowlands near the sea are the principal cane and rice fields, which with taro are the staple crops. The rice is cultivated entirely by Chinese, near Honolulu; but on the sugar plantations the Japanese are largely employed. To see a Chinese laboriously transplanting little handfuls of rice into straight rows or ploughing in the mud and water with a primitive plough drawn by a queer Chinese buffalo are sights very foreign to an American eye. Sugar cane is eminently productive in the islands, and, hitherto, has proved the main source of revenue; but now the Hawaiians are bewailing the depression caused by the free admission of sugar from other countries into the United States; as, hitherto, their product has enjoyed practically a monopoly of the American market, having been admitted by treaty free of duty.

I made several trips up the valleys back of the city, but owing to the almost constant rain in many of them, these were not always agreeable. However, one is richly repaid by the luxuriance and variety of the vegetation. For a mile or two we pass between grass-covered hills, or hills overgrown in places with the lantana, which, introduced as an ornamental plant, has become a great pest. This plant covers some of the hills with an absolutely impassable thicket, and spreads very rapidly, so that it is a serious problem what is to be done with it. Of the common roadside plants, an orange and yellow milkweed and the showy white *Argemone Mexicana* were the most conspicuous. As one proceeds farther, where more moisture prevails, the variety becomes larger. Thickets of Canna and a Clerodendron with double rosy-white flowers, are common, and the curious screw-pine (*Pandanus odoratissimus*) is occasionally seen. This latter is a very characteristic plant, but is much more abundant in some of the other islands. In this region some very showy species of Ipomœa are very common, among them the well known moon-flower, *I. bona nox*.

With the increase in moisture, as might be expected, the mosses and ferns increase in number and beauty. There are many of them of types quite different from those of the United States. One of the commonest ferns of the lower elevation in *Microlepia tenuifolia*, a very graceful fern with finely divided leaves and terminal sori. Species of Vittaria, with very long undivided leaves, are also common here.

As we ascend one of the commonest ferns is *Sadleria cyatheoides*, a very large fern, often more or less arborescent. Ascending still higher the number and variety of ferns increases rapidly, and many beautiful and interesting ferns and mosses and liverworts become common.

At about one thousand feet elevation we begin to meet with species of Cibotium, to which genus belong the largest of the tree ferns of the islands. Here, also, I met for the first time with the smallest of all the ferns I have ever seen, *Trichomanes pusillum*. This dainty little fern, one of the Hymenophyllaceæ, forms dense mats on rocks and tree-trunks, looking like a delicate moss. The full grown frond is fan shaped, and, with its stalk, is not more than half an inch high. These tiny leaves, nevertheless, in many cases bore sporangia.

SOCIETIES AND ACADEMIES

LONDON.

Royal Society, December 8.—"Preliminary Account of the Nephridia and Body Cavity of the Larva of *Palæmonetes varians*." By Edgar J. Allen, B.Sc., University College, London. Communicated by Prof. W. F. R. Weldon, F.R.S.

The Green Gland, in a larva of *Palæmonetes* which is a few days old, consists of an end sac, which communicates by means of a U-shaped tube with a very short ureter, opening at the base of the second antenna. At the time of hatching, the gland consists of a solid mass of cells, without a lumen. In later stages the tube of the gland enlarges to form the bladder. The enlarged bladders of the two sides subsequently meet and fuse in the middle dorsal line, forming the nephroperitoneal sac described by Weldon and Marchal.

The Shell Gland is found in late embryos and young larvæ of *Palæmonetes*. It consists of a short renal tube, with a considerable lumen, which communicates internally with an end-sac, and opens externally at the base of the second maxilla.

Sections through the anterior region of the thorax of *Palæmonetes* show that the body cavity may be divided into four regions: a *dorsal sac*, surrounded by a definite epithelium, in which the cephalic aorta lies, but which does not itself contain blood; a *central cavity*, containing liver, intestine, and nerve cord; two *lateral cavities*, containing the proximal ends of the shell glands; and fourthly, the *cavities of the limbs*, which contain the distal ends of the same organs.

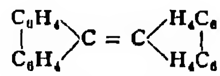
In late embryos of *Palæmonetes* solid masses of cells lie upon either side of the cephalic aorta. The dorsal sac is formed by the hollowing out of these masses of cells. Two lateral cavities are thus formed, which are separated by the aorta. The protoplasm of the cells lining these cavities, which is at first gathered into masses around the nuclei, then spreads out into a thin sheet, drawing away from the lower portion of the aorta, and causing the two lateral cavities to unite ventrally, and so form a single sac.

In the posterior region of the thorax the central and lateral cavities are similar to those of the anterior region, whilst dorsal to them the pericardial chamber lies. This chamber is separated from the central body cavity by the pericardial septum. The genital organs are situated immediately below the front end of this septum.

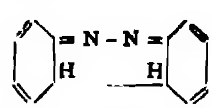
A comparison with the body cavity of *Peripatus* suggests the following relations. In the anterior region of the thorax of *Palæmonetes* the dorsal sac is homologous with the dorsal portions of the mesoblastic somites of *Peripatus*, and its cavity is a true cœlom. The central and lateral cavities, together with the cavities of the legs, represent the pseudocœle. In the posterior region of the thorax the cavities are all pseudocœlomic, and agree with those of the adult *Peripatus*.

December 15.—"Preliminary Note on the Relation of the Ungual Corium to the Periosteum of the Ungual Phalanx." By F. A. Dixey, M.A., M.D., Fellow of Wadham College, Oxford. Communicated by E. A. Schafer, F.R.S.

Chemical Society, December 1.—Prof. A. Crum Brown, President, in the chair.—The following papers were read:—The isolation of two predicted hydrates of nitric acid, by S. U. Pickering. The author announces the isolation of two crystalline hydrates of nitric acid, the monohydrate and the trihydrate, melting at $-36\cdot8°$ and $-18\cdot2°$ degrees respectively. In the case of either the melting-point is lowered by the addition of acid or water. The existence of these compounds was foreseen from an examination of the curves plotted from Bertholet and Thomsen's heat of dissolution values. This result is an important confirmation of the author's views.—Anhydrous oxalic acid, by W. W. Fisher. The best method of obtaining crystallized anhydrous oxalic acid is by allowing the hydrated acid to remain in contact with concentrated sulphuric acid for some months in a sealed glass tube. Oxalic acid is soluble in about 30 parts of cold sulphuric acid; the anhydrous acid dissolves with absorption of heat, whilst the reverse is the case with the hydrated acid. Anhydrous oxalic acid may be crystallized from nitric acid of sp. gr. 1·5. Oxalic acid may be completely dehydrated in a vacuum at 60°; the anhydrous acid is soluble in ethyl oxalate or glacial acetic acid, and separates from these solvents in a powdery form.—The production of orcinol and other condensation products from dehydracetic "acid," by N. Collie and W. S. Myers. The authors have obtained orcinol by the action of barium hydrate on dehydracetic "acid" or dimethylpyrone; on boiling a mixture of syrupy caustic soda and dehydracetic "acid," a true carboxylic acid is first produced, and, losing carbonic anhydride, yields orcinol. Among the products of the interaction of barium hydrate and diacetylacetone bright yellow needles melting at 180–181° are found; these probably consist of a naphthalene derivative $C_{11}H_{10}O_2$. Amidodehydracetic "acid," obtained in long needles melting at 192–196°, by the action of strong ammonium hydrate on dehydracetic "acid," readily yields dehydracetic "acid," on acid or alkaline hydrolysis.—Observations on the origin of colour and on fluorescence, by W. N. Hartley. It cannot be stated in general terms that colour is due to special methods of atomic arrangement; the statement may, however, be applied in a restricted sense to certain organic compounds, especially to those included in the class to which organic dye stuffs belong. It is pointed out that all open chain hydrocarbons exert a continuous absorption, the extent of which depends on the number of carbon atoms in the molecule. The condition of strain and instability existing in many coloured substances has been remarked by Armstrong; the author points out that all organic colouring matters are endothermic compounds, and considers this to be the physical cause of what Armstrong terms "reactivity" or "high potential." It is shown that anthracene is not colourless, but has a true greenish-yellow colour in addition to its fluorescence. A number of experiments on fluorescence are detailed, and the following conclusions drawn from them:—(1) Alcoholic solutions of quinine exhibit a beautiful, bright violet fluorescence. (2) Hydrochloric acid is not fluorescent. (3 and 4) Quinine hydrochloride and chloroform are feebly fluorescent, but without distinct colour. (5) Both hydrochloric acid and chloroform can extinguish those rays which are the cause of fluorescence in quinine. (6) Some alkaloids may be recognized by the degree and colour of their fluorescence. (7) Normal alcohols of the ethylic series and the fatty acids are fluorescent. (8) Glycerol has a violet fluorescence. (9) Benzene has a pale blue fluorescence, azobenzene a greenish-blue. (10) Rock crystal has a pale bluish-violet fluorescence, flint glass a strong blue, and crown glass a very brilliant blue fluorescence. (11) Substances which are not fluorescent in strong solutions may become so on dilution, particularly if they exert a very powerful absorption of the ultra-violet or invisible spectrum.—The origin of colour, V. coloured hydrocarbons and fluorescence: a reply to Prof. Hartley's observations on the origin of colour and of fluorescence, by H. E. Armstrong. If attention be paid to visibly coloured organic substances, it is a most remarkable fact that in those cases in which the "constitution" is fairly well established coloured substances are found to be all of one type. The author starts from this basis to inquire whether all coloured organic substances are not similar in type. Hartley's remark that all organic colouring matters are endothermic compounds has little importance in the present connection, inasmuch as the converse does not hold. The author contends that before admitting the fluorescence of many substances, *e.g.* alcohol and its homologues, every precaution must be taken to ensure their purity; instances in which easy explanation of the fluorescence of certain substances is possible are given. Hartley's observation that anthracene is coloured strongly confirms the author's hypothesis. Anthracene is fluorescent, and may be represented by a quinonoid formula, whilst its isomeride phenanthrene, which cannot be so represented, is colourless and non fluorescent. Furthermore, whilst intense colour is produced by "weighting" what the author terms the "quinonoid radicles" of anthracene by replacing the central hydrogen atoms by a halogen, no such effect attends the similar treatment of phenanthrene, dibromophenanthrene being colourless like the hydrocarbon. And yet anthraquinone and phenanthraquinone are coloured yellow and deep orange respectively. Reference is made to other coloured hydrocarbons, viz. carotin and the red hydrocarbon, $C_{26}H_{16}$, recently investigated by Graebe. The formula assigned to the latter by Graebe—



—is an improbable one; such a substance would be colourless. The author gives a possible constitution, and, for the present, proposes to call the compound "erythrophene." The yellow hydrocarbon, $C_{26}H_{18}$, obtained together with this, is possibly a diphenylated anthracene, and may be termed "xanthophene." The "quinonoid radicles" in both hydrocarbons are heavily "weighted," hence their strong colour. With reference to Hartley's statement that a very little shifting of the region of absorption determines the presence or absence of colour in a compound, it is contended that this shifting may be due to a special character of structure. The author then explains his views as to the manner in which the "quinonoid mechanism" conditions colour. He suggests that in quinonoid compounds there are two "colour centres" correspon ling to and expressed by the symbol $\supset$ in formulæ such as he has used in representing coloured substances. These centres co-operate in producing colour through interaction of the light waves which traverse them. Substances in which there are no such co-operating centres may absorb generally and selectively in "ultra" or "infra" regions of the spectrum, but without exhibiting "visible colour."—The origin of colour, VI. azobenzene, by H. E. Armstrong. Azobenzene, a highly coloured substance, is generally represented as Ph.N : N.Ph, a formula in disaccord with the author's hypothesis explained in the preceding paper. Moreover, the formulæ usually attributed to the colourless diazo-salts (Ph.N : N.Cl, for example) represent them as comparable in constitution with azobenzene. The behaviour of azobenzene towards bromine and other reagents leads the author to doubt the correctness of the conventional formula assigned to it, and to consider the following a more probable one:—



—The reduction products of dimethyldiacetylpentane, by F. S. Kipping. The author shows that dimethyldiacetylpentane, a diketone produced by the hydrolysis of ethyl dimethyldiacetylpimelate is converted by reduction with sodium in a moist ethereal solution into dimethyldihydroxynonane and a compound

which, judging from the manner in which it is formed, may be regarded as tetramethyldihydroxyheptamethylene

$$CH_2\langle\begin{matrix}CH_2 . CHMe & CMe & OH \\ & | & \\ CH_2 & CHMe & CMe & OH\end{matrix}$$

—The products of the interaction of zinc chloride or sulphuric acid and camphor (third notice), by H E Armstrong and F S Kipping The authors have previously shown that the crude product obtained on heating camphor with sulphuric acid or zinc chloride contains 1 2 . 4 acetylorthoxylene On oxidizing the oil remaining after the separation of the latter substance, a-methylglutaric acid is formed This acid being the characteristic oxidation product of the phorone obtained by distilling calcium camphorate, it is probable that a homologue of this phorone is present in the camphor product —The Griess Sandmeyer interactions and Gattermann's modification thereof, by H. E Armstrong and W P Wynne. In employing the Griess Sandmeyer methods for displacing the amido-group by halogens, the authors find that, in very many cases, much better results may be obtained by operating at relatively low temperatures instead of at the boiling point It appears also that the Gattermann process affords a larger yield than the Sandmeyer process, only because it is carried out at a lower temperature —Methods of observing the spectra of easily volatile metals and their salts, and of separating their spectra from those of the alkaline earths, by W N Hartley Persistent flame colourations of easily volatile metals, such as lithium, potassium, rubidium, cæsium, and thallium, may be obtained by heating beads of their fluosilicates, borates or silicates, on platinum wires in the Bunsen flame If the substance to be spectroscopically examined be converted into a borate, the spectra of the alkali metals may be first observed, and on subsequently passing hydrogen chloride into the flame, the spectra of the alkaline earth metals may be rendered visible —Manganese borate, its constitution and properties, by W N Hartley and H. Ramage Manganese borate, after drying *in vacuo* over sulphuric acid has the composition $MnH_4(BO_3)_2.H_2O$ On heating at 100° it loses one molecule of water, and at a red heat two molecules more of water are lost, leaving a salt of the composition $Mn(BO_2)_2$ From the rate of loss of water with rise of temperature the existence of a number of intermediate salts is inferred Manganese borate possesses a maximum of solubility in water at 18°, and a minimum at 80° This is probably due to dehydration of the compound having the composition $MnH_4(BO_3)_2.H_2O$

Anthropological Institute, December 13 —Edward B Tylor, President, in the chair —Mr. Arthur J Evans read a paper on the prehistoric interments of the Bahi Rossi caves near Mentone and their relation to the Neolithic cave burials of the Finalese He described the recent discovery of three skeletons in the cave of Barma Grande, and showed that the character of the sepulchral rites practised, the relics found, and the racial type of the human remains agreed with the earlier discoveries made by M Rivière and others in the same caves Mr Evans, however, opposed the theories that had been put forward as to the Palæolithic date of "Mentone Man" The bones of extinct Pleistocene animals and implements of the Moustier and Magdalenian types found in the cave earth above the interments proved nothing, for the simple reason that they were interments. No remains of extinct animals had been found in actual juxtaposition with the skeletons On the other hand the complete absence of pottery, of polished implements, and of bones of domesticated animals in this whole group of interments and the great depth at which they occurred proved that the remains belonged to a very early period. Evidence was here supplied of an earlier Neolithic age than any yet authenticated. Still the remains belonged to the Later Stone Age and to the days of a recent fauna Mr Evans compared some bone ornaments found with the so called hammer-beads of the chambered barrows of Scandinavia and the decorative system with that found on Neolithic pottery in northern Europe He further showed that interments of the same tall dolichocephalic race in a more advanced stage of Neolithic culture were to be found in the cave-burials of the Finale district further up the Ligurian Coast The physical form and the character of the sepulchral rites was essentially the same Only the skeletons were here associated with polished axes, pottery, and bones of domesticated animals. The direction from which the new civilising influences had come was indicated by imported shell ornaments from the southern and eastern Mediterranean , in the Mentone caves the imported shells were from the Atlantic In conclusion Mr Evans showed that the latter Finale interments exhibited forms of pottery and implements identical with those of the Italian terremare of the other side of the Apennines, and included ceramic shapes which seemed to be the prototypes of vessels found in the early Sikel tombs of Mycenæan age The Italic culture here revealed fitted on not only to that of the early pile-settlements of the Po Valley and the Lake dwellings of Switzerland, but might be traced to the Danube valley, to Thrace, and the Troad Amongst other parallel forms owl-like idols bearing a strong resemblance to those described by Dr Schliemann from the site of Troy had been found by Padre Morelli of Genoa in one of the Finale caves —Dr H Colley March read a paper in which he sought to prove that the peculiar features of Polynesian ornament are due to a mythography which is, in the main, a symbolism of origin and descent Thus regarded, unattractive and bewildering designs are resolved into emblems of divinity and demonstrations of lineage He traced the evolution and defined the attributes of Tiki, explained the nature of oromatuas and the meaning of unus, described the various methods of recording pedigrees, whether along a male or along a female line, and illustrated the mythical use of tapa and sinnet He discussed, as modes of origin, totemism, gemmation, and generation, of which Polynesian examples were given, tabulated the kinship of the superior gods, set forth in full the Tane cult, especially in relation to the axe and the drum, and endeavoured, in conclusion, to account for the development of the complicated Mangaian adze

EDINBURGH

Royal Society, December 5 —Sir Douglas Maclagan, President, in the chair —After an introductory address by the President, a note by Prof Cayley, on uniform convergency of series, was read —Prof Tait communicated a note by Prof P. H Schoute, of Groningen, on the locus of a uniformly revolving line, which always passes through a point moving uniformly round a circle, and which always lies in a normal plane passing through the centre of that circle The degree of the locus is found by an elegant and very simple method —Dr C Hunter Stewart gave notice of a paper on the further development of Kjeldahl's method of organic analysis. The carbon, as well as the nitrogen, present can be determined by the same analysis in the developed method, and much smaller quantities than formerly of the substance analyzed lead to results as accurate as those previously obtained —Prof Tait read a note on the division of space into cubes He gives a different, and more direct and short, solution by quaternions than that given by him some years ago

PARIS

Academy of Sciences, December 26.—M d'Abbadie in the chair —Thermal elevation under the influence of injections of soluble microbian products, by MM Bouchard and Charrin An elevation of temperature recalling that observed by Koch is produced in a marked degree in tuberculous patients by injections of the toxic substances secreted by the pyocyanic bacillus. —Vessels and clasmocytes of the hyaloid in the frog, by M. Ranvier —Observations of Holmes's comet (November 6, 1892) made with the great equatorial of the Bordeaux Observatory, by MM G Rayet and L. Picart, report by M Rayet.—Observations of Swift's comet (1892, I) made with the great equatorial of the Bordeaux Observatory, by MM. G Rayet, L Picart and F Courty, report by M Rayet —On the laws of dilatation of fluids at constant volume, coefficients of pressure, by M E H Amagat —Observations of Holmes's comet, made with the *equatorial coudé* (32 cm) of the Lyon Observatory, by M G Le Cadet —New experimental researches on the personal equation in transit observations, by M P Stroobant —On conjugate systems and couples of applicable surfaces, by M. A Petot —On infinitesimal deformation and Bianchi's associated surfaces, by M E Cosserat —On contiguous surfaces relative to the hypergeometrical series with two variables, by M Levavasseur —Test for the convergence of series, by M A. de Saint-Germain —Criterion of divisibility by any number, by M Fontés —On the motion of a particle in the case of a resistance proportional to the velocity, by M Elliott —General form of the law of vibratory motion in an isotropic medium, by M E Mercadier —Employment of springs in the measurement of explosive pressures. If errors due to the inertia of the moving parts of the indicator are to be avoided, the amplitude of the

tracing point must not exceed 1 mm in the case of pressures used in modern firearms. This necessitates careful reading with a microscope.—On the decrease of temperature of the air with the elevation, by M. Alfred Angot. Experiments conducted on the Eiffel Tower indicate a decrease for each 100 m., between the soil and a height of 160 m. ranging from 0·6° in December to 1·46° in June. Between 160 m. and 302 m. the decrease per 100 m. ranges from 0·64° in February to 0·96° in October. At 300 m. the decrease per 100 m. is on the average 0·5° in winter, 0·6° in autumn, 0·7° in spring, and 0·8° in summer.—On the temperature of the electric arc, by M. J. Violle. From calorimetric measurements made with a portion of the arc light carbon detached from the hottest part during the passage of the current, the temperature of the arc, *i.e.* that of the volatilization of carbon, appears as 3500°, assuming the carbon to have its theoretical specific heat, 0·52, at the higher temperatures. This temperature of volatilization is constant, whatever the power employed.—Remarks on high temperatures and the vaporization of carbon, by M. Berthelot. The vapour tension of carbon is quite appreciable even below volatilization, which involves the reduction of a polymer to the monomolecular state, thus in reality representing a chemical process. Higher temperatures than that of the arc can be attained by purely chemical means, such as the explosive combustion of a mixture of oxygen and cyanogen.—On the equality of velocities of propagation of electric waves in air and along conducting fibres, verified by the example of a large metallic surface, by MM. Ed. Sarasin and L. de la Rive.—On nets of electric conductors; reciprocal properties of two branches, by M. Vaschy.—On the enfeeblement of electromagnetic oscillations with their propagation and their subsidence, by M. A. Perot.—Determination of the coefficients of self induction by means of electrical oscillations, by M. P. Janet.—Doppler Fizeau's method, exact and approximate formulæ, evaluation of the error involved, by H. de la Fresnaye.—Magnetic properties of oxygen at different temperatures, by M. P. Curie. A series of measurements with oxygen compressed to 5 and to 18 atmospheres respectively gave identical results at temperatures between 20° and 450°. Within this range, the volume coefficient of specific magnetization of oxygen varied inversely as the absolute temperature. The volume coefficient of magnetization of air at the ordinary pressure and at temperature t is given by $10^6 k_t = 2760 \times T^{-2}$, where T is the absolute temperature.—On the rotatory power of quartz at low temperatures, by MM. Ch. Soret and C. E. Guye.—On the fusion of carbonate of lime, by M. A. Joannis.—Ammoniacal compounds derived from ruthenium sesquichloride, by M. A. Joly.—On an iodo-sulphide of phosphorus, by M. L. Ouvrard.—Action of bismuth on hydrochloric acid, by MM. A. Ditte and R. Metzner.—Action of potash and soda on the oxide of antimony, by M. H. Cormimbœuf.—Relation between the heats of formation and the temperatures of the point of reaction, by M. Maurice Prud'homme.—On the study of the chemical reactions in a liquid mass by the index of refraction, by M. C. Féry.—On a propylamidophenol and its acetyl derivatives, by M. P. Cazeneuve.—Quantitative determination of impurities in the methylenes, by M. Er. Barillot.—Separation of micro organisms by centrifugal force, by M. R. Lezé.—Loss of nitrogen in manures, by MM. A. Müntz and A. Ch. Girard.—Fermentation of manure, by M. A. Hébert.—Drying up of marshes in Russia, by M. Venukoff.—Chemical conditions of the action of ferments, by M. J. Effront.—On trichophytia in man, by M. R. Sabouraud.—Evolution of the functions of the stomach, by M. J. Winter.—On the histology of the organs attached to the male apparatus in *Periplaneta orientalis*, by M. P. Blatter.—On the presence of a fossil Araliaceæ and Pontederiaceæ in the coarse Parisian limestone, by M. Ed. Bureau.—On a new geological map of the French and Spanish Pyrenees, by MM. Emm. de Margerie and Fr. Schrader.—Differential motion of the ocean and the atmosphere; water tides and air tides, by M. F. de Saintignon.—On the perforation of the basaltic rocks of the Gulf of Aden by shingle; formation of a Giant's Kettle, by M. Jousseaume.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, JANUARY 5.

ROYAL INSTITUTION, at 3.—Astronomy: Sir Robert S. Ball, F.R.S.
LONDON INSTITUTION, at 6.—Jewish Wit and Humour: The Rev. the Chief Rabbi.

SATURDAY, JANUARY 7.

ROYAL INSTITUTION, at 3.—Astronomy: Sir Robert S. Ball, F.R.S.

SUNDAY, JANUARY 8.

SUNDAY LECTURE SOCIETY, at 4.—In Search of Pharaoh—Ancient Egypt: its Temples, Pyramids, Monuments, and Mummies (with Oxy-hydrogen Lantern Illustrations): Whitworth Wallis.

MONDAY, JANUARY 9.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Qualitative Analysis of Colouring Matters: A. G. Green.—The Proportion of Free Fatty Acids in Oil Cakes: Dr. B. Dyer.—Further Notes on Nitrous Oxide: Watson Smith.
ARISTOTELIAN SOCIETY, at 8.—The Psychology of the Subconscious: A. Boutwood.
LONDON INSTITUTION, at 5.—Social Pictorial Satire (Illustrated): G. du Maurier.

TUESDAY, JANUARY 10.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—A Contribution to the Ethnology of Jersey: Dr. Andrew Dunlop.—Points of Contact between Old World Myths and Customs and the Navajo Myth, entitled "The Mountain Chant": Miss A. W. Buckland.

WEDNESDAY, JANUARY 11.

GEOLOGICAL SOCIETY, at 8.—Variolite of the Lleyn and Associated Volcanic Rocks: Miss Raisin (Communicated by Prof. T. G. Bonney, F.R.S.).—On the Petrography of the Island of Capraja: Hamilton Emmons (Communicated by Sir Archibald Geikie, For. Sec. R.S.).

THURSDAY, JANUARY 12.

MATHEMATICAL SOCIETY, at 8.—On the Application of Clifford's Graphs to Ordinary Binary Quantics, 2nd Part, Seminvariants: The President.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Experimental Researches on Alternate-Current Transformers: Prof. J. A. Fleming, F.R.S. (Discussion.)
LONDON INSTITUTION, at 6.—Electric Lighting (1) Generation of Electric Currents: Prof. Silvanus Thompson, F.R.S.

FRIDAY, JANUARY 13.

PHYSICAL SOCIETY, at 5.—Upon Science Teaching: F. W. Sanderson.
AMATEUR SCIENTIFIC SOCIETY, at 8.—Geology in 1892: A. M. Davies.—Recent Developments in the Metallurgy of Gold: T. K. Rose.

SATURDAY, JANUARY 14.

ROYAL BOTANIC SOCIETY, at 3.45.

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THURSDAY, JANUARY 12, 1893

AMERICAN MECHANISM

Modern Mechanism Edited by Park Benjamin, LL B , Ph D (London and New York Macmillan and Co , 1892)

IN order to appreciate this volume thoroughly, it is necessary in the first instance to consider the reason for its existence Appleton's "Dictionary of Engineering," an American book, was published in the year 1851, and was the first to gather in cyclopedic form descriptions of products of American mechanical industry Some thirty years afterwards it became necessary to bring the work up to date, and its complete reconstruction was decided upon The editor observes that no previous work of a technical character had so signally, and so quickly, demonstrated its own usefulness, it rapidly became a recognized standard of American mechanical practice Owing, however, to the great progress made in mechanical invention, and the marvellous rapidity with which electrical science has advanced, a new record of the results has become necessary, and hence the present volume

The list of contributors includes the names of eminent men, well known in this country for their high attainments in the different branches of mechanical and electrical engineering, forming a sure guarantee that the information to be gleaned from the pages is valuable and accurate It would be impossible in the space at our disposal to notice more than a small part of the contents Some interesting information is to be found on the subject of aerial navigation, more particularly the interesting experiments being carried out by Mr Hiram S Maxim Commenting on Prof Langley's statement, that with a flying machine the greater the speed the less would be the power required, Mr Maxim says "In navigating the air we may reason as follows if we make no allowance for skin friction and the resistance of the wires and framework passing through the air—these factors being very small indeed at moderate speeds as compared to the resistance offered by the aëroplane—we may assume that with a plane set at an angle of 1 in 10, and with the whole apparatus weighing 4000 pounds, the push of the screw would have to be 400 pounds Suppose, now, that the speed should be 30 miles an hour, the energy required from the engine in useful effect on the machine would be 32 horse-power (30 miles = 2640 feet per minute, $\frac{2640 \times 400}{33,000} = 32$) Adding 20 per cent for slip of screw, it would be 38 4 horse-power Suppose, now, that we should increase the speed of the machine to 60 miles an hour, we could reduce the angle of the plane to 1 in 40, instead of 1 in 10, because the lifting power of a plane has been found to increase in proportion to the square of its velocity A plane travelling through the air at the rate of 60 miles an hour, placed at an angle of 1 in 40, will lift the same as when placed at 1 in 10, and travelling at half this speed The push of the screw would therefore have to be only 100 pounds, and it would require 16 horse-power in useful effect to drive the plane Adding 10 per cent for the slip of the screw, instead of 20, as for the lower speed, would increase the engine power required to 17 6 horse-power These figures, of course, make no allowance for any loss by atmospheric friction Suppose 10 per cent to be consumed in atmospheric resistance when the complete machine was moving 30 miles an hour, it would then require 42 2 horse-power to drive it Therefore at 30 miles an hour only 3 84 horse-power would be consumed by atmospheric friction, while with a speed of 60 miles an hour the engine power required to overcome this resistance would increase eightfold, or 30 7 horse-power, which, added to 17 6, would make 48 1 horse-power for 60 miles an hour "

Mr Maxim goes on to observe that his experiments show that as much as 133 pounds can be carried with the expenditure of 1 horse-power, and under certain conditions as much as 250 pounds It will be evident, therefore, that the question of motors is all important, and that the total weight per horse-power developed must be as low as possible It is stated that the greatest force can be obtained from a compound high-pressure steam engine using steam at 200 to 350 pounds pressure, and such engines have been constructed weighing 300 pounds , the horse-power of these engines is not stated

It will be interesting to watch the outcome of these investigations They indicate that much information is being accumulated, and that sooner or later a successful aerial machine will be forthcoming

The question of armour plates has long vexed the soul of the British Admiralty , many very costly trials have been carried out in order to find the most suitable plate for the service All these data have probably been known in the States, and that country must have benefited by them Under this heading we find much information in the book, American experiments being quoted and illustrated Naturally, the Americans wish to make their own plates, and wisely endeavour to do so by rolling only, to do without the heavy expense of forging These experiments show that the high-carbon nickel Harveyed plate is undoubtedly the best plate ever tested As a result of these trials, orders have been placed for plates for the cruisers under construction An excellent full-page engraving is given of the U S armoured battle ship *Indiana*, and to judge by the blackness of the smoke she is not using Welsh coal ! The article on steam boilers is well written, and very complete, containing much useful information Among the many types of boilers illustrated there is a good print of the Yarrow torpedo boat boiler We miss however, the familiar Thornycroft boiler, and note an American water tube-boiler for fast launches very like the Thornycroft in the arrangement of the tubes

The boilers for marine purposes are purely of the British type, and there is nothing of importance to note on this subject beyond the many experimental results recorded.

Further on in the book there is an interesting description of railway-car heating We are told that car-heating, in the usual acceptance of the term, has come to mean the heating of railway cars by the use of steam from the locomotive This is important, showing as it does the direction in which American railway companies are moving in the solution of a problem at present occupying the best attention of engineers in this country Gener-

ally, we are told, the systems consist of a separate hot-water circulating system in each car, in connection with a heater, fed by steam from the locomotive, by a continuous train pipe running the length of the train, and coupled together between the cars by flexible hose-pipes and universal couplings; the Sewall steam coupler being generally used. Another important railway necessity is the continuous brake Under this heading the latest form of Westinghouse quick-action automatic brake is described In the original design the brake is applied by the engine-driver allowing a little air to escape from the train pipe, lowering the pressure, and thus applying the brake by the automatic action of the triple valves It is evident that the vehicle next the engine will feel this reduction first, and its triple valve will work before that on the second vehicle, and so on On trains of ordinary length this very slight difference in time between the brake's application on each vehicle is of little consequence, but when this automatic brake is fitted to a long goods train it becomes a serious matter The length of a goods train of fifty American cars is 1900 feet, and the brake should act instantaneously to be perfect The new triple valve is itself designed to discharge air from the train pipe, so on the driver opening the driver's valve, allowing air to escape to apply the brakes, the reduction of pressure operates the triple valve on the first car; this lets out more air, and so on through the train, the brake on the last car, 1900 feet away, being operated in 2 5 seconds after that on the first car

The vacuum automatic brake is not described or illustrated This brake is now being more and more brought into use, and for general purposes it appears to be simpler and less liable to get out of order than its competitors

A considerable part of the volume is taken up with the applications of electricity, for lighting and motive power purposes generally On dynamo electric machinery much has been written and well illustrated. The reader is taken step by step from the rudiments of the subject to its latest applications, from a description of armatures to the arrangements of the field-magnets, then to the varying designs of dynamos, including most of the known machines The same may be said on the treatment of the electric motors Under the head of the transmission of power there is more useful information to be found, this being all the more interesting, because of the proposed use of electricity as a means of transmitting some of the power of Niagara to distant towns There is, however, something wanting under the heading of electrical measuring instruments. The only ones mentioned are Weston's volt and ammeters At the present time the street tramways of this country are in an uncertain stage as far as motive power is concerned; horse-power is admittedly expensive, the steam locomotive seems to have got into disrepute, the cable and electric traction appear to be struggling for the mastery It is interesting therefore to read the memoir on electric traction in this volume The accumulator system is just described, but the overhead cable or trolley system takes up the greater part of the space, so it is safe to assume that the latter is more generally in use, the principle of which is as follows. the current starts from the positive brush of the dynamo, passing out to the main conductor, suspended over the middle of the track, and along this conductor until it reaches the point where the trolley of one of the motor cars is in contact Here it divides, and a portion passes down through the trolley to the motors, and thence to the rails forming a return lead to the negative brush of the generator The main portion of the current passes on to feed other cars upon the line in the same manner, each car taking the quantity of current necessary to develop the required power There are at the present time nearly 500 electric railways in America, and taking the results of twenty-two electric trolley lines, we find that the expenses vary per car mile from 22 99 cents to 7·89 cents, the highest and lowest respectively A view is given of the electric street railway at Washington, D C, the overhead conductors being not at all unsightly

On electric welding there is also much information, the Thomson process being very fully described It consists briefly in completing the electrical circuit through the parts to be welded together, the resistance being sufficient to heat the parts so as to weld them, this being assisted by pressure

The Bernado process is not described, in this process the work to be welded is connected to one terminal of the dynamo The positive terminal being connected with a carbon rod, held in a portable insulated holder, the carbon rod is then placed on the work, and immediately withdrawn slightly, thus forming an arc, where the metal melts, and with skill much can be done.

The locomotive practice in America has long been of interest to locomotive engineers in this country, owing to the many differences in design and practice A very good *résumé* of American practice is to be found in the memoir under this heading A useful table is given showing a few leading dimensions, weights, &c, of typical engines in use Take, for instance, the express passenger engine, a four-coupled bogie engine, the cylinders being 20 inches in diameter and 24 inches stroke The driving or coupled wheels are 72 to 78 inches in diameter The weight on coupled wheels is 75,000 pounds (33 48 tons), the total weight of the engine being 116,000 pounds (51 78 tons), and that of the tender 72,000 pounds (32 14 tons Comparing these data, we find that the American engine is heavier than an 18×26 cylinder British engine and not so powerful, assuming equal steam pressures, the tender is light in a similar comparison, probably carrying less water The reputed weight of trains hauled given in the table is of little use, because the speeds are not given, and for this reason comparisons cannot be made

The paragraph on locomotive boiler construction is far too short, many interesting details might have been added It is stated that the circular smoke-box tube plate is a conspicuous difference between the practices of the two countries, being purely American, whereas the Midland Railway Company have, amongst others, used the arrangement for some time Owing to the enforced use of anthracite coal in certain parts, many peculiar designs of locomotive boilers have been used, the Wootten boiler being probably the most common All, however, have particularly large grate areas, which, in the case of the Wootten, may in some cases exceed 76 square feet, or four times the area of the grate of

recent British engines. An illustration is given of an engine of this type, as well as a full-page engraving of a compound locomotive with a similar boiler. This compound is very different from the Webb or Worsdell engines common in this country, being the design of the superintendent of the Baldwin Locomotive Works. The cylinders are outside the frames—there are two on each side, viz. one high-pressure and one low-pressure. The distribution of the steam being effected in each pair by one piston valve, each pair of pistons is connected to one crosshead, coupled in the usual way to the wheels.

A compound engine of the "Webb" type is also illustrated. This engine was constructed to Mr. Webb's designs in this country for the Pennsylvania Railway in 1889. It is stated that the results of experiments showed a saving of fuel over the ordinary engine of from 20 to 25 per cent.

This book is so full of interesting matter of so varied a nature that it would be possible to prolong this notice far beyond the space available. Take, for instance, agricultural machinery; the Price ploughing outfit is typical of the rest, consisting of a traction engine drawing four gangs of three ploughs, the twelve ploughs cutting eleven feet wide. The subject of milling tools is also of interest, because it is only during the last few years British engineers have used this means of shaping metals, the system having been brought into general use in the States.

Under the head of the manufacture of steel all the usual processes are described. We are informed that the Whitworth compression process is only partly successful in the formation of sound ingots; with this statement we cannot agree; the Whitworth steel ingot after compression is certainly sound throughout.

Taking into consideration the great mass of information contained in the 900 odd pages of this work, and the general excellence of the matter accumulated, it is only just to congratulate the editor on the completion of a work which must prove useful to many, and which should find a place in all technical libraries. The volume goes far to describe modern American mechanism, exhibiting the latest progress in machines, motors, and the transmission of power.

SEEDLINGS.

A Contribution to our Knowledge of Seedlings. By the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., D.C.L., LL.D., with 684 figures in text. In two volumes. (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1892.)

SEEDS and seedlings have occupied the attention of Sir John Lubbock for a somewhat lengthened period. They have formed the subject of various communications, on his part, to the Journal of the Linnean Society and other publications. In the present volumes, modestly styled a "contribution," he gives us the details upon which his inferences have been founded.

The physical and chemical aspects of germination are entirely passed over, but the morphological phenomena are treated with a fulness never before attempted. The author has availed himself of the resources put at his disposal by the authorities at Kew, where the larger proportion of the seedlings described were grown expressly for the purpose. The Natural History Museum and the Cambridge Botanic Gardens have also been requisitioned, and much help has been rendered by capable assistants, whilst the services of Sir Joseph Hooker and Mr. Rendle, in looking over the proof sheets, are duly acknowledged. A work of such dimensions, crowded with detail, could hardly have been produced without such zealous co-operation. Nevertheless unity of plan and uniformity of treatment are conspicuous throughout, and thus comparison is readily effected.

Some previously published papers in the Journal of the Linnean Society, dealing with the causes which determine the form of leaves and cotyledons, are reprinted as the introduction to the treatise. The conclusion therein arrived at is that the form of the embryo, and especially that of the cotyledons, is essentially influenced by the form of the seed. On p. 78 the author begins the detailed examination of seedlings taken from almost all the orders of flowering plants. Five hundred and thirty succeeding pages in the first volume, and five hundred and eighty-eight in the second volume, are thus occupied. This little bit of statistics will serve to show the amount of detail which is contained within these volumes. The plan adopted is to give, first of all, a general sketch of the principal modifications exhibited by the fruit and seed in each order. Then follows a more detailed description of the seed and of the seedling plant in various representatives of the order. As these descriptions are identical in plan throughout, they are of great value to the student of comparative morphology. Naturally some orders are much better represented than others, but sometimes the omissions are rather unfortunate. In the genus Araucaria, for instance, seedling representatives of which are common in botanic gardens and nurseries, the diversities in the form of the seedling and in the mode of germination are very remarkable. "Characters" derived from the seedling plant have been recognized as of the highest importance for classificatory purposes since the time of John Ray (1682–1703).[1]

But whilst this is generally the case, such extraordinary exceptions as that mentioned in Araucaria are very noteworthy, and not less so because the genus in question is one of the very oldest of which fossil botanists have cognizance.

Myrtaceæ and Sapindaceæ are remarkable for the extremely diverse character of the embryo in different genera, and of which due note is taken in Sir John Lubbock's book. In Rosaceæ, on the other hand, the diversity is much less, nor is there any important morphological difference in the seedlings of the great order Compositæ, and scarcely more in Umbelliferæ, so far as they are known. These are facts of great significance with reference to the theories of inheritance and relative antiquity of groups.

[1] It may not be without interest to cite what Ray says on this matter:—"Floriferas dividemus in *dicotyledones* quarum semina sata binis foliis anomalis, seminalibus dictis, quæ cotyledonum usum præstant, e terra exeunt vel in binos saltem lobos dividuntur, quamvis eos supra terram foliorum specie non efferant; et *monocotyledones* quæ nec folia seminalia bina efferunt nec lobos binos condunt." Thus Ray not only recognised the presence of one or of two cotyledons, but also their nature and their epi- or hypogeal condition. As Ray has been mentioned, it is certainly not inappropriate to allude to Grew also, for the first chapter of his "Anatomy of Plants" (1682), and the whole of the fourth book is devoted to the seeds and seedlings, and in perusing them the reader will perceive that Sir John Lubbock has in a few cases been anticipated by his celebrated predecessor.

The gradual evolution of the perfect plant from the seedling is indeed a subject of great interest to the phylogenist, although it is difficult—nay, impossible—to separate those appearances which are merely hereditary from those which are the result of varying outward conditions, the more so because analogous conditions must have influenced the ancestors in past times even as they affect their successors now

Amid such a mass of detail it is difficult to pick out points worthy of special note We select two only out of many scores that might be mentioned Some Onagrads are remarkable for the intercalary growth which takes place in the cotyledons, of which several illustrations are given in Sir John Lubbock's book They call to mind the experiments of the late Prof Dickie, who, by suppressing the plumule of seedling castor-oil plants, succeeded in inducing the cotyledons to continue their growth and to assume dimensions much greater than that which is habitual to them

The small tubercles on the root of *Myrica californica* (vol ii p 523, Fig 663) have, so far as we know, not previously been observed The author compares them to those found on *Alnus cordifolia*, and it would be interesting to ascertain whether these outgrowths are caused by an organism analogous to *Schinzia alni*, as described by Woronin, or to that which induces the peculiar tubercles on the roots of Leguminosæ, recently studied by Prof Marshall Ward

Monocotyledons generally have been rather badly treated by the author, although such genera as Potamogeton, Aponogeton, Orontium, and other Aroids, and Palms (of which not a single illustration is given) would have furnished examples at once interesting and easily accessible

The work includes nearly seven hundred illustrations, faithfully executed, and very valuable to the student The bibliography, in spite of its occupying no fewer than thirty-eight pages, is the weak part of the book. Some of the most important references are omitted, and whole series of species whose mode of germination has been recorded and some times figured, have been passed over This only shows how colossal has been the task which Sir John Lubbock has set himself We do not think the worse of the sun for having a few spots on his disc, nor are botanists at all likely to disparage this work because further research might have added a few more illustrations As it is, it forms one of the most substantial and important contributions to botanical literature that have ever emanated from the press It must continue to be a standard book of reference for generations, and it will, we hope, stimulate observers, according to their several opportunities, to prepare similar monographs on the various organs of plants.

MAXWELL T. MASTERS

EPIDEMIC INFLUENZA

Epidemic Influenza a Study in Comparative Statistics. By F. A. Dixey, M A., M D (London Henry Frowde and H. K. Lewis, 1892)

AFTER an epidemic disease has visited a country, when the pathologist and practical physician have had their say, there still remains the work of the statistician to be done. It is his province to sum up the results of the visitation in the clear light of hard figures, and to trace its onset and decline in mathematical curves Such work is of value in more than one direction It preserves for future generations a definite record of an epidemic of greater precision than the impression left on the mind of the physician it enables a comparison to be drawn between our own experience and that of other countries by the sifting and sorting of facts which it necessitates it may lead to the discovery of relationships with allied diseases which may prove of no small value to the pathologist

This work has been done for influenza by Dr Dixey in a very thorough and painstaking manner from the material collected under the supervision of the Registrar-General It says much for the completeness of our registration system in London, that it is possible to compile from them such tables and curves as those with which we are presented in this work, nor are such materials available from any other city in Europe The only cities whose statistics have been found by Dr. Dixey sufficiently accurate for comparison with our own are Paris and Berlin

Dealing first with the epidemic of 1889-90, he shows in Table 1 the rise and progress of the disease in London, as indicated by the weekly returns of fatal cases, grouped according to the seven age periods adopted in the official returns Table 2 gives us, so far as the returns of the period permit, the similar figures for the epidemic of 1847-48 The similar characters of the two epidemics are strikingly illustrated: in both we see the same extreme suddenness of rise, and the same features of decline, rapid at first, but becoming gradually slower during the succeeding months In the next two tables are included similar figures for Paris and Berlin, and in these, and in Table 5, the author gives an analysis of the meteorological conditions accompanying the rise and fall of the epidemic in the three cities These are of interest as showing how little influence the weather had on the course of the disease as a whole

In the tables which follow—which are perhaps of greater interest than any of the others Dr Dixey has compiled—the effects which influenza has exerted on the mortality from other diseases in London and other cities are shown These effects are of two kinds influenza may aggravate the mortality of pre-existent disease such as phthisis or heart disease, or diseases such as bronchitis or pneumonia may occur as complications of influenza and swell its death-roll It is interesting to observe that whereas in 1847-48, which was in all respects a more fatal epidemic than that through which we have just passed, bronchitis showed the most extreme departure from the normal mortality, pneumonia holds that place in the late epidemic, while bronchitis falls into the second rank. In this connection may be mentioned a point of much interest illustrated in Tables 10, 11, and 12, which deal with the age incidence of influenza and its concomitant diseases It is possible to draw curves showing the special age incidence of each, and each curve has its own special features. Now during an influenza epidemic the pneumonia curve is found to be modified so as to take on some of the characters of the influenza curve, thus affording corroborative evidence of a conclusion already reached both in this country and in

Germany, that influenza may occur sometimes as an apparently primary pneumonia

The remaining tables deal with the data afforded by the epidemics of 1891 and 1892 in this country and abroad That of 1891 is shown to have been much more fatal, especially at advanced periods of life, than that of 1890, while that of 1892, here treated of with less fulness than the preceding, seems to have been of still greater severity Those who would follow Dr Dixey into the details of these outbreaks must study the work for themselves It is a contribution to statistical literature of very great value, and will save an infinity of labour to those engaged in the study of influenza.

A word of praise must be bestowed in conclusion upon the graphic charts with which the tables have been illustrated, those in particular which deal with the mortality curves from influenza and its allied diseases These have been calculated and mapped out as percentage deviations from the mean, and show the main facts at a glance in a way which mere columns of figures fail to do Those also which illustrate the age incidence of the diseases in question are of great value

OUR BOOK SHELF

An Elementary Text-Book of Hygiene By H Rowland Wakefield (London Blackie and Son, 1892)

THE appearance of yet another elementary text-book upon the subject of Hygiene has the effect of aggravating the *embarras de richesses* which already obtains in this department of study, one is therefore justified in questioning the utility of the present volume, and on reading in the preface that it is adapted to the requirements of the Science and Art Department, there is all the more matter for surprise at its appearance in the face of three other publications—each better than the present—which have been written to meet the same end

The manual is well printed and concisely written, and a surprising amount of matter is condensed within its tiny compass This latter fact, however, is not entirely a matter for congratulation, for apart from making the book "dry reading," it must have the effect of rendering it in many places difficult of comprehension to those for whom it is intended, *i e* those who approach the subject with no prior knowledge whatever

And thus it comes about, that in less than 200 small pages the whole range of Hygiene is surveyed, including chapters upon Eyes and Sight, School Hygiene, House Sanitation, Personal Hygiene, Parasites, Infectious Diseases, Accidents and Injuries

Though the material given has been on the whole well selected and carefully compiled, the work is a little uneven, one finds seventy-three pages devoted to "food," whereas "water" is dismissed in seventeen, and "sewage and its removal" in eleven.

Here and there is evidence of the fact that the author is not of the profession to which Hygiene holds a filial relation, and that he was not quite at home with some of the departments of the subject—even in their elementary form—which he had set himself the task of handling, the very few errors and ambiguities which this fact is accountable for, are, however, too trivial to much affect the general accuracy of the book

The small work will doubtless suffice for the examination requirements of those for whom it is intended, but the brevity and superficiality of treatment which is so frequently apparent within its pages, will not justify one in recommending it to those who wish to lay a good and useful foundation for a study of the science of Hygiene.

Ostwald's Klassiker der Exakten Wissenschaften Nos. 38–40 (Leipzig W Engelmann)

WE are glad to note the addition of three volumes to this admirable series No 38 is the second part of the original account of the photochemical researches of R Bunsen and H. E Roscoe (1855–59) The other volumes are translations of a paper by Pasteur on the minute organic bodies in the atmosphere (1862), and of papers by Lavoisier and Laplace on heat (1780 and 1784) In all the volumes there are figures in the text

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

Geographical Names

AS the names of places given to the public with the authority of the Geographical Society of London are very apt to be accepted by geographers and be ultimately inserted in atlases and works on geography, I have to call attention to the paragraph "Nomenclature of the Karakoram Peaks," under "Geographical Notes," p 857, in the December number of the Proceedings of the R G S, 1892, which I have lately read It is to be regretted that so much reliance and importance has been placed on what a native drew on the sand, and the names he gave to various peaks Natives are not always to be depended upon, not even when the topographical features are in sight, and unless verified from other and independent information, the names they give cannot be implicitly trusted and placed on record, as is so well exemplified in this case The traveller must also have a considerable knowledge of the native languages or he may be very much misled As fortunately I know both the places bearing the names given for two very conspicuous peaks, it may not be too late to prevent these names thus put forward from being accepted and perpetuated "Skeenmung" or "Skinmang" is the name of a comparatively level piece of somewhat grassy ground at the great bifurcation of the Punmah Glacier, the name itself is expressive and is derived from "*Skeen*" an ibex, and "*Mang*," a level place in Balti = *Marg*, Kashmiri, *Maidan* Hindustani—which disposes of it as a likely designation for a peak

Next we have "Chiring" given as the name of K2, the second highest peak in the Himalayas, quite as inaccurate, for it happens to be the name of another camping spot or bivouac at the end of a spur and about halfway between Skeenmang and the Mustakh pass, as used about the period I was there (1860). It is situated just above a very narrow part of the glacier, where its action is most marked on the rocky sides "*Chirna*" in Hindustani is to rend, tear, and Chiring Gause is the name of all that portion extending six miles up to the main watershed

H H GODWIN-AUSTEN

Shalford Park, Guildford, January 7

The Weather of Summer.

THE number of days with rain, in summer, at Greenwich, during most of this century, has been subject to a pretty regular fluctuation The curve (from 1825) having been smoothed by means of five-year averages, we obtain that shown in the diagram And putting with it a curve of sun-spots, we find a strikingly definite correspondence (somewhat "lagging" in character) throughout at least four of the sun spot cycles, the rain day maxima coming soon after the sun-spot maxima, and rain day minima soon after sun-spot minima In recent years, however, the curves appear to have got out of step (*so to speak*) with each other; so that, *e.g.* we find a rain day *maximum* in 1880, two years after the sun-spot *minimum* of 1878, and a rain day *minimum* in 1885, two years after the sun-spot *maximum* of 1883.

I do not remember to have seen the facts of our summer weather put in this way. But it is well known that, in the discussions which arose some time ago about sun-spots and rainfall, there appeared some reason to believe that in the period of

those four earlier sun-spot cycles, at least, we had had, on the whole, wetter years about sun-spot maxima than about the minima. A good deal was written on the subject (as your own columns show) in the seventies, and the data used seem to have been generally those of annual rainfall Of late, apparently, the matter has attracted less notice, for the reason (I suppose) that the correspondence referred to has not been maintained, and recent facts have seemed rather against the theory of a causal relation between the two orders of phenomena

Thus the teaching of the curve here given appears to harmonize, in general, with known facts about annual rainfall. I do not propose to try and weigh the data so far as they may be considered to favour the theory just indicated (earlier and greater part of the curve), nor the data which may be considered adverse (in the short, later part) It seems to me that the curve may be usefully studied *per se*, apart from any relation to sun spots. Thus we might note the fact that all those maxima where our summers have got to a turning point from wet to dry have been quite near the beginnings of the decades The dates are 1830, 1839, 1850, 1861, and 1880 The curve ends at 1890 (the final point representing, of course, 1888–92), and the position of this point, together with the date, seem to warrant our

Smoothed curve of rain days in Summer at Greenwich, with curve of Sun-spots

looking for an early descent of the curve, and a commencing series of (on the average) drier summers than we have had lately

We might also note that the minima of the curve have ranged from the fives to the eights. Thus we have, 1827, 1835, 1845, 1857, 1868, 1885 Should the recurrence continue, we might look for the next minimum about 1895–1898 Of course there may be difference of opinion as to the strength of the presumption here afforded for such a forecast, and no good reason is offered (beyond experience) why the curve should now take the course roughly indicated.

It is not at variance with the above view that there is reason, it would appear, to anticipate soon a series of wetter *years* In an article contributed to the *Times* of October 22 last year (cited in NATURE, vol xliv. p 630) Mr. Symons says · "There is no doubt that since 1887, at all events, the rainfall over England has been much below the average, and a consideration of all the facts leads to the conclusion that such a period of scarcity is very likely to be followed by one of abundance, and that the coming few years will probably be more rainy than those recently experienced, although possibly the increase will not occur in the summer months—at a time when it would be most noticed "

A B M

"Aminol"

MY attention has only now been called to the letter of Dr Klein, which appeared in NATURE, *ante*, p. 149.

To the remarks referring to "Aminol" (with Periodate I am in no way concerned) I desire, with your kind permission, to make the following reply, as they contain inaccuracies which, if not corrected, must do me injury

The samples of "Aminol" alluded to by Dr Klein were sent by me to a number of medical practitioners who had kindly consented to give it a trial. The strength of the samples was 1 in 5000.

Dr Klein has carried out between September, 1890, and March, 1891, five separate consecutive series of experiments with "Aminol," with the object of testing its applicability to the treatment of certain external disease processes His results are recorded in a report, the summary and conclusions of which were published last year with his full approval The strength of solution employed in the first four series (which were only of a tentative nature with a view to arrive at a proper strength of solution for practical application) was 1 in 6000, in the fifth series a solution of the strength of 1 in 600 was used. Dr Klein's letter leads one to suppose that he operated only with the latter strength

The pathogenic germs selected for testing the power of the disinfectant were spores of *Bacillus anthracis*, sporeless *Bacillus anthracis*, *Staphylococcus aureus*, *Bacillus diphtheriæ*, and *Streptococcus erysipelatis*. Amongst the results obtained with the solution of the strength of 1 in 6000 his report mentions the following: In Series IV, "On *Staphylococcus aureus*, which may be taken as the most resistant microbe amongst those associated with surgical and other external disease processes, the "Aminol" solution (1 in 6000) did produce an effect, though a limited one, after two hours already, and after twenty four hours destroyed the microbes" In Series I - "'Aminol' solution (1 in 6000) kills the *Bacillus diphtheriæ* in two hours This was confirmed in Series III" In this connection it deserves to be noted that I possess already ample evidence, which will be published in due course, of conspicuous successes obtained in practice not only with the solution of the strength of 1 in 5000, but also with dilutions of the same, even to 1 in 20,000

Dr Klein's statement of the results which he obtained with "Aminol" in the strength of 1 in 600 is misleading He says "Spores of *Anthrax bacilli* remained unaffected after eight hours, only after an exposure of twenty-four hours did the number of living spores decrease, but some escaped disinfection even after so long an exposure Now what are the facts? I quote from Dr Klein's report —

"Spores of *Bacillus anthracis* after 1, 2, 8, and 12 hours	good growth
"Spores of *Bacillus anthracis* after 24 hours	growth reduced from 100 to 6"

Is it putting the case fairly or even clearly, seeing that no tests were made between twelve and twenty-four hours, to say "only after twenty four hours did the number decrease," and seeing that only 6 per cent remained after twenty-four hours? Is not that a decrease practically amounting to disinfection? Would it be extravagant to assume that the insignificant percentage remaining would be eliminated after a very little longer exposure (say another hour), and is there any doubt that a solution of the strength of 1 in 500 or 1 in 400 would have accomplished complete disinfection in a much shorter time than twenty four hours? But in order to illustrate the significance of the results actually obtained with this solution of the strength of 1 in 600, let us see which other disinfectants can kill anthrax spores in twenty-four hours. I quote from "Koch on Disinfection," abstracted and translated by Whitelegge, published by the New Sydenham Society ·—

(1) "For practical purposes a disinfectant should not require much longer than twenty-four hours"

(2) "Except chlorine, bromine, and iodine, only mercuric chloride, osmic acid, and potassic permanganate (5 per cent) destroyed anthrax spores within twenty four hours Since a 5 per cent solution of permanganate is inadmissible for disinfection in bulk, and osmic acid is out of the question, we have left only mercuric chloride and iodine, bromine, and chlorine"

The strengths in which the above-named substances succeeded in destroying anthrax spores in twenty-four hours are stated in Koch's tables thus.—

Permanganate,	aqueous solution	5 per cent	(1 in 20).
Bromine	,,	2 ,,	(1 in 50).
Chlorine	,,	?	
Iodine	,,	?	
Mercuric chloride	,,	1 per cent	(1 in 100).
Osmic acid	,,	1 ,,	(1 in 100).

Now put against this the fact, quoted above, that Dr Klein found "that 'Aminol,' strength 1 in 600, killed 94 per cent of anthrax spores in twenty-four hours," and further (I am quoting his report again), "that this solution is a perfectly harmless fluid as regards the human organism; therefore no undesirable disturb-

ances could ensue owing to its being absorbed, this is well known to be the fact with some antiseptics, as in carbolic acid applications or in the use of perchloride of mercury."

Does not all this clearly establish the claim of "Aminol" to be called not only a true disinfectant, but a most potent and a most safe one at the same time?

But with all this (I mean what relates to its effect on anthrax spores) its application in medical and surgical practice has nothing to do, unless it be to demonstrate its comparative potency, for, as Dr. Klein himself points out in his report, "The spores of *Bacillus anthracis* may be left out of consideration, as they do not occur in the living body, under these conditions the *Bacillus anthracis* is always sporeless, a malignant carbuncle of the skin contains the *Bacillus anthracis* only in the sporeless state, and in infection with anthrax generally the bacilli are always in the sporefree state both in the blood and in the tissues."

What is of real importance in practice is the effect of "Aminol" on the other pathogenic germs on which Dr Klein has tested it. And here again his letter states the case in a manner which is apt to mislead, "*Anthrax bacilli*, *Staphylococcus aureus* and others were destroyed, but only after a lengthy exposure"

Now what does his report say? "Series V From this series it will be seen, therefore, that the solution used in the same (1 in 600) acted very differently from that used in the previous experiments (1 in 6000) inasmuch as the *Staphylococcus aureus*, which was not killed heretofore in eight hours, was in this instance completely disinfected in that time, and was considerably reduced even in one hour The sporeless *Bacillus anthracis*, *Bacillus diphtheriæ*, and *Streptococcus erysipelatis* were killed in one hour" Can it be fairly said, then, that these were killed only after lengthy exposure, and does the word "only" apply at all to the one-hour results, when it is considered that there was no test made under the one hour? What is there to show that those of which there was no growth after one hour's exposure to the disinfectant had not been killed after ten minutes already?

Does it not look, then, as if Dr Klein had penned his letter without consulting either his notes or his report?

A word in conclusion Dr Klein, for whom perhaps nobody entertains a higher personal regard than myself, may rest assured that the designation, "a true disinfectant," is meant by me to apply only to such strengths of solutions of "Aminol" as can compete with those substances and their respective strengths to which Koch has accorded that appellation Nor need he to apprehend that anything has been or will ever be done by me intentionally committing him to what is not fully warranted by his actual results as recorded in his authorized published report

HUGO WOLLHEIM

101, Leadenhall Street, E C, January 2

THE point at issue between Mr Wollheim and myself is a very simple one, and needs no long explanation on behalf of Mr. Wollheim As you will see from the letter which you kindly printed in NATURE, *ante*, p 149, Mr Wollheim, without my authority, has sent round a leaflet with my name on it, accompanying bottles of "Aminol," stated to be "a true disinfectant"

1 On this leaflet my name is introduced in a somewhat misleading manner, for it quotes to a large extent from my reports on the lime and brine experiments on microbes without saying so, but leaving the reader to infer that these reports of mine refer to "Aminol"

2 Mr Wollheim never asked my permission or informed me of his intention of sending with each sample bottle of "Aminol" such a leaflet. It is unnecessary to say that had he asked me whether he could use my name on a wrapper of a patent medicine I should have emphatically answered *no* He has recently informed me that he has cancelled the leaflet

3 The samples of "Aminol" sent out were of the strength of 1 in 5000, the experiments in which I showed that "Aminol" possesses a certain disinfecting power were made with a strength of 1 in 600. This strength did not kill spores of anthrax in 12 hours; 1 in 6000 did not kill *Staphylococcus aureus* in 8 hours.

• A substance which, like the "Aminol" sent out (viz. 1 in 5000), cannot kill *Staphylococcus aureus* in 8 hours, and has practically no effect on spores of *Bacillus anthracis* cannot be considered "a true disinfectant."

To show that Mr. Wollheim had a very strange idea about the whole matter, one has only to compare the actual facts of the case, as regards "Aminol" of the strength of 1 in 5000, with the motto put on the leaflet and the inscription on the label of the samples For Mr Wollheim quotes Koch to the effect that no disinfectant can be called a true disinfectant that does not kill spores, and notwithstanding that I have shown that "Aminol" even of the strength of 1 in 600 cannot kill spores in 12 hours, yet Mr Wollheim advertises the "Aminol" of the strength of 1 in 5000 as "a true disinfectant" A true disinfectant kills spores after short exposure, a substance that requires many hours to do so cannot claim the name of a specific disinfectant Vinegar, dilute acids, alkalies, and a host of substances affect spores after exposure for many hours (8, 12, and 24 hours), yet no one would consider these substances as specific disinfectants

Again, a substance used in a certain strength (say 1 in 600) may have considerable disinfecting power on non-spore bearing microbes, with or without having any conspicuous action on spores The same substance more diluted (say 1 in 5000) may have retained such action only to a very insignificant degree Take for instance perchloride of mercury, while this substance is a powerful disinfectant when used in the strength of 1 in 500, 1 in 1000, even 1 in 2000, it has greatly less effect when used in more increased dilution

No one is justified in advertising perchloride of mercury of the strength of 1 in 100,000 as "a true disinfectant," knowing that 1 in 500 or 1 in 1000 only can be so called How much more does this hold good for a substance like "Aminol," which even in the strength of 1 in 600 does not kill the spores of anthrax in 12 hours, a period which for practical purposes of disinfection is out of the question

E KLEIN

19, Earl's Court Square, S W, January 9

Super-abundant Rain

IN NATURE of November 10 the fact that "very nearly one-third" of the annual rainfall fell in one month at Nant-y-Glyn, in North Wales, is recorded as "remarkable"

But at Peshawar, on the north-west frontier of India, we received during last August a rainfall of 17 75 inches, the average local annual fall, calculated from the last fifteen years, being 13 51 inches

We therefore had very nearly sixteen months fall in one month, and by far the largest portion of this fell in ten days of the month

I need hardly add that the whole valley was flooded, and that we have since paid for our super-abundant rain in the form of very prevalent and fatal malarious fever

H COLLETT

Peshawar, December 19, 1892

Earthquake Shocks.

THERE were two unmistakable shocks of earthquake on the afternoon of Tuesday, January 3, the first at 2h 15m 15s. G M T, and the second at 2h 17m I was sitting in a railway carriage at Severn Junction Station waiting for the Bristol passengers, when I felt a sensible upward movement of the seat (as if pushed from below) and saw the carriage sway The movement was from south to north (i e at right angles to the railway) This was repeated four times in about six seconds. At 2h. 17m. there were two more (less strong) shocks The carriage was placed in a siding, and there was no train at the station, and the air was calm and frosty Ice was said to have cracked near here at this time.

E J LOWE

Shirenewton Hall, Chepstow

A Brilliant Meteor

ON Wednesday, January 7, at about 6 35 p.m, I was fortunate enough to see a brilliant meteor descending a little north of Castor. My attention was drawn to it by the brilliant light it threw over the country. The head was a ball of dazzling white and the tail yellow, with red streaks It disappeared before reaching the earth, and I heard no report or rushing sound whatever

As the duration was only a few seconds the above are more impressions than observations.

W POLLARD

Pirton, Herts, January 7

CHEMICAL SOCIETY'S MEMORIAL LECTURES

AT an extra meeting of the Chemical Society, held on December 13 last, this being the first anniversary of the death of Stas, a paper was read and discussed which had been prepared for the occasion by Prof J W Mallet, F R.S, of the University of Virginia, U S N A—himself a high authority on atomic weight determinations, and well known to chemists through his papers on the atomic weights of aluminium and gold, published by the Royal Society of London

The lecture marks a new departure in the work of the society Hitherto our learned societies have been in the habit of publishing more or less complete—it would probably be nearer the truth to say incomplete—obituary notices of their foreign members The Chemical Society has come to the conclusion, however, that inasmuch as its foreign members are always men of great distinction who, as a rule, have lived a considerable number of years after accomplishing their life work, it will be to the advantage of its fellows and of chemists generally, if the obituary notices of foreign members take the form of critical monographs of the subjects with which they have principally dealt

The anniversary of the death of the foreign member is obviously the most appropriate occasion for the delivery of such a lecture During the past year the society has lost two of its foreign members Hermann Kopp, noted as an historian, as well as on account of his very numerous exact determinations of atomic volumes and specific heats, and A W von Hofmann The life and work of the first mentioned will form the subject of a lecture to be delivered on February 20 next, by Prof Thorpe, the Treasurer of the Society, than whom no one is more qualified to undertake the task Prof Thorpe is not only a pupil of the deceased chemist, but has reverently followed in his footsteps—having very largely extended Kopp's observations on atomic volumes in an elaborate investigation, the importance of which was recognised by the Chemical Society in 1881 through the award to him of its first Longstaff medal

Von Hofmann, although originally a foreign member, became an ordinary member of the Chemical Society on coming to England as professor at the school in Oxford Street, long since merged in what is now known as the Royal College of Science, London Hofmann was never again regarded as a foreigner, he served the society both as foreign secretary and as president, filling one of the vice-chairs during the remainder of his life It is felt that owing to the special nature of his relations to the society and to english chemistry, it will be necessary to deal with his case in an exceptional manner, it is therefore hoped that in May next Lord Playfair—who was so intimately connected in his early days with chemical science and with the society—in the first place will picture the state of affairs chemical at and prior to the time of Hofmann's arrival in England Sir F Abel, Hofmann's first pupil and assistant, will follow with an account of Hofmann at the Royal College of Chemistry, calling to his aid for this purpose the remaining friends and pupils of Hofmann The coal-tar colour industry, which has now attained such important dimensions, it is well known, had its origin in the Oxford Street laboratory, and Dr Perkin—its parent—has consented to sketch the history of its development. In this manner it is hoped to impart considerable "local colour" to the Hofmann memorial lecture, thereby distinguishing it from the notice which is being prepared by the German biographers.

Passing now to Prof. Mallet's lecture on Stas, which is of considerable length, as it will occupy fully sixty pages in the Society's Journal. The biographical portion is brief, as a number of such sketches have already been published Stas was born at Louvain on August 21, 1813. He graduated as Doctor of Medicine His taste for chemical research was evidenced in 1835, when, together with a friend, he investigated in an attic of his father's house the crystalline substance phloridzin which they had extracted from the root bark of the apple tree He continued the study of this substance in Dumas' laboratory in Paris, and it is an interesting proof of the acumen of Berzelius that in his annual report on the progress of chemistry he referred to this first research made by Stas with praise, and a prediction of future eminence for the author

The starting-point of the long train of research with which his name will ever be associated was the redetermination of the atomic mass of carbon which Dumas and he together undertook, in order to explain the fact, noticed by Liebig and others, that the sum of the carbon and hydrogen found in hydrocarbons by the combustion process, as calculated from the carbon dioxide and water, not unfrequently exceeded the quantity of material analyzed As the result of this investigation, which was carried out with unprecedented care and the most elaborate precautions, the value hitherto accepted for carbon on the authority of Berzelius (76 432 $O = 100$) was considerably reduced (to 75 005) In 1840 Stas was appointed Professor in the École Royale Militaire at Brussels, he held this post for more than a quarter of a century, until an affection of the bronchial tubes and larynx obliged him to give up lecturing He then received an appointment in the Mint, but resigned this in 1872 on political grounds, and withdrew into private life He appears to have been a man of great independence of character

Apart from his atomic weight investigations Stas did much work of value in other departments His method of separating alkaloids from organic messes—no other name is applicable—which has been of such service in subsequent toxicological inquiries, was devised in 1850, in the course of the inquiry into the celebrated Bocarmé nicotine poisoning case He examined into the methods of hydrolysing fats for the purpose of a report on the chemical section of the London 1862 Exhibition In connection with the preparation of international standards he took an active part, along with Devile, in the inquiry into the properties of the platinum metals It is known also that he did important work for his Government in investigating alloys for use in the construction of artillery

Prof Mallet prefaces his account of Stas's special investigations by an historical survey of the fundamental ideas which have gradually led up to the question, What is the mass of an atom of a particular element? Even in and beyond the days of Cavendish and Priestley the fact that atmospheric air was found of constant or nearly constant composition was long a stumbling-block in the way of clear distinction between a homogeneous compound and a uniform mixture. To the labours of Van Helmont, Boyle, and Boerhave much credit is due for the gradual advance towards the doctrine of the conservation of matter The discoveries of Black and Cavendish brought it further into view, and it assumed its due importance and began to receive universal recognition with the constant appeal to the balance which Lavoisier made and taught others to make Next came a comparison of the quantities of different substances, at first chiefly the then known acids and bases, which would enter into combination with each other Proust, in the course of his controversy with Berthollet as to the fixedness of combining proportions, had observed that in certain cases it was true that in different compounds, consisting of the same constituents, for a fixed quantity of one constituent, the different quantities of another constituent bear to each other a simple multiple or sub-multiple relation To Dalton, however, belongs the honour of announcing the principle as a general one, and of basing upon it a true chemical atomic theory of the nature of matter. Berzelius,

in the early years of the present century, with apparatus in many respects inferior to that of the present day, and with scarcely any aid from chemical manufacturers in preparing pure materials and reagents, but with unsurpassed manipulative skill and the most honest criticism of his own work, produced the first fairly trustworthy list of numbers representing the proportions by weight in which the elements combine. Berzelius began work in this direction in 1807, his attention having been attracted by Richter's investigations, but soon afterwards he became acquainted with Dalton's new atomic theory of the nature of combination, and appears to have been impressed with its great importance, and at the same time with the need of more exact experimental data for its support and development. The wonderful accuracy of Berzelius's work generally is illustrated, as Prof. Mallet points out, by the fact that his number for oxygen, 16·021, becomes 15·894, almost exactly agreeing with the latest determinations of the present day, if the weighings of Dulong and Berzelius's three experiments on the synthesis of water be corrected for the buoyancy of the air. Since Berzelius many other chemists have worked in the same field, but his most worthy successor in such labours has undoubtedly been Stas. With greatly better resources in the way both of apparatus and material, with equal earnestness in seeking for the truth, with equal intelligence and skill he took up the task which became that of the largest part of his scientific life, and for a more limited list of elements than Berzelius had investigated, produced results of a degree of accuracy which it is high praise to say would have delighted no one more than Berzelius himself. He aimed at the determination with greater precision than any one before him had attained of the atomic weights of some ten or twelve of the elements. But by so determining these constants he endeavoured also to settle several general questions of fundamental importance in regard to matter as studied by the chemist.

Thus it has generally been assumed as true beyond dispute since the early part of the present century, that the mass of an atom of a given element is a constant quantity. This has, however, occasionally been doubted, and Stas himself considered the question as one requiring examination. His researches, however, lend no support to it. On this point Prof. Mallet expresses himself strongly in favour of the orthodox view.

Assuming that the atomic weights are immutable values, the question arises, Are they commensurable? This is the much-discussed hypothesis of Prout, the origin and development of which is very fully discussed by Prof. Mallet. A widespread feeling at one time undoubtedly existed among chemists that Prout's hypothesis, that the atomic weights of the other elements are integer multiples of that of hydrogen, if not true in its original form would ultimately prove to be so at least in a modified form. That Stas began his work under the influence of this feeling is clear from his own words:—

"Je le dis hautement lorsque j'ai entrepris mes recherches, j'avais une confiance presque absolue dans l'exactitude du principe de Prout."

But his experimental results clearly contradicted the hypothesis, and he satisfied himself that the atomic weights of the elements which he determined with such precision could not with truth be represented by integer multiples of the atomic weight of hydrogen, or the half or the fourth of this unit. In his own words:—

"Aussi longtemps que, pour l'établissement des lois qui régissent la matière on veut s'en tenir l'expérience, on doit considérer la loi de Prout comme une pure illusion. La simplicité de rapport de poids que présuppose l'hypothèse de Prout entre les masses qui interviennent dans l'action chimique, ne s'observe donc point dans l'expérience; elle n'existe point dans la réalité des choses."

The great majority of chemists—Prof. Mallet remarks—at the present day, are probably agreed in believing that the hypothesis of Prout has been shown by Stas to be untenable. But the fact that so many well determined atomic weights, referred to hydrogen as unity present numbers *nearly approaching integers*, is very striking and calls for further investigation. Stas himself is quoted as admitting this much. Prof. Dewar, in the course of the discussion after the paper was read, drew special attention to this question and gave several most striking instances of the nearer approach to whole numbers which resulted from a recalculation of the accepted values, using the lower value for oxygen (15·87) which so many recent researches tend to support, although on the other hand, of course, some of the values now near to whole numbers are considerably thrown out. Evidently there is ample opportunity for further experimental investigation of this all-important problem, and it is impossible—notwithstanding the extraordinary degree of accuracy attained by Stas—to formulate any final conclusion. The supreme interest attaching to the problem was clearly recognised by Stas himself, as the following words show:—

"Au point de vue de la philosophie naturelle, la portée de l'idée de Prout est immense. Les éléments des corps composés que nous considérons comme des corps simples en égard à leur immutabilité absolue pour nous, ne seraient eux-mêmes que des corps composés. Ces éléments, dont la découverte fait la gloire de Lavoisier et a immortalisé son nom peuvent être considérés ainsi comme dérivant de la condensation d'une matière unique: nous sommes naturellement conduits à l'unité de la matière, quoi qu'en realité nous constations sa pluralité, sa multiplicité."

This quotation is almost alone sufficient to show that Stas was a philosophical chemist of the highest order, and not a mere mechanical worker, as has sometimes been supposed; his unwearied attention to minutest details has undoubtedly served to completely overshadow the philosophical motives and aspirations by which he was guided.

Stas also endeavoured to obtain evidence with regard to the possible dissociation of the elements at high temperatures and to this end purified his materials with every imaginable precaution. The skill with which he carried out his operations is attested by the statement made by Mr. Crookes, the chairman at the reading of Prof. Mallet's paper, that he had seen in Stas's laboratory a large mass of potassium chloride, which Stas had been years in preparing, and in which he had failed to find a trace of sodium even spectroscopically—such an achievement appears almost inconceivable to the chemist. Stas, in fact, in the course of his work investigated the methods of analysis to be used with a degree of rigour, and discovered and applied refinements upon older methods of experiment with a degree of patience and skill, such as had never before been used in chemical investigation. Only those who are thoroughly conversant with such work can fully appreciate his labours; they probably will agree that owing to the multitude and diversity of the precautions to be taken, his work is the most difficult hitherto attempted, and that he stands unsurpassed among all who have undertaken the execution of exact physical measurements.

A lengthy section of Prof. Mallet's paper is devoted to the consideration of the objects to be aimed at and the methods to be pursued in future work. He advocates the repetition by competent hands of some one at least of Stas's fundamental results, calling attention to Stas's own emphatic expression of the wish that this should be done. It is also most important that no distinction should be made between rare and common elements, and that the atomic weights of all should be determined with the least possible delay and the highest attainable degree of accuracy. Certain of the elements particularly call

for a more searching and exact investigation of their atomic masses, *e g* elements such as tellurium, which occupies a position in the periodic system not in harmony with its atomic mass, and cobalt, which plainly occupies the intermediate position between iron and nickel, and therefore should be intermediate in atomic mass

In a number of cases the accepted value is based on the investigation of but a single interchange, the value for iron, for instance, being practically based on the results obtained on converting the metal into ferric oxide, and *vice-versâ*, and the relation of hydrogen to oxygen having been established by the reduction of cupric oxide. It is desirable that in such cases other and independent methods should be resorted to, *e g* that oxides of a number of metals other than copper should be reduced, with the object of detecting possible constant errors

It is eminently desirable that an attempt be made to directly determine the ratio of hydrogen to each of the halogens without in any way bringing in the atomic mass of oxygen Prof Mallet suggests various methods deserving of study Also it is very important that the metals of the yttrium and didymium groups should be further investigated Prof Mallet rightly terms the yttrium group the opprobrium of inorganic chemistry

Nearly all that has been written hitherto in regard to the periodic relationship among the elements has involved the use of roughly approximate values only, but it is time that the foundation be laid for a more minute and critical study of the periodic system of classification Anomalies in the classification as we now find it in our books, glimpses of more detailed relations than as yet clearly appear, tantalizing suggestiveness in so much of what is already before us, call for more precise determinations of the numbers we would discuss before we allow premature discussion to drift into mere fanciful speculation

In regard to the methods which it is desirable shall be pursued in the determination of atomic masses, Prof Mallet has much to say He discusses the selection of processes, the purity of materials, the very numerous directions in which vigilance must be exercised in order to avoid extraneous or accidental causes of error, the quantities of material to be used, the practical precautions to be observed so as to secure accuracy of manipulation and in weighing and measuring, the mode of stating and calculating results, finally calling attention to the advantage to be derived from the application of greater working force and ampler means than can be commanded by private individuals to the determination of atomic masses, with reference to this last point, during the discussion on the paper, the opinion was freely expressed that it was undesirable that such work should be carried out in organized public or semi-public laboratories The question is, no doubt, a difficult one to settle—such work demands a special temperament combined with genius of a high order and an infinite capacity for taking pains, qualities which must rarely occur united in a single individual Moreover, in order that the value of a result may be appraised, it is essential to overlook every detail involved in the determination Given the man, however, there can be no longer a doubt that every possible assistance he may require should be afforded him It is marvellous that men like Berzelius and Stas, working all but alone and unaided, should have achieved results of such magnitude and universal importance—the moral effect of their example is certainly not less important than are the actual results of their labour

The last section of Prof. Mallet's paper is devoted to the discussion of the form in which it is desirable finally to state the results. He here advocates the uniform substitution of the expression "atomic mass" for "atomic weight," on the ground that precision in language conduces to precision in thought—an aphorism far too commonly disregarded by chemists. We have now clear conceptions of atoms having constant mass for the same element, of determinable difference of mass in the case of different elements, the several masses and numbers of which regulate the composition of all known substances and the products resulting from interaction among them The atomic theory has advanced far beyond the condition of a mere working hypothesis on which chemists long stood with more or less uncertain feet, but even if this were not so, considering it, to use a common metaphor, only as a scaffold, there is no good reason, so long as we stand on it and work from it, that we should be careless about tying our scaffold-poles and nailing our planks

Lastly, Prof Mallet urges that all atomic masses shall be expressed in terms of the mass of the hydrogen atom taken as unity, objecting strongly to the change to $O = 16$ which several writers have recently advocated, the most objectionable argument put forward in favour of such change being, he thinks, that the numbers we use are expressive of *ratios* only—that any figures are allowable which correctly express combining ratios, and that there are no reasons for using one set of figures rather than another save mere arithmetical convenience This involves a grave error, as in adopting as unity the mass of a single atom of any particular element, preferably that one of which the mass is the smallest, we have reason to believe that we express the mass of all the others in terms of this as a really existent, definite, and constant quantity of matter It is, indeed, difficult to understand when the scientific necessity in so many cases of taking hydrogen as the unit is realized, how the change to $O = 16$ can be advocated except on the simple utilitarian plea that it is to the analyst's convenience

Prof Mallet's monograph is undoubtedly a most admirable exposition of the philosophical lessons to be learnt from the contemplation of Stas's labours

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EXTINCT MONSTERS[1]

THE volume with this title treats of large animals It is clearly and simply written, without any pretence at being scientific, and is an excellent book for boys and unlearned people who are curious to be informed upon the subject of fossil animals It would have escaped criticism altogether but for emphatic words of praise in the preface, and one or two passages in which the author, with second-hand information, speaks authoritatively of predecessors who restored extinct types of life with the slender materials which were available forty years ago. The attraction of the volume and its novelty is a series of restorations of saurians and mammals drawn chiefly by Mr Smit These for the most part are based upon the restorations of skeletons made by Prof Marsh, whose discoveries have inspired Mr Smit's pencil as much as they have influenced the author's pen There is not much anatomy beneath the skins of the "Monsters," and they have an aspect as though cotton-wool had taken the place of muscle, or as though the drawings were models for the "Lowther Arcade" This, however, is of less importance than the answer given to the question, Are they reasonably faithful to nature? It does not seem to me that they can claim this merit, they are only reasonably faithful to Marsh. Prof Marsh draws an animal so as to give one type the maximum height to which the bones can be hoisted; while another is given the maximum length to which the remains can be extended. My own studies would not have led me to reconstruct one of the extinct reptiles upon the lines which are adopted in

[1] "Extinct Monsters." A popular account of some of the larger forms of ancient animal life. By Rev H N Hutchinson, B.A., F.G.S., with illustrations by J Smit and others. (London, Chapman and Hall, Ld, 1892.)

these restorations As an example of how a restoration should not be made, we may instance the figure of *Stegosaurus ungulatus* (p. 104), in which the management of the limbs is out of harmony with the evidences of the muscular structure of the tail, and the supra-vertebral crest The restoration of the Scelidosaurus from the Lias of England is unsatisfactory There is no better ground for giving a kangaroo-like position to that animal than there would be for drawing Teleosaurus in the same position. The mobility of the neck as drawn is astonishing

The restorations of mammals are happier The subjects diverge less from existing types And probably the most successful in the volume is the spirited restoration of *Sivatherium giganteum* from the Sivalic Hills, though the Glyptodon and Irish Deer are meritorious

In the text the author is generally content with telling the story of the history of science; but he sometimes strays into less safe matter. Thus an account is given of the eye of the Ichthyosaurus. And it is urged that the bony plates exercised a pressure on the eyeball, so as to make the eye more convex, and improve the definition of near objects The study of sclerotic defences does not support this interpretation; and in at least one generic division of the Ichthyosauria the sclerotic plates do not overlap at all, but join each other by their lateral sutural margins.

It is perhaps unfortunate that the author gives currency to nomenclature and classification of the terrestrial types of saurians which may not always prevail If the genera with a bird-like type of pelvis are terrestrial representatives of birds, and the genera with a reptilian type of pelvis are terrestrial wingless representatives of Pterodactyls, then it may not be an advantage to have the Dinosaurs treated as a homogeneous group, or the divisions adopted by Prof Marsh, or in the British Museum (Natural History), handed on to the unlearned as representing the best available classification On page 75, the author introduces a restored skeleton of Megalosaurus, which is attributed to Prof Marsh The skeleton certainly is not referable to Megalosaurus, which never has the pubic bones or the ilium constructed as in the figure The restoration has been previously used in Nicholson and Lydekker's "Palæontology," and in Dr Woodward's "Handbook to the Geological Department of the British Museum," but we do not remember any published authorization for the use of Prof Marsh's name as authority for confounding Megalosaurus with the allied American type

Another example of the same kind of interpretation occurs in dealing with Stegosaurus It is said to have been proved that bones to which the name Omosaurus has been applied really belong to Stegosaurus, and that an unnecessary name has been disposed of The ground on which this determination is made, not being stated, need not concern us now, but it is undesirable that a popular work, whose main merit is that it does not pretend to teach the facts of science, should appear to enunciate judgments on scientific problems. Having described the immense enlargement of the spinal cord in the sacral region of Stegosaurus, the author remarks — "So this anomalous monster had two sets of brains—one in its skull, and the other in the region of its haunches!—and the latter in directing the movements of the huge hind limbs and tail did a large part of the work" Remarks of this character are sure to be misunderstood, are out of place and incorrect

The author has read much, and shown an excellent capacity for quotation, but has not always succeeded in using the newest results He has conscientiously endeavoured to tell the story which is contained in his quotations, but beyond this he does not pretend, except

The four-horned extinct Mammal *Sivatherium giganteum* The animal on the left is Helladotherium.

in the occasional use of supposed scientific principles as a means of accounting for facts of animal structure He has dealt with a subject of great difficulty with commendable clearness, and will interest readers who would be unable to follow a more technical exposition of extinct types of life H G S

ENERGY AND VISION

THE interesting researches of Prof S P Langley on energy and vision have recently been published in the Memoirs of the American National Academy of Sciences From this we gather that he was led to investigate the question by the fact that it was not generally recognized how totally different effects may be produced by the same amount of energy in different parts of the spectrum Two series of experiments were necessary, the first to determine the amount of energy in each ray, the second to observe the corresponding visual effect. The energy was determined as heat by the use of the bolometer, the heat dispersed by a prism being very nearly proportionate to the energy

In the second series of experiments a beam of sunlight from a siderostat passes through a small hole in a darkened room and falls on a slit with a standard width of 0 1 mm It is then received on a collimating lens of 11 9 centimetres aperture and 755 centimetres focal length, after which it passes through a prism of about 60° refracting angle The spectrum thus formed is reflected and brought to a focus on a second slit of one millimetre aperture by a concave mirror, any particular colour being adjusted on the slit by a rotation of the prism This second slit is screened from all possible stray light by a dark curtain, and is used as a source of illumination for a series of numbers from a table of logarithms, which is attached to a sliding screen The greatest distance from the slit at which the figures could be distinctly read was then determined, and the law of inverse squares applied. For the brighter colours of the spectrum, the light entering the first slit was reduced by an adjustable photometer wheel

Actinometric measures were made during the progress of the photometric observations, and showed a solar radiation of 1 5 calories per square centimetre per minute, this naturally being an essential unit

The energy necessary to give the bare impression of luminosity in different parts of the spectrum, expressed in terms of horse-power, was found to be roughly as follows, the *minimum visibile* being defined as the feeblest light which is observed to vanish and reappear when silently occulted and restored without the knowledge of the observer —

	Horse-power
Violet (λ 400)	0 000000 000000 00018000
Green (λ 550)	0 000000 000000 00000075
Scarlet (λ 650)	0 000000 000000 00017000
Crimson (λ 750)	0 000000 000000 34000000

These values were derived from observations made by a single observer, Mr F W Very, and are, of course, subject to a large percentage of error

The general results of the investigation may be best summarized in Prof Langley's own words —

"The time required for the distinct perception of an excessively faint light is about one-half second A relatively very long time is, however, needed for the recovery of sensitiveness after exposure to a bright light, and the time demanded for this restoration of complete visual power appears to be greatest when the light to be perceived is of a violet colour. The amount of energy required to make us *see* varies enormously according to the colour of the light in question. It varies considerably between eyes which may ordinarily be called normal ones, but an average from those of four persons gives the following proportionate result for seven points in the normal spectrum, whose wave-lengths correspond approximately with those of the ordinary colour divisions, where unity is the amount of energy required to make us see light in the extreme red of the spectrum near A, and where the six preceding wave-lengths given correspond approximately to the six colours, violet, blue, green, yellow, orange, red

Colour	Violet	Blue	Green	Yellow	Orange	Red	Crimson
Wave length	400	470	530	580	600	650	750
Luminosity	1600	62 000	100 000	28 000	14 000	1200	1

It appears from this that the same amount of energy may produce at least 100,000 times the visual effect in one colour of the spectrum that it does in another

If now it be inquired what the actual value of unity is in ordinary measure, we are able to give this also with a fair approximation, and to say that the *vis-viva* of the waves whose length is 7500 (tenth metres) being arrested by the ordinary retina, represents work done in giving rise to the sensation of the deepest red light of about 0 001 of an erg in one-half second

NOTES

THE Prince of Wales has consented to become Chairman of the Committee for the memorial of the late Sir Richard Owen, and to preside at a meeting to further the object, which will be held in the rooms of the Royal Society, Burlington House, on Saturday, the 21st inst, at half-past eleven o'clock Admission will be by tickets, which may be obtained from Mr Percy Sladen, Linnean Society, Burlington House, W (who is acting as secretary to the Committee), or from Mr H Rix, assistant secretary of the Royal Society

THE annual general meeting of the Royal Meteorological Society will be held at 25, Gre at George-street, Westminster, on Wednesday, the 18th instant, at 7 15 p m, when the Report of the Council will be read, the election of officers and council for the ensuing year will take place, and the President (Dr C Theodore Williams) will deliver an address on "The High Altitudes of Colorado and their Climates," which will be illus trated by a number of lantern slides This meeting will be preceded by an ordinary meeting, which will begin at 7 p m

THE general meeting of the Association for the Improvement of Geometrical Teaching is to be held at University College, Gower Street, W C, on Saturday, January 14, the Rev C Taylor in the chair At the morning sitting (11 a m) the report of the Council will be read, the new officers will be elected, and several candidates will be proposed for election as members of the Association After the conclusion of the formal business Mis Bryant will give "A Model Lesson on Geometry, as a Basis for Discussion" After an adjournment for luncheon at 1 p m members will re-assemble (2 p m.) to hear papers by Mr G. Heppel on "The Use of History in Teaching Mathematics," and Mr F E Marshall on "The Teaching of Elementary Arithmetic" Members who wish to have any special matter brought forward at the general meeting, but who are unable to attend, are requested to communicate with one of the Honorary Secretaries. All interested in the objects of the Association are invited to attend

DR. LUDWIG BECKER has been appointed to the chair of astronomy at the University of Glasgow.

THE Comet Medal of the Astronomical Society of the Pacific Coast has been awarded to Mr Edwin Holmes, of London, for his discovery of a new comet on November 6.

ON Tuesday next (January 17) Prof. Victor Horsley, F.R.S., will begin a course of ten lectures, at the Royal Institution, on "The Functions of the Cerebellum and the Elementary Prin-

ciples of Psycho-Physiology" The Friday evening meeting will begin on January 20, when Prof Dewar, F R S, will give a discourse on "Liquid Atmospheric Air"

THE severe frost which set in just before Christmas was succeeded by a rapid rise of temperature in Scotland on Friday, but in England the thermometer did not rise much above the freezing point until about twenty-four hours later On the 5th and 6th instant the thermometer fell below 10° in many parts of Great Britain, and snow was falling in Scotland, which afterwards spread to many parts of England The absolute shade minima recorded were—2° at Braemar, and 2° at Fort Augustus, in the north of Scotland The distribution of pressure was unusually high over Scandinavia and northern Europe (inadvertently referred to in our issue last week as over these islands) having reached about 31 3 inches in Central Russia on the 4th, while areas of low pressure lay over the Gulf of Genoa and the south-west of Ireland The latter depression gradually extended eastwards, causing strong easterly gales on the Irish coasts, while the anticyclone over Europe gradually gave way, the barometer at Haparanda on Monday being 1 5 inch lower than a few days previously By Sunday all stations reported temperatures above the freezing point, while in the south west of Ireland the maxima reached 47° and in the south of France even 63° These changes were accompanied by rain in most parts of the country, which added materially to the rapidity of the thaw Bright aurora was seen on Monday night in Scotland and Ireland On Tuesday an anticyclone from the north-westward was spreading over our islands, with finer weather and lower temperatures generally, frost occurring in the north of Scotland and the central parts of England. The *Weekly Weather Report* of the 7th instant showed that the temperature in the eastern and midland parts of England was 12° to 13° below the average for the week, at several of the inland stations in England the daily maxima were below 32° through the whole period

AN enlightened Bengali, Babu Govind Chandra Laha, has contributed fifteen thousand rupees towards the expenses of the proposed snake laboratory at Calcutta. We may expect, therefore, that the institution will soon be in full working order According to the *Pioneer Mail*, two main lines of research will be followed in the laboratory So-called cures for snake bites will be tested under strictly scientific conditions, and the properties of the snake poison as such will be investigated The laboratory will be the only institution of its kind in the world, and the Committee of the Calcutta Zoological Gardens, who have taken the matter in hand, expect that it will be largely resorted to by the scientific inquirers who visit India during cold weather In accordance with the practice of scientific laboratories in Europe, a charge will be made for the use of the tables and instruments at a rate sufficient to cover working expenses Work done on behalf of the Government will also be charged for according to a regular scale.

THE members and friends of the Society for the Study of Inebriety met on Tuesday to congratulate Dr. Severin Wielobycki on having completed one hundred years of life

PROF BAIN contributes to the new number of *Mind* an interesting sketch of the career of the late Prof G C Robertson, with whose name *Mind* will always be intimately associated. Prof. Bain includes in his article the admirable notice of Robertson written by Mr Leslie Stephen for the *Spectator*.

WE are glad to note the publication of a fifth edition, revised and augmented, of the Official Guide to the North Gallery at the Royal Gardens, Kew. It includes a short and interesting biographical notice of Miss North. A map is given to convey some idea of the extent to which her collection illustrates the vegetation of the temperate and tropical regions of the world.

A NEW edition of the list of members of the Institution of Civil Engineers, corrected to the 2nd inst, the seventy-fifth anniversary of its establishment, shows that the aggregate number of all classes is 6341, an increase during the past year at the rate of 3½ per cent

A PSYCHOLOGICAL laboratory has been established at Yale College, where Prof Ladd has for some years been lecturing on physiological psychology *Science* gives an interesting account of the new institution, which has been placed under the charge of Dr E W Scripture, a pupil of Wundt The laboratory consists of fifteen rooms, three of which, including an "isolated" room, are given over entirely to research The isolated room is a small room built inside of another room, four springs of rubber and felt are the only points in which it comes in contact with the outer walls The space between the walls is filled with sawdust as in an ice-box The room is thus proof against sound and light, and, according to *Science*, affords an opportunity of making more accurate experiments on the mental condition than any yet attempted

STUDENTS of ethnography will be interested to hear that Dr N B Emerson, of Honolulu, is preparing a full account of the Polynesian canoe In a communication printed in the new number of the Journal of the Polynesian Society he points out that the various migrations of the ancient Polynesians and their progenitors, from whatever source derived, must have been accomplished in canoes or other craft, and that the *waa*, the *pahi*, &c, of to-day, however modified they may be under the operation of modern arts and appliances, are the lineal descendants of the sea-going craft in which the early ancestors of the Polynesians made their voyages generations ago He holds, therefore, that a comparative study of the canoes cannot fail to shed light on the problems of Polynesian migrations and relationships

AN interesting little paper on the destruction of wild birds' eggs, and egg-collecting, is contributed to the new number of the *Annals of Scottish Natural History*, by Col W H M Duthie Collectors who require to be specially dealt with he groups in three classes—the aimless, the greedy, and the mercenary In contrast with these is "the true collector," whom Col Duthie defines as "a naturalist, acquainting himself with birds, their habits, flight, migration, language, and breeding haunts, his egg collecting being only one of the means of acquiring this knowledge" The true collector should collect for himself, and should never receive an egg into his cabinet unless authenticated by an individual in whom he can implicitly trust If all collectors were of this type, egg-dealers would cease to exist, and with them would disappear the tribe of hangers-on whom they maintain

A GOOD study of the form of eggs has been recently made by Dr Nicolsky of St Petersburg He constructs an abstract formula, by which different eggs can be compared without regard to absolute dimensions. Calling the longer axis 1000, he obtains a figure representing the ratio of the longest transverse axis to it, and another, that of the distance of the obtuse end from the "centre," or point where the longer axis cuts the plane of the equator, then forms a fraction with these two figures, and takes it as the formula of the egg Various explanations have been offered for the different forms of eggs Dr Nicolsky traces all to gravity He considers that every egg not yet coated with a solid shell departs from the spherical form and elongates, simply because of pressure on it by the walls of the ovary. In birds which keep a vertical position when at rest (such as the falcon and owl) the soft egg becomes short through the bird's weight acting against the ovarian pressure. In birds which, like the grebe, are nearly always swimming, the egg lengthens, because the body weight acts in the same direction as the ovarian compression Lastly, eggs become

pyriform (more pointed at one end than the other) in birds which, like the guillemot, often change their position, sometimes swimming and diving, sometimes perching on rocks, &c. An examination of all the eggs in the zoological collection of the St Petersburg University fully bore out these views Dr Nicolsky thinks it would be useful to test the theory by experimentation, birds being kept in a vertical or horizontal position at the laying time

FOR twelve years (1878 to 1890) M P Plantamour made careful observations of the displacements shown by two spirit levels (one north-south, the other east west), in the cellar of his house at Sécheron The instruments were transferred to the Geneva Observatory, and the work resumed by M Pidoux in April 1891 (after six months' interruption) M Plantamour found that the mean air temperature had a preponderating influence in the oscillations observed, while some other factors of obscure nature were involved The first year's data at Geneva (*Arch de Sci*) reveal an annual oscillation of the ground of the Observatory about an axis directed north east and south west, such that the south-east part sinks in summer and rises in winter The east side went down till July 16, then rose gradually till the end of December (29), thereafter sinking again The extremes were $-4'' 73$ and $+4'' 85$ (an amplitude of $9'' 58$) The variations of the south side were similar, but the amplitude somewhat greater The north-south level showed some quite abnormal variations in the autumn of 1891, to which, however, the author does not attach great importance

AN interesting contribution to our knowledge of the adaptation of structure to function in the human body is afforded in an investigation by Signor Minervini (of the Naples Society of Naturalists) of the blood-vessels of the skin in different parts Portions of skin were prepared so as to show the exact structure of the chief arteries in them The results are as follows — (1) The artery-walls of the skin in men are generally thicker than those of other organs (2) This greater thickness is due generally, and during most of life, to thickening of the middle layer, but in childhood the outer, and in advanced years the innermost, layer is most developed (3) The artery walls in the hollow of the hand, the finger-tips, and the sole, are, other things equal, thicker than those in the back of the hand, the forehead, the arm, &c. This greater thickness is due chiefly to a greater development of the middle layer, and in all ages of life The arteries in the hollow of the hand in the case of occupations involving hard manual labour show a greater increase of thickness than in the case of those with little or no such work In these cases all three layers of the artery are thickened, but the middle layer most (4) In women all the chief arteries of the hollow of the hand and of the back of the hand are somewhat less thick than in men The difference is not great, but occurs at all ages.

IN a paper on the Santa Isabel Nitrate Works, Toca Chile, read lately before the Scottish Institution of Engineers and Shipbuilders, and now printed in the Institution's Transactions, Mr. G. M Hunter has something to say regarding the origin of "caliche," as nitrate of soda is called in its native state Some contend that "caliche" is a marine deposit, others that it is an animal deposit, while others say it is a vegetable deposit. Mr Hunter holds the first of these views. The coast of Chile has several times been disturbed and upheaved by volcanic agency, and he suggests that a large tract of sea was enclosed and heaved up to the present height of the nitrate region, and there formed an inland sea, which, after a lapse of time under a tropical sun, evaporated, leaving the salts to percolate and form the beds of nitrate From the formation of the ground, showing depressions and ravines leading to the sea, it is evident that immense volumes of water at some remote period have passed through them In proof of this, Mr Hunter points out that no "caliche" is ever found in such places, the accepted opinion being that there has been a "wash out," as it is called During a later period than that of the formation of the "caliche" great floods passed over the plains, as is shown by the deep tracks of rivers, and the smooth washed appearance of the surface Such periodical floods are common in tropical, rainless regions, and would not call for special remark, but from the fact that wherever these river tracks or washed surface appear no "caliche" can be found. This is so well known that even the workmen never attempt to search for it in such places The only surface indication for the presence of "caliche" is rising ground covered with small black stones. The "caliche" in its native state is white, very compact and amorphous, not unlike rock salt, but when rich in iodine it assumes various colours, according to the composition and quality of the iodine it contains. For example, at times it contains masses of bright yellow, red, or blue, and again wholly composed of a dull black colour, in which state it requires an expert to distinguish it from *costra* or rock

MR. E LOMMEL claims to have found a simple explanation of the Hall effect A simple train of reasoning shows, he says, that the equipotential lines perpendicular to the lines of flow in a plate are also the lines of force due to the current If iron filings are strewn upon the plate they will arrange themselves along the equipotential lines if the current be strong enough. On bringing the plate into a magnetic field these lines of force change their position Hence the lines of flow, necessarily orthogonal to the lines of force, will also change in form and position

ACCORDING to Dr J Bohm, the statement that *Phytophthora infestans*, the fungus which causes the potatoe diseases, hibernates in the tubers, is incorrect, nothing whatever being known about its mode of hibernation He further states that the infection of the potatoes never takes place in the soil through the uninjured skin, but is always brought about through injury to the tubers by insects or snails In potatoe heaps sound tubers can never be infected by their diseased neighbours An infected potatoe either does not germinate at all or produces a healthy plant

IN examining milk which is suspected to contain the tubercle bacillus it is usual to subject a sample of the milk to the action of a centrifugal machine after separating the fat One method of working is described by Ilkewitsch (*Munchener med Wochenschr* 1892) The casein in 20 c.c of milk is coagulated with citric acid, and, after filtering, the residue is dissolved in a solution of sodium phosphate. The butter-fat is separated by shaking with 6 c.c. of an aqueous ether solution, and acetic acid is then added until the liquid is on the point of coagulating It is then placed in a copper tube tapering at the bottom, and this tube is inserted in the centrifugal machine and turned at the rate of 3600 revolutions per minute for fifteen minutes. The bacilli collect at the narrow end of the tube together with other sediment and dirt The liquid is poured off, and the sediment examined microscopically Thörner (*Chem. Ztg* 1892, pp. 791–2) gives another method, which is as follows :—20 c.c. of the suspected milk are mixed with 1 c c. of 50 per cent. potash solution, and heated in a bath of boiling water until the fat is saponified, when the solution turns yellowish brown. By this treatment the casein and albumen become soluble in acid Twenty cubic centimetres of acetic acid are added, the solution shaken, heated on water-bath for three minutes, transferred to a strong glass tube, and turned in the centrifugal machine for ten minutes. The liquid is poured off, and the sediment is washed by shaking with 30 c.c. hot water, and again turned in the centrifugal machine. The water is poured off, and the sediment placed upon cover-glasses, which are treated in the ordinary way,

staining with hot Neelsen's solution, decolourizing in 25 p c sulphuric acid, and finally staining in methylene blue, instead of washing the cover-glasses in sulphuric acid Thörner simply uses a solution of methylene blue containing sulphuric acid

A METHOD of producing an intense monochromatic light is described by Dr Du Bois (*Zeitschr. fur Instr* p 165) It differs from the usual processes in the form in which the sodium is introduced into the flame A mixture of sodium bromide and bicarbonate is made cohesive by adraganth and moulded into sticks 4 mm. in diameter and 12 to 15 cm long These are kept in the flame of a Linnemann burner by means of a rack and pinion motion Their conductivity being very low, they are only vaporized at the extreme end. The latter must be covered to avoid a continuous spectrum At the greatest intensity, two or three centimetres of the substance are consumed per minute The spectrum exhibits, besides the enormously preponderating D lines, a air of lines in the green, and a fainter pair in the red

FROM the ages of persons who have died in France during the last 32 years, M Turquan computes the average life there to have been about 38 years for women, 36 for men, and 37 years for both sexes together (*Rev Sci*) But this is now exceeded, and the average is over 40 years, a result, partly, of more attention to hygiene, partly of a diminished birth-rate From a map showing the distribution of the average life, one finds the average very low in Finistère and Brittany (28 years 11 months in the former) in the Nord, the Pyrénées Orientales, &c, and especially in Corsica (28 years 1 month) In Finistère and Corsica one finds least hygiene and most children, but not the highest mortality of children. In some parts of Normandy, with a high infantile mortality, the mean life is yet very long Thus it is about 48 years in Eure, 47 in Orne and Calvados, &c. The difference between the average life of men and women rises to 4 years (excess in case of women) in the north-west, and diminishes as you come towards the Mediterranean, and in Basses Alpes and Gard (in the south-east) man lives longer than woman by about a year and a half. In Normandy and Brittany there are most widows, and woman appears to have a greater vitality

IT is now many years since electric currents were proved to exist in plants In the study of these currents, an important step in advance was taken when Prof Burdon Sanderson proved their existence in *uninjured* parts of living plants (it was usual before to apply electrodes, often polarizable, to cut parts) As to their cause, certain experiments made by Kunkel, some time ago, led him to think it was in the purely mechanical process of water-motion, set up on application of the moist electrode The subject has been recently investigated by Herr Haake, who pronounces against this view He used Du Bois Reymond's clay electrodes, with some woollen fibres projecting at the ends, and he enclosed the leaves in a tube in which they were guarded from air-draughts and kept moist. Arrangements were also made for various operations, such as varying transpiration, admitting hydrogen, removing oxygen, &c (for details see *Flora*, p. 455, of this year) Herr Haake's results are briefly these — 1. It is unquestionable that changes of matter of various kinds are concerned in the production of the electric currents, especially oxygen respiration, and carbonic-acid assimilation 2 Water-movements may possibly share in their production, but certainly their share is but a small one

THE *Isvestia* of the East Siberian Geographical Society (vol. xxiii, 3) contains an account of M Obrutcheff's further researches in the Olekma and Vitim highlands. In the north-eastern, formerly quite unknown part of this region, the author found a further continuation of the "Patom plateau"—that is, a swelling from 3500 to 4000 feet high, devoid of tree vegetation, with ridges and mountains rising over it to heights of from 5000 to 5600 feet They consist of granite and crystalline schists, probably of Laurentian age, covered with younger, probably Huronian, gneisses and schists The other parts of the highlands consist of Cambrian and Lower Silurian deposits, while Upper Silurian limestones and Devonian Red sandstones are only met with in the valley of the Lena We thus have a further confirmation of the hypothesis, according to which the great plateau of north eastern Asia is a remnant of an old continent which has not been submerged since the Devonian epoch Further traces of mighty glaciation have been found in the south east part of the region As to the gold bearing deposits, they are pre-glacial in the south, and post-glacial or recent in the north The high terraces in the valleys are indicative of a considerable post-pliocene accumulation of alluvial deposits, and of a subsequent denudation on a great scale

MESSRS MACMILLAN AND CO announce that a new edition of Sir Archibald Geikie's "Text-book of Geology" is in the press, and will appear shortly

THE third and fourth volumes (completing the work) of Mr H C Burdett's "Hospitals and Asylums of the World" will be published by Messrs J and A Churchill about the end of this month Vol iii deals with the history and administration of hospitals in all countries throughout the world Vol iv relates to hospital construction, and contains a bibliography and portfolio of plans

MESSRS R SUTTON AND CO have published a second edition of Mr J E Gore's "Scenery of the Heavens," with stellar photographs and various drawings. Mr W F Denning contributes to the volume a chapter on fireballs, shooting stars, and meteors.

THE second annual issue of "The Year-Book of Science," edited by Prof Bonney, F R S, is now in a forward state of preparation, and will be shortly published by Messrs Cassell and Company

MESSRS DULAU AND CO have published "Annals of British Geology, 1891," by J F Blake This is the second issue, and geologists will be unanimously of opinion that it is a decided improvement upon the first It contains a digest of the books and papers published during the year, with occasional notes

LECTURES on the ear will be delivered in Gresham College, Basinghall Street, E C, on January 17, 18, 19, and 20, at 6 o'clock, by Dr E Symes Thompson

IN Mr R Assheton's letter (NATURE, vol xlvii p 176) the sentence beginning line 31 of the second column should have read thus.—"But it is more metazoic—if I may use such a word—to call the whole animal resulting from the segmentation of the fertilized ovum, the sexually produced generation."

TWO interesting new compounds are described by Prof Anschutz, of Bonn, in the current number of the *Berichte* They are well-crystallized compounds of the lactides derived from salicylic acid and the next higher (cresotinic) acid with chloroform, which latter substance is so loosely united with the lactide that warming to the temperature of boiling water is amply sufficient to dissociate them Hence the compounds may be employed for obtaining perfectly pure chloroform, and for preserving chloroform in a solid form in which it is not prone to decomposition The lactide of salicylic acid has long been supposed to be formed when the acid is treated with oxychloride of phosphorus, Prof Anschütz, however, shows that the product of this reaction contains many other substances in addition, but by working under special conditions he has succeeded in

isolating pure salicylide Salicylic acid is dissolved in an indifferent solvent, preferably toluene or xylene, before the addition of the phosphorus oxychloride The product of the reaction is washed first with soda and afterwards with water Owing to the property, discovered by Prof Anschutz during the course of the work, which salicylide possesses of combining with chloroform, it may be extracted from the white solid product, after drying, by means of chloroform, the compound being deposited from the chloroform solution in large colourless transparent crystals belonging to the tetragonal system The compound possesses the composition C_6H_4 CO O $2CHCl_3$ The chloroform readily escapes upon warming, in very much the same manner as the water of crystallization contained in many crystallized salts The free salicylide remaining is a solid substance melting at 261° As regards its molecular constitution it is shown, by the amount of lowering of the melting-point of phenol employed as a solvent, to contain four of the salicylic radicles C_6H_4 CO O, and is probably a closed ring compound In a precisely similar manner phosphorus oxychloride reacts with the three cresotinic acids, the acids next higher than salicylic, with formation among other substances of lactides, which may be isolated in the same way in the form of their chloroform compounds, CH_3 C_6H_3 CO O $2CHCl_3$ Ortho-cresotinic acid lends itself best to this reaction The pure lactides are readily obtained from the chloroform compounds by warming to 100°, pure chloroform being gently evolved

THE two substances above described, salicylide chloroform and the corresponding compound derived from ortho-cresotinic acid, are admirably adapted for the preparation of pure chloroform, on account of their large content of the latter substance, salicylide-choloroform containing 33 24 per cent and the cresotinic compound 30 8 per cent of its weight Moreover, in closed vessels they may be preserved any length of time, when exposed to the open air salicylide chloroform slowly loses its chloroform, but the cresotinic compound is well nigh stable, even under these conditions The same quantity of the free lactide may be used over and over again without decomposition, it being only necessary, in order to re-form the chloroform compound, to allow it to remain in contact with the chloroform to be purified for twenty-four hours at the ordinary temperature None of the usual impurities in chloroform crystallize along with the compound, so that a perfect separation is effected Again, it is well known that pure chloroform decomposes more or less on keeping, this loss may be avoided by storing it in the form of the lactide, and regenerating it when required by the application of a gentle heat, with the certainty of obtaining it perfectly pure

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Mr W Stutely, two Barbary Mice (*Mus barbarus*) from North Africa, presented by Lord Lilford, four Bearded Titmice (*Panurus biarmicus*), European, four Ani (*Crotophaga ani*) from South America; six Hog-nosed Snakes (*Heterodon platyrhinos*), a Striped Snake (*Tropidonotus sirtalis*); a —— Snake (*Pitnophis* ——), from North America, purchased.

OUR ASTRONOMICAL COLUMN

THE MOTION OF NOVA AURIGÆ —Prof. W W. Campbell, of the Lick Observatory, has communicated further results relating to Nova Aurigæ to the December number of *Astronomy and Astrophysics* He is now perfectly convinced that the variation in the velocity previously suspected is real, and probably due to orbital motion The values given below have been calculated on the assumption that the brightest line in the spectrum of the Nova, since the reappearance in August, is really the chief nebula line The bright lines were displaced towards the violet, indicating approach, whereas in February and March last they were displaced towards the red

Date 1892	λ	Velocity of approach Miles per sec
Aug 20	5003 6	128
21	3 7	125
22	3 7	125
23	3 1	147
30	2 4	173
Sep 3	2 4	173
4	1 9	192
6	2 1	184
7	1 9	192
15	2 2	180
22	2 5	169
Oct 12	3 6	128
19	3 8	121
Nov 2	4 4	99
3	4 7	87

In the same journal Mr Sidgreaves points out that the new lines cannot simply be revivals of those of February, and, further, that on account of the great difference of velocities and the reversed direction, they cannot be supposed to belong to the bright-line component of February Neither is it likely that the dark-line component has become a planetary nebula, and the probability of three bodies rushing together being very small, Father Sidgreaves believes the new results to strengthen the view that the compound character of the spectrum was produced by local disturbances of a single star

ASTRONOMICAL DISCOVERIES IN 1892 —In the *Observatory* for January Mr Denning gives an excellent summary of the astronomical discoveries of 1892, a year which was very remarkable for the special attention given to the science by the press and the public In chronological order the principal events were as follows —

January 20 —Minor planet (324) discovered by photography by Max Wolf at Heidelberg (Altogether 27 were discovered during the year by various observers)

January 23-30 —Discovery of Nova Aurigæ by Dr Anderson

February 11 —The great sun spot, extending over 150,000 miles of longitude, reached the sun's central meridian This was followed by remarkable magnetic disturbances and displays of aurora

March 6 —Comet discovered by Lewis Swift

March 18 —Comet discovered by Denning at Bristol On this day also, Dr Spitaler, of Vienna, re-detected the periodical comet of Pons (1819) and Winnecke (1858)

August 6 —Opposition of Mars Mr Denning writes. "Practically our knowledge stands where it stood before The results are not sufficiently discordant to settle disputed points."

August 27 —A new comet discovered by Brooks, of Geneva, N Y.

September 9 —Prof Barnard's memorable discovery of the fifth satellite of Jupiter

October 12 —Comet discovered by photography by Prof Barnard

November 6 —Bright comet discovered in Andromeda by Mr Edwin Holmes, London

November 20 —A faint comet discovered by Brooks

November 23 —Brilliant shower of shooting stars observed in Canada and the United States The shower was evidently that of the Andromedes connected with Biela's comet.

COMET HOLMES —Mr Lewis Boss finds for this comet a period of 6 914 years, and concludes that no very close approach to Jupiter can have taken place in recent years; the eccentricity, however, is so small that important perturbations by Jupiter may have occurred He further states that "the recent remarkable decrease in brightness of the comet seems to do away with the necessity of supposing that it has been recently made a member of the solar system. This decrease also renders it reasonably certain that the comet must have been subjected to some extraordinary disturbance of its internal economy, by the application of forces from without or within, with the result of giving to it that which was really an unaccustomed and temporary size and brightness" (*Astronomical Journal*, No 283). According to Mr. Lockyer's views, such increase of brightness would be produced by the comet colliding with another meteor

swarm lying in its track, and it is quite possible that the brightening of the comet at the time of the discovery was very sudden, thus explaining why the comet was not detected earlier

The Rev E M Searle (*Astronomical Journal*, No 283) has deduced a period fifteen days shorter than that of Mr Boss

M Schulhof, of Paris, finds a period of 6 909 years He also points out that among the known periodic comets that of De Vico shows the greatest orbital similarity to Holmes's comet, and he considers that they may possibly have a common origin

Mr Roberts, of the Nautical Almanac Office, accepting as real the supposed impression of the comet obtained by Mr Schorling in a photograph of the region taken on October 18, found a period of fifteen years, but the general agreement of the latest computations seems to indicate that the image in question could not be that of the comet

The comet is now so dim that it is not considered necessary to continue the ephemeris

EPHEMERIS OF COMET BROOKS (November 20, 1892) —The following ephemeris of Comet Brooks (Berlin, midnight) is given in *Ast Nach*, No 3140, by Kreutz —

Date	R A	Decl (app)	Log r	Log Δ
	h m s	° ′		
Jan 12	21 40 18	+ 59 41	0 0786	9 8915
13	56 4	58 8 1	0 0791	9 9012
14	22 9 53	56 33 6	0 0797	9 9114
15	22 3	54 59 1	0 0803	9 9220
16	32 47	53 25 7	0 0810	9 9330
17	42 18	51 54 2	0 0818	9 9442
18	50 47	50 25 2	0 0826	9 9556
19	22 58 23	48 59 3	0 0835	9 9670

THE METEOR SHOWER OF NOVEMBER 23, 1892 —Further observations of this fine display of shooting stars are recorded in *Astronomical Journal*, No 283 Prof J K. Rees counted 165 meteors in half an hour, and noted some as bright as Mars, all of them were very swift The Rev J G Hagen estimated that one observer, with a clear view to the west would have seen 250 meteors in half an hour, and notes that some were as bright as Jupiter Mr Sawyer estimated the maximum frequency as about 300 per hour, and, strangely enough, describes them as "slow-moving, generally quite bright, although none were observed as bright as the planets Mars and Jupiter" Both Prof Rees and Mr Sawyer note that the meteors appeared in clusters, four or five falling almost at the same instant, while for a few minutes none were seen The radiant was near γ Andromedæ, and there is little doubt that the shower was that due to Biela's comet

GEOGRAPHICAL NOTES

IN M Dybowski's journey from the Mobangi to the Shari, as described at a recent meeting of the Paris Geographical Society, he encountered one of the most systematically cannibal tribes which has yet been described This tribe, known as the Bonjos, have only one object of purchase—slaves to be eaten They refuse to sell food or any other products of their country for anything else, and the surrounding tribes capture and export canoe-loads of slaves for this purpose The French expedition experienced great difficulty in obtaining food amongst a people who had no desire for ordinary articles of trade.

THE boundaries of the republics of South and Central America are certainly the least definite lines on the political map of the world so far as civilized lands are concerned. The question of delimitation is never at rest Dr. H. Polakowsky gives in the last number of *Petermann's Mitteilungen* a brief account of the negotiations and surveys relating to the frontier of Costa Rica and Nicaragua from 1858 to 1890 The difficulty in this case lies in the fact that the mouth of the San Juan river, a certain point of which was fixed on in 1858 as the coast frontier, is continually changing, and a breakwater belonging to the harbour and canal entrance of Greytown, in Nicaragua, now stands in what was formerly the territory of Costa Rica On the Pacific coast years of diplomacy were required to fix the centre of Salinas Bay, but it is satisfactory to know that permanent boundary stones have now been erected at both ends of the line

MR. COLES delivered his second lecture to young people under the auspices of the Royal Geographical Society, on Friday evening, when a large audience of both young and old enjoyed his spirited descriptions of Iceland and British Columbia, illuminated by many anecdotes of personal adventure

THE defective condition of the charts, even of the coast of Europe, was strikingly brought out by the recent court martial on the stranding of H M S *Howe* in Ferrol Channel The chart used on board was drawn from soundings made about a hundred years ago, with a few subsequent corrections, which failed altogether to indicate the rock on which the *Howe* struck. The Spanish authorities are reported to have refused permission for the new chart surveyed by the officers of the Channel Squadron to be published, and meanwhile the Hydrographic Office has cancelled the old chart

A NEW SEISMOGRAPH

BEFORE speaking of this memoir, let me enter a protest against the method of publishing these "Annali" in such a way as to convey the impression that the papers composing it were written three years before their actual date All readers are warned that when the volume is bound up, and the paper covers are removed, they must post date the papers by three years

The seismograph described in the present paper is intended for stations of the second class The objects in view in its construction were amplification of the record in a pendulum seismograph, and improvement of the warning apparatus in the form of a style seismoscope of the Milne type which the author finds frequently fails

The amplifying lever is composed of fine placfont tubes arranged girder-like in the form of a short hollow triangular prism, surmounted by an acute triangular pyramid, which points downwards, and carries at its apex the writing style The pendulum bob is a flattened cylinder, supported by a placfont wire 1 50 m long. The amplifying lever at the junction of the three pyramidal and the prismatic tubes supports three radial arms meeting in the centre, as it were, of the pyramid base, and support a ball-and-socket joint of agate, the cup part of which is at the end of an arm projecting from the supporting wall Immediately above this centre, and occupying the prism space of the lever, is the cylindrical box, the wire supporting which passes through a small hole in the centre of the base of the prism We thus have a simple lever of the first order of light girder work It is prevented from rotating in azimuth by including some steel wire permanently magnetized

The style has been modified by lightening it and making it more rigid and non oxidizable, which is done by using a capillary glass tube

The registering apparatus is a smoked glass plate, supported over a clock, started at the moment of the earthquake by a seismoscope To prevent the complex figures of the ordinary registration in a pendulum seismograph, the author has arranged so that the plate shall rotate through a segment of a circle every three seconds, so as to bring a fresh surface of smoked glass beneath the style

Some modifications are then described. The principal one is making the bob annular, carrying a suitable aperture, in which is engaged the short end of a lever This lever is composed of three very thin brass tubes, graduating away smaller from the fulcrum, which is a gimbal joint such as suggested by the reviewer some years since in NATURE. This lever carries at its lower and longer end the style which records on the glass plate as in the original one described in this memoir

Another modification is a combination of the triple and single suspension of the pendulum bob, that is, the bob ring is first suspended by triple wires to a button which in its turn hangs at the end of a single wire

The details of these seismographs are fairly well worked out, but the employment of aluminium in many of the parts has been neglected Likewise, no arrangement has been made for the oblique play of the engaged pinion in the newer lever The only new point about this seismograph is the interrupted rotation of the recording plate This has a decided advantage in giving a dissected record, but is part counterblanced by the fact that important movements that may be taking place at the moment

[1] G. Agamennone, "Sopra un Nuovo Pendolo Sismografico" *Annali dell' Ufficio Centrale Meteor e Geodinamico*, ser sec, pt 3, vol xi., 1889. (Roma, 1892)

of the advance are represented by a curve or curves which would require a series of careful experiments to be carried out in each instrument, followed by difficult and elaborate calculation for each advance

Much credit is due to the author for working out the modifications, but until we have some original method of finding a steady-point, not so far suggested, it is doubtful if we can improve on the Gray, Ewing, and Milne seismographs, that are not, as the author imagines, little used or tested instruments.

H J JOHNSTON LAVIS

PHYSICAL GEOGRAPHY AND CLIMATE OF NEW SOUTH WALES

A SECOND edition of an excellent pamphlet on the "Physical Geography and Climate of New South Wales," by Mr H C Russell, F R S, astronomer royal for New South Wales, has just been issued at Sydney It is published by authority of the New South Wales Government The following extracts may be of interest to various classes of readers in Great Britain —

Looking back through the pages of history, and the dim traditions of an earlier time, we find abundant evidence of a belief in the existence of a great south land to the south and east of what was then the well known earth Those early navigators whose travels had fostered this belief, had doubtless followed down the Malay Peninsula and the string of islands which seem to form part of it, in search of spices and other treasures which the islands supplied Pliny, who had evidently gathered up the traditions of "Terra Australis incognita," says that it lay a long way south of the Equator, and in proof of this mentions the fact, strange in those days, that when some of its inhabitants were brought to civilization they were astonished to find the sun rise on their left hand instead of on their right And Ptolemy, A D 170, after describing the Malay Peninsula, says Beyond it, to the south-east, there was a great bay in which was found the most distant point of the earth, it is called "Cattigara," and is in latitude 8½° south, "thence (he goes on to say) the land turns to the west, and extends an immense distance until (as he believed) it joins Africa" And it may fairly be assumed that the extreme south latitude of Cattigara, and its situation in a great bay where the land turns to the west until it joins Africa, is proof that it was some point in the Gulf of Carpentaria, for no other place would fulfil the conditions The idea that the land actually reached Africa was not Ptolemy's, it was a necessary part of the system of Hipparchus, for he taught that the earth surrounded the water and prevented it from flowing away It is not surprising, therefore, that the early navigators, following down the islands, came at length to that part of the Gulf of Carpentaria where the land turned to the west, and believing Hipparchus' system of geography, thought that in turning to the west they were in reality turning towards home, and Cattigara was therefore the most distant point known Marco Polo tells us that the Chinese navigators in his day (A D 1293) asserted there were thousands of islands in the sea to south of them, and in the present day we find proofs of their early visits to Australia in the traces of Chinese features amongst the natives of the northern coast, indeed, some historians think that Marco Polo, in the account he gives of the expedition sent to Persia by the Great Khan, refers directly to Australia, under the name of Lochac This place he says was too far away to be subjugated by the Great Khan, and was seldom visited, but it yielded gold in surprising quantity, and amongst other wonders contained within it an immense lake or inland sea. It is impossible that such a description should apply, as has been thought, to the Malay Peninsula,—a country within easy reach, and one which his ships must have passed in every voyage, and so far from being beyond his power, it was within the limits over which his sway extended That Lochac formed part of the main land was also quite in accordance with their ideas of the earth, which surrounded the ocean, and the abundance of gold is certainly more likely to be true of Australia than of the Malay Peninsula

For long years after Marco Polo we find no direct reference to Australia, except the stories which lived amongst navigators, and seemed to lose none of their marvellous points by transmission These kept alive the desire to explore the great south land, so rich in treasures and wonders. All the evidence collected so far goes to prove that the Portuguese had, early in the sixteenth century, explored at least the northern parts of Australia What they learned was, however, kept a profound secret until about 1540, when one of their government maps was stolen, and there are now in existence six maps believed to be copies of it, which were all published between 1539 and 1555 These all show Australia under the name of the "Land of Java," the real Java being called the "Little Java," and from this time onward frequent attempts were made to explore what had for so many generations been "Terra Australis incognita" Sturdy navigators could not understand the silence of the Portuguese, except as proof of the richness of the land, about which tradition told wonderful tales "It was a land of gold and spices, of magnificent tropical fruits and vegetation—a perfect paradise, in which the happy and simple inhabitants were loaded with jingling ornaments of gold Its very atmosphere was elixir, and existence a round of enjoyment" No wonder that in an age when, at least upon the ocean, the power to take was mistaken for the right to do so, there were many who cast longing glances towards the southern Paradise Whether these stories of gold had any foundation in fact or not, when barter was regularly exchanged on the coast of Australia, it is impossible now to say, but more recent discoveries of rich surface gold lend some colour to them, and the vegetable richness of the northern part of Australia is quite in accordance with tradition But all the early English navigators were unfortunate, and Australia got a reputation the very reverse of what further investigation has shown that it deserves In point of fact, all the glowing colouring of tradition is true, but when Dampier, in 1688, sailed down the western coast, he saw nothing but a "dry sandy soil," and the "miserablest people in the world", and later on, when the first English settlers landed on Australia, they chose a bay, beautiful to look at, but there was no gold and no fruit worthy of the name, the soil was barren and sandy, and the climate in the worst part of its summer No wonder that the fame of Australia was blackened, and report made it a miserable land, subject to droughts and floods—a land in which everything was turned topsy-turvy The summer came at winter time, trees shed their bark, not their leaves—were brown instead of green, the stones were on the outside of the cherries, and the pears, pleasant to look at, were only to be cut with an axe, and there was nothing to eat, "unless, perchance, ye'l fill ye with root of fern or stalk of lily" Such was the early verdict upon Australia. Fortunately the first colonists, once here, were obliged to stop By degrees they found that everything that was planted grew well, that wheat in the valley of the Hawkesbury yielded 40 to 50 bushels to the acre, and in one memorable season actually ruined the farmers by its very abundance, for in the then limited market, the price fell so low that it was not worth gathering, and it was left in the fields to rot, while the farmers sought other work. Horses, sheep, cattle, and pigs throve marvellously, and some of the cows getting away, the bush soon contained numbers of wild cattle Even wool did not deteriorate in the new Colony, and step by step the facts became too strong for prejudice, and the first fleeces of Australian sheep sent to England lifted the veil Manufacturers would gladly take as many as could be sent, their demand for more wool extends with the supply, and now only from Australia can they obtain the fine wools which they need Quantity and quality of wool have increased together, and the Grand Prize at the Paris Exhibition for our New South Wales wool has proclaimed the fact far and wide Wool has done still more for the Colony We took possession of it as a narrow strip of coast country, the demand for pasture forced us to find a way over a hitherto impassable range, and the same want has driven all the desert out of the Colony, and covered it with sixty two millions of valuable sheep (1892) The country which early writers upon Australia called a barren waterless desert is now growing the finest wool and yielding abundant water from wells, and when, in 1851, it was announced that gold had been discovered in abundance, the world was convinced that Australia was a promising country after all Year by year the people have been coming in increasing numbers to supply our great want (population), and as our numbers increase new avenues of wealth and prosperity are opening before us

Geographically, Australia has a grand position, lying between the 10th and 40th degrees of south latitude—that happy mean where it is neither too hot nor too cold Surrounded by the ocean, the sea breezes temper what might otherwise be a hot climate in the summer, the air is clear and dry, and yet brings rain in heavy showers. Vegetation is abundant, and includes

all the cereals and fruits of the world, so that, in the words of the old tradition, it has "all the conditions which make life a pleasure"

Australia measures from north to south 1900 miles, and from east to west 2400 miles, and speaking generally, has a rounded outline, the only great inlets on the coast line being the Gulf of Carpentaria and the Australian Bight. The total area is rather greater than that of the United States, and almost equal to the whole of Europe. On the east, north, and west, and at a short distance from the coast are found ranges of mountains, of no great elevation, yet almost the only high land. On the west and north-west coasts the mountains form a bold outline of granite, rarely more than 200 miles from the coast, and attaining to heights of 2000 to 3000 feet. Between these and the sea the land is low and good, but on the inland side is found a vast table land which slopes towards the unknown interior so gradually that the inclination is not easily seen, and no rivers running to the interior have yet been discovered—all known streams running to the sea.

On the east coast we have also the mountain chain parallel to the coast, but it is much higher and more extensive, and the strip of low land by the coast is much narrower, often not more than 30 miles wide, and at Point Danger the range comes right to the sea. This grand chain of mountains is known generally as the Great Dividing Range, and extends for about 1500 miles along the east coast. Near its southern extremity is the Snowy Range, the only spot in Australia where snow may always be found. The highest peak, Mount Kosciusko, 7170 feet, is also the highest land in Australia. The ravines on its sides always contain snow, and the mountains near it, about 6000 feet high, are also covered with snow for the greater part of the year.

Of this great continent island, the Colony of New South Wales holds the choicest portion—the southern part of the east coast—the part where, with remarkable sagacity, the first settlement was made. It has the best climate, all the most important rivers in Australia, the great bulk of the coal land, unlimited stores of all the useful minerals, and the finest pastoral and agricultural lands for extra-tropical vegetation, besides which, its extensive highlands afford climatic conditions for all purposes. It is naturally divided into three portions. The comparatively narrow coast district, from 30 to 150 miles wide, abundantly watered by rivers and smaller streams coming down from the mountains. The rainfall here, fed by winds from the Great Pacific Ocean, is very abundant, from 40 inches in the south to 70 in the north, and at Sydney 50 inches. The mountains have doubtless very much to do with this abundant precipitation, and at times the rains are so heavy that the rivers, fed by mountain torrents, carry heavy and dangerous floods. In years past wheat was largely and profitably grown, but rust has of late so frequently appeared that little or no wheat is grown, for it pays better to supply the city markets with dairy produce, Indian corn, and various kinds of hay. In the northern districts sugar-growing is a profitable industry, and increasing rapidly. About Sydney enormous quantities of oranges are grown for exportation.

The second division includes the mountains and elevated plains, and extends the whole length of the colony, varying in width from 120 to 200 miles. On the south, with the exception of the Monaro Tableland, the country is very rough and mountainous, the highest points, Mount Kosciusko and the Snowy Range, catch the rain and snow that feed the river Murray and the Murrumbidgee. Wheat grows well here, but nearly all the land is used for pastoral purposes. Proceeding northwards, the mountains decrease in height and extend laterally. A part of the land is taken up for agriculture, some for mining. In its natural state the western country is open plain or lightly-timbered, and large areas are covered with rich volcanic soil which seems fit to grow anything, but the want of labour and carriage, and the profit and security to be found in raising wool and meat, has for the most part tempted capital into squatting pursuits, but since the railway has reached this part of the country more attention is being given to agriculture, and it is rapidly extending. Between Goulburn and Bathurst, the western waters form the Lachlan and the eastern the Hawkesbury rivers, and from Bathurst northwards to latitude 25° all the western waters go to form the various tributaries of the Darling river. These mountains are from 2000 to 3000 feet, with some peaks rising to nearly 6000 feet. The central parts of the western slopes are celebrated for rich soil and herbage, and here also the greater part of the gold mining area, as well as mines for other minerals have been found, including coal, which is also found in great abundance, with iron and lime, at Lithgow and other places. Deposits of copper, silver, lead, tin, and mercury are also found in abundance. A very large portion of the high land here is suitable for agriculture, and is being taken up for that purpose by degrees. English fruits—the apple, cherry, currant, &c.—grow to perfection here, as well as in other parts of the mountain districts.

The third division covers by far the greatest area, and consists of the Great Western Plains, extending away to the Darling river, and thence to the south Australian border. Here there are but few known mineral deposits except copper, and the enormous deposits of silver and lead at Broken Hill, and no attempt at agriculture. All the land may be said to be held for grazing purposes, and for that purpose, now that capital has been invested in tanks and wells for water supply, this country is unequalled. Sheep and cattle thrive in a remarkable degree, and form a most profitable investment, the climate being dry and wonderfully healthy for man and beast.

These are the three great natural divisions, made so by the conformation of the land and the climate. It will be evident from what has been said of the elevation of the mountains that snow is not a common feature upon them, and the only part where snow lies for any considerable time is the extreme south. As a necessary consequence, the river system is peculiar; indeed, it has often been asserted that Australia had no rivers—at least none which were of any use as such, but as we shall presently see, this statement, like many others affecting Australia, was made in ignorance. The necessity for increased pasture had driven the early colonists to cross the Great Dividing Range, aptly so named, in search of pasture, in 1815, and the desire to extend the new pastures beyond the Bathurst Plains, which were the first discovered, led them on, and one of the first questions that demanded their attention was to account for the direction in which all the streams were flowing. The shortest road to the sea was to south-west, and yet all the water was running to north west, and quite naturally it was asked—Could there be a great inland sea into which these rivers discharged? In 1818 Oxley started with a determination to see where at least one of them went to; so he followed the Macquarie for more than 200 miles, and found that he was going due north west, further and further, as it seemed to him, from the natural outlet on the south coast. At last the river spread out to an apparently interminable marsh. Turn which way he would his progress was stopped by a shallow fresh-water sea, for sea he was at last convinced it must be, so great was its extent, and he was obliged to turn back. He had got there after two very wet seasons (1817 and 1818), and his inland sea is now known as the Macquarie Marshes, and the mystery was not solved until Sturt, in 1829, found all these streams trending to north-west unite in the Darling, and then turn to south west.

Coming from mountains of such moderate elevation, these streams are necessarily dependent upon the rainfall, and have no snow to help them, so that in rainy seasons they become important rivers and in dry ones sink into insignificance, but since most of the rains which feed these waters are, as it were, offshoots of the tropical rains, they seldom fail altogether, and as a rule the Darling is navigable for four months of each year, and sometimes all through the year, up to and beyond Bourke. The current is very slow, seldom reaching two miles per hour, and therefore offers little hindrance to the steamers which carry wool and stores.

In the exploration of our rivers there was another surprise when settlement extended south-west from Sydney. The waters here were found to flow to the west, and the Lachlan has for a considerable portion of its course a south west direction, that is, at right-angles to the Macquarie and the Bogan. Could the Lachlan, the Murrumbidgee, and the snow-fed Murray ultimately join the waters that ran north west from Bathurst? Sturt had not solved this question—he only followed the Darling part of the way down—and it was left for Sir Thomas Mitchell to find the junction of the two river systems in 1835, and to prove that the Darling and the Murray were united at and below Wentworth.

After dealing with the rivers and harbours of New South Wales, Mr. Russell discusses the temperature, rainfall, droughts, and winds of the colony. Of the temperature he says:—

In works of reference, Australia generally is credited with heat in excess of that due to its latitude. It is difficult to say why, unless it arose from a habit of one of our early explorers who carried a thermometer and carefully published all the high, and none of the low readings he got, until, fortunately for the colony, the thermometer was broken and the unfair register stopped. But not only the interior—Sydney even to the present day is credited, in standard works of reference, with a mean temperature of 66·2°, or more than three degrees higher than the true mean, which is 62·9°. Such an error is not excusable when meteorological observations have been taken and published for just forty years. There is another error made by some writers when describing Australia. It is shown by them inverted on the corresponding latitudes in Europe, and the reader naturally infers that Australia is as hot as those parts of Europe. Confining our attention to New South Wales, that is between 29° and 37° of south latitude, we find that generally it is cooler than a corresponding part of Europe. The mean temperature of the southern parts of England is about 52°, and that of France, near Paris, about the same, increasing as you go south to 58·5° at Marseilles. Taking this as a sample of the best part of Europe, let us see how the mean temperatures in the colony compare with those. Kiandra, our coldest township, situated on a mountain, is 46°; Cooma, on the high land, 54°; Queanbeyan, high land, 58°; Goulburn, high land, 56°; Armidale and New England district, 56°; Moss Vale, 56°; Kurrajong, 53°; Orange, 55°. These towns are scattered along the high table lands from south to north, and represent fairly the climate of a very considerable portion of the whole colony. Next to this in point of temperature is the strip of land between the ocean and the mountains, and which is affected by the cooling sea-breezes. Here we have a mean temperature ranging from 60° at Eden, the most southern port, to 68° at Grafton, one of the northern ports. Sydney, in latitude 34°, has a summer temperature only four degrees warmer than Paris, which is in latitude 49°. Now the usual difference for a degree in latitude is a degree in temperature, and therefore, if Sydney were as much warmer than Paris as its latitude alone would lead us to expect, its temperature should be 74°, and that is 15° warmer than Paris; but as we have seen, it is only 4° warmer. This single example is enough to prove the comparative coolness of our coast districts. The investigation made during recent years shows that the mean temperature of the whole colony, as derived from forty five stations scattered over it, is 59·5°, three degrees lower than that of Sydney, or only one degree hotter than that of Paris.

It may be mentioned that the highest shade temperature ever recorded in Sydney was 106·9°, and near Paris a temperature of 106·5° has been recorded.

The third great district, consisting of lower land and plains to the west of the mountains, has a climate considerably warmer in summer than the parts above described, owing to the powerful effect of the sun on land having little forest and little or no wind; but in winter the temperature sinks down much lower than the coast districts, owing to the great radiation; so that the annual mean temperature is not so great as the summer heats would lead one to anticipate. A table has been prepared for the purpose of showing by comparison with many places in Europe and America the temperature of the colony. The places have been arranged in order of temperature, taking for that purpose the mean annual temperature. This shows at once that the range of temperature here is equivalent to that offered by Europe from the north of England through France to Sicily. Such a range is more remarkable, because if New South Wales were placed on the map of Europe according to its latitude it would extend from Sicily to Cairo, whereas when placed by its temperature it stretches as we have seen from Sicily northwards to England. Nor is this all that the table shows us. For even when we find a place in Europe with a temperature equal to that of some place here, it is at once observed that the summer temperature in Europe is warmer than the colonial one and the winter colder; for instance, Naples, 60·3°, Eden, 60·3°, summer at Naples, 74·4°; at Eden, 67·9°, winter at Naples, 47·6°, Eden, 51·9; and so generally the southern country has the cooler and more uniform temperature. It is worthy of remark that the only places here of equal mean and summer temperature with places in Europe are those which are to be found on the western plains, as at Wagga Wagga, which has a mean temperature of 60·3°; Naples, 60·3°; and summer temperature of both is 74°; or again, to compare the places of the same or nearly the same latitude, Messina, in Sicily, latitude 38° 11′, has a mean temperature of 66°, summer 72·2°, winter 55°; Eden, New South Wales, in latitude 37°, has a mean temperature of 60·3°, summer 67·9°, winter 51·9°, or Cairo, in latitude 30°, mean of 72°, summer 85·1°, winter 58·2°, Grafton, latitude 29° 45′, mean 68·1°, summer 76·8°, winter 58·4°. It is useless to multiply examples,—we have here enough to show how much cooler Australia really is than the fervid imaginations of some writers have made it appear in print.

Looking at this question of temperature generally, it will be seen that New South Wales is no exception to the general deduction of science that the southern lands are cooler than those of corresponding latitudes in the north, and it is only during hot winds, which are very rare in New South Wales, that the temperature rises to extremes. But to leave Europe, and compare the climate of New South Wales with that of America. Our limits of latitude would place us from Washington to New Orleans. Now the mean temperature at Washington is 55° and at New Orleans 68°, while that of Eden is 60·3° and Grafton 68·1°, so that if mean temperature were a complete test of climate it would appear that our coast is hotter than corresponding latitudes in America. But mean temperature is not enough; we must compare the summer and winter temperatures, and summer at Washington rises to 76·7° and at Eden only to 67·9°, 9° cooler; New Orleans summer is 82° and Grafton 76·8°, but 82° hardly represents the summer heat at New Orleans, for it is a steady broil, during which every day for three months of summer the heat is over 80°, a temperature that is only reached on this coast during hot winds, or in other words, very seldom. But winter temperature at Washington falls to 37·8°, and at New Orleans to 56°, at Eden 51·9°, and at Grafton 58·4°. Hence it is evident that on this coast the heat is very much less in summer and greater in winter than upon the coast of America. Such facts place the colony in a very different position in regard to climate from that which it has occupied in published works, for instead of being a hot country we see that its coast districts are much cooler than corresponding latitudes in Europe and America, and that in its elevated districts, which comprise a large part of it and much of the best land, it has a climate no warmer than the best and most enjoyable parts of Europe in much higher latitudes; but while bringing these facts into due prominence it is not the intention to deny that another considerable part of the colony, forming the western plains, is subject to greater heat, caused, no doubt, by the sun's great power on treeless plains, and the almost total absence of cooling winds; yet, although in summer the temperature here frequently rises over 100°, and sometimes up to 120°, yet, owing to the cold at night and in winter, the mean temperatures are not greater than those of corresponding latitudes in the northern hemisphere; and this part of the colony being remarkably dry, the great heat is by no means so enervating as a temperature of 80° in the moist atmosphere of the coast, and, what is of still more importance, it does not produce those terrible diseases which are usually the offspring of hot countries. This is also, no doubt, due to the dryness of the air. Stock of all kinds thrive remarkably well, and are very free from disease in those hot western districts.

SCIENTIFIC SERIALS

THE *Quarterly Journal of Microscopical Science* for August 1892 contains:—On the anatomy of *Pentastomum teretiusculum* (Baird), by Prof. W. Baldwin Spencer, M.A. (Plates i. to ix.) Whilst collecting on Kings Island, which lies to the west of Bass Straits, half-way between the mainland of Victoria and Tasmania, numerous specimens of the copper-head snake (*Hoplocephalus superbus*) were found, in the lungs of which a large species of Pentastomum were parasitic; afterwards the same parasite was discovered in the lungs of the black snake (*Pseudechys porphyriacus*) in Victoria; on examination there seemed little doubt but that the species was the one described by Baird long ago (1862) from specimens obtained in the mouth of a dead copper-head snake in the Zoological Gardens, London, under the name of *Pent. teretiusculum*. In this paper we have a very complete account of the anatomy of this form, there being descriptions and figures of its external anatomy, schematic

representations of the muscular, alimentary, secretory, nervous, and reproductive systems, and an account of the sense organs. The paper is illustrated by ten double plates —On the minute structure of the gills of *Palæmonetes varians*, by Edgar J. Allen, B Sc (Plate x) It would seem that so far as the gills of this crustacean are concerned, the statement made by Haeckel and Ray Lankester, that the circulatory system of the Decapods is everywhere closed, does not hold true It would also seem fairly certain that the masses of cells surrounding the venous channels, in which Kowalevsky found litmus deposited a few hours after its injection, exercise an excretory function In addition to these excretory cells, a large number of glandular bodies occur in the axis of the gill, and these are of two kinds—clear and reticulate glands.

The number for November 1892 contains —On the development of the optic nerve of vertebrates, and the choroidal fissure of embryonic life, by Richard Assheton, M A (Plates xi and xii) That the optic nerve is formed by the differentiation of the cells of the optic stalk into nerve fibres, which consequently lose connection with the inner wall of the optic cup, and piercing the outer wall, make connection with the outer face thereof, is held to be probable by such writers as Balfour, Foster, Marshall, Haddon, and others, whilst the opinion that it is formed by the growth of nerve fibres either from the retina (outer wall of the optic cup) or from the brain, along the optic stalk, but outside it and unconnected with it, is or has been held by His, Müller, Kolliker, Hertwig, Orr, and has been recently supported by Keibel, Froriep, and Cajal Schafer seems to be uncertain which view to take As the result of the author's investigations in the frog and chick, he concludes that the optic stalk takes no part in the formation of the nervous parts of the organ of sight The optic nerve is developed independently of the optic stalk, and at first entirely outside it The great majority of the fibres forming the optic nerve arise as outgrowths from nerve cells in the retina.—On the larva of *Asterias vulgaris*, by George W Field, M A (Plates xiii to xv) —On the development of the genital organs, ovoid gland, axial and aboral sinuses in *Amphiura squamata*, together with some remarks on Ludwig's hæmal system in this ophiurid, by E W MacBride, B Sc (Plates xvi to xviii) Concludes that echinoderms agree with other cœlomata in the origin of their genital cells these latter have at first an unsymmetrical position in echinoderms, and afterwards take on a radially symmetrical disposition in correspondence with the secondarily acquired radial form of the body. The origin of these cells adjacent to the stone canal suggests a comparison of the origin of the genital cells near the nephridia in many annelids, but the homology of the stone canal with a nephridium has yet to be proved —On a new genus and species of aquatic Oligochæta belonging to the family Rhinodrilidæ, found in England by W B Benham, D Sc (Plates xix and xx) This new worm receives the name of *Sparganophilus tamesis*, it was found in some numbers in the mud of the Thames, adhering to the roots of *Sparganium ramosum*, near Goring; the cocoon is drawn out to a point at one end, while in the other it shows a narrow frayed end. As the home of the Rhinodrilidæ is America, the author suggests that the cocoons of this worm may have been introduced into the Thames amongst the roots of water plants, or attached to timber from the United States

American Meteorological Journal, December —Atmospheric electricity, earth currents, and terrestrial magnetism, by Prof C Abbe The author has collected from various telegraph companies particulars about electrical storms, which illustrate the magnitude of the disturbances that frequently occur. The present electrical and magnetic observatories, which usually observe only some part of the whole series of phenomena, need to be supplemented by completely equipped establishments recording continuously the north-south, the east west, and the zenithal-antipodal differences of potential The ordinary records of atmospheric electricity give merely the difference of potential of the earth and a point in the atmosphere defined as the end of the water-dropping collector.—Notes on the use of automatic rain gauges, by J E Codman. Observations were made continuously for three years with the object of showing what difference the size of the gauges would make in the amount of rainfall collected. The largest gauge had a diameter of over 22 inches, and the smallest 2 inches. The results show that the size of the gauge made no practical difference He also gives the results of rainfall collected in gauges erected at various heights on a mast The result showed that a gauge at an elevation of 50 feet or less above the surface of the ground will collect the same amount as one on the ground, provided both are situated in a position not affected by counter currents of air This result agrees with that found by Prof Hellmann in his experiments at Berlin —Sunshine recorders, by Prof C F Marvin Thus far two methods only have been in general use, (1) the focussing of the rays of the sun by means of a glass sphere and obtaining a burn on the surface of a card, and (2) the photographic method, producing a trace on sensitized paper The first method records only bright sunshine, while the latter method is more sensitive and records fainter sunshine Prof Marvin has improved a method first developed by D T Maring of the Weather Bureau, consisting in principle of a Leslie differential air thermometer, mercury being used to separate the air in the two bulbs When properly adjusted and exposed to sunshine the lower blackened bulb becomes heated and causes the column to rise above a platinum point and close an electric circuit The instrument, of which a drawing is given, is said to respond promptly to sunshine and shadow The other articles are —Late investigation of thunderstorms in Wisconsin, by W L. Moore —Observations on the aurora of July 16, by T. W Harris, and Temperature sequences, by Prof H A Hazen

THE articles in the *Journal of Botany* for November and December are mostly of interest to students of British botany Mr F J Hanbury adds two more to his new species of *Hieracium*, *H britannicum* and *H caniceps*, Mr Bagnall describes a new species of bramble, *Rubus mercicus* from the Midland counties, and Mr. W H Pearson a new British liverwort, *Scapania aspera* Mr G F Scott Elliot contributes some useful hints on botanical collecting in the tropics

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 8, 1892 —"On the Photographic Spectra of some of the Brighter Stars" By J Norman Lockyer, F R S

The present communication consists of a discussion of 443 photographs of the spectra of 171 stars, which have been obtained at Kensington and Westgate-on Sea during the last two years

The chief instrument employed in this work has been a 6 inch refracting telescope in conjunction with—at different times—objective prisms of $7\frac{1}{2}°$ and $45°$ respectively

By this method the time of exposure is short, and good definition, with large dispersion, is easily secured The spectra thus obtained will bear enlargement up to thirty times without much sacrifice of definition

The 30-inch reflector and slit-spectroscope at Westgate on-Sea have also been used in the inquiry

My object has not been so much to obtain photographs of the spectra of a large number of stars as to study in detail the spectra of comparatively few

In the classifications of stars adopted by others from a consideration of the visual observations, only the broader differences in the spectra have been taken into account. Prof Pickering has more recently employed a provisional classification in connection with the Henry Draper Memorial photographs of stellar spectra, but this chiefly relates to photographs taken with small dispersion. With larger dispersion it becomes necessary to deal with the presence or absence of individual lines.

In the first instance, the various stars of which the spectra have been photographed at Kensington have been arranged in tables, without reference to any of the existing classifications, and taking into account the finer details The basis on which the main tabular divisions of the spectra are founded is the amount of continuous absorption at the blue end This distinction was not possible in the case of the eye observations.

The stars included in the first table are characterized by the absence of any remarkable continuous absorption at the blue end, and by the presence in their spectra of broad lines of hydrogen These have been further classified in four sub-divisions, depending on the presence or absence of other lines

In the stars of the second table there is a considerable amount of continuous absorption in the ultra-violet, and the spectra beyond K are very difficult to photograph as compared with the stars of the first table In these stars the thickness of the hydro-

gen lines is about the same as in the solar spectrum These also are arranged in two sub divisions

In all the stars included in the third table there is a very considerable amount of continuous absorption in the violet, extending to about G, and it is a matter of great difficulty to photograph these spectra, as most of the stars of this class are below the third magnitude The hydrogen lines are very thin. One sub division includes the spectra which show flutings shading away towards the less refrangible end of the spectrum. The other comprises stars without flutings in their spectra The brightest star in this table, α Orionis, is discussed in detail, the result tending to show that the temperature of the absorbing iron vapours is not much greater than that of the oxy hydrogen flame

The relations of the various sub-divisions to which reference has been made are then traced

One important fact comes out very clearly, namely, that whether we take the varying thicknesses of the hydrogen lines or of the lines of other substances as the basis for the arrangement of the spectra, it is not possible to place all the stars in one line of temperature Thus, there are stars in which the hydrogen lines are of the same average thickness, while the remaining lines are almost entirely different These spectra cannot, therefore, be placed in juxtaposition, and it is necessary to arrange the stars in two series

The next part of the paper consists of a discussion of the photographic results in relation to the meteoritic hypothesis In the Bakerian Lecture for 1888, I brought together the various observations of the spectra of stars, comets, and nebulæ, and the discussion suggested the hypothesis that all celestial bodies are, or have been, swarms of meteorites, the difference between them being due to different stages of condensation The new classification rendered necessary by this hypothesis differed from previous ones, inasmuch as the line of evolution followed, instead of locating the highest temperature at its commencement, as demanded by Laplace's hypothesis, placed it much later Hence bodies of increasing temperature were demanded as well as bodies of decreasing temperature

The question how far this condition is satisfied by the new facts revealed by the photographs is next discussed

This involves the consideration of some points in connection with the hypothesis to which brief reference alone has been made in previous communications. The phenomena to be expected on the hypothesis, and the actual facts, are given side by side below —

Nebulæ.

The bright lines seen in nebulæ should have three origins :—	
(1) The lines of those substances which occupy the interspaces between the meteorites Chief among these, from laboratory experiments, we should expect hydrogen and gaseous compounds of carbon.	(1) Lines at wave lengths approximately very closely to the lines of hydrogen, and to some of the carbon flutings, appear in the spectra of nebulæ
(2) The most numerous collisions between the meteorites will be partial ones—mere grazes—sufficient only to produce comparatively slight rises of temperature.	(2) There is a fluting most probably due to magnesium at λ 500, and the longest flame lines of iron, calcium, and magnesium are seen
(3) There will, no doubt, be a small number of end on collisions, producing very high temperatures, and there should be evidence of some high-temperature lines.	(3) The chromospheric line D_3 and another line at λ 4471 (which is always associated with D_3 in the chromosphere) have been recorded in the spectrum of the Orion Nebula.

Bright-Line Stars

The lines seen in the spectra of bright-line stars should, in the main, resemble those which appear in nebulæ. They will differ, however, for two reasons given in the paper	Prof Pickering has shown that the Draper Memorial photographs prove that bright-line stars are intimately connected with the planetary nebulæ, the lines in the spectra being almost identical.

Stars of Increasing Temperature

Stage 1 —Immediately following the stage of condensation giving bright line stars, the bright lines from the interspaces will be masked by corresponding dark ones, due to absorption of the same vapours surrounding the incandescent meteorites, and these lines will therefore vanish from the spectrum	The spectra of stars given in the third table answer these requirements They show no bright lines under normal conditions
Owing to the interspaces being restricted, absorption phenomena will be in excess, and low-temperature metallic fluting absorption will first appear The radiation spectrum of the interspaces will now consist chiefly of carbon	The dark flutings in the visual spectrum agree very closely in position with the flutings seen in the flame spectra of manganese, lead, and iron The evidence afforded by the photographs proves the actual presence of carbon radiation
Under these conditions the amount of continuous absorption at the blue end will be at a maximum	The photographs show a considerable amount of continuous absorption in the ultra-violet and violet
Stage 2 —With further condensation, the radiation spectrum of the interspaces will gradually disappear, and dark lines replace the fluting absorption owing to increase of temperature, though this line absorption need not necessarily resemble that in the solar spectrum	The spectra consist of numerous dark metallic lines, but they do not exactly resemble the solar spectrum α Tauri and γ Cygni are types of stars at this stage
Stage 3 —(1) The line absorption and the continuous spectrum at the blue end will diminish as the condensations are reduced in number, as only those vapours high up in the atmospheres surrounding the condensations will be competent to show absorption phenomena in consequence of the bright continuous spectrum of the still disturbed lower levels of those atmospheres	(1) These conditions are satisfied by such stars as α Cygni, Rigel, Bellatrix, δ Orionis, and α Virginis In these there is no continuous absorption at the blue end, the spectra consisting of simple line absorption
(2) Lines of iron and other substances will disappear at this stage, because the bright lines from the interspaces will counteract the lines in the same positions due to absorption of surrounding vapours.	(2) In the spectrum of α Cygni, which represents the earliest example of this stage there are a few of the longest lines of iron, but in other stars of this class the iron lines disappear.
(3) The chances of violent collisions being now enormously increased, we should expect the absorption of very high temperature vapours The solar chromospheric lines may be taken as examples of lines produced at such temperatures	(3) The new lines which appear include the chromospheric line at λ 4471, and possibly a few others

The Hottest Stars

The order of the absorbing layers should follow the original order of the extension of the vapours round the meteorites in the first condition of the swarm, and the lines seen bright in nebulæ, whatever their origins may be, should therefore appear almost alone as dark lines.	In stars like α Andromedæ we have absorption lines agreeing in position with some of the bright lines which appear in nebulæ.

Stars of Decreasing Temperature

Stage 1 —Owing to the diminishing depth of the absorbing atmosphere, the hydrogen lines will, on the whole, get thinner, and new lines will appear. These new lines will not necessarily be identical with those observed in the spectra of stars of increasing temperature. In the latter there will be the perpetual explosions of the meteorites affecting the atmospheres, whereas in a cooling mass of vapour we get the absorption of the highest layers of vapours. The first lines to appear, however, will be the longest low temperature lines of the various chemical elements.	Taking Sirius as a type of stars in the first stage of decreasing temperature, it is found that its spectrum shows many of the longest lines of iron.
Stage 2 —The hydrogen lines will continue to thin out, and the spectra will show many more of the high-temperature lines of different elements. These will differ from the lines seen in stars of increasing temperature owing to the different percentage composition of the absorbing layers, so far as the known lines are concerned.	The conditions at this stage of cooling are satisfied by such stars as β Arietis and α Persei. In the spectrum of these stars nearly all the solar lines are found, in addition to fairly broad lines of hydrogen.
Stage 3 —With the further thinning out of the hydrogen lines and reduction of temperature of the atmosphere, the absorption flutings of the compounds of carbon should come in.	There is undoubted evidence of the presence of carbon absorption in the solar spectrum and the spectrum of Arcturus, the only star which has yet been investigated with special reference to this point.

The photographs, then, give us the same results as the one formerly obtained from the eye observations.

Comparison is then made between the groups in the classification first suggested by the eye observations, and the various sub-divisions in which the photographs have been arranged.

Geological Society, December 7 —W H Hudleston, F R S., President, in the chair —The following communications were read —Note on the Nufenen stock (Lepontine Alps), by Prof T. G Bonney, F R S. In 1889 the author was obliged to leave some work incomplete in this rather out of the-way portion of the Lepontine Alps. In the summer of 1891 he returned thither in company with Mr J Eccles, F G S, and the present note is supplementary to the former paper. The Nufenen stock was traversed from north to south, and a return section made roughly along the eastern bank of the Gries Glacier. Gneiss abounds on the north side of the Nufenen Pass, followed by rauchwacké and some Jurassic rock. On the flank of the mountain are small outcrops of rauchwacké and of the so-called "Disthene schists" (both badly exposed), followed by much Dark-mica schist, often containing black garnets. Higher up is a considerable mass of Jurassic rock with the "knots" and "prisms" which have been mistaken for garnets and staurolites, but Dark mica schists set in again before the summit is reached. They continue down the southern flank of the peak; but rather north of the lowest part of the water shed, between Switzerland and Italy, the "Disthene schist" is again found, followed by a fair-sized mass of rauchwacké. The return section gave a similar association in reverse order, and both confirmed the conclusions expressed by the author in 1890 as to the absence of garnets and staurolites from Jurassic rocks (with belemnites, &c), and the great break between these or the underlying rauchwacké (where it occurs) and the crystalline schists, in which garnets often abound, of the Lepontine Alps. The crystalline schists and the Mesozoic rocks are thrown into a series of very sharp folds, which, locally, presents at first sight the appearance of interstratification.—On some schistose "greenstones" and allied hornblendic schists from the Pennine Alps, as illustrative of the effects of pressure metamorphism, by Prof T G Bonney. The author describes the results of study in the field, and with the microscope, of (*a*) some thin dykes in the calc schist group, much modified by pressure, (*b*) some larger masses of green schist which appear to be closely associated with the dykes, (*c*) some other pressure modified greenstone dykes of greater thickness than the first. The specimens were obtained, for the most part, either near Saas Fee or in the Binnenthal. These results, in his opinion, justified the following conclusions —(1) That basic intrusive rocks, presumably once dolerites or basalts, can be converted into foliated, possibly even slightly banded, schists, in which no recognizable trace of the original structure remains. (2) That in an early (possibly the first) stage of the process, the primary constituents of the rock-mass are crushed or sheared, and thus their fragments frequently assume a somewhat "streaky" order, that is to say, the rock passes more or less into the "mylonitic" condition. (3) That next (probably owing to the action of water under great pressure) certain of the constituents are decomposed or dissolved. (4) That, in consequence of this, when the pressure is sufficiently diminished, a new group of minerals is formed (though in some cases original fragments may serve as nuclei). (5) That of the more important constituents hornblende is the first to form, closely followed, if not accompanied, by epidote, next comes biotite (the growth of which often suggests that by this time the pressure is ceasing to be definite in direction); and, lastly, a water clear mineral, probably a felspar, perhaps sometimes quartz. (6) That in all these cases the hornblende occurs either in very elongated prisms or in actual needles. The author brings forward a number of other instances to show that this form of hornblende may be regarded as indicative of dynamometamorphism, so that rocks where that mineral is more granular in shape (cases where actinolite or tremolite appears as a mere fringe being excepted) have not been subjected to this process —On a secondary development of biotite and of hornblende in crystalline schists from the Binnenthal, by Prof T G Bonney. Both the rocks described in this communication come from the Binnenthal, and were obtained by Mr J Eccles, F G S, in the summer of 1891. They belong to the Dark mica schists described by the author in former papers, and have been greatly affected by pressure. In each a mineral above the usual size has been subsequently developed. In the rock from near Binn this mineral is a biotite: the dimensions of one crystal, irregular in outline, and having its basal cleavage roughly perpendicular to the lines indicative of pressure, are about 175″ × 03″. The other mineral, from the peak of the Hohsandhorn, is a rather irregularly formed hornblende, the crystals (which lie in various directions) being sometimes more than half an inch long. The exterior often is closely associated with little flakes of biotite. The author discusses the bearing of this fact, and the circumstances which may have favoured the formation of minerals, so far as his experience goes, of an exceptional size. Some remarks also are made on relation of these structures developed in the Alpine schists to the various movements by which those rocks have been affected, and on the general question of pressure as an agent of metamorphism. The reading of these papers was followed by a discussion, in which the President, Mr Eccles, the Rev. E Hill, Mr Rutley, Mr Teall, and the author, took part —Geological notes on the Bridgewater District in Eastern Ontario, by J. H Collins.

PARIS

Academy of Sciences, January 2 —M d'Abbadie in the chair —M Lœwy was elected Vice-President for 1893. MM Fizeau and Fremy were elected into the central committee of administration. The President gave a list of the members, associates, and correspondents deceased and elected during 1892. The new members were MM Appell, Perrier, Guyon, and Brouardel. Foreign associates, MM von Helmholtz, and van Beneden. Correspondents, MM Sophus Lie, Considère, Amsler, Auwers, Rayet, Perrotin, de Tillo, and Manen — Observations of Brooks's comet (November 19, 1892) made with the *equatorial coudé* of the Lyon Observatory, by M G. Le Cadet.—On a new method of approximation, by M E Jablonski. —On the movements of systems whose trajectories admit of an infinitesimal transformation, by M Paul Painlevé —On the general form of vibratory motion in an isotropic medium, by M E. Mercadier.—On thermo-electric phenomena between two

electrolytes, by M. Henri Bagard. The thermo-electric force between two portions of the same electrolyte in different stages of dilution was determined by experiments performed at the physical laboratory of the Faculty of Sciences at Nancy The diaphragm employed consisted of goldbeater's skin, which has the advantage of closely adhering to the glass The results are given in the case of zinc sulphate With a 5 per cent and a 45 per cent solution the difference of potential ranged from 78 at 17 9° to 155 at 73 5°, the unit being 1/10000th of the E M F of a Daniell cell The law of intermediate bodies was strictly fulfilled, as shown by opposing a couple of 5 and 25 per cent in series with another of 25 and 45 per cent to a third of 5 and 45 per cent., when no deflection of the electrometer was observed between 0° and 73 3° —On the age of the most ancient eruptions of Etna, by M Wallerant The first eruptions of Etna have been variously estimated to have occurred in the later quaternary or in the upper pliocene periods These conclusions were based on the study of the prismatic basalt laid bare by the sea round the foot of the cone The pliocene deposits found in conjunction with part of the basalt appear from palæontological evidence to be contemporaneous with the sub-Appenine blue marls, which belong to the lower pliocene. In the Cyclopean Isles the basalt is covered with a layer of clay, which is also found interpenetrated by the basalt The identity of age of the two formations is evidenced by lenticular patches of sand interstratified in the clay, whose particles consist of fragments of pyroxene, peridote, and triclinic felspar, proving that when the sub-Apennine marls were being deposited Etna was the scene of eruptions accompanied by the emission of ashes

DIARY OF SOCIETIES.

LONDON.

THURSDAY, JANUARY 12

MATHEMATICAL SOCIETY, at 8 —On the Application of Clifford's Graphs to Ordinary Binary Quantics, 2nd Part, Seminvariants The President —On the Evaluation of a Certain Surface integral and its Application to the Expansion of the Potential of Ellipsoids in Series Dr Hobson,

SOCIETY OF ARTS, at 4 30 —Upper Burma under British Rule H Thirkell White

INSTITUTION OF ELECTRICAL ENGINEERS, at 8 —Experimental Researches on Alternate-Current Transformers Prof J A Fleming, F R S (Discussion)

LONDON INSTITUTION, at 6 —Electric Lighting (1) Generation of Electric Currents Prof Silvanus Thompson, F R S

FRIDAY, JANUARY 13

PHYSICAL SOCIETY, at 5 —Upon Science Teaching' F W Sanderson

SOCIETY OF ARTS, at 8 —The Development and Transmission of Power from Central Stations Prof W Cawthorne Unwin, F R S

INSTITUTION OF CIVIL ENGINEERS at 7 30 —Description of the Design and Construction of a Roadway Bridge over the River Cam Edwin Hulme.

AMATEUR SCIENTIFIC SOCIETY, at 8 —Geology in 1892 A M Davies —Recent Developments in the Metallurgy of Gold T K Rose.

SATURDAY, JANUARY 14

ROYAL BOTANIC SOCIETY, at 3 45

SUNDAY, JANUARY 15

SUNDAY LECTURE SOCIETY at 4 —Some Invasions of India and their Results" (with Oxyhydrogen Lantern Illustrations) R W Frazer

MONDAY, JANUARY 16

ROYAL GEOGRAPHICAL SOCIETY at 8 30 (at the University of London, Burlington Gardens, W)—Journeys in Sarawak, Borneo (Illustrated by the Oxy-hydrogen Lantern) Charles Hose.

VICTORIA INSTITUTE at 8 —Why the Ocean is Salt Prof Hull, F R.S

LONDON INSTITUTION, at 5 —The Spanish Armada (Illustrated) F L. S. Horsburgh.

TUESDAY, JANUARY 17

ZOOLOGICAL SOCIETY, at 8 30 —A Proposed Classification of the Hesperiidæ, with a Revision of the Genera E Y Watson.—Descriptions of New Species of Dipterous Insects of the Family Syrphidæ In the Collection of the British Museum, with Notes on the Species described by the late Francis Walker: E. E Austen.—On Two New Species of Copepoda from Zanzibar Gilbert C. Bourne.

MINERALOGICAL SOCIETY, at 8.—On a Discovery of Oriental Ruby and Margarite in the Province of Westland New Zealand Prof G H F. Ulrich.—On the Isomorphism of the Red Silvers' H A. Miers.—On the Occurrence of Baddeleyite (Native Zirconia) in Brazil. L. Fletcher, F R.S.

ROYAL STATISTICAL SOCIETY, at 7 45.—The Reorganisation of our Labour Department David F Schloss.

INSTITUTION OF CIVIL ENGINEERS, at 8 —Gas Power for Electric Lighting J Emerson Dowson. (Discussion)—Reception by the President and Council

ROYAL INSTITUTION, at 3.—The Functions of the Cerebellum, and the Elementary Principles of Psycho-Physiology Prof Victor Horsley F R.S

WEDNESDAY, JANUARY 18

ROYAL METEOROLOGICAL SOCIETY, at 7 15.—Annual Meeting —The High Altitudes of Colorado and their Climates Dr C Theodore Williams

ROYAL MICROSCOPICAL SOCIETY, at 8 —Annual Meeting —Presidential Address Dr R Braithwaite

ENTOMOLOGICAL SOCIETY, at 7 —Election of Council and Officers for 1893 Report of the Council, and Address by the President, F D Godman, F R.S

THURSDAY, JANUARY 19

ROYAL SOCIETY, at 4.30 —The Bakerian Lecture The Rate of Explosion In Gases Prof H B Dixon, F R.S

LINNEAN SOCIETY at 8 —The Plants of Malanji collected by Mr A Whyte, and described by Messrs Britten, Baker, and Rendle W Carruthers, F R.S —Report on the District traversed by the Anglo French Sierra Leone Boundary Commission G F Scott Elliot

CHEMICAL SOCIETY, at 8 —The Determination of the Thermal Expansion of Liquids Prof T E Thorpe, F R S.—The Thermal Expansion and Specific Volumes of Certain Paraffins and Paraffin Derivatives Prof Thorpe, F R S, and Lionel M Jones —The Hydrocarbons formed by Decomposition of the Citrine Dihydrochlorides W A Tilden, F R S, and Sidney Williamson —Camphorsulphonic Derivatives F S Kipping and W J Pope —Note on the Decaphanes formed from Terpenes and Camphor Henry E Armstrong

INSTITUTION OF CIVIL ENGINEERS, at 2 30 —Students' Visit to the Works of Messrs Maudslay, Sons, and Field, Westminster Bridge Road, S F

ROYAL INSTITUTION, at 3 —Tennyson Rev Canon Ainger

LONDON INSTITUTION, at 6.—Electric Lighting (2) Electric Lamps Prof Silvanus Thompson F R.S

FRIDAY, JANUARY 20.

ROYAL INSTITUTION, at 9 —Liquid Atmospheric Air Prof. Dewar, F R S

SATURDAY, JANUARY 21

ROYAL INSTITUTION, at 3 —Expression and Design in Music (with Musical Illustrations) Prof C. Hubert H Parry

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THURSDAY, JANUARY 19, 1893

HEREDITY.

Das Keimplasma Eine Theorie der Vererbung. By August Weismann, Professor in Freiburg i B (Jena. Gustav Fischer, 1892)

IN the substantial volume whose title stands at the head of this article Prof Weismann has gathered together the results of the essays and researches which he has given to the world during the last eleven years, and he now presents us with a theory of heredity, for which his previous writings have been but preparatory

Those who have followed the German philosopher since the appearance of "Die Dauer des Lebens" in 1882 have traversed a wide territory They have seen many theories and hypotheses come into view and attain a certain degree of definiteness Some of these are now lost to sight, others have changed their outline and altered the relative proportion of their parts, but, whatever was the standpoint, the central feature of Prof Weismann's theory of heredity—the continuity of the germ-plasma—remained unchanged

The work before us consists of an introduction, partly historical, and of four books, in which the theory and its application to various biological problems are set forth in the fullest possible manner, and in language for the most part free of technical phrases, so that a non-scientific reader can easily follow the argument At the close of the volume are a summary of the four books and an index The latter is a novelty in a German book of this kind, for which we cannot be too grateful to its compiler, Fraulein Diestel

The title of the work strikes the key-note of Prof Weismann's theory Heredity, according to his view, is brought about by the transference from one generation to another of a substance with a definite and very complex constitution, the germ-plasma This substance is the material basis of heredity, and it is supposed that a part of it in each reproductive cell is not used up in the construction of the offspring, but is transmitted unchanged to form part of the reproductive cells of the following generation. As the author points out, his theory might be termed "Blastogenesis," or the origin from the germ-plasma, as opposed to Darwin's Pangenesis, or the origin from all parts.

This germ-plasma is necessarily a most complicated substance, it cannot arise anew, but can grow and increase. Its ultimate constituents, according to the latest view of the Freiburg professor, are certain units termed biophores, which possess the properties of assimilation, growth, and multiplication by means of fission So long as the organic world consisted of biophores living either singly or united in colonies, heredity and multiplication with subsequent growth were one, since each division resulted in two similar halves, which by growth gave rise to organisms exactly like the parent.

But, when the principle of the division of labour made itself felt, the biophores became differentiated, and simple division no longer sufficed to give rise to two similar organisms, each exactly like their parent. A special mechanism was needed to bring about heredity, and according to our author this was found in the nucleus This differentiated part of the cell was originally a collection of reserve biophores. After the division of the nucleus the biophores in each half multiplied, and so replaced those which had separated from them, and thus rendered possible the completion of the new organism The structure of the nucleus became still more complicated when amphimixis, the mingling of the hereditary substance of two individuals, made its appearance Amongst multicellular organisms, with their endless variety of cells, the same mechanism exists, but in a still more complicated form Sexual reproduction has arisen, that is, the "Anlagen" for the whole organism are collected into a single reproductive cell, two such cells come together, and the resulting fertilized egg cell contains the hereditary substance of two individuals.

According to Prof Weismann's present view, this hereditary substance or germ-plasma consists ultimately of biophores These units are built up in a definite order and arrangement into units of the second degree, which are termed "cell determinants," or simply "determinants" Every cell of a multicellular organism is dominated in its histological character, and in the rhythm and nature of its division by one of the determinants. Each cell has not, however, a corresponding determinant in the germ-plasma, but cells of the same sort, as, for instance, blood corpuscles, may be represented in the hereditary substance by the same determinant In the germ-plasma of any species there must be as many determinants as there are variable cells or cell groups in the organism The determinants are arranged in a definite order in units of the third degree termed "ids"

These ids, which will be familiar to readers of Prof Weismann's latest essay, that on Amphimixis, are again built up into idants, and these last probably correspond with the chromatosomes, or nuclear rods of the nucleus. Thus the germ-plasma consists of idants, the idants are composed of ids, the ids are built up in a definite manner of determinants, and the determinants are formed of the final units, the biophores.

It is assumed that the biophores can pass out of the nucleus and divide and multiply in the surrounding cell protoplasm Amphimixis brings about the mingling of a certain number of biophores from one parent with a similar number from the other, and the organism whose body is dominated by this mixed assemblage of biophores partakes of the nature of both parents.

In the reproductive cells of the higher plants and animals the nucleus must contain not only those determinants which dominate the structure, rate of division, &c, &c, of the cell itself, but also those which will dominate the various cells and systems of cells which will eventually arise from the reproductive cell, and furthermore these must be definitely arranged in a given order, so that they may not be all called into activity at once, but may become functional successively, in accord with the origin of the cells they control.

It is not possible within the limits of a short article to describe the many ingenious applications of his theory, by means of which Prof. Weismann attempts to explain such phenomena as the Regeneration of lost parts, Reversion, Budding, Alternation of Generations, &c.: all

these are brought into line, and are shown to be capable of an explanation in the theory of germ plasma. Dimorphism and seasonal dimorphism are explained by the assumed existence of double determinants, one corresponding with each form, and remaining inactive during the life-time of the organism controlled by the other.

Such changes as affect the cell body cannot be transmitted according to this view, since alterations in the cell have no effect upon the biophore which in the next generation will dominate the corresponding cell of the offspring. But, since variation must be ultimately dependent on external circumstances, influences such as climate, change of food, &c., are considered to have in the course of time some effect upon the determinants, and a corresponding change in the organism results. In this lies one of the chief differences between the germ-plasma theory of Prof. Weismann and the Pangenesis of Darwin. They both give a possible explanation of heredity, but in the latter case the gemmules, coming from every cell of the body, afford an explanation of the transmission of acquired somatic changes, in the former case the biophores, arising only from other biophores, would be uninfluenced by any such change.

A. E. S.

THE BASIS OF ALGEBRA.

The Algebra of Co-planar Vectors and Trigonometry. By R. Baldwin Hayward, M.A., F.R.S., Senior Mathematical Master in Harrow School, formerly Fellow of St. John's College, Cambridge. (London: Macmillan & Co., 1892.)

THIS work is constructed on the methods of the school of mathematicians who derived their inspiration from the teaching of De Morgan, a school which is represented by many of the most influential of our recent writers on mathematical subjects. It is intended to occupy the place of the "Trigonometry and Double Algebra," published in 1849 and now a long time out of print, at the same time incorporating such improvements in elementary treatment as have been evolved out of half a century's discussion of the foundations of Algebra. Those who are acquainted with Mr. Hayward's other writings, such as his "Elements of Solid Geometry," will expect a fresh and interesting treatment of his subject; and they will not be disappointed. On turning over the pages we constantly come across elegant touches and happy turns of expression, and historical appreciations—the stuff which constitutes the basis of literary excellence in mathematical writings.

The treatise is primarily concerned with the logical exposition and illustration of the principles on which Algebraic Analysis, including Analytical Trigonometry, is founded. The utility of this subject in its practical applications renders it a necessary part of even an elementary course of reading, while a very refined treatment of it may lead so far into the notions of the Theory of Functions and algebraic continuity in general, as to somewhat overlay the really simple matters with which it is concerned. In this country the tendency in elementary books has, until recently, been rather to take the fundamental formulæ on credit, and to make the subject consist of the development of their analytical and practical consequences. The philosophical principles which bind them into an organic whole have retained so much the aspect of *à posteriori* developments, that there is some temptation to proceed in the view that Mathematical Analysis is an inductive science like Natural Philosophy, that it is one part of the science to invent and verify the formulæ, while the logical calculus which gives them precision and limitation is quite another department. The great majority of readers of the elements of Algebra have no time for an exhaustive discussion of the nature of continuous quantity and all the types of singularity to which it is liable, while on the other hand complete neglect of the logical basis of Analysis deprives it both of a main source of its interest, and of a large part of its value as an intellectual training. Hence arises the importance, even in presence of the complete theory with which a specialist must be acquainted, of the simplification and improvement of methods of exact treatment within the domain of elementary ideas.

The author's method starts off from an *à priori* discussion of the Algebra of Co-planar Vectors, which leads him to the two modes of specification of a vector, as a power of the fundamental vector, and as a sum of components. The identification of these two expressions leads to the analytical definitions of the *sine* and *cosine*, and by way of certain theorems in algebraic limits [whose explicit enunciation is by the way not essential] to the orderly development of the subject. The theorems concerning series which involve the complex variable are strikingly illustrated by corresponding vector chains, and geometrical interpretations are throughout very copious. The treatment is here so full and many-sided, that it would form an interesting occupation for the reader to take up the other aspect of the matter, and try to pick out the simplest and briefest analytical foundation on which the formulæ required for practical applications may be built.

The remarkable formula of p. 115, $(4{\cdot}810475\ldots)^{\iota} = \iota$, if removed from the context in which it is set, might be propounded as a puzzle in interpretation. The author introduces us straight off to an expression with a complex index, and proceeds to ascertain whether any meaning can be assigned to it, which will allow the inclusion of such expressions in the algebraic calculus. The geometrical method gives him very neatly and definitely an expression for the values of A^B, where A and B are both complex, by means of the vector ribs of a fan of equiangular spiral form. But when the conception of logometers (analytical logarithms) to a vector base comes up for interpretation, the answer proves to be some one of an infinito-infinite series of vectors related to one another in a manner so complicated as to elude definite grasp; and we have arrived at a case in which the inclusion of the function in our calculus would, in the absence of special machinery of representation like a Riemann's surface, be best avoided.

The origin of all difficulty in the treatment of complex algebra lies in fact in the multiplicity of values of the functions with which it deals. If each function can be defined as spread out in a multiple sheet so as to be single-valued at each point on each leaf of the sheet, a great part of the trouble disappears. We can then if we

please make explicit use of the Principle of the Permanence of Equivalent Forms, which, after having been expounded at length and defended by Peacock (appendix to "Algebra"), has been summarily rejected as misleading and unmeaning by many recent authors To the formal reintroduction of this principle Mr Hayward's language exhibits a tendency to return Outside the domain of elementary Algebra, its strict employment in the prolongation of an analytical function into a new region is indeed of common occurrence in Analysis; while its tentative application in unrestricted form, as an instrument of suggestion and discovery in the Theory of Operations, is fundamental. To the effort to widen the limits of interpretation in connexion with it, has been due most of the advances in Analysis

It is a fundamental question in mathematical logic how far, after having carried the stream of our analysis through regions of uninterpreted symbols, and having at length arrived at a stage in which these symbols have disappeared, we are entitled to claim this procedure to be demonstrative It is of course of the very essence of Algebra that the intermediate steps of its analysis remain uninterpreted, though in the Algebra of real quantities we have a tacit assurance that an interpretation can be supplied if necessary Why then was there an objection to a similar procedure in the Algebra of complex quantities, and what is the source of the timidity and doubt which characterized the use of complex analysis before its geometrical interpretation was developed? Simply that complex quantities turned out to be multiple-valued, and that the selection of the proper value under given circumstances had to be settled by tracing the continuity of the quantities in a way that was to the mind practically impossible until a visual geometric representation was discovered. The Argand diagram is not essential to the logic of the matter, it rather makes Analysis possible by bringing its scope within our grasp It simply forms a more extensive and systematic example of the method which has been in use since the time of Descartes for studying functions and approximating to their roots, by aid of their graphical representation

The Principle of Permanence of Equivalent Forms thus lies at the very root of Algebra, but it is rendered ineffective by indeterminateness of interpretation Its strict use, when most needed, is subject also to another hitch. It requires that the forms be expressed in exact terms, an infinite series must be expressed in the sum of n terms together with a residue R These residues must be retained throughout the analysis until we arrive at a point where interpretation comes in, and it must then be settled how far they can be neglected in the circumstances of the actual interpretation. In the language of Mr Hayward, it cannot be asserted about series that are not absolutely convergent, that the fundamental laws of Algebra hold without limitation

It is perhaps a question how far the idea, thus restricted and safeguarded, is worth being expressly retained as a working principle of ordinary Algebra. In subjects like the Calculus of Operations and Finite Differences, which are still in an unsytematized stage, it cannot be dispensed with; and the extent to which its use is boldly pushed, by De Morgan and Boole, even to the discussion in an operational manner of divergent series without their residues, contrasts with the more exact processes of recent Analysis. How far this boldness arises from the profound logical studies of these writers, and their appreciation of the imperfect character of inference at the best, may be a subject open to discussion.

In connexion with the doctrine of convergence of series, the author gives a very clear account, from Sir G Stokes, of how it is that, on approaching certain critical points, the convergence may gradually fall off and finally disappear. The illustrations employed are algebraic series of an exceptional character, and the whole circumstances may possibly suggest to the uninitiated that it is a phenomenon of exceptional rarity The most natural context is, of course, in connexion with the wonderful and far-reaching theory initiated by Fourier, by means of which functions arbitrarily discontinuous are expressed by seemingly continuous series In that connexion, the necessity of explanation is so obvious that it is interesting to examine the previous attempts at elucidation Thus De Morgan, in 1839, is able to conclude ("Diff and Int Calc.," pp 233, 239) that such discontinuity cannot occur in series proceeding by powers of a real variable, that in other cases it occurs only through the series becoming divergent at the point of discontinuity It is, however, an important question how far it would be allowable to avoid burdening an elementary exposition by complete precautions against the existence of anomalies like this, which would hardly have originally occurred to any one in that early stage

The book ends with a wider survey, including a clear and interesting account of Cauchy's theory of the radical points of a rational function The graphs of the cubic $x^3 + ax$, which are given as an illustration, would also form excellent and rapid examples of the Rankine-Maxwell method of graphical addition, applied to the separate graphs of x^3 and ax

J L

FOSSIL PLANTS AS TESTS OF CLIMATE

Fossil Plants as Tests of Climate, being the Sedgwick Prize Essay for the Year 1892 By A C Seward, M A, F G S, Lecturer in Botany in the University of Cambridge (London: C. J. Clay and Sons, Cambridge University Press, 1892.)

THIS admirable essay is really a digest of the opinions of the principal writers on fossil plants, so far as they throw light on geological climates, and a critical *résumé* of the subject up to date. It should be read by all who prefer to deduce the relative temperatures of various latitudes in the past from such solid data as assemblages of ferns, cycads, and conifers, the ancestors of living genera and species, rather than from utterly extinct belemnites, ammonites, and saurians, of whose habits little can ever be known, and which might have drifted far out of their temperature zones by warm and cold sea-currents

Perhaps if any criticism can be made, it is that too little has been said by the author as to what is known of the Mesozoic floras, which, if scanty, are extremely interesting In fact only the widely separated Palæozoic and Cenozoic floras are fully dealt with. Owing to the magnitude, difficulty, and freshness

of the problems presented by the former, they have received the larger share of attention and have ever attracted some of the most acute and philosophic of scientific workers But while the researches of such investigators as Williamson and Renault into the actual structures and affinities of the carboniferous plants have been rewarded with the most brilliant successes, attempts to speculate and theorize have only been productive of barren controversy All inferences as to the temperatures in which they flourished have merely been inductions from unknown data their affinities with existing plants are so remote that they can tell us of little beyond moist climates and spongy, marshy soils, liable to inundation, with possibly an atmosphere more highly charged with carbonic acid than at present But that neither the flora nor identical conditions were uniformly present over the whole land during the deposition of the carboniferous, becomes every year more apparent, and perhaps few would now maintain that fossil floras met with in widely-different latitudes must necessarily be contemporary because similar, or reject as impossible the correlation of the Glossopteris floras of the southern hemisphere simply because they are so dissimilar

Tertiary floras, however, have to be approached from almost totally different standpoints, for here minute investigations into vegetable structure can only exceptionally lead to important results On the other hand it may be possible to predicate the climate that any group among them would have required, with almost perfect accuracy. Allowing that even most closely-allied species may have had different habits, enough remain that are practically identical with living species These not only prove to us that in every land in our hemisphere the temperatures remained warmer throughout the Tertiary period than at present, but also that the temperatures were far from equable during Eocene time. Thus it is impossible to hesitate as to the evidence of the flora in the lower stages of our Eocene, which exhibits an abundance of planes, poplars, and alders and an absence of all approach to sub-tropical essences, nor as to that of the London Clay, with its tropical nipas, sabals, and a host of others almost indistinguishable from species existing at the present day There is scarcely need of the corroborative evidence of the Mollusca as to cooler seas in the Thanets, nor of tropical conditions in the large turtles, crocodiles, snakes, and nautili of Sheppey In fact, the temperature of the spots occupied by Reading, Bournemouth, or Mull at a particular stage of the Eocene could be predicated from the fossil floras almost as accurately as from living plants If the same cannot be said of the Arctic regions it is simply that the specimens brought home are, perhaps from the exigences of travel and inexperience of the collectors, for the most part so imperfectly preserved and fragmentary, that few of the determinations can carry the smallest weight. It may suit quidnuncs to accept indeterminable fragments as evidence of the growth of palms and cycads in the Greenland Eocene—it is time the Miocene age of these beds was relegated to the limbo of Coal-measure palms and yuccas—and to become excited over the presence of a sub-tropical flora within the Arctic circle; but as a fact it is doubtful whether anything has been discovered there which might not have grown in our own temperature, if slightly modified, a state of things which it is conceivable the damming back of the Arctic seas by the land connection which then existed between Europe and America, aided by an active Gulf Stream, might have brought about When we come to the Miocene, worked out as that of Switzerland was by Heer, or still more the Quaternary, with such data as those laboriously amassed by Clement Reid, the inferences as to climate are still more irresistible

As to evidence of the age of rocks, plants are less trustworthy, because they have neither been so perfectly studied nor are their zones as yet at all properly defined All we can say is that certain assemblages are found in association at the beginning of the Tertiary, and that changing temperatures have since compelled them not to disperse, but to migrate far and wide Fewer probably of the species are extinct than is generally supposed, and the primitive associations have held together perhaps to the present day, with many gaps from extinction and desertion and a large infusion of recruits through the ordinary causes of evolution, stimulated by the increase in browsing mammalia Whether, on the other hand, the marine deposit zones are really entitled to the weight attached to them as evidences of age, except locally, is not so clear They are usually the littoral deposits of a limited area, where some changes of level or current have apparently suddenly driven out the fauna and introduced new colonies more adapted to the changed conditions If we could follow the subsequent wanderings of these assemblages under the sea our faith in their sudden extinction and consequently in their chronological value might be greatly modified At all events, many of the less conspicuous groups of mollusca, when critically examined, prove to have surprisingly near relatives in distant seas at much later periods, and even at the present day

J STARKIE GARDNER

OUR BOOK SHELF

Pioneers of Science By Oliver Lodge, F R S (London and New York Macmillan and Co, 1893)

THIS book consists of eighteen lectures on the history and progress of astronomy, which were delivered by Dr Lodge in 1887 "The lectures having been found interesting," he thought it "*natural* to write them out in full and publish," and, although this can scarcely be considered a sufficient excuse, the intrinsic merits of the work are abundant justification for its existence. In Part I, "From Dusk to Daylight," the progress of astronomy from Copernicus to Newton is traced in a series of vivid pictures of Copernicus, Tycho Brahe, Kepler, Galileo, Descartes, and Newton; while Part II, "A Couple of Centuries' Progress," brings the history of gravitational astronomy from Newton down to the present time. In these latter lectures Roemer and Bradley are associated with the velocity of light and aberration, Legrange and Laplace with the solar system and the nebular hypothesis; Herschel with the motion of "fixed" stars; Bessel with the distances of stars, Adams and Leverrier with the discovery of Neptune, and Lord Kelvin and George H Darwin with tides. Dr Lodge has been able, by judiciously combining clear statements of scientific facts and laws with interesting personal details, to give his lectures all the charm of a romance. The book is an admirable introduction to the study of astronomy, and no better gift for a beginner could well be chosen, while to those to whom many of

its details are already familiar, the picturesque clearness with which they are presented will make their knowledge more real and more complete The standard of excellence maintained in the lectures makes distinction difficult and invidious, or we would distinguish the lectures on Newton and those on tides as models of what such popular scientific expositions should be The book is copiously, and, on the whole, well illustrated, but some of the illustrations—notably those of clusters and nebulæ—are very familiar and somewhat out of date A curious mistake occurs on page 291, where a well-known drawing of a comet appears as an "old drawing of the Andromeda nebula" The illustration on page 326, showing the paths of Uranus and Neptune and their relative positions from 1781 to 1840, and professing "to illustrate the *direction* of their *mutual* perturbing forces," is partly misleading, but in introducing this Dr Lodge has erred in good company, for the diagram, originally due to Dr. Houghton, appears in many of our recent astronomical text-books A 'I

Electric Lighting and Power Distribution Part I By W Perren Maycock, M I E E (London. Whittaker and Co, 1892)

THIS cheap and useful little text-book has been written for the author's junior students, as he is of opinion that no trustworthy elementary work on the subject is to be obtained The scope of the work has been limited to the syllabus of the ordinary grade examination of the City and Guilds of London Institute We find, however, much information on subjects not usually found in other manuals The book is freely illustrated, and the descriptions are clear

It is very important for the junior student to understand clearly what is meant by a line of force, and to grasp the fact that lines of force are only *assumed* to exist, because, by such an assumption it is possible to explain many, otherwise inexplicable, phenomena On page 47 we find the following statement —"The power which any magnet possesses, of picking up pieces of iron, and of acting upon another magnet, depends upon the existence of lines of magnetic force" This quotation is vague, a junior student might easily imagine that the lines of force really existed, whereas they are purely assumptions, to elucidate the phenomena of magnetic attraction The illustrations of simple bar magnets, solenoids, and electro-magnets, in which the lines of force are delineated, should have the assumed directions of the lines of force clearly shown by arrow-heads. This might be done with advantage in Figs. 17 to 20

Chapter IV deals with induction of currents, electromagnetic induction, Faraday's Law, and concludes with a clear description of magneto-motive force, magnetic resistance, magnetizing force, induction and permeability These latter are very difficult for a junior student to understand thoroughly, and the author should have devoted more space to the discussion of these important points in dynamo construction One particularly good feature in this text-book is the large number of questions arranged at the end of each chapter These are well suited to test the knowledge of a student Chapter V deals generally with electrical testing, measuring instruments used in installations, and meters for measuring the current, such as Teague's, Elihu Thomson's, and the Wright-Ferranti Chapter VI concludes the book, describing the principle of the dynamo, different types of machines, and the construction of the various parts.

Taken as a whole this book attempts too much. The matter described has suffered considerably by condensation, a serious thing where junior students are concerned. Most of the illustrations are good, some are indistinct, and Fig. 98 is decidedly wrong, showing the brushes set for one direction of rotation, and the arrow indicating the reverse.

On the other hand the sequence of matter is good, and a student should learn much from the work. The author takes great pains to describe clearly the many units involved, particularly the applications of Ohm's law The book would last much longer in the hands of the average student if the present paper binding were replaced by something stronger

The Naturalist on the River Amazons. By Henry Walter Bates, F R.S With a memoir of the author by Edward Clodd Reprint of the Unabridged Edition With Map and Numerous Illustrations (London John Murray, 1892)

THIS work is so well known, and has long held so high a place among scientific books of travel, that it is unnecessary to do more than note the appearance of a new edition. It is clearly printed on good paper, and the illustrations are well reproduced The introductory memoir by Mr Clodd is a most welcome record of the main facts of Mr Bates's career The materials for this interesting sketch were enriched by letters placed at the author's disposal by Sir Joseph Hooker and Mr Francis Darwin An excellent portrait of Mr Bates is included in the volume

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

A Proposed Handbook of the British Marine Fauna

SUCH a handbook as Prof Herdman suggests is so much wanted that many naturalists must from time to time have felt tempted to essay it But the difficulties are very formidable Prof Herdman seems to contemplate the preparation of such a work mainly as a labour of compilation. But the groups where compilation would nearly suffice are just those where the handbook is least required On the other hand, such a group as the Amphipoda, in spite of Canon Norman and Mr Stebbing's many papers, is still in great need of revision, It was only the other day that Canon Norman opened our eyes to our rich fauna of Mysidæ, before which time no search among published records would have told us anything worth the having, we are in just the same position as to our British Cumacea, until Canon Norman again reveals the treasures of his cabinet, our Pycnogons are almost as little known In every one of these groups, and in many others like them, the preparation of a hand-list would need the experience of a specialist, just as much as the Tunicata would require Prof Herdman's own special knowledge The area to be embraced is another difficulty Prof Herdman proposes to take the British area as defined by "Canon Norman's" B.A Committee in 1887, on which he himself served But the committee's report was repudiated by Canon Norman himself, who afterwards suggested a wider "British area," whose boundaries I fancied had since been recognized as more suitable by everybody However the British area be defined, there will long remain a difficulty in the numerous forms not yet recorded from within it, but which are likely, or certain, to turn up when sought for Such things as the parasitic and other Crustacea described of late years by Giard and his pupils from Wimereux form a case in point I am inclined to think that to make in the first instance a hand-list of the whole fauna of the North Atlantic basin would be not a bit more difficult, but in some respects easier, than to restrict the list to the British area alone. That it would be incomparably more useful is certain. It would make a book not more than three times (perhaps little more than twice) as big as Carus's "Fauna Mediterranea." And it would be a very important step towards that new *systema naturæ* of which the Germans are already beginning to talk, and which it is high time were begun

But Prof. Herdman both asks discussion of his plan, and also invites criticism on his execution of it Take his very first illustrative genus, which he tabulates as follows:—

ANTENNULARIA.—Stems simple or branched, pinnæ verticillate; nematophores along the stems, gonothecæ axillary, unilateral.

A antennina, L, stems clustered, usually simple, hydrothecæ separated by 2 joints 6 to 9 in high. Gen. distr deep w

A ramosa, Lamk, stems single, usually branched, hydrothecæ separated by 1 joint only 6 to 9 in. high Gen. distr deep w

Now there are *no* nematophores along the stem, but only on the pinnæ, *A ramosa* may sometimes grow up unbranched, but I for one never saw it so, and *A antennina* is always simple, save by the rarest individual abnormality, the dimensions are quite inaccurate, for we have *A antennina* here of all sizes up to 24 inches high. The distribution given is too vague In the report of the B A Committee, which Prof Herdman goes by, deep water is defined as that below 100 fathoms, but these two are not deep water species, either in that or any other common use of the phrase The authorities are very loosely given *A. antennina*, L, should be (L), and if the bracketed authority, *i e* the original user of the specific name, is to be the one quoted, then for *A ramosa*, I think Lamk should give place to (Lamx) And why is the authority for the genus left out altogether?

Moreover, even if these definitions were verbally accurate so far as they go, they would only suffice to exclude one another, with no reference to other non-British species They are rather definitions of groups of species or sub-genera, than of these two particular forms It would not matter very much, perhaps, in this case, where other species are not likely to turn up upon our coasts, but such definitions, drawn with reference only to known British forms, would soon lead to hopeless confusion in the case of less known groups D'ARCY W THOMPSON

Dundee, January 11

On an Abnormality in the Veins of the Rabbit

AMONGST a number of rabbits dissected in my laboratory last term, one specimen exhibited a peculiarity in the venous system which is especially interesting in connection with Hochstetter's and Macalister's accounts of the development of the veins Unfortunately the specimen had been too far dissected before the abnormality was noticed to follow out every detail

The blood from the hinder extremities, urinogenital organs, and abdominal walls, passed into a large vessel having the position and relations of a postcaval posteriorly Instead, however, of passing through the dorsal border of the liver to penetrate the diaphragm, it was seen at the anterior part of the abdomen to correspond to the azygos, receiving the superior intercostal veins, and opening into the right precaval. This vessel evidently, then, corresponded to the persistent right posterior cardinal The portal system was apparently normal, and the hepatic veins opened into a postcaval, which extended through the diaphragm to the heart in the usual manner

Thus the independently-formed section of the postcaval (*Leberabschnitt*) had taken on no connection with the part developed from the cardinals (*Urnierenabschnitt*), but had remained as a separate vein, bringing back the blood from the alimentary organs (and ? diaphragm) only.

I have not thought it necessary to do more than mention these facts, as the whole question has recently been fully discussed by Dr A Robinson ("Abnormalities of the Venous System and their relation to the Development of Veins," "Studies in Anatomy from the Anatomical Department of the Owens College," vol 1 p 197, Manchester, 1891). The above case, however, supports the view that the renal veins are direct tributaries of the right cardinal, and not of the postcaval; while the reverse conclusion is derived from Dr Robinson's observations. W N PARKER.

University College, Cardiff, January 14

Difficulties of Pliocene Geology.

YOU were good enough to print a letter from me a week or two ago, in which I called attention to some of the difficulties in explaining the distribution of the so-called Pliocene beds. I should like to prosecute the subject a little farther

The geographical distribution of the mastodon is assuredly one of the greatest paradoxes in natural science.

As is well known, it occurs both in North and South America, and on both sides of the Rocky Mountains and the Andes. It has not occurred, however, so far as I know, north of the great lakes in the east, nor of Oregon in the west, nor has it ever been reported from Alaska, where mammoth remains are so abundant. I do not know any evidence that it has been found anywhere in Asia, north of the Himalayas, neither in China, nor Manchuria, nor Mongolia, nor Turkestan, nor in Siberia, nor has it occurred in European Russia, except close to the Black Sea, nor in Poland, nor in Scandinavia, nor in North Germany

In the Old World its zone of distribution extended from India to the Pyrenees, including the Mediterranean borders, the valleys of the Danube, and the Middle Rhine, Eastern England, and perhaps Iceland, whence some teeth are said to have been sent to the royal collection at Copenhagen This distribution of a very highly specialized beast is certainly most extraordinary Granted that the mastodons of Western Europe and those of America are slightly different, the difference is so slight that, as Falconer says, Cuvier treated them as the same species, and they cannot have been very long isolated Yet how are we to explain the facts, and do justice to the widespread view that the ocean areas are very old?

It seems to me as clear as anything can be that when the mastodon was distributed over Western Europe and America, there must have been a land communication between the two areas, and I cannot see how, with the facts before us, we can escape the conclusion that this connection must have been across either the Atlantic or the Pacific, not in high but in low latitudes, perhaps across both

The mastodon is not the only animal which points the same lesson The machairodus, a very highly specialized feline, has been found both in the Old and the New World, but did not inhabit the great palæarctic province of Europasia, east of the Rhine, nor America north of the great lakes The American jaguar, a mere variety of the Old World leopard, is another animal with the same abnormal distribution, so are the American and the Old World tapirs.

Now this connection between the Old and the New World cannot, so far as we can judge, have been in high latitudes, for the forms in question have not occurred in high latitudes. If the connection had been across the Northern Pacific, we should have had some remains of these animals in Japan, where more than one fossil elephant has occurred, or in the Sandwich islands, which are, to all appearances, a very old land surface

The connection must, therefore, if it was across the Pacific, have been across its more equatorial part It seems similarly to follow from the absence of these animals in the high latitudes of America and Europe, save the doubtful case of Iceland, that in the case of the Atlantic also the land bridge must have been further south, and perhaps where the Atlantic islands still remain One more inference If there was a penannular or circular belt of land about the earth in the tropical or subtropical zone over which these beasts could travel, it would possibly account for the tertiary climate of high latitudes having been a warm one, as we know it was A zone of land in the tropics would act as a furnace, whose heat would be widely distributed by the ocean currents in contact with it

The views here urged, it will be said, are like those of the advocates of a Miocene Atlantis They are in essence very different, and meant to explain a very different phenomenon, namely the aberrant and abnormal distribution of the mastodon and its companions. The mention of the Miocene Atlantis, however, suggests another and more critical difficulty in explaining the Pliocene beds, but this must be postponed to another letter HENRY H HOWORTH

The Athenæum Club, January 13

Earthquake Shocks.

A SERIES of slight earthquake shocks have lately occurred in this district, viz. January 3, 2.15 p.m. at Severn Junction (E.J.L.) January 4, 11 a.m, Itton Court, Chepstow (a heavy plant stag in a greenhouse was seen to move four times by Mr J. Curr and the Rev. N. S. Barthropp), January 5, between 2 and 3 p m, and again on the 6th (a little earlier), Llanthony Monastery (a rumbling noise on the Black Mountains near the monastery Mr. P. E. Hill); January 14, 6 55 p m., a shock lasting more than a second, Bigswear House, Coleford, Mr. J V. Newbery (Mr. Newbery has had experience of earthquakes, from a long residence in Japan) E. J. LOWE.

Shirenewton Hall, Chepstow.

The Weather of Summer.

I REGRET to find that, in making a quotation at the end of my letter last week (p. 246), I erred in supposing Mr. Symons to be the writer. I beg to apologize for the slip. A B M.

ON THE ORIGIN OF THE ELECTRIC NERVES IN THE TORPEDO, GYMNOTUS, MORMYRUS AND MALAPTERURUS

THE subject of this communication may seem remote and uninteresting, but it will not be difficult to show that questions of the highest importance for physiology, anatomy, and the Darwinian theory are closely related to those touching the structure of the electric organs of certain fishes and the laws of their functions

The fact that the body of an animal should become a complete electrical apparatus acting at the will of its owner induces us to inquire how this extraordinary result has been attained, that is, to investigate the origin of the electric organs of fishes, and the manner in which the animal throws them into action We shall see that in pursuing both lines of enquiry we open far-reaching views into regions as yet unknown

According to the present state of our knowledge there can be no doubt that most of the electric organs hitherto discovered are of muscular origin It is not my intention to dwell on this transformation of muscular tissue, but it may nevertheless prove interesting to cite an example of the completeness with which such transformation can take place, I refer to the Mormyrus—the so-called pike of the Nile—a fish which has only of late been sufficiently known to possess electric power A transverse section of the tail of any ordinary fish shows scarcely anything more than the vertebral column, muscles and their tendons, attached to the bones. On the other hand, a transverse section of the tail of Mormyrus (Fig 1) shows no conspicuous muscles, but in place of them electric tissue filling up the entire space occupied by muscles in ordinary fishes. Of the muscular apparatus there is nothing left except the longitudinal tendons passing outside the electric organs from muscles placed anteriorly. If these tendons were cut across the Mormyrus would be unable to move its tail.

Omitting the complicated arrangement of histological elements in this modified muscular tissue in the different electrical fishes—which could not be sufficiently explained without a large number of illustrations—it may be sufficient to state that a kind of swelling loosens the molecular elements of the muscles and allows them to be settled again in a very regular but quite new form.

The well-known electric eel of America, *Gymnotus electricus*, has only the external shape of an eel, and is in reality a very short fish, carrying very powerful electric organs in a long tail springing from a very short rump A transverse section of the tail shows that a part of the muscle is changed into electric organs, while another remains unchanged

In the different kinds of electric skates—Torpedinidæ—the electric organs are developed from muscles, which originally belong to the branchial arches and the arch of the lower jaw

When we look to the nerve apparatus which enables the fish to throw the electric organs into action by a voluntary impulse, we find in every case wonderfully developed ganglion cells from which the impulse is transmitted directly to the electric batteries Such a coincidence certainly cannot be the result of mere chance But beyond the invariable presence of large ganglion cells as the starting points of electric nerve fibres there is very little uniformity in the arrangement of these elements in the different sorts of electrical fishes, on the contrary, there are most remarkable and striking differences not only in the position but also in the number and in the appearance of these nerve centres It is to be hoped therefore, that some important views regarding the character and functions of ganglion cells in general may be suggested by their study

In the Torpedo the electric ganglion cells—being in vast numbers—form a bean-shaped mass in the medulla constituting the well-known electric lobe It represents modified motor centres of the vagus nerve; anteriorly it is covered by the cerebellum, but emerging from beneath that organ, the lobe increases rapidly where the largest electric nerve leaves the medulla. Lower down its size again diminishes, where it gives rise to the fourth electric nerve and terminates quite free in a blunt point on each side. On counting the ganglion cells in a complete series of sections one finds the number to be about 54,000—a number that can be found to nearly correspond with the fibres in the electric nerves that arise from them. A transverse section of the medulla, close to the spot where the roots of the electric nerves are gathering, shows the so-called axis cylinder processes of the cells entering the roots to form the nerves. This is seen in Fig 2—a photogram taken from nature like all the other illustrations of this paper

FIG 1—Transverse section of the tail of *Mormyrus cyprinoides*

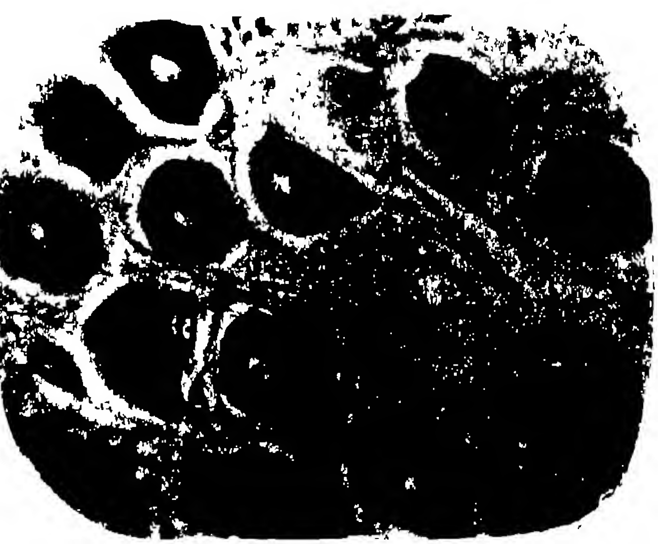

FIG 2—Ganglion cells from roots of electric nerves of Torpedo

Even the first and smallest of the electric nerves shows a great number of nerve fibres collected into bundles which on transverse section appear as if perforated by numerous small openings—each apparent aperture being a nerve fibre I counted about 8039 fibres in the first electric nerve, in the second or largest about 23,770, in all four nerves about 58,318 fibres This total exceeds that of the ganglion cells by at least 4000, but the disparity of number is probably to be accounted for by the impossibility of getting an exact total from a series of sections where the cells are very often dragged away by the knife

The ganglion cells of the Gymnotus, or electric eel, are disposed in a different manner Behind a short portion at the anterior end of the spinal cord where ordinary cells are found, the grey substance contains large rounded ganglion cells, the most anterior of them forming a semicircle around the central canal of the cord Since these first cells extend in front of the most anterior electric nerves, a transverse section of this region shows no axis cylinders leaving the grey substance, all being directed downwards to the gathering place of the first electric nerve roots, and therefore must be cut off. If, however, a transverse section be made in the middle portion of the cord the whole grey matter is seen to be packed with electric cells and their axis cylinders are seen passing very straight and undivided to join the electric nerve roots at once. The other processes of the cells are so pale and fine that it is impossible to recognize them sufficiently well in a complete section. Since the electric batteries extend along both sides of the tail to its very end, the electric nerves and their ganglionic centres have a similar extension. The electric cells form a continuous column in the spinal cord, but it is very slender, therefore, notwithstanding the great longitudinal extent of the electric centre, the number of cells is not so very great. I estimated the total number of cells to be about 60,000—not many more than the estimated number in the Torpedo.

The genus Mormyrus, whose electric power was doubted until quite recently, resembles the Gymnotus in the structural arrangement of its electric apparatus. I was fortunate enough to find the ganglion cells for the electric nerves in the spinal cord, where the tail is endowed with the electric batteries, as seen in Fig 1 The cells are very soft, and must be very carefully preserved to show all their details Their regular undivided axis cylinders leave the cord-like motor roots, and form a sort of plexus before leaving the vertebral canal. It is to be considered as a very important fact, that broad processes of the cells regularly intercommunicate on so large a scale that their union into a complete system for simultaneous action cannot be doubted

Fig 3 shows such cells in the grey substance of the spinal cord; the intercommunicating processes can be seen much more distinctly in the microscopic slide and even in a photogram, than they appear in that figure.

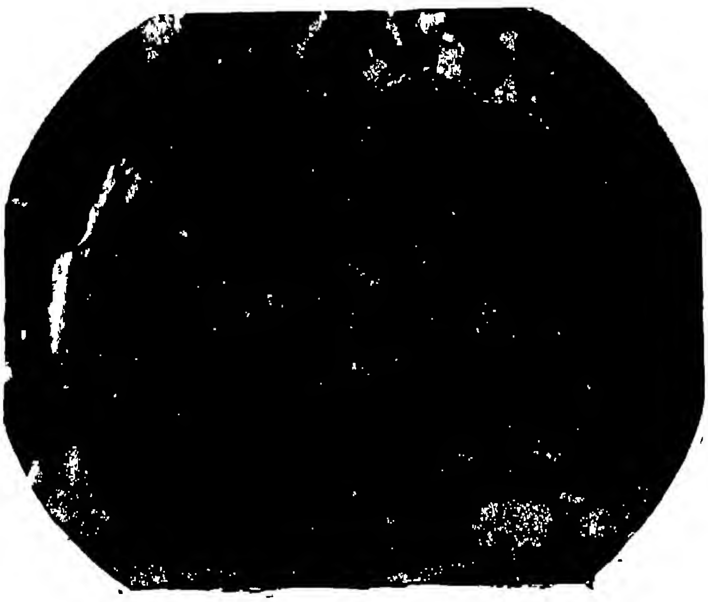

FIG 3.—Communicating Electric Cells in the Spinal Cord of Mormyrus

The axis cylinder of each cell being a well-defined undivided process, the intercommunicating processes must be regarded as protoplasmic in the sense expressed by Deiters Their general intercommunication cannot have any other significance than to insure equality of action in giving the impulse to the electric batteries If that statement be admitted *the protoplasmic processes of the cells must have a conducting function* If that be true in the Mormyrus there is no reason whatever why it should be otherwise in other vertebrates Yet Golgi maintains that the protoplasmic processes of nerve cells are to be regarded as having a simply nutritive and therefore a non-nervous function

There is another most remarkable fact in the organization of the Mormyrus having reference to the combined action of the electric organs on both sides The upper as well as the lower electric nerves form a decussation outside the vertebral canal resembling the chiasma of the optic nerves I am not acquainted with any other instance of motor nerves crossing the median plane to the other side of the body outside the cerebrospinal axis In all other cases they are outside the brain and the spinal cord confined to their own side of the body to insure the isolated action of each muscle or group of muscles on that side It is therefore stated that in changing the motor into an electric function these nerves at the same time became liberated from the strict rules of their predecessors. Certainly the case of Mormyrus gives a very good idea of the extraordinary power of adaptation to function with which Nature is endowed, but who can say how this particular anatomical arrangement could come about by gradual variation? I consider this difficulty far greater than that relating to the first development of electric organs in general which is so frequently the subject of reference.

Since the celebrated investigations of Prof E. du Bois-Reymond have shown that the function of the muscular system is intimately associated with electric currents it is permissible to take them into account where muscle and their derivatives are under consideration.

I have shown elsewhere that most of the electric fishes are liable to a degeneration of the muscular system, seemingly caused—in part, at all events—by a certain lazy mode of life (disuse of organs). We therefore find along with fully developed electric tissue in the Gymnotus, nests of muscles which have not arrived at perfection. In the Mormyrus degenerating muscles in the forepart of the electric organ suggest the impression that the process of transformation is still going on. Still more is this the case in the common Raja.

Moreover, we know that the peculiar degeneration of muscular tissue into electric tissue destroys the contractile power of the muscles, but does not interfere with their

electromotor properties, on the contrary the loosened and differently arranged elements of the changed muscles are more capable of producing electric currents In that

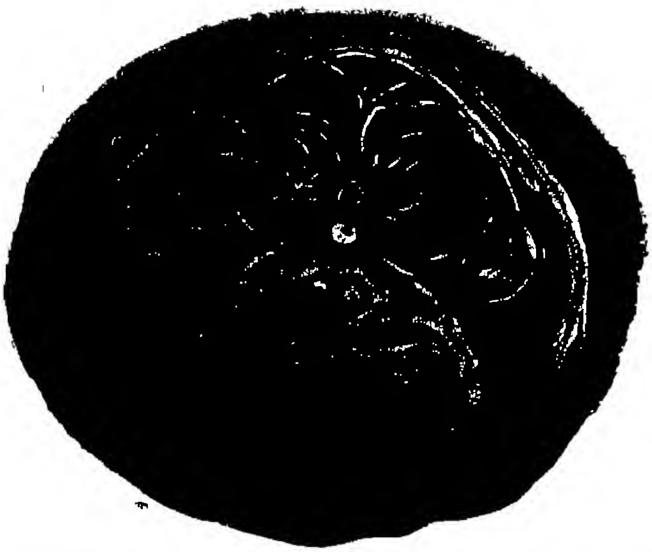

FIG. 4—Transverse section through the body of Malapterurus with a parasite in the electric organ

state of development which has still quite an occasional character, it seems only necessary to assume that under certain favourable circumstances the fish while trying to catch a prey or to defend itself against an enemy in the sudden excitement becomes aware of its electric power hitherto unknown to itself. On perceiving the advantage of the electric power in the struggle of life the fish might begin to use it regularly and to develop it gradually to perfection in its descendants, just as a man might one day perceive that he is endowed with the power of hypnotism, consequently learns to use it and gradually improves it

But now it is necessary to consider also the electric Shadfish of the Nile, the *Malapterurus electricus*, a powerful fish of very peculiar structure, which places it in quite a different category from the electric fishes already mentioned. A transverse section of the whole fish (Fig 4) shows the difference at once The body of the animal is enveloped in a very thick electric skin, constituting one electric organ. Muscular tissue is nowhere deficient, other histological elements must therefore have furnished the material for the electric plates, which are packed very close in lozenge-shaped compartments of the skin

In my opinion the plates are nothing else than modified cells of the cutaneous glands which are plentiful in the remainder of the skin The precise proof of that statement ought to be furnished by a complete investigation of the development of the animal, which as yet is quite unknown. But the differences between the two kinds of electric organs are so great that we are surely entitled to separate the *muscular* from the *cutaneous* electric organs.

Assuming that the origin of these cutaneous batteries differs from those developed from muscle, we cannot wonder that their functions also differ in most important points. The electric current passes through the body in a direction the opposite of that in other electric fishes. There are *only two* electric nerve fibres, one on each side, which divide and subdivide until they give off more than two million branches. We shall see that these two nerve fibres are not true axis cylinder processes of ganglion cells Before making a more detailed reference to these interesting elements it may not be amiss to point out in the section shown in Fig 4 the existence of an intruder, a specimen of the so-called *Filaria piscium*, which had taken up its abode in the electric organ itself This proves that animals can become accustomed to strong electric currents without receiving injury, and it suggests that the immunity of electric fishes against their own currents and that of their young *in utero* (Torpedo) is a faculty acquired by gradual training

The construction of the single electric nerve fibre in Malapterurus resembles to a surprising extent that of an electric cable on a minute scale We see the tiny nerve fibre like the central wire of the cable surrounded by a little non-conducting material and held *in situ* by a sort of network, the whole being enveloped in an enormous mass of connective tissue sheaths just like a cable protected externally by numerous layers of strong material. Fig 5 shows a transverse section of the central part only to render the details of the round fibre and supporting network more distinct If we follow this single fibre inwards to its origin in the central nervous system we are led to *a single ganglion cell* from which the single fibre arises. There is one cell on each side of the cord, therefore just two cells in all, whereas in Mormyrus, which has the smallest number of electric cells in the fishes with electric organs of muscular origin, the cells must be estimated at more than 1500 The position of the two cells in the spinal cord of Malapterurus reminds one of Clarke's column in the cord of higher vertebrates where the cells differ in certain particulars from the motor cells As already stated there is only one cell on each side, but

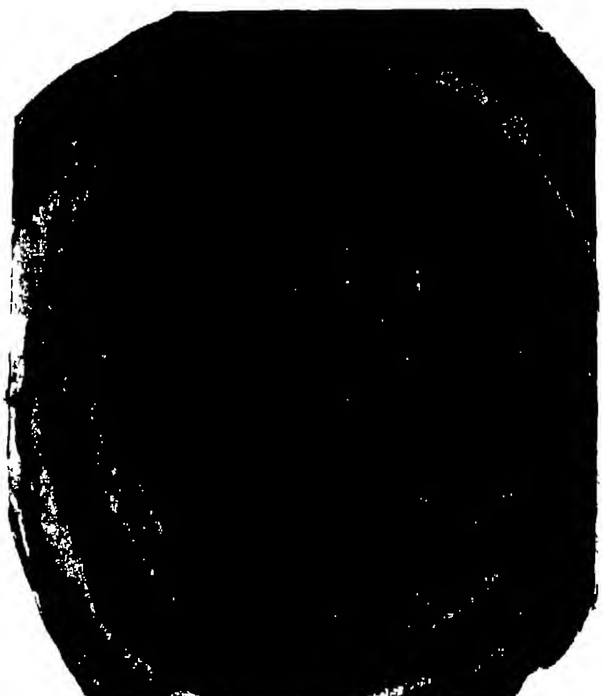

FIG. 5.—Transverse section of the central part of the electric nerve of Malapterurus.

that is a giant of its race. There is no real axis cylinder arising from the cell, but in place of it branched protoplasmic processes join and form a kind of perforated

plate beneath the cell, from which the nerve fibre starts with a broad base (Fig 6) I consider this a chief point of difference between this peculiar cell and all the other afore-mentioned cells of a motor character Fig 6 gives a good idea of this magnificent histological specimen with its elegant nucleus showing its network and its nucleolus on one side

Reviewing from a physiological standpoint the several facts stated above, we must feel convinced that the peculiar ganglion cells which are invariably found in relation to electric organs must play an essential part in bringing the electric organ into action In my opinion that is tantamount to proof that other ganglion cells must be essential for sending nerve impulses to peripheral organs, and that the idea lately suggested by Nansen that ganglion cells have only a trophic influence on nerve tissue cannot be reasonably maintained in the face of these and similar facts I may here refer to the well known peculiar ganglion cells found in the motor region of the brain of higher animals, including man Betz, who discovered them, searched for them for the purpose of stating anatomically the laws of localization found by Prof Hitzig and myself

It may not be out of place to adduce here another piece of evidence taken from the department of pathology. My friend and collaborator Hitzig has lately published the case of a man who died from tetanic cramp of the head He observed that in the ganglion cells of the motor centre of the fifth nerve presiding the affected muscles there was a very singular change to be observed *in these cells only* It appears that the bacteria of tetanus caused a granular decomposition of the protoplasm in the cells, which led to a further state of degeneration characterized by the appearance of large holes, while the other ganglion cells and the remainder of the organ appeared quite healthy I am convinced the case shows that the cramps in the combined muscles resulted from the irritation and gradual disorganization of the ganglion cells

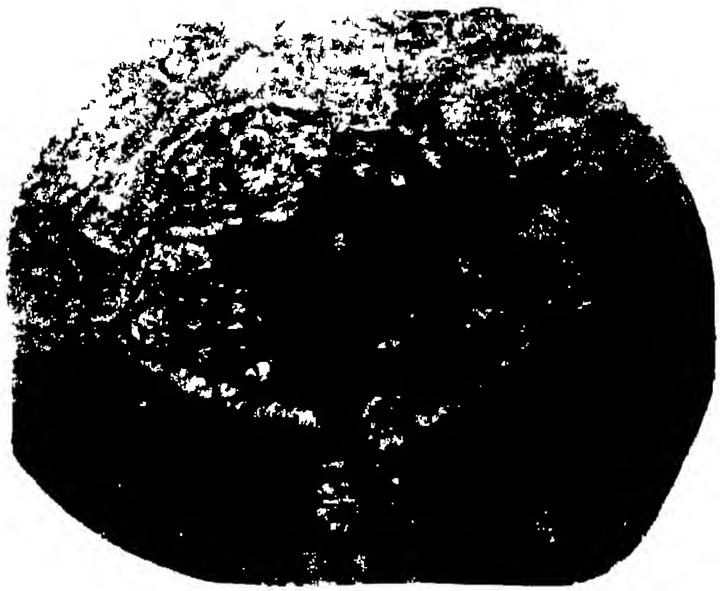

Fig 6 —The right giant ganglion cell with the origin of its electric nerve from spinal cord of Malapterurus

The above statements may suffice to show that the electric fishes and their nervous elements are really not such outsiders in science, and that the observations made on them should be brought into comparison and correspondence with those gathered from other sources Indeed the histological elements in their organs are so instructive, that I would strongly recommend that the conclusions deducible from their study should be employed in maintaining well-founded former notions regarding the organization of the nervous system in vertebrates against certain revolutionary ideas of some modern authors GUSTAV FRITSCH

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AUSTRALIAN TRAVELS[1]

On opening this work, one is at once struck by the beauty of the illustrations, particularly those of the New Zealand Alps. The double-page plate opposite p 248, drawn from a photograph taken by the author, is especially worthy of remark For effect this view may well compare with some of the most picturesque parts of Switzerland. Some of the photographs, however, have a familiar appearance to the travelled reader, one recognizes in the beautiful picture "Off the West Coast of Ceylon" (p. 300) an old friend, none the less worthy of reproduction.

[1] "Australische Reise," by R von Lendenfeld, pp 325, with Illustrations. (Innsbruch Wagner, 1892)

The work makes no pretensions to a virgin freshness its professed object being to gather together the already published observations of the author, and to present them in a popular form This it does very successfully, though the English reader could have dispensed with a good deal of the very apparent "padding" Thus the first twenty pages of this book of travel are devoted to the history of Australia, and remind one of Coghlan's opening chapter in the "Wealth and Progress of New South Wales" the next twelve pages on gold differ from Coghlan's second chapter, particularly in giving greater prominence to Count Strzelezki's discovery, and one regrets that no mention is made of James McBrian, who certainly has prior claims The author is candid in his criticisms and condemns both the theatres and University of Sydney, as being, from the German standpoint, decidedly bad On p 34 we come to a "Journey into New South Wales," and here commences an interesting medley of natural history, traveller's tales, and geographical investigation In this vacation ramble Von Lendenfeld claims to have discovered the culminating point of the Australian continent in Mount Townsend, to which he assigns (by aneroid) the height of 2241 metres The doggerel verse on p 82, in which a red sunset is taken to indicate approaching rain, must be wrong in its meteorology, so at least it proved, a red sunset being followed, much to Lendenfeld's surprise, by a fine day It is satisfactory to find that the signs of the weather are not inverted at the Antipodes

The author's familiarity with glaciers and ice-action in Europe served him in good stead in the southern hemisphere Several interesting pages are devoted to his discovery of the former existence of glaciers in the Australian Alps, though there seem to have been contemporaries in this matter, for while Von Lendenfeld's observations proved the existence of *moutonnéed* and striated surfaces down to a level of 1500 metres above the sea—Mr James Stirling claimed to have found signs of ice-action at lower levels still, as in the neighbourhood of Omao, where they occur at 800 metres above sea-level. The historical conscience is strong in the author, or he would scarcely have troubled to recall the

fact, that when his communication on the discovery of glacial markings was read before the Geological Society of London, it was received with scepticism by Prof Bonney (and, let us add, though the author does not, by Dr Blandford also) On turning to the *Journal* of the Society we find that Prof Bonney considered the observations then adduced by Von Lendenfeld as insufficient to establish his conclusions, and in this opinion we fancy most geologists will be inclined to agree with him That the conclusions were right after all is a different matter It is to be regretted that even in this, his latest published summary, Von Lendenfeld does not always supply us with facts on which we can base an independent judgment The personal opinion of an observer, however skilled, can be no sufficient substitute for these A single instance will suffice An important joint expedition was undertaken by the author and Mr Stirling to examine into the accuracy of the latter's statements as to the downward extension of the ice After several pages of interesting traveller's gossip we reach the result in words much to the following effect —"After three-quarters of an hour's ride in the valley bottom we reached an old moraine, which we investigated closely A dam 35 metres high and 200 broad composed of various (*verschieden*) great blocks of rocks with sharp angles stretched across the valley A brook flowed through the middle We are here at a height of from 900 to 1000 metres, and since it is a veritable moraine Stirling is right and our dispute is ended"

We will not offend the susceptibilities of the author by questioning whether this is really a moraine probably it is, but no convincing proof of the fact appears in the description One would like to know whether other signs of ice-action were observed in the immediate neighbourhood, in what respects the fragments differed from each other and from those of the adjacent valley slopes, and especially what evidence existed to show that they had been carried down the valley, and how far they are removed from their source This information could have been conveyed in a few words, and would have been welcomed by inquiring minds, who now may wonder whether after all this dam could by any chance be merely the remains of an ancient landslip New Zealand is introduced to us on p 161, and after a short historical account we pass on to the New Zealand Alps and fjords. With regard to the latter the author stoutly maintains their glacial origin one of his chief arguments resting on their great epth as compared with the sea into which they open They are apparently submerged rock basins, but although the author may be right in his contention that they are not merely moraine-dammed valleys, yet he altogether overlooks another more probable explanation, depending on unequal subsidence submergence of the land has certainly taken place, and one has only to concede that the central mountain masses have sunk to a greater extent than the adjacent sea-floor to understand how the previously existing valleys would be converted into fjords The greatest depth of Milford Sound is 360 metres, and one must travel (so our author tells us) at least 100 kilometres from the coast before this depth is reached at sea, now as the watershed is distant only 30 kilometres from the coast, it is at least as probable, considering the gradient, that we have to do here with differential movements of the land, as with locally concentrated erosive action.

An ingenious attempt to explain the last glacial episode leads to several bold generalizations. The author commences with the assertion that the whole of the southern hemisphere is at present much more severely glaciated than the northern, indeed he goes so far as to state that the northern hemisphere in the middle of the ice period was not much more severely glaciated than the southern is now. Since the mean temperature of the southern is not lower than that of the northern hemisphere the reason for its excessive glaciation must lie in a more uniform climate and a damper atmosphere, and these again are a direct consequence of the greater extent of the oceanic surface

Let us now suppose the sea-level in the northern hemisphere to rise 100 metres, the lowlands will become submerged (as during the last glacial episode they apparently were) the climatal conditions will then approach those now prevailing in the southern hemisphere, and excessive glaciation will result

But in the southern hemisphere also, the ice was formerly of much greater extent, and this is not susceptible of the same explanation, since a depression of the land would not greatly affect the existing climate What, however, would be the effect of a depression of the sea level? The submarine slopes of most of the land in the southern hemisphere are so steep that the present distribution of land and sea would not be largely modified, though the latter should sink 300 metres, on the other hand, the increase in the height of mountains (300 metres) would lead to a descent of the snow line, the growth of snow fields, and a corresponding enlargement of glaciers Thus the glacial episode in the northern hemisphere might be attributed to an elevation of the sea-level, that in the southern to its depression and these changes of level may have been produced by a bodily movement of the ocean waters from one hemisphere to the other, a result itself possibly due to a shifting of the centre of gravity of the earth The author does not explain how to shift the centre of gravity of the earth

We notice that the author speaks with disrespect of the maps of the Tasman glacier by Mr W S Green, stating that they are nothing like so good as Von Haast's, since however, later explorers prefer them to Von Lendenfeld's own, it would appear that we have here a descending scale of excellence

After pointing out the failure of Mr Green to reach the actual summit of Mount Cook, the author gives a glowing account of a successful ascent of his own, not of Mount Cook however, but of the Hochstetter Dome! He therefore claims to be the first who has set foot on the top of a high mountain in New Zealand We offer him our congratulations

In commenting on the author's style, which in its lucidity is far more English than German, we must offer a serious protest against his manner of using what he terms our "transcendentally intense adjective" Bob Acres' remark that, "The best terms will grow obsolete Damns have had their day," does not appear to apply to Australia, where, to judge from our author, they flourish along with other survivors of a Mesozoic age

AMERICAN FORESTRY[1]

COMPETENT English authorities on forestry are so rare that no apology is needed for presenting some extracts from a translation from the German, of an important paper by Sir D Brandis on American forestry This is in continuation of a similar translation which appeared about a year ago in the columns of NATURE (vol xliv p 60)

Upwards of 1,000,000 acres of forest are required for the annual supply of wooden sleepers for European railways These forests are properly managed so as to yield a steady return, whilst nothing of the kind can be said of American forests This explains why German foresters are interested in watching the progress of forest destruction in America, where it is now merely a question of ten or

[1] "The Silva of North America" By C S Sergent, vols i-iv (Boston and New York Houghton, Mifflin and Co, 1891-92) Notes on the above by Sir D. Brandis, K C.I E, F R S, in *Zeitschrift für Forst und Jagdwesen*, October, 1892

fifteen years before a timber famine must occur, which will greatly enhance the value of European forests.

Brandis explains the present lamentable state of affairs in the United States, as follows.—The Timber Culture Act, which was in force in certain of the States, provided that settlers should plant up with trees one quarter of the area allotted to them, and it was thus hoped to obtain forests in the treeless regions between the Rocky Mountains and the Mississippi river. Large tracts of land have been occupied under this Act, but very little progress has been made in afforestation. It is not difficult in the Republic for people to neglect engagements they have made with the State. It has been recognized for some time past that this law has been practically of little use, and it was therefore abrogated in March, 1891. The law abrogating it, in section 24, empowered the President to demarcate and reserve certain tracts of State forest. Great hopes were therefore entertained, and soon afterwards a proclamation was issued largely extending the Yellowstone Park, in Montana, on the borders of Canada.

This measure had been strongly supported for some time past by the American Forestry Association. The Park is a mountain forest tract on the water-parting between the Rivers Columbia and Missouri, and its preservation and proper management is of immense importance. In October, 1891, the extensive forest tract in Colorado in the Rocky Mountains, in which several large tributaries of the Colorado river have their rise, and containing 1,365,000 acres, was proclaimed as the White River Forest Reserve. It was also expected that a portion of the western slopes of the Sierra Nevada, bordering on the Yosemite National Park, and other localities where the *Sequoia gigantea* flourishes, would be proclaimed as State reserves. These two national parks were previously reserved under older laws. The numerous intelligent friends of forestry in America confidently expected that a beginning would now be made in the demarcation of extensive State forest reserves, and in their scientific management.

The most recent news from America, however, has thoroughly upset these expectations. A Bill has been introduced into Congress, to hand over most of the Yellowstone forest reserve to a railway company. It is considered certain that this Bill will pass the Lower House, and it is not expected that the Senate will refuse to sanction it. Wood merchants, mining speculators, and sheep owners are vigorously agitating against the proposed reserve in the Sierra Nevada, and it is feared that their agitation will carry the day.

The American Forestry Association, which held its tenth annual meeting last January, has "memorialized" the President that instead of making a few reserves here and there, he should proclaim the reservation of all State forests still left to the Union, and arrange for their proper management. Friends of the forest are numerous in America, and insight into the essential necessity of forest protection is spreading, owing to the numbers of Americans who travel in Europe, but in a land where the dollar rules, and where an individual who will not recognize its authority is considered a fool, any steady progress towards State forest management cannot be expected.

Bernhard Fernow, the chief of the Forestry Branch of the Ministry of Agriculture at Washington, still hopes for action in this direction on the part of Congress and the State Executive. At the last meeting of the Forestry Association he rightly urged that æsthetic and sentimental grounds for improving American forests must be left entirely in the background. Only where important material interests are concerned, such as securing a continuous supply of wood, or a supply of water, or climatic considerations, should the State limit the freedom of its citizens in dealing with forests. If, however, for urgent reasons of public utility, it should be necessary to reserve a forest, the State should not be contented with merely demarcating and protecting it, but should introduce scientific management, so that the neighbouring populations may be able to utilize the forest produce, and in any case, all pre-existing rights acquired by the people in the forests should be strictly protected. Fernow concludes with the strongly-expressed advice that a law should be passed reserving the relics of the forests of the Union, and preventing any fresh alienations. He firmly believes that such a law is most urgently required. It is, however, quite a different matter for Congress to pass any such law, though more may perhaps be expected from the separate States in the Union, and in those of New York and California some rather halting steps have been taken in the right direction.

As matters stand at present in the United States, it is pretty obvious that a time will come when landowners will look upon their private forests as a good investment, for prices of wood and other forest produce are steadily rising. Little progress has, however, yet been made in this direction, and recent attempts made by some rich men to manage their forests properly with advantage have failed.

Sir Dietrich Brandis then turns to the progress made in the study of American forest trees, and states that literature on the subject is pretty abundant, but is after all merely thrashing straw. What is wanted in America is a practical proof that in forests of the Weymouth pine, of Minnesota, or of Californian red wood, or of Douglas fir in Washington and Oregon, or in the splendid mixed broad-leaved forests of the Alleghany mountains, good forest management will prove more remunerative than wasteful pillage (*Raubbau*).

The remainder of Brandis's paper is chiefly of botanical interest, and greatly praises Sergent's magnificent work. One other passage is too interesting to be omitted. It refers to the mesquit tree, *Prosopis juliflora*, which belongs to the dry zone in the south west of the United States, and is also found in Mexico, and in the Andes as far as Chili and Argentina. In the river valleys of Arizona, where, although the air is dry, yet subsoil water is near the surface of the ground, this species forms extensive forests. On drier soils the aerial parts of the tree are reduced, but the root system is greatly extended. Sergent states that while the stem may be only a few inches high, and may only bear a few leaves, yet the tap root goes straight down to the subsoil water, and the aerial growth of the tree furnishes a clear indication of the depth at which the latter may be found.

Wherever the mesquit is a tree the subsoil water is forty to fifty feet down, where it is a small shrub it is from fifty to sixty feet down, and wherever the roots descend over sixty feet, the plant is not more than two or three feet high. In the scantily-wooded districts, where the mesquit tree grows, its roots yield most of the firewood, and are dug up, or dragged by oxen from the ground. *Prosopis spicigera* in the drier parts of India similarly furnishes fuel and cattle fodder in the Punjab, Sindh, and parts of Berar. This tree, there termed the *Jhand*, sends down its roots to a depth of fifty feet and more, to the subsoil water, and thus produces wood in a dry country, providing the peasant with fuel and wood for his plough.

W. R. FISHER.

JOHN STRONG NEWBERRY

IT is not only in the United States that the death of this veteran of scientific research will bring widespread regret. To many geologists and palæontologists in this country and on the Continent he was personally known, and those whom he honoured with his friendship will feel keenly the loss they now sustain. He was born at New Windsor, Connecticut, on December 22, 1822,

and took the degree of M.D. from the Cleveland Medical College, Ohio, in 1848. Before beginning the practice of medicine, which he intended to be his occupation in life, he spent two years in Europe. During his stay at that time in Paris he acquired a good knowledge of the French language, and had many opportunities of cultivating a love of science, which soon manifested itself as one of his distinguishing characteristics. Returning to his native country, he began practice as a medical man at Cleveland in 1851. Even at the outset of his professional work he contrived to find time also for scientific enquiry. His first published paper appeared in the same year in which he started in his medical profession. It is devoted to the geographical distribution of land and fresh-water shells.

But he soon entered upon the two branches of geological investigation in which he was to make his name familiar all over the civilized world—the study of fossil botany and of fossil fishes. As early as the year 1853 he made his first contribution to the history of Carboniferous plants, and three years later his earliest memoir on fossil fishes was published. By this time his scientific acquirements and enthusiasm were widely known. Hence when an expedition under Lieutenant Ives was organized for the exploration of the Colorado River of the West, Newberry was selected to accompany it, and to take charge of the observations to be made in natural history. His geological contribution to the famous Report at once placed him in the very front rank of American geology. His account of the geological structure of the region traversed by the expedition, and of the marvellous denudation of the cañons, will always remain as one of the landmarks of geological progress.

He had now been touched by the fascination of exploration in the far west. The drudgery of medical practice became irksome to him, so that when in the year following his return from Colorado the offer was made to him to take part in another expedition, he gladly availed himself of the opportunity. He accordingly accompanied Captain Macomb in an exploring expedition in the summer of 1859, from Santa Fé, New Mexico, to the junction of the Grand and Green Rivers of the Grand Colorado. This journey forms the subject of another masterly report by him, which, however, was not published for some sixteen years.

The shadows of the coming great Civil War were already falling on the United States, when Newberry was at work on the preparation of the record of the results of his western journeys. The storm at last burst in 1861, the same year in which his Colorado report was issued. Among the many scientific men who placed their services at the disposal of the North, Newberry took a foremost place. His medical skill and wide general scientific knowledge enabled him to be of great use to the army. He specially distinguished himself in the organization and administration of the hospital department. Among the reminiscences of his not uneventful life he had many graphic tales to tell of his experiences during that momentous epoch in the history of the United States. After the close of the war in 1865 he returned with renewed ardour to his scientific labours, and specially devoted his energies to the study of the ancient floras and fish-faunas of North America. Among his numerous memoirs on these subjects the two large monographs forming vols. xiv and xvi of the series published by the United States Geological Survey are specially worthy of notice. But they represent only a part of the enormous mass of material which he had worked over.

Prof. Newberry early in his career saw how great was the aid which geology could afford in the development of the mineral industries of his native country, and he gave himself with great energy to the practical applications of the science. He became one of the highest authorities on mining matters in the country, and he was mainly instrumental in the equipment of the great mining school of Columbia College, New York. He occupied the Chair of Geology in that establishment, and threw himself heart and soul into its duties. At last, in the midst of his work and honours, a stroke of paralysis disabled him from active duties, and he grew gradually feebler until his death. With him American science loses one of its most honoured and distinguished cultivators. His piercing eyes and well-cut features made him a marked figure in any assembly, while his courtesy and gentleness, and his unfailing helpfulness and serenity, gave him a charm which will endear his memory to a wide circle of friends.

A. G.

NOTES

ALL entomologists in the country will learn with great satisfaction that the Treasury has consented, on the recommendation of the Trustees of the British Museum, to make provision in the estimates for the coming financial year for the purchase of Mr. Pascoe's well known collection of insects. The importance of the acquisition of this collection by the nation is very great, as it contains an immense number of types, especially of the families Longicornes and Curculiones, to which Mr. Pascoe devoted so much attention for a period of more than forty years. Its dispersal or removal to a foreign country would have been an irreparable loss to British entomologists.

THE medals and funds to be given at the anniversary meeting of the Geological Society of London on February 17 next have been awarded as follows: The Wollaston Medal to Prof. N. S. Maskelyne, F.R.S.; the Murchison Medal to the Rev. O. Fisher, the Lyell Medal to Mr. F. T. Newton; and the Bigsby Medal to Prof. W. J. Sollas, F.R.S.; the balance of the proceeds of the Wollaston fund to Mr. J. G. Goodchild; that of the Murchison fund to Mr. G. J. Williams; and that of the Lyell fund to Miss C. A. Raisin and Mr. A. Leeds.

BETWEEN June 10 and 18 the University of Montpellier will celebrate the third centenary of the foundation of its Botanic Garden, on which occasion it is intended to invite a general congress of the botanists of all nations.

A MEETING of the Association for the Improvement o Geometrical Teaching was held on January 14, at University College, Gower Street, the chair being taken by the Master of St. John's College, Cambridge. The reports of the Council and treasurer having been read and adopted, Dr. Wormell was elected President for 1893, the hon. secretaries (Mr. E. M. Langley, 16, Adelaide Square, Bedford, and Mr. C. Pendelbury, 4, Glazbury Road, W. Kensington), and the other members of the Council being re-elected. Dr. Wormell having taken the chair, Mrs. Bryant gave a model lesson on geometry to a class of about twenty ladies. After an adjournment papers were read by Mr. G. Heppel on the use of history in teaching mathematics, and by Mr. F. E. Marshall on the teaching of elementary arithmetic. The attendance was larger than usual, and interesting discussions followed the lesson and the papers.

A DEPARTMENTAL committee, consisting of officers of the Charity Commission, the Education Department, and the Department of Science and Art has been appointed by Mr. Acland, Vice-President of the Committee of Council on Education, to consider the question of the organization of secondary education in England and Wales, and the relation of the Departments among themselves in connection with this subject. The Committee consists of the following members:—The Vice-President of the Council (chairman), Sir H. Longley, K.C.B., Chief Charity Commissioner, Mr. T. E. Ellis, M.P., Parliamentary Charity Commissioner, and Mr. Fearon, Secretary to the

Charity Commissioners, representing the Charity Commission, Mr Kekewich, C B, Secretary to the Committee of Council on Education, and the Rev T W Sharpe, her Majesty's Senior Chief Inspector of Schools, representing the Education Department, and Major General Donnelly, C B, Secretary of the Department of Science and Art, Captain Abney, C B, F R S, Assistant Director for Science, and Mr Armstrong, Director for Art, representing the Department of Science and Art, Mr H W Simpkinson, Examiner in the Education Department, acts as Secretary to the Committee

ON the 25th inst an influential deputation will wait upon the President of the Board of Trade to urge the adoption of the decimal system of coinage and weights and measures in Great Britain Among those who propose to form part of the deputation are the Agents General for Victoria, Queensland, and the Cape, and several prominent members of the various chambers of commerce

THE Infant University of Chicago seems to be resolved to arrange its staff of teachers on a scale commensurate with the size of the North American Continent Thus, the Department of Geology is placed in the hands of no fewer than seven distinct professors and two assistant professors, each taking some special branch of this wide science under the competent leadership of Prof T C Chamberlin Three of the professors are non-resident, but they will probably give occasional lectures, and will at least direct the studies in their own branches of research

MR JOHN D ROCKEFELLER, who had already presented the University of Chicago with 2,600,000 dollars, has now given it another million The university owns land, buildings, and other property valued at £1,400,000 sterling, and the principal is ambitious enough to hope that in course of time it may have "such an array of magnificent buildings as one sees at Oxford or Cambridge"

A BOTANICAL laboratory has been established at Eustis, Lake co, Florida, chiefly for the investigation of diseases of the orange and other species of *Citrus*, under the direction of Prof W T Swingle The anatomy, physiology, and pathology of other sub tropical economic plants will also be investigated

ON Saturday last Prof Flinders Petrie delivered his first lecture as professor of Egyptology at University College, Gower Street In the course of the lecture he said that, besides more than a thousand photographs and various impressions or "squeezes" of sculpture, a collection of original objects would be exhibited for the close examination of students Miss Edwards had formed a collection with much care—as complete and typical as possible He hoped also to place on loan his own collection, and to have a series of annual loan exhibitions drawn from the many valuable private collections in England There would thus be found a collection of deities, the most complete collection of scarabs, the only chronological collection of beads, a dated series of pottery, the largest collection of funeral cones, and also of Egyptian weights In certain lines of study their museum would not be merely supplemental, but would be in advance of any historical museums He proposed to give a series of lectures in the autumn and spring, and would prepare students who might wish to undertake practical work in Egypt, where he would spend the time before Christmas to Easter

MR ROWLAND WARD is exhibiting in his studio a valuable collection of African trophies and curiosities, most of which have been brought to England by Captain Lugard and Mr. F. C Selous Besides natural history specimens, the collection includes many weapons and products of native art.

ANOTHER severe loss has been sustained by science in Russia through the death of the well-known mineralogist, Nikolai Ivanovitch Koksharoff He died at St Petersburg on January 2 He was born on December 2, 1818, in West Siberia, in a village near which at that time was the fort of Ust Kamenogorsk, and he made his studies in the Mining Institute at St Petersburg In 1841, when he was a mining engineer in the Urals, he accompanied Murchison on his journey to Russia and to the Urals, and the intercourse with the great geologist led him to adopt a scientific career He spent the next three years studying in Western Europe, and on his return he devoted himself entirely to minerology, and especially to goniometric measurements of minerals, in which he was so much aided by his wife that his numerous writings on this subject are as much her work as his He lectured in his early years on geology and physical geography, but later on devoted himself almost entirely to the description of Russian minerals, of which he discovered and described many new ones His chief works are embodied in eleven large quarto volumes of "Beitrage zur Mineralogie Russlands," illustrated with numerous plates. The twelfth volume was in type when he died In 1866 he was made a member of the St Petersburg Academy of Sciences, and many scientific bodies of Western Europe elected him corresponding or honorary member

DURING the past week the weather has been of a very unsettled character, at first an anticyclone lay over the greater part of these islands, while areas of low pressure were situated over the North Sea and to the west of Norway With these conditions the weather became warmer in this country, the daily maxima varying from 40° to 46°, but over the Continent very low temperatures continued to be registered, the minima in Sweden varying from 60 to 65° below the freezing point, while exceptionally severe weather also prevailed over France and Germany On Sunday a depression was passing to the southward of these islands, and under its influence north-easterly gales were experienced in the eastern and southern parts of England, a sharp frost occurred over this country, accompanied by snow in most parts, while a thaw set in over Scotland and rapdidly spread southwards, accompanied by rain, the maximum temperatures reaching from 45° to 50 Subsequently the conditions were again becoming anti cyclonic, accompanied by a return of colder weather, but they were not at all settled, snow was falling on Tuesday in the south of England For the week ending the 14th instant the temperature was everywhere below the mean, the deficit ranging from 2° to 5° The amount of bright sunshine exceeded the average in the north and west of Scotland and in the south-west of England, elsewhere the amount recorded was very small, being only 3 per cent in the north west of England

Das Wetter of December last contains an account of a heavy thunderstorm which occurred at Paderborn on August 9, 1892, in which a number of living pond mussels were mixed with the rain. The observer who is in connection with the Berlin Metereological Office sent a detailed account of the strange occurrence, and a specimen was forwarded to the Museum at Berlin, which stated that it was the *Anodonta anatina* (L). A yellowish cloud attracted the attention of several people, both from its colour and the rapidity of its motion, when suddenly it burst, a torrential rain fell with a rattling sound, and immediately afterwards the pavement was found to be covered with hundreds of the mussels. Further details will be published in the reports of the Berlin Office, but the only possible explanation seems to be that the water of a river in the neighbourhood was drawn up by a passing tornado, and afterwards deposited its living burden at the place in question.

MR C F. MAXWELL writes to *Science* from Dublin, Texas, that on the night of November 29, about 8 o'clock, a very large meteor was seen passing westward, a little to the south of that place Just as it seemed to be passing the body exploded, producing a sound that was distinctly heard, resembling that of a rocket explosion or a pistol-shot After the explosion a body half as large as a full moon moved away to the westward, making a hissing or frying sound Mr Maxwell has seen no one who saw the meteor before the explosion The whole country was brilliantly lighted for a moment as if by a continued electric discharge, but at the time of the explosion the light was red and blue, or perhaps violet The sound of the explosion was heard by parties five miles west and seven miles east of Dublin, who could not have been less than ten miles apart on an air-line, and they report the sound together with the other phenomena to have been about the same as they were at Dublin

WHEN commanding the *Naïade* during the cyclone of November 6, 1891, Rear Admiral Cavelier de Cuverville had the opportunity of testing the efficiency of oil in calming the troubled waves of the North Atlantic The last number of the *Revue Maritime* contains an account of his experiences and conclusions When the waves threatened to become dangerous he gave orders to fill two coal sacks with tow steeped in oil, one of them to be suspended freely at the extremity of a spar spanned to the cat-head, the other near the bridge The effect was excellent No seas were shipped, and the vessel escaped without breaking a spar It appears that the oil takes effect upon the "breakers" due to horizontal translation produced by the wind, leaving the orbital motion or "swell" unaffected The former is the only element of danger in a rough sea It was found that two sacks, filled with 5 kgr of tow, holding 5 litres of colza or machine oil each, were sufficient to protect a vessel 75 m long The oil had to be renewed every six hours Too much oil has the disadvantage of spreading more slowly, and theoretically the best system of distribution would be one in which the oil would reach the surface from below in a large number of small drops

HERR J NAUE has been fortunate enough to discover at a prehistoric station near Schaffhausen a piece of limestone, on both sides of which are drawings like those which have been found in caves in France and in the cave at Thayngen It was found in the lowest part of the yellow "Kulturschicht" among bones and teeth of reindeer, horses, and other animals On one side are a horse, a foal, and a reindeer, while several horses appear on the other The style is not so fine as that of the Thayngen drawings, but, according to Herr Naue, they display a power of keen observation, and he points out that it was more difficult to work on stone than on a bone still fresh

THE remarkable address delivered by Prof Virchow on his assumption of the office of Rector of the University of Berlin has been issued by the German publisher, August Hirschwald, of that city The title is "Lernen und Forschen"

THE *Pharmaceutical Journal* of the present week prints the first of what promises to be a good series of papers, which are intended to make bacteriology intelligible and interesting to students, and to be of some practical value to pharmacists in business. The *Journal* rightly thinks that the time has come when pharmacists ought to make themselves familiar with the principles of "this newest department of experimental science."

LAST week Lord Kelvin delivered an interesting speech at a dinner given to the members of the new watch factory at Prescot He said it was something to be proud of that the article they were making was a triumph of mechanism There was nothing in the whole of scientific art, nothing in the results of mechanics applied to the useful purposes for mankind, that was a more splendid success than the science of watchmaking He had been all his life engaged more or less with scientific experiments, with measurements, and with instruments which their French friends would call instruments of precision They knew something of instruments of precision in electricity, and they were thankful if they could make a measurement which was accurate to one-tenth or one-twentieth per cent But what did watchmaking do? The commonest cheap watch—cheap but good—which would issue from the Prescot works would keep time to a minute a week Now a minute a week, if they made a little calculation, was something like one-hundredth per cent of accuracy, or just about ten times as accurate as they considered exceedingly good work in electrical measurements

AT a recent meeting of the College of Preceptors, Mr Foster Watson read a remarkably interesting paper on Richard Mulcaster, who was head-master of St Paul's School from 1596 to 1598 The paper is printed in the current number of the *Educational Times* Mulcaster's ideas were in some respects far ahead of those of his time The following, according to Mr Watson, were his "main educational contentions" —(1) Culture and learning for those who have the wit to profit by it, whether rich or poor Adequate knowledge for those who go into trade (2) Education for girls and women, as well as boys and men Higher education for girls who have good abilities (3) Training colleges for teachers (4) Physical training for all—boys and girls, teachers and pupils, and this to be continued in after life (5) Liberal education, with disinterested aims for the elementary schools (6) The best masters to take the lowest classes (7) Drawing and music to be taught in every school, not as "extras," but as essentials "You will notice," says Mr Watson, "that the last named five aims are only within the field of discussion even yet, they are not *faits accomplis* All this time they have been in Mulcaster's book, and Mulcaster's book—a few copies of it, very few—have been gathering dust"

THE Association of Officers of Colleges in New England have recommended the gradual adoption of the following changes in the curriculum of New England grammar schools —(1) The introduction of elementary natural history into the earlier years of the programme as a substantial subject, to be taught by demonstrations and practical exercises rather than from books (2) The introduction of elementary physics into the later years of the programme as a substantial subject, to be taught by the experimental or laboratory method, and to include exact weighing and measuring by the pupils themselves (3) The introduction of elementary algebra at an age not later than twelve years. (4) The introduction of elementary plane geometry at an age not later than thirteen years. (5) The offering of opportunity to study French, or German, or Latin, or any two of these languages from and after the age of ten years (6) The increase of attention in all class-room exercises in every study to the correct and facile use of the English language In order to make room in the programme for these new subjects, the association recommends that the time allotted to arithmetic, geography, and English grammar be reduced to whatever extent may be necessary The association explains that it makes these recommendations in the interest of the public school system as a whole, but that most of them are offered more particularly in the interest of those children whose education is not to be continued beyond the grammar school

MR. WALDO DENNIS gives in *Science* a minute and very interesting account of a snake which he watched for an hour in the woods one morning in July last It went straight up a tree "without crook or turn," and by and by lay still for a while,

basking in the sun Mr Dennis notes that while in this position it lifted up its head four or five inches and gaped Its mouth opened very wide; and when the mouth was closing, the nervous spasm, only half expended, again seized upon the jaws, whereupon they went wider than before, the spasm exhausting itself at last in a parting wriggle or two to the head "So natural," says Mr Dennis, "was this novel performance, that I involuntarily listened for that characteristic accompaniment, the little agonizing whine so common with the dog, and and not uncommon with us"

FEW things are more frequently said than that diseases of the nervous system, especially those of a hysterical character, have increased with the growth of civilization Dr de la Tourette has been trying to show, in the *Journal de Médecine*, that this is an error, and Dr D G. Brinton, in *Science*, expresses cordial agreement with him Travellers who give the soundest information on the subject, says Dr Brinton, report that in uncultivated nations violent and epidemic nervous seizures are very common Castren describes them among the Sibiric tribes An unexpected blow on the outside of a tent will throw its occupants into spasms. The early Jesuit missionaries paint extraordinary pictures of epidemic nervous maladies among the Iroquois and Hurons. During the Middle Ages there were scenes of this kind which are impossible to day

THE question as to whether electrification is produced by the friction of gases has been exhaustively dealt with by Mr. Wesendonck, who gives an account of his results in *Wiedemann's Annalen* The apparatus resembled that employed by Faraday with negative results, in the case of dry air Mr Wesendonck used air compressed to 100 atmospheres in Elkan steel bombs of 1000 litre capacity This was passed through a brass tube widening out into a cone into which a similar cone could be screwed from the opposite direction, so as to leave a conical path for the air issuing from the bomb. The second cone was connected to a delicate electrometer, which indicated any electrification produced by the impact of the air Ordinary air was thus found to give considerable negative charges, up to 1½ volt, if the cones were far apart, and positive charges if they were screwed up close But no electrification was produced when the air had been previously freed from dust and moisture. Oxygen behaved in the same way Carbonic acid, evaporated from the liquid state, imparted a strong positive charge to the brass, which was, however, reversed as soon as the cold led to the precipitation of water vapour Ordinary atmospheric dust was found to electrify the brass negatively, the charge being increased by previous drying It seems, therefore, that pure gases are incapable of producing electrification by friction, and that the effects observed are conditioned by the presence of minute solid or liquid particles

FISHES in badly-ventilated aquaria give various signs of oppression, such as restlessness, frequent gasping, mounting to the surface, leaping into the air, &c. Experiments have been recently made by Messrs. Duncan and Hoppe-Seyler (*Zeitschrift für Phys. Chemie*) to ascertain to what point the oxygen-content of the water may be lowered before fishes indicate uneasiness They were made with tench, trout, and crayfish in an elliptical glass vessel, with pipes for injecting and removing water and air, &c, in one case a pipe communicating with a chamber in which was a live rabbit, conveyed to the fishes air impoverished by the latter's breathing, while the behaviour of rabbits and fishes in the same air could be compared. With 4 to 3 cubic centimetres O in the litre of water, the fishes seemed well and content, and with the corresponding O tension in the air (8 to 11 volume-percentage) the rabbit was in no difficulty. With 1 7 to 0·8 cubic centimetres O in the water, the trout were evidently ill at ease, and, if it continued, they died. The tench and crayfish, however, stood still further reductions, the former finding relief at the surface Reduction of the O to zero soon produced the worst symptoms.

IT was long ago shown by Sir J. B Lawes that plants on ground that has been long without manure evaporate more water than those on good ground Further research has proved that transpiration is not proportional to leafy development, for it largely depends on the activity of the roots, as well as evaporative surface. M Dehérain has lately (*Ann Agr*) been led to investigate the influence of manure on the development of roots; and he finds that roots in unmanured ground have a much larger growth than in manured, having to spread more in search of the scanty nutriment If, then, a plant with small leafy growth, evaporates more water relatively than one with large, it is probably due to large root-growth procuring more water The observation of Volkens is cited, that desert plants have extraordinarily long roots Further, M Dehérain points out, the solar rays falling on a plant have a twofold work to do, viz assimilation and transpiration And these are complementary In strong leafy plants there is vigorous assimilation, so that transpiration is limited, while in the leaves (with little chlorophyll) of an "anæmic" plant a larger fraction of the solar energy is given to transpiration

IN the *American Geologist* an account is given of a preliminary examination of some specimens of a coaly mineral, having the general properties of a cannel, from the Kootanie and Lower Cretaceous of British Columbia. Their examination was of more than ordinary interest on account of their peculiar physical constitution and the great difficulty of ascertaining their connection with any of the materials ordinarily known to contribute to coal formation The main characteristics of the mineral are the total absence of structure, and the presence of tubular ramuli resembling fungus mycelia, as well as rounded cavities Angular fragments of material of the same nature as the larger rod-like bodies appear in the sections, and an amorphous substance either occurring in distinct flakes or acting as a cement to unite the rods Mr Penhallow's examination has made it probable that the origin of these coals must be sought in some other direction than modified vegetable structure It is suggested that they represent a form of fossil resin accumulated during a period when resin-bearing trees were very abundant, and possessed a structure favouring the rapid disintegration of organic tissue.

A YOUNG lady in America seems to have the power of awakening not only the intelligence but the affections of insects. Her experiences are recorded in *Science* by a friend of hers, who signs himself "B." In September some one gave her a beetle, which is described as a specimen of *Pelidnota punctata* Linn At first she kept it in a small box, feeding it with grass, leaves, and small pieces of fruits, such as peaches, pears, &c. Occasionally she would give it a drop of water to sip It would sometimes bite a little out of a leaf, would eat the fruits, and would take water eagerly From the first she would take the insect in her fingers several times a day and stroke or caress it, also putting it to her lips and talking to it all the while she handled it When she put it to her lips it would brush its antennæ over them with a gentle, caressing motion When she left her room she would shut it up in its box. One day, about two weeks after she received it, she was called out suddenly and neglected this precaution She was absent for some time, and when she returned the insect was not in its box nor anywhere to be seen Fearing that she might injure it, she stood still and called "Buggie, buggie," when it came crawling from its retreat towards her. "After this," says "B," "she would frequently leave it free in the room when she went out, and when she returned, if the insect was not in sight, she would

call it, and it would crawl or fly to her. As this was continued, it would more and more frequently fly to her instead of crawling, until at last it flew nearly every time it was called When it came in this way she would put it to her lips or to her nose, and the insect would appear to be pleased, moving its antennæ gently over her lips, or taking the end of her nose between them and touching it with a patting motion" Unfortunately this interesting beetle lost its liveliness in winter It was placed on a cloth above the kitchen boiler, where it revived to some extent, but in December it accidentally fell to the floor and soon afterwards died

THE annual report of the U S Commission of Patents for the year 1891 has been issued In addition to the usual statistical information there are added to this report two tables and two diagrams illustrative of the growth of patent-granting from 1790 to 1890, the first century of the existence of the American patent system The first table gives the patents granted in that period by years and by States to American citizens The second table does the same for patents granted to citizens of foreign countries. The first diagram has one line illustrating graphically the growth of patent-granting during the century, along with another line denoting the increase of population in the same period The second diagram has one line illustrating the growth per capita of patent-granting as a whole during the century, and other lines illustrating the growth per capita of patent-granting in the States by groups of States There is also a list of patentees and their improvements, by years, prior to the year 1800

THE first volume of the *Irish Naturalist*, a monthly journal of general Irish natural history, has just been published, and a very interesting volume it is The editors are Mr G H Carpenter and Mr R Lloyd Praeger, and they have secured from able contributors many good articles on subjects which cannot fail to be attractive to Irish readers The volume also records work done by some of the foremost of the Irish scientific societies

THE Bureau des Longitudes has issued, through Messrs Gauthier-Villars et Fils, its "Annuaire" for the year 1893. It contains, as usual, a great mass of scientific information, clearly arranged Among its "notices" is an interesting paper upon the observatory of Mont Blanc, by M J Janssen

THE Belgian Royal Academy of Science, Letters, and Art has also issued its "Annuaire" Among the contents is a rather elaborate memoir of Jean Servais Stas, accompanied by an excellent portrait

MESSRS. CHARLES GRIFFIN AND CO have published a ninth edition of "A Pocket Book of Electrical Rules and Tables for the Use of Electricians and Engineers," by John Munro and Andrew Jamieson. The authors state that the work has been carefully revised and enriched with fresh matter, including several important communications by leading authorities on electro-technics.

MESSRS. GEORGE BELL AND SONS have issued the first portion of a supplement to the third edition of "English Botany, or Coloured Figures of British Plants." This part has been prepared by Mr N. E. Brown The rest will be done by Mr. Arthur Bennett.

IN our review of "Modern Mechanism" last week (p. 242) a typical American express locomotive with 20 × 24 cylinders was said to be less powerful than an 18 × 26 cylinder British engine. This should, of course, be reversed, the American engine being the more powerful

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr F Skinner, eleven Tuatera Lizards (*Sphenodon punctatus*) from Stephen's Island, Cook's Straits, New Zealand, presented by Captain E A Findlay, a Puff Adder (*Vipera arietans*) from East Africa, presented by the Directors of the British East African Company, a Vulpine Phalanger (*Phalangista vulpina*), from Australia; a a Stanleyan Chevrotain (*Tragulus stanleyanus* ♂) from Java, deposited, a Sanderling (*Calidris arenaria*), European, two Brown Capuchins (*Cebus fatuellus*), an Azara's Fox (*Canis azaræ*), a Ring-tailed Coati (*Nasua rufa*), seven Glossy Ibises (*Plegadis falcinellus*), a Brown Milvago (*Milvago chimango*), four Barn Owls (*Strix flammea*), a Ypecaha Rail (*Aramides ypecaha*), a Chilian Pintail (*Dafila spinicauda*), a Geoffroy's Terrapin (*Platemys geoffroyana*) from South America, purchased, a Hog Deer (*Cervus porcinus*), born in the Gardens

OUR ASTRONOMICAL COLUMN

COMET HOLMES —The following telegram was received from Dr Copeland on Tuesday evening —"Comet Holmes reported suddenly brighter Stellar" (nucleus) We therefore continue the ephemeris (Schulhof, for Paris, midnight)

Date		R A app. h m s.	Decl app ° ′
Jan	19 ..	1 25 53 2	+33 39
	20	27 13 7	39
	21	28 35 1	39
	22	29 57 2	39
	23	31 20 1	40
	24	32 43 7	40
	25	34 8 0	41
	26	1 35 33 0	+33 42

The comet is now almost midway between β Andromedæ and α Trianguli

BURNHAM'S DOUBLE-STAR OBSERVATIONS —Mr. Burnham's splendid series of double star measures, made chiefly with the 3 foot refractor at the Lick Observatory during the first six months of 1892, are published in *Ast. Nach.* No 3141 He states that the superiority of the great telescope for this work has been fully demonstrated In the present list there are micrometric measures of eight new double stars, and additional measures of 170 old ones χ Pegasi has completed more than one revolution since its discovery in 1880, the period being about eleven and a half years, which "is probably shorter than that of any other known pair in the heavens"

Mr Burnham's connection with the Lick Observatory having permanently ended in June last, the present list of measures concludes his work on double stars It is to be hoped that the field of work which he has so brilliantly occupied will not be neglected in the future.

EPHEMERIS OF COMET BROOKS —The following is a continuation of Kreutz's ephemeris for Berlin, midnight —

Date	R A. (app.) h m s.	Decl. (app) ° ′	Log r	Log Δ.
Jan. 19	22 58 23	+ 48 59 3	0 0835	9 9670
20	23 5 14	47 36 7	0·0845	9 9786
21	11 26	46 17 3	0·0856	9 9902
22	17 4	45 1 2	0·0867	0 0017
23	22 13	43 48·5	0·0879	0 0132
24	26 56	42 39 0	0·0891	0·0245
25	31 16	41 32 8	0 0904	0 0358
26	23 35 17	+ 40 29·6	0 0917	0 0468

THE ECLIPSE OF APRIL 16, 1893 —In a communication to the Astronomical Society of France, M. de la Baume Pluvinel indicates some of the points to which attention should be directed in the eclipse of the sun in April In the first place, he does not think any of the precious moments of totality need be devoted to the study of prominences, as these can now be completely studied at any time. The investigation of the corona is all-important, and attempts should be made to obtain photographs showing its general aspect with various exposures, as well as photographs of its spectrum The different parts of

the corona are of such varying brightness that it will be impossible to obtain all the details with a single exposure For the spectroscopic work it is also recommended that isochromatic plates be employed, with special reference to the distribution of the material which gives the green line 1474 Kirchoff Mr. Lockyer proposes to use an objective prism, so as to obtain monochromatic images of the corona, that is, rings corresponding to each elementary radiation of the coronal light This method will not only give the spectrum of the corona, but the distribution of each spectrum line over the whole of it The problem of the "reversing layer" is also wanting definite solution, and it is pointed out that instantaneous photographs may settle the question once for all M Pluvinel also points out the importance of noting the presence or absence of the hydrocarbon bands suspected by Tacchini in 1883, as this observation may throw further light on the analogy between the corona and the tails of comets

Photometric observations should also be secured, and the polariscope should be employed to determine the proportion of polarized light in various parts of the corona

NOVA AURIGÆ —Prof Barnard has recently made some measures of the position of Nova Aurigæ, with a view to detecting proper motion The two comparison stars selected were the stars E and F in Mr Burnham's previous list of comparison stars. The results are stated thus (*Ast Nach* No 3143) — "The measures with F come out identical with Mr. Burnham's during February, but those with E seem to show some sort of motion in distance and possibly in angle From the position of the comparison star this can hardly be due to parallax It is possible, though, if the discrepancy is a real displacement, that it is due to orbital motion, the orbit being so situated as to show no motion with reference to F The difference is not sufficiently great, considering the distance, to prove anything" Prof Barnard further remarks that although the Nova presented no nebulosity at its first appearance, it has always appeared as an undoubted planetary nebula since he observed it on August 19 Estimates of magnitude in the present condition of the Nova will depend greatly upon the telescope and magnifying power employed Since August the nucleus has become fainter, while the light as a whole has remained essentially constant

"ASTRONOMICAL JOURNAL" PRIZES — "A gentleman earnestly interested in the development and progress of astronomy in his native land has authorized the editor of the *Astronomical Journal* to offer two prizes, for resident citizens of the United States" (*Ast Jour* No 284). The prizes will either take the form of money or of gold medals, one being of the value of two hundred dollars and the other of four hundred dollars In the first instance the prizes will be awarded for observations tending to advance our knowledge of cometary orbits, one being for the best series of measurements of the positions of comets during the year ending March 31, 1894, and the other for the best discussion of the path of a periodic comet, with due regard to its perturbations With regard to the first, astronomers who hope to gain the prize must frequently be at work until sunrise, as special value will be attached to observations made at inconvenient hours.

GEOGRAPHICAL NOTES.

THE name Ibea, contracted from the initials of the Imperial British East African Company to designate their territory on the east coast of Africa, has acquired a certain amount of currency, and although open to philological criticism is practically convenient On the same principle the great Dutch possessions in the East Indies have been termed Noi (*Nederlandsch Ost Indie*), and Mr. Ravenstein has suggested a similar abbreviation for the German East African territory (*Deutsch Ost Afrika*), only he would combine the initials with a Swahili affix or suffix signifying "land," and make it either Udoa, or Doani The cumbrousness of using many words to specify a well-defined region seems to justify a somewhat bolder coinage of new names in geography than has hitherto been customary

THE *Mouvement Geographique* publishes a sketch map of the Stanley Falls district of the Congo, compiled from the compass-bearings of M. Page, one of the members of the disastrous Hodister expedition. Besides Stanley, Lieutenant Gleerup and Dr Oscar Lenz are the only other authorities on this stretch of the river Special information is given regarding the three groups of rapids which occur between Stanley Falls station and Kibonge. The cataract of Mandombe above Stanley Falls is composed of a succession of falls from six to ten feet high and numerous rapids, but local canoe-men are able to take boats through in four or five hours Three hours of free navigation leads to the rapids of Mamanga, where the river is barred from bank to bank by a ridge of rock about twelve feet high, and followed by rapids and other smaller falls necessitating a portage Three and a half hours of free navigation lead to Basundu, the last cataract, which canoes are able to pass in about three hours after being lightened

THE Antarctic whaling fleet, the dispatch of which was noticed in vol xlvi p 477, has been reported from the Falkland Islands The *Balaena*, which has the most complete scientific equipment, arrived at Port Stanley at the end of November, the *Active* on December 8, the *Diana* on December 11 The fourth vessel, the *Polar Star*, was spoken off the Plate on November 16 The telegram from Monte Video reports all well, and a preliminary notice of the scientific observations will probably follow by mail

IN a communication to the Paris Geographical Society, M Venukoff calls attention to the fact that although the extensive Government drainage works have almost obliterated the Pinsk marshes from the valley of the Pripet, the most recent non Russian atlases continue to represent these marshes as they were thirty years ago Now their site is largely forest and meadowland

TRAVELS IN BORNEO

MR CHARLES HOSE'S paper on "A Journey up the Baram River to Mount Dulit and the Highlands of Borneo," read to the Royal Geographical Society on Monday evening, was a pleasant variety in the succession of African papers which has formed the staple of the Society's programme for the session

The Baram River runs on the whole northward through eastern Sarawak, reaching the sea in 4° 37′ 15″ N and 115° 59′ 30″ E Its mouth is complicated by a series of sandbanks shifting with the change of the monsoons The river is in parts very deep, and is navigated by a fleet of Government steamers The bordering land is low and swampy or covered with jungle until Claudetown, about sixty miles from the mouth, is reached There the ground rises, and a prosperous trading town has been established by Chinese merchants At Long Mari, about fifty miles further up, there are great rapids which can only be passed with difficulty, and gorges of considerable depth occur at intervals further up the stream The journey to Mount Dulit was made up the Linjar, a large tributary of the Baram The people on the banks of this river have a peculiar custom of keeping dead bodies in their houses encased in ornamental coffins for three months before burial, and Mr. Hose gave some highly interesting particulars regarding their burial customs, their complicated subdivisions of the world of the dead, and their habit of interchanging messages with departed friends At the head of canoe navigation the Sibop tribe hunt various species of monkeys with the blowpipe, the valuable commodity being the intestinal calculi known as Bezoar stones, which are greatly in demand by Chinese apothecaries.

The ascent of Mount Dulit was commenced on September 21, when a hut was built at the height of 2000 feet, and a path cut through the thorny scrub to 4000 feet, near which another hut was built Several days were spent here collecting natural history specimens, many of which were species new to science, amongst the smaller quadrupeds *Hemigale hosei*, and amongst birds *Calyptomena hosei* and *Mesobucca eximius* may be mentioned. A cave some distance higher was found with wild tobacco growing at its mouth and several remarkable ferns, one with fronds 14 feet long; but except for bats and a solitary snake, the cave was untenanted. The fauna of Mount Dulit closely resembled that of Kina Balu, showing the widespread distribution in the highlands of Borneo of Himalayan forms The flat moss-clad summit of Mount Dulit was found to be, by aneroid, 5090 feet, and there was a magnificent view of distant ranges, the position of a number of peaks in which was fixed Some natives reported having heard a tiger roaring in the neighbourhood, but Mr Hose found the sound to proceed from a gigantic toad, measuring 14½ inches round the body. At the close of the paper Dr Bowdler Sharpe F R.S., pointed out the great importance of Mr Hose's results in their bearing on geographical distribution

BACILLI IN BUTTER.

THE fact that milk affords a particularly suitable medium for the growth and multiplication of most micro organisms, has rightly led to its being regarded as a dangerous vehicle for the propagation of disease On the Continent the practice of boiling all milk before use, and so destroying any pathogenic microbes which may be present, is almost universal, and recently a number of special pieces of apparatus have been devised for household use, ensuring the efficient so called "pasteurization" of milk In England, however, we but rarely boil our milk in spite of outbreaks of diphtheria and typhoid fever having been not infrequently traced to a particular milk supply In a paper by Cnopf on the bacterial contents of milk it is stated, that on one occasion out of every thirteen samples of milk supplied to Paris one was found to contain tubercle bacilli, whilst it is well known that the germs of typhoid, cholera, diphtheria, anthrax, &c, thrive readily in this medium But although milk has been made the subject of much careful experimental investigation, comparatively little is known of the microbial condition of butter Heim has shown that cholera bacilli purposely rubbed into butter could be demonstrated after thirty-two days, whilst typhoid bacilli similarly introduced were found after three weeks, and tubercle bacilli after the lapse of a month, although Gasperini discovered the latter in butter even after 120 days Quite recently Lafar has published a paper, "Bacteriologische Studien uber Butter" in the *Archiv fur Hygiene*, in which he has recorded his investigations on the micro-organisms found in Munich butter These experiments are instructive as exhibiting the fitness of butter to support a large number of bacteria, and thus furnish an interesting supplement to what is already known concerning the longevity of pathogenic microbes in this medium The samples examined were prepared from fresh cream and were investigated as soon as possible after the butter was made It was found that the number of microbes differed according as the portion for experiment was taken from the outside or from the interior of the piece of butter Thus in one instance whilst one gram from the centre of the pat contained 2,465,555, on the outside in the same quantity as many as 47,250,000 micro-organisms were found Taking the average of a number of examinations, it was estimated that the interior of a lump of butter possessed from 10 to 20 millions of bacteria in a single gram Lafar is inclined to regard this as an under rather than an over statement of the number, inasmuch as there are always probably present a certain proportion of microbes which will not develop at the ordinary temperature, or on the gelatine-peptone medium usually employed He graphically puts it that, in some cases it is conceivable that the number of organisms swallowed with a moderately sized slice of bread and butter may exceed that of the whole population of Europe! Lafar found that butter kept in a refrigerator, with a temperature of between 0° to + 1° C at first (after five days) showed a marked reduction in the number of bacteria, but that no further diminution took place, although the sample was kept for a month at this temperature Samples kept at from 12° to 15° C. exhibited a marked increase in the number of micro-organisms, a rise from 6 to 35 millions being observed in the course of nine days, whilst when placed in the incubator (35° C) after four days the bacteria had fallen from 25 to 10 millions, and after thirty-four days only 5 per cent of the original number present were discoverable Experiments were also made to ascertain what was the bacterial effect of adding salt to butter kept in a refrigerator It was found that although the numbers were thereby considerably reduced, that yet, even when as much as 10 per cent. of salt was added, the complete destruction of the bacteria was not accomplished. On examining, however, gelatine-plates prepared from these samples, it was ascertained that the organisms present consisted almost entirely of a pure cultivation of one particular microbe, which was apparently entirely unaffected by the addition of salt, and had grown and multiplied to the exclusion of nearly all the other bacteria originally present. When samples similarly salted were placed in the incubator (35° C) the result was rather different, for whilst there was more apparent connection between the proportion of salt added and the diminution in the number of bacteria, more varieties of micro-organisms were found on the gelatine plates. But in this case, also, the germicidal effect produced was not proportional to the increase in the amount of salt. Samples of artificial butter were also examined, and were invariably found to be much poorer in bacteria than ordinary butter Thus, whilst the smallest number found in one gram was 747,059, in real butter considerably over two million microbes was the minimum Two varieties of bacilli have been isolated and described, which were found very constantly present in butter throughout these investigations They are beautifully illustrated and shown in coloured plates as individual organisms and colonies at the end of the paper Lafar purposes continuing his investigations, and it is to be hoped that the examination of butter for pathogenic micro organisms, about which so little is known, will form an important feature in any further researches he may undertake

GRACE C FRANKLAND

THE OCCURRENCE OF NATIVE ZIRCONIA (BADDELEYITE)

THE discovery of native zirconia was first made public in my letter to NATURE (vol xlvi p 620) in October last, at the same time I gave characters sufficient for the recognition of the new mineral, and suggested the name *Baddeleyite*, in honour of Mr Joseph Baddeley who had brought the specimen with other dense minerals from Rakwana in Ceylon As there was only a single fragment of what at first sight seemed a hopelessly imperfect crystal, the determination of all the important characters without appreciable injury of the specimen was a task of an attractive kind the technical details of the investigation (including quantitative chemical analyses) and the line of argument by which definite results were evolved from the observations, were communicated to the Mineralogical Society at the meeting held on October 25 (NATURE, vol. xlvii p. 70), and crystals of hydrous zirconium oxychloride prepared by identical methods from Baddeleyite and artificial zirconia, respectively, were exhibited for comparison Having regard to the unexpected result of the chemical examination and the difference of the characters of Baddeleyite from those of artificially prepared crystals of zirconia, every care had been taken to get results as accurate as the material itself would admit of

Of course it was hoped that the occurrence of native zirconia, once established, would soon be noticed elsewhere, and in fact, I hear this morning (January 3) from Dr Hussak of the Geological Survey of Brazil, that flawless crystals of zirconia are actually met with in the south of São Paulo as an accessory constituent of an augitic rock described under the name of Jacupirangite by my friend Mr O A Derby

The Brazilian mineral had three or four years ago been regarded by Dr Hussak (who had then only a small amount of material for examination) as probably orthite (silicate of cerium, iron, &c), a mineral with which it agrees in its more obvious external characters, and it was mentioned later under that name in Mr Derby's description of the Jacupirangite, but more recently Dr Hussak, on isolating a score of flawless crystals from the decomposed rock, recognized the distinctness of the mineral from orthite, determined the geometrical and physical characters of the crystals, and decided from a chemical examination that the material was a tantalo-niobate of probably some member of the yttrium cerium group these results were published in the *Neues Jahrbuch fur Mineralogie*, 1892, Band II p 142, immediately after my announcement of the occurrence of native zirconia in Ceylon had been sent for publication, but they had been forwarded from Brazil as early as the month of June Dr Hussak now informs me that the Brazilian mineral, which had been sent to Sweden for a complete quantitative examination, has been determined by Prof Blomstrand to be almost pure zirconia

As regards crystalline form, the parametral elements obtained by myself for Baddeleyite, and announced at the meeting of October 25, agree in a very satisfactory way with those determined by Dr Hussak for the Brazilian mineral, while as regards optical characters, the two descriptions are practically identical The only important deviation of external character is in the specific gravity, that of Baddeleyite is 6 025, that of selected crystals of the Brazilian mineral is 5 006

Now it seems almost impossible that the specific gravity of crystals of a simple oxide presenting otherwise identical characters can vary to this extent, and the explanation of all the difficulty will probably be found to be that Dr Hussak's specimens really belong to two distinct minerals, that while the crystalline form and optical characters were determined from the one (zirconia), the specific gravity and the chemical composition

were originally determined from the other (yttrium tantalate) In fact, it was stated in my former communication that the Baddeleyite of Ceylon is itself associated with such a chemical compound, and I may add that this associated mineral was there designated without the mention of a species-name because it had been found to have a specific gravity (4 9) far below the inferior limit (5 5) hitherto observed in the case of undoubted Yttrotantalite: it was intended to determine later whether or not the lowness of the specific gravity was accompanied by a difference in the proportion of the chemical constituents, further, the similarity of aspect of the zirconia and yttrium tantalate of Ceylon is such that a confusion of the two would be easy. In this way the discrepancy of the chemical results and the complete accuracy of the observations of Dr Hussak, whose reputation stands so high in the annals of mineralogical science, would be found consistent with each other

There remains the inconvenience that two names have been suggested for the same mineral, but according to the rules of nomenclature formulated by Dana (rule 13*d*) the name of *Baddeleyite* has the prior claim I may add that the name *Brazilite* was in use eight years ago, commercially at least, for the specification of an oil bearing rock found in the neighbourhood of Bahia L FLETCHER

GAS POWER FOR ELECTRIC LIGHTING

AT the ordinary meeting of the Institution of Civil Engineers on Tuesday, January 10, an interesting paper on "Gas-Power for Electric Lighting" was read by Mr J Emerson Dowson The author stated that in Great Britain alone gas-engines had been sold for electric lighting, exceeding in the aggregate 7000 horse-power, and that in Germany engines were used for about 1100 arc and 90,000 glow-lamps It was, however, only within the last few years that gas-engines of large size had been before the world in a practical form The varying load factor in central stations was a serious trouble, and the author hoped to show that much of the present loss, due to fuel, water, and wages, would be avoided if gas power were used instead of steam-power

Special reference was made to the central-station at Dessau, belonging to the German Continental Gas Company That station was opened in 1886 with two 60 horse-power, one 30 horse-power, and one 8 horse power (effective) engines, worked with town-gas, and all the dynamos were driven by belting and counter-shafts In 1891 considerable alterations were made One 60 horse-power engine, with its belting and counter-shaft, was retained, and one of 120 horse-power introduced, coupled direct to its dynamo The speed of the engine and coupled dynamo was 145 revolutions per minute, and the consumption of town-gas was equal to 39 cubic feet per kilowatt Formerly, without accumulators, it was thought necessary to adjust the size of the engines to the supply, so that they should always be worked to their full extent It had, however, been found that a limited supply could more advantageously be furnished entirely from accumulators In spite of the loss of about 21 per cent in the accumulators, large engines worked more profitably in parallel than smaller ones supplying direct without accumulators Since February, 1889, the Municipality of Schwabing, a suburb of Munich, had used an Otto engine worked with Dowson gas for 10 arc- and 300 glow lamps. The load was variable, but with an average output of 22 5 kilowatts per hour the fuel-consumption was 3 3 lbs per kilowatt The town of Morecambe was lighted by nine arc-lamps and glow-lamps, equal to 1600 of eight candle-power each, the dynamos being driven by Stockport gas-engines worked with Dowson gas. With an output of only 1155 kilowatts per week the consumption of fuel was 2 58 lbs, and the cost of the gas, including wages and fuel, was ½d. per kilowatt delivered. At the château of Mr. Say, at Longpont, in the South of France, there were 650 glow-lamps and one arc-lamp, supplied by a dynamo driven by a Crossley engine worked with Dowson gas The consumption of fuel was 1·2 lb per indicated horse power, and 2·7 lbs. per kilowatt per hour

It was believed that the late Sir William Siemens first drew attention to the fact, that when illuminating-gas was burnt in a gas-engine to drive a dynamo, much more light was produced electrically than could be produced by burning the same quantity of gas in burners in the usual way. Latterly the consumption of gas per horse power in gas-engines had been reduced, and the ratio was at the present time about 20 to 1 in favour of converting the gas into an arc-light, by means of a gas-engine The author had collected data from various sources, as to the consumption of ordinary town-gas by engines supplying electric light with and without accumulators The average of all the returns, with engines under varying loads and without accumulators, was about 47 cubic feet per kilowatt-hour; when accumulators were used, the consumption of gas was less, because the engines then worked under a full load With 47 cubic feet per kilowatt, and 55 watts per 16 candle-power, one light of that power required only 2 6 cubic feet per hour, whereas a standard Argand burner required 5 cubic feet per hour. In this comparison, it was assumed that the glow lamps and gas-burners were in good order, but under ordinary working conditions they did not maintain so high a duty

The question of load-factor was a serious one with any type of engine, but with gas-engines the loss was much less than with steam-engines When a gas-engine was stopped, its consumption of fuel stopped also, and there was no furnace to maintain, nor was there any water to boil at starting. At the same time, it was desirable that the gas-engine should be worked as much as possible under a full load, and in this respect the experience at Dessau was generally confirmed A central-station was worked under trying conditions, and in the London district there was only a full output of current during from three to five hours in every twenty-four, moreover, about 60 per cent of the total output was required during that short period In practice, this meant that in a station where the current was supplied without accumulators, the engines were run at a reduced speed during a portion of the time, and at other times some of them were stopped altogether, but all had to be ready to work in the evening, and occasionally in the day time, when there was fog Generally, it might be assumed that the average consumption was more than 6 pounds per kilowatt where accumulators were used, and about 9 to 12 pounds where they were not used In any case, with the best possible arrangement of steam-power, there must be a large amount of fuel consumed which did no useful work, for, even if some of the fires were drawn, they had to be re-lighted, and the large quantity of water which had cooled during the time of standing must be re-heated.

The author believed that the solution of the difficulty was to be found in the use of gas-plant instead of steam-plant With a large gas-engine, one brake horse-power per hour could be obtained with a consumption of about 1 lb of anthracite, or 1¼ lb of coke, whereas the consumption of coal with the steam engines used for central-stations, must be taken at about 2½ lbs per brake horse-power, when working under a full load A saving of not less than 50 per cent could therefore be effected in stations where the engines were fully loaded; and where there were great fluctuations in the output, the loss of fuel with boilers not used, or only partly used, could be almost entirely avoided For a maximum of 400 kilowatts, there would be three gas-generators, each capable of supplying one-third of the maximum required The production of gas could be raised or lowered in several ways, and the working of each generator could be stopped immediately by shutting off its steam supply Supposing, therefore, that all three generators were working at their maximum rate, and a gradual reduction was required, this could easily be effected, and when the production of one or two generators could be dispensed with their operation was at once stopped The third generator could then be kept at work, and its production adjusted to suit the minimum consumption required A gas-generator had a small grate-area compared with that of a boiler, and much less cooling-surface. it contained no water, and required no chimney-draught. A generator of the size referred to lost only 6 to 8 lbs. per hour whilst standing If an average of only 40 per cent. of the maximum power were required for twenty-one hours, it was equivalent to letting two of the generators stand for that period, and at 8 lbs each per hour that meant a total loss of only 3 cwts., compared with the much greater waste when steam-power was used. As the use of large engines, driven with generator gas, was of recent date, the author proceeded to describe the gas-plant used, and gave the results of engines working regularly with Dowson gas, under the usual conditions obtaining in factories. He also gave the results of brake-tests made with several engines of large size, and reproduced indicator diagrams taken from engines of different makers. Although admirable results had undoubtedly been obtained from engines

working with the Otto cycle, he was of opinion, that, with engines of large size, the results would be still better if the cycle were altered, especially when generator-gas was used His reasons for this were fully stated in the paper

The following was a summary of the points urged by the author.—

1.—When town-gas was used for driving the engines of an electrical station, the consumption was about 50 per cent less than the volume of gas required to give the same amount of light by ordinary burners

2.—When town-gas was used, neither boiler nor firemen were required, and there were no ashes to remove; less space was needed, no accumulators were required, except such as might be necessary to equalize the load of the engines and to provide for a small amount of storage. The engines could be worked in the most crowded districts, close to where the lights were required, and where boilers were not allowed

3.—When generator gas was used, the consumption of fuel under a full load would be at least 50 per cent less than with steam-power, and the loss due to steam boilers not being fully worked could be almost entirely avoided.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—We regret to hear that Professor Cayley has been suffering from serious illness, and that he is in consequence unable to give this term his advertised course of lectures in Pure Mathematics.

L Cobbett, M A, M B, of Trinity College, has been appointed Demonstrator of Pathology in the place of Dr E Lloyd Jones, who has resigned the office

Mr F Darwin, Deputy Professor of Botany, announces a special course of lectures in the Chemical Physiology of Plants, to be given by Mr Acton, of St. John's College, on Tuesdays in the present Lent Term

Mr J. Y Buchanan, F.R S, announces a second course of lectures in Geography, to be given in the Easter Term

Mr. A. E. Shipley has been appointed an additional member of the Special Board for Biology and Geology

SCIENTIFIC SERIALS.

Journal of the Royal Agricultural Society of England, 3rd series, vol iii pt 4.—Cottage sanitation (illustrated), by H McLean Wilson, a paper prepared under the supervision of Dr Spottiswoode Cameron and T Pridgin Teale, F R S It contains a discussion of the principal sanitary defects, which are most likely to be found in the houses of agricultural labourers, with valuable suggestions and remedies. The object aimed at is "to put the whole country, and every house in the country, into such a condition that if the epidemic (cholera) should break out it would have no chance of spreading"—Field experiments on the fixation of free nitrogen, by James Mason, gives an account of the enriching of some plots of poor land on the Oxford clay at Eynsham by the growth of two leguminous crops in succession. The two crops chosen were beans and mixed clovers. So far as they go the results are striking. Prior to 1888 the land had never been cultivated or received any manure. Brought into tillage in that year two plots produced 10½ cwts. and 9 cwts. per acre of barley and oats respectively, straw included,—an excessively low return. In the autumn of 1888 the plots were treated with 20 cwts. of basic slag per acre, and the subsoil with the same amount Beans in the following year yielded an average of 46 bushels and 23 cwts. straw per acre. In 1890 mixed clovers gave a yield of 28 cwts. per acre as the average of the two plots, and in 1891 a crop of three tons clover-hay was obtained Potatoes were grown upon the plots last year, and gave an average yield of eight tons per acre. Excepting the basic slag, no manure of any kind had ever been applied to the plots. The experiments are being continued and extended.—Wild birds, useful and injurious (illustrated), by C. F. Archibald.—Utilization of straw as food for stock, by Joseph Darby. Showing methods of using chaffed straw as a remedy for the deficient hay crop of last summer, with records of previous experiences under similar circumstances.—Yew poisoning, by Mr. E. P. Squarey, Mr Charles Whitehead, Mr. W. Carruthers, F.R S, and Dr Munro. But few definite conclusions can be arrived at, owing to the conflicting nature of the information available It appears, however, (1) that both the male and female yews are poisonous, (2) the poisonous alkaloid (or alkaloids) exists chiefly in the leaves and in the seeds, (3) the fleshy part of the fruit is harmless, or nearly so, (4) the amount of poisonous alkaloid in the leaves varies considerably with individual trees, and perhaps with the season of the year. Dr Munro contributes a review of the chemical work done upon taxine, the only alkaloid in yew which has been investigated, very little is known with certainty about it, either as to its chemical nature or its physiological action As Dr Munro suggests, "yew leaves merit *exhaustive* chemical examination"—Besides the official reports, there are several short articles, including one upon the ferments of milk, abridged by Dr Munro from Prof. H. W Conn's pamphlet on the subject, issued last summer, also a paper upon the decline of wheat growing in England, by the editor

American Journal of Science, January.—The age of the earth, by Clarence King This paper contains an application of Lord Kelvin's reasoning from probable rates of refrigeration to the determination of the earth's age, aided by Dr Carl Barus's recent work in geological physics, especially his determination of the latent heat of fusion, specific heats melted and solid, and the volume expansion between the melted and solid state, of the rock diabase Thermal considerations have shown that with a given initial excess of temperature of the earth over surrounding space, and an assigned value for rock conductivity, it is possible to determine the curve of temperature from the earth's centre to its surface. It appears that for an initial temperature of 2000° C, the initial maximum temperature must still extend uniformly from the centre to within a few hundred miles of the surface for any admissible value of the age But since the pressures increase steadily as we proceed towards the centre, there must be a point at which their effect outweighs that of the temperature, and the material, though very hot, remains in the solid state Now on the data supplied by Barus's researches it is possible to state what temperatures are necessary to keep a certain representative species of rock in the fluid state at successive points within the earth. The amount of possible liquid layer is limited by the facts of tidal rigidity, which fix the maximum admissible temperature at 1950° and the age at 24×10^6 years Lower values are excluded by the gradient of temperature observed on proceeding downwards from the surface. This value, twenty four million years, agrees fairly well with the age assigned by Helmholtz and Kelvin to the sun. It is also concluded that the earth never was all liquid, that the original liquid layer did not exceed 53 miles, and that the spheroidal shape is due to the plasticity of the lithosphere as manifested under the action of very slowly applied forces.—Tertiary geology of Calvert Cliffs, Maryland, by Gilbert D. Harris.—"Anglesite" associated with boleite, by F A Genth.—Preliminary account of the iced bar base apparatus of the United States Coast and Geodetic Survey, by R S Woodward.—Some experiments with an artificial geyser, by J C Graham.—Observations of the Andromed meteors of November 23 and 27, 1892, by H A Newton.—Preliminary notice of a meteoric stone seen to fall at Bath, South Dakota, by A E Foote.—New Cretaceous bird allied to Hesperornis, by O C Marsh.—Skull and brain of Claosaurus, by O. C. Marsh

THE *Botanical Gazette* for October contains an interesting article by Mr H. L. Russell on the bacterial investigation of the sea and its floor The author has had the opportunity of carrying on bacteriological observations in sea water, both from the Bay of Naples and from the coast of Massachusetts. He finds micro-organisms invariably present in sea water, though not in such large numbers as in fresh water, even at a great distance from the shore, and to a depth of 3200 feet, and a larger number in the slime at the bottom than in the water itself Some marine forms are cosmopolitan, and the bacteria that are so universally present in sea-water and mud seem to be quite peculiar to this habitat.—Mr E. L. Berthoud describes the mode in which the geographical distribution of some plants has been greatly extended by the agency of the buffalo.—In the number for November Prof. Underwood gives a report of the proceedings of the International Botanical Congress lately held at Genoa.—Mr G W. Martin contributes an account of the development of the flower and embryo sac in *Solidago* and *Aster*.

Bulletin of the New York Mathematical Society, vol. ii No. 2, November 1892 —This number practically consists of one paper, and that a very interesting one, by Dr Emory McClintock, "On the Non Euclidian Geometry," a subject which has been more than once brought before our readers In vol. viii (1873) appeared Clifford's translation of Riemann's Habilitationsschrift "ueber die Hypothesen welche der Geometrie zu Grunde liegen" (1854) In 1883 this geometry was considered in Cayley's British Association address, and quite recently (February 25, 1892) in a translation of Poincaré's "Revue Generale des Sciences" "The chief lesson to be obtained from all non euclidian diversions is that the distinguishing mark of euclidian geometry is fixity of distance-measurement, by which alone it is possible to draw the same figure upon different scales That the same figure may be drawn upon different scales might well be laid down as the axiom necessary and sufficient to distinguish euclidian from non-euclidian geometry" To this is appended a footnote which says that this is "referred to as 'the axiom of similars' by Sir *Richard* (sic) Ball in the article 'Measurement' of the "Encycl Brit" A short article follows on the new logarithmic tables of J de Mendizábal Tamborrel (Paris, Hermann, 1891) In addition there are the usual "Notes," but no list of publications

No 3, December 1892 —This number contains a careful criticism of Ball's "Mathematical Recreations," with suggestions and discussions by Prof J. E Oliver of Ithaca, New York, and an account of Dr Julius Bauschinger's "Zweites Munchener Sternverzeichniss, enthaltend die mittleren Oerter von 18,200 Sternen fur das Aequinoctium, 1880," by Prof T H Safford "Notes" and "New Publications" follow

Wiedemann's Annalen der Physik und Chemie, No 12 —On the temperature coefficient of the electrical resistance of mercury and on the mercury resistances of the Imperial Institution, by D Kreichgauer and W Jaeger The coefficient was measured in the case of the copies of standard resistances already described The formula obtained for the resistance w_t at temperature t by two independent methods was

$$w_t = w_0 \ (1 + 0\ 0008751 + 0\ 000001251^2)$$

—Generation of electricity by friction of gases against metals, by K Wesendonck —On galvanic polarization at small electrodes, by F. Richarz.—Electric oscillations in wires, direct measurement of the moving wave, by Kr Birkeland The oscillations were produced in two copper wires running parallel to each other at a distance of 80cm They were 30m long, and ended in one direction in brass plates 40cm. square, facing two similar plates connected with the terminals of the spark gap of a powerful induction coil The potentials along the wire when the coil was working were determined by measuring the length of the sparks crossing between the knobs of a spark micrometer, one of them being connected with the wire by a sliding contact, the other leading through a telephone to earth Statical effects on the telephone were made inappreciable by laying a thread moistened with dilute sulphuric acid across the wires near the "collector" plates Under these circumstances the passage of sparks was immediately indicated by the telephone, and their length could be measured down to 0 0005mm —Determination of dielectric constants by means of the differential inductor, by Oscar Werner —Measurement of resistances by means of the telephone, by Max Wien —Diffusion of light by rough surfaces, by Christian Wiener Experiments made on cast gypsum show that Lambert's law of diffusion, according to which the brightness of a surface is independent of the angle from which it is seen, is not strictly correct. The brightness at the edge of a round surface is 0 6 times that given by his law. In the vicinity of reflection points the brightness is greater, and at the greatest brightness the angle of incidence is greater than the angle of reflection —A unit for measuring intensity of sensation, by the same.—On internal friction of solid bodies, especially metals, by W Voigt.—Measurement of the coefficient of diffusion of liquids, by F. Niemoeller.—Absolute compressibility of mercury, by G de Metz —Propagation of energy through the ether, by G. Helm.—On the utilization and action of the telephone in electrical null methods; reply to Hr Winkelmann, by E. Cohn —On the solution of sodium silicates, and influence of time upon their constitution, by F Kohlrausch —Behaviour of polarized light in refraction, by G. Quincke.—On a mercury arc light, by L. Arons.

SOCIETIES AND ACADEMIES

LONDON

Royal Meteorological Society, December 21 —C. Theodore Williams, President, in the chair.—The following papers were read —Moving anticyclones in the Southern Hemisphere, by Mr H. C Russell, F R S, Government Astronomer, New South Wales The author describes the results of his practical study of the daily weather charts for Australasia, and states that the leading fact brought out is that the weather south of 20° S latitude is the product of a series of rapidly moving anticyclones, which follow one another with remarkable regularity, and are the great controlling force in determining local weather These anticyclones are more numerous in summer than in winter, the average number for the year being 42 They usually take seven or eight days to travel across Australia in summer, and nine or ten days in winter, the average daily rate of translation being 400 miles The shape of the anticyclone appears to undergo some modification as it nears the east coast The winds on the north side of the anti cyclone are not so strong as those on the south side, and the intensity of the weather is in proportion to the difference in pressure between the anticyclone and the V depression, but the relation of the pressures varies frequently before the wind responds, the pressure appearing to be controlled from above by the more or less rapid descent of air which feeds the anticyclone Cyclonic storms are very unusual, and do not occur more than once in two or three months —The tracks of ocean wind systems in transit over Australasia, by Capt M W C Hepworth The author has examined the daily weather charts of Australia and New Zealand, and has prepared maps showing the daily positions of the centres of high and low pressures for a whole year He finds that the wind systems, which make their first appearance to the westward and south-westward, advance to the eastward rapidly, and frequently very rapidly, during the winter months, but during the summer months they usually move more slowly, and not unfrequently recurve Their progress is retarded by contact with the areas of high pressure which they encounter, the mean of the tracks of these anticyclones, moving also from west to east, appears to be across the southern portion of Australia and onward, crossing the islands of New Zealand during the winter months, but to the southward of Western and South Australia, across Victoria and New South Wales, and thence to the north eastward, avoiding New Zealand during the summer months —Rainfall of Nottinghamshire, 1861–90, by Mr H. Mellish The author has collected and discussed all the rainfall records made in the county during the thirty years, and finds that in the extreme west the mean rainfall is 27 inches or more, and that over the rest of the county it varies between 25 and 27 inches, except north of the Manchester, Sheffield and Lincolnshire Railway, where the rainfall is less than 25 inches, and in the north east towards Gainsborough, where it is not more than 23 inches The year of greatest rainfall was 1872, and of least rainfall 1887. October is the wettest month and February the driest —A new instrument for cloud measurements, by Dr. Nils Ekholm

Geological Society, December 21, 1892 —Prof. J. W Judd, F R S, Vice President, in the chair —The following communications were read.—On a Sauropodous Dinosaurian vertebra from the Wealden of Hastings, by R. Lydekker In addition to *Hoplosaurus armatus* and *Pelorosaurus Conybearei*, there is evidence of another large Sauropodous Dinosaur in the Wealden, now known as *Morosaurus brevis* Up to the present time it has been impossible adequately to compare *Hoplosaurus armatus* with *Morosaurus brevis*, but recently Mr Rufford has sent to the British Museum an imperfect dorsal vertebra of a large Sauropodous Dinosaur from the Wealden of Hastings, which enabled the required comparison to be made. The author describes the vertebra, contrasts it with that of *Hoplosaurus armatus*, and gives presumptive evidence that it should be referred to the so-called *Morosaurus Becklesi* (Marsh), which apparently cannot be separated from *M* (*Cetiosaurus*) *brevis*. He has not been able to compare Mr Rufford's specimen with the dorsals of the American *Morosaurus*, in order to discover whether the English Dinosaur is correctly referred to that genus. This paper led to a discussion, in which the chairman, Mr. Hulke, Prof Seeley, Mr E. T. Newton, and the author took part.—On some additional remains of Cestraciont and other fishes in the Green Gritty Marls, immediately overlying the Red Marls of the Upper Keuper in Warwickshire, by the Rev. P.

B Brodie The vertebrate remains occur in a very thin band of marly friable sandstone lying between two beds of green marl, though in some places the same bed has itself no admixture of sandy material Bones and teeth are so numerous that it might almost be called a bone-bed. It does not exceed three inches in thickness. It contains Ichthyodorulites of Cestraciont fishes, abundant palatal teeth of *Acrodus keuperinus*, ganoid fish-scales, and abundant broken bones, some of which may belong to fishes, others to labyrinthodonts, and amongst the latter a fragment of a cranial bone The Chairman congratulated the Society on the presence of one of its Fellows who had been connected with it for nearly sixty years, and had read his first paper almost half a century ago He hoped that the Society would still continue to receive communications from the same source of like interest and value Mr J W Davis, Mr H B Woodward, and Mr E T Newton also spoke —*Calamostachys Binneyana*, Schimp, by Thomas Hick Communicated by J. W Davis —Notes on some Pennsylvanian calamites, by W S Gresley. — Scandinavian Boulders at Cromer, by Herr Victor Madsen, of the Danish Geological Survey Communicated by J W Hulke, F R S During a visit to Cromer in 1891 the author devoted much attention to a search for Scandinavian boulders, and obtained three specimens, one (a violet felspar porphyry) was from the shore, and the other two were from the collection of Mr Savin The first was considered to come from south east Norway, and indeed Mr K O Bjorlykke, to whom it was submitted, refers it to the environs of Christiania The author considered that the two specimens presented to him by Mr Savin who had taken them out of Boulder Clay between Cromer and Overstrand, were from Dalecarlia , and these were submitted to Mr E Svedmark, who compared one of them (a brown felspar-hornblende porphyry) with the Gronklitt porphyry in the parish of Orsa, and declared that the other (a blackish felsite porphyry) might also be from Dalecarlia This paper was discussed by Mr C Reid, Mr J W Davis, the Rev P B Brodie, Dr Hicks, Mr Marr, and the Chairman

EDINBURGH

Royal Society, December 19, 1892 —Sir Douglas Maclagan, President, in the chair —Dr Hunter Stewart read a paper on an extension of Kjeldahl's method of organic analysis, and described an apparatus which he had devised for the estimation of the amount of organic carbon present in water —Prof Rutherford read a note by Dr W G Aitchison Robertson on the madder-staining of dentine Rabbits were fed on madder for some time and were then killed, the dentine being then found to be stained When other food was supplied for a time, the process of feeding on madder being resumed afterwards, two coloured layers were found in the dentine, with an intermediate colourless layer —Prof C G Knott read a paper on recent innovations in vector theory He entered into a critical examination of the anti quaternionic attitudes taken up by Prof Willard Gibbs, Mr Oliver Heaviside, Prof Macfarlane, and others. His chief arguments were (1) that the quaternion was as fundamental a geometric conception as either its scalar or its vector part—indeed more fundamental , (2) that in the development of his dyadic notation, Prof Gibbs, being forced to bring the quaternion in, logically condemned his own position , (3) that a really flexible vector analysis must be versorial, the equations $ij = k$, $jk = i$, $ki = j$, &c , being from the geometrical and physical point of view essentially rotational , (4) that the non-associative character of the vector-analysis, in which i^2, j^2, k^2, were *assumed* to be $+ 1$, rendered it totally unfit for higher physical research , (5) that this tinkering with the algebraic sign quite spoiled the real efficiency of the very beautiful quaternion operator ∇—Prof. Gibbs, for example, being compelled to introduce the (*supposed*) *new functions of operation* Pot, New, Lap, Max, which in quaternions are the very simplest of inverse functions of ∇, and are best expressed as such.

DUBLIN

Royal Dublin Society, December 21, 1892.—Prof A C Haddon in the chair.—Prof Sollas, F.R.S., read a paper on pitchstone and andesite from tertiary dykes in Donegal The author found that a microscopical examination of some remarkably fresh glassy rocks from Donegal revealed a close resemblance between them and rocks of the same age in Arran This helps to confirm the supposed great extension of tertiary dykes through the north-west of Ireland Prof Sollas next read a paper on the variolite and associated igneous rocks of Roundwood, co. Wicklow He described them as a complex of basic rocks, including altered ophitic dolerite, spilite (variolite du Drac), and spherulitic tachylite (variolite de la Durance) In connection with the epidotisation of the rock the author pointed to the excessive fissuring which it has undergone , and showed that the formation of epidote is attended with considerable diminution of volume, sufficient to account for the cracks The formation of serpentine and chlorite is attended with expansion, and chlorite can scarcely be formed without the simultaneous liberation of a disproportionately large percentage of quartz This explains the common association of chlorite with the quartz of quartz veins —Sir Howard Grubb, F R S , described a new system of mounting for monster reflecting telescopes —Mr. H H Dixon read a paper on the germination of seedlings in the absence of bacteria Seeds, the outer coats of which were sterilized, germinated in the absence of bacteria, and being kept absolutely free from bacteria did not, after growth had ceased, suffer the decay of death, but remained for more than twenty months apparently unchanged An apparatus for sterilising the outer coats of the seeds and sowing them without the introduction of bacteria was also described —A paper was communicated by Prof A C Haddon, and Miss A M Shackleton, describing some new species of Actiniæ from Torres Straits

BERLIN

Meteorological Society, December 6 —Dr Vettin, President, in the chair —Prof Assmann gave a detailed description of the meteorographs set up in the "Urania pillars" Each pillar contains a thermograph, a barograph, and a hygrograph, placed side by side in a metal case through which a rapid current of air is kept up The thermograph consists of a Bourdon spring, filled with alcohol, whose movements are communicated to an external recording lever The barograph is made of four boxes joined together, and delicately balanced by a weight, whose movements are similarly recorded externally The hygrograph consists of a bundle of hairs 2 m in length The above instruments have continued to work well after several months' use Their chief defect is due to the hygroscopic properties of the paper on which the three levers trace their record The large amount of material in the shape of meteorograms already collected has revealed a number of interesting facts Thus, for instance, the temperatures recorded on two closely adjacent pillars may differ by 1° or more not only on a warm summer day, but also during the night of November 26, the coldest of this year In one case the air was found to be warmed by the adjacent row of houses exposed to direct sunlight In another the radiation was observed to be greater opposite a gateway than in the street. The very considerable local differences of air temperature recorded on closely neighbouring pillars could scarcely have been *à priori* expected

Physiological Society, December 9, 1892 —Prof du Bois Reymond, President, in the chair —Prof Exner, of Vienna, gave a *résumé* of his researches on the innervation of the crico thyroid muscle in rabbits and dogs In each he had found a branch from the pharyngeal branch of the vagus distributed to this muscle, together with the superior laryngeal nerve, to which he has given the name of median laryngeal nerve The communication was illustrated by an experimental demonstration —Dr Hansemann stated that he had obtained photographs of microscopic objects which when placed in a stereoscope, presented an appearance of solidity. They were produced by taking one photograph of the object in focus for a given level, and then a second photograph at a different level. These photographs united stereoscopically gave the impression of solidity.—Prof Hilgard drew attention to the remarkable fact that the most civilized races of antiquity usually established themselves in dry districts This he attributed to the fact, borne out by numerous analyses of soils in America, that in dry regions the earth is far richer in mineral food stuffs necessary to plant life than in wet regions where these are largely washed out of the soil Hence in dry regions simple irrigation suffices to produce a luxuriant vegetable growth, while on the other hand the soil of most regions is very rapidly exhausted.

PARIS

Academy of Sciences, January 9 —M de Lacaze Duthiers in the chair —Drainage waters of cultivated lands, by M. P P Dehérain. An experimental investigation of the substances found in water drained from various cultivations showed that all the waters contained a fair proportion of nitrates Even beetroot, which not only utilizes nitrogen for the formation of its

albuminoids, but also stores nitrates in its tissues, gave 31, 39, and 95 gr of nitric acid per cubic metre of drainage water. Beetroot gives, however, the least quantity of nitrogen in the drained water in proportion to the crop. Next comes Turkey corn, and then potatoes. It appears certain that all nitrogen which enters the soil is either assimilated or else lost In the case of a bad harvest there is a loss both from the poverty of the crop and the impoverished state of the soil —On the small planets and nebulæ discovered at the Nice Observatory by MM Charlois and Javelle, and at the Mounier observing station, by M Perrotin. A list of eight minor planets discovered by the photographic method in four weeks, *i e* one-sixteenth of the time necessary to achieve the same result by eye observation —Dilatation and compressibility of water, by E H. Amagat. Tables are given showing the relative volumes of a quantity of water at pressures varying from 1 to 3000 atmospheres and temperatures ranging from 0° to 198°, and others showing the compressibility of water under the same conditions. This is seen to vary inversely as the pressure, and also inversely as the temperature up to very high pressures, when it begins to increase with the temperature —Observations of Brooks's comet (November 19, 1892), made at the Paris Observatory (west equatorial), by M O Callandreau —Observations of solar phenomena, made at the observatory of the Roman College during the third quarter of 1892, by M P Tacchini —On the reduction of elliptic integrals, by M J C Kluyver —On the thermal variation of the electric resistance of mercury, by M Ch Ed. Guillaume Pointing out the remarkable agreement of his results with those obtained by Messrs Kreichgauer and Jager, at the Physico-Technical Institute of Germany (see *Wiedemann's Annalen*, No 12) —On the measurement of power in multiphase currents, by M. Blondel —Absolute value of the magnetic elements on January 1, 1893 The elements for that date, determined at the magnetic observatory of the Parc Saint Maur, situated in long 0° 9′ 23″ E and lat 48° 48′ 34″ N, are the following —

	Absolute values on January 1, 1893	Secular variation in 1892
Declination	15° 24′·3	− 6′·4
Inclination	65 8·5	− 0·5
Horizontal force	0·19596	+ 0·00016
Vertical force	0·42297	+ 0·00019
Total force	0·46616	+ 0·00024

The values for the magnetic and meteorological observatory of Perpignan, long 0° 32′ 45″ E, lat 42° 42′ 8″ N, are

	Absolute values on January 1, 1893	Secular variation in 1892
Declination	14° 12′·9	− 5·9
Inclination	60 13·3	− 1·8
Horizontal force	0·22278	+ 0·00030
Vertical force	0·38933	+ 0·00003
Total force	0·44856	+ 0·00017

—On the purification of arsenical zinc, by M H Lescoeur. Zinc destined for toxicological operations can be obtained free from arsenic, antimony, sulphur, and phosphorus by two successive operations, viz. oxidation by means of nitre, and fusion with chloride of zinc.—Combinations of quinoleine with the halogen salts of silver, by M Raoul Varet —Symmetric dipropylurea and dipropylsulphourea, by M F. Chancel.—On a substance derived from chloral, or chloralose, and its physiological and therapeutic effects, by MM Hanriot and Ch Richet —On phagocytosis observed on the living animal, in the branchiæ of the lamellibranch molluscs, by M de Bruyne —New observations on the affinities of the different groups of gasteropods, by M. E. L. Bouvier.—On an anomaly recently presented by the secular variation of the magnetic needle, by M. Léon Descroix —Influence of motion on the development of fowls' eggs, by M. A. Marcacci.

AMSTERDAM.

Royal Academy of Sciences, December 24, 1892 —Prof. Van de Sande Bakhuyzen in the chair.—In a paper read by MM S Hoogewerff and W A. van Dorp, some isoimides of camphoric acid were described These were obtained by the action of $POCl_3$ or $CH_3.COCl$ on some substituted camphoramic acids. The following reaction takes place.—

$$C_8H_{14}\left\langle\begin{matrix}CO\,NHR\\ COOH\end{matrix}\right. + CH_3.COCl = C_8H_{14}\left\langle\begin{matrix}C=NR\\ >O\\ C=O\end{matrix}\right. + HCl + CH_3COOH$$

where R is put for CH_3, C_2H_5 or C_7H_7. The isoimides are very unstable, they easily add one molecule of water, re-generating the acids from which they derive By the action of heat they are transformed into the ordinary imides $C_8H_{14}\begin{matrix}-CO\\-CO\end{matrix}\Big\rangle NR$. —The same authors called attention to the fact that it seems to be a general reaction of the anhydrides of bibasic acids to dissolve in the aqueous solutions of ammonia and the primary amines, forming the corresponding acid amides · $R\left\langle\begin{matrix}CO\\CO\end{matrix}\right\rangle O + NH_2.R_1 = R\left\langle\begin{matrix}CO\,NHR_1\\COOH\end{matrix}\right.$ —Mr. Bakhuis Roozeboom dealt with the solubility curve for systems of two bodies The general form of such a curve in its totality, as yet not known even by the researches of Engel, has been encountered by the author and Mr Schreinemakers in studying the solubility of Fe_2Cl_6 $12H_2O$ in solutions of HCl The curve is a continuous one, combining the two solubilities of the hydrate, recently made known by the author It presents a summit when the proportion of Fe_2Cl_6 is the same as in the solid hydrate. Part of the solutions give on water-additions a deposit of the hydrate, part of them give redissolution The general form of the curve for double salts would be represented in its totality by a closed curve, surrounding the point, indicating the composition of the double salt With this form the same division of the solutions in regard to their behaviour on water-addition is possible as above —Prof Lorentz treated of Stokes's theory of the aberration of light The hypothesis of M Stokes, that the movement of the ether admits of a velocity-potential, is in contradiction with the supposition that, at the surface of the earth, the velocity of the ether is equal to that of the planet It might, however, be doubted whether, in M Stokes's explanation, the first hypothesis is really necessary In the present note it is shown that it cannot be avoided

CONTENTS.

THURSDAY, JANUARY 26, 1893

MODERN ADVANCED ANALYSIS

Theory of Numbers By G B Mathews, M A Part I (Cambridge Deighton, Bell and Co, 1892)

THE book under review is a great contrast in many ways to the "Théorie des Nombres" of M Edouard Lucas, the first volume of which has recently appeared under the ægis of Messrs Gauthier-Villars The latter, reminding the reader much of the same author's "Récréations Mathématiques," exhales human interest from well-nigh every page The former is on severe philosophical lines, and may be greeted as the first work of the kind in the English language That this should be a fact is somewhat remarkable When the late Prof H. J S. Smith died prematurely many years ago he left his fellow-countrymen a very valuable legacy Fortunately he had been commissioned by the British Association to frame a report on the then present state of the Theory of Numbers, a subject with which he was pre-eminently familiar, and in which his own original researches had won for him a great and world-wide renown The pages of the reports for the years 1864–66 inclusive yield as a consequence a delightful account of modern research in this recondite subject It is, however, much more than a recital of victories achieved by many able men in many special fields Prof Smith's fertile genius enabled him to marshal the leading facts of the theory, and to impress upon them his own personality in a manner that was scarcely within the reach of any other man He contrived to impart a glamour to those abstract depths of the subject to which few mathematicians have sufficient faith and energy to penetrate Since that day the scientific world has been yearly expecting his collected papers There is no doubt that their appearance will greatly stimulate interest and research in Higher Arithmetic The reports of the British Association are not sufficiently accessible Doubtless the papers will soon emerge from the hands of those upon whom has devolved the responsibility of their production In the meantime we welcome Part I of the present work

The theory of numbers is the oldest of the mathematical sciences, and may be regarded as their sire Just as applied mathematics is based on pure, so pure mathematics rests on the theory of numbers Every investigator finds that sooner or later his researches become a question of pure number Continuous and discontinuous quantity are indissolubly allied The theory of series, the theory of invariants, the theory of elliptic functions throw light upon and receive light from higher arithmetic Algebra in its most general sense is everywhere pervaded by numbers. It may safely be affirmed that there is nothing more beautiful or fascinating in the wide range of mathematics than the interchange of theorem between arithmetic and algebra. A proposition in arithmetic is written out as a theorem in continuous quantity or conversely an algebraic identity is represented by a statement concerning discontinuous quantity In this country the more recent advances in this attractive method are in large measure due to the labours of Sylvester and J W. L Glaisher. In a "Constructive Theory of Partitions," published some half-dozen years ago in the *American Journal of Mathematics*, Sylvester showed some beautiful progressions from arithmetic to algebra, and was followed in the same line by Franklin, Ely, and others, whilst in the pages of the *Quarterly Journal of Mathematics* and *Messenger of Mathematics* Glaisher has applied elliptic function formulas to arithmetical theory The famous theorem which asserts that every number can be composed by four or fewer square numbers, was due to an application by H J S Smith of elliptic functions to arithmetic These interesting matters are not alluded to in this first volume

Chapter I discusses the divisibility of numbers and the elementary theory of congruencies Euler's function $\phi(n)$, which denotes the number of positive integers, unity included, which are prime to and not greater than n, is not treated as fully as might be desired Gauss's theorem

$$\phi(d) + \phi(d') + \phi(d'') + \quad = n$$

where d, d', d'', are all the divisions of n (unity and n included) is given, but not some interesting theorems connected with permutations, of which this is a particular case Sylvester has written much about the same function, which he calls the "totient" of n M Ed Lucas employs the term "indicateur" in the same sense, and believing that there is a great convenience in having a special name for the function, we regret that Mr Mathews has not taken a course which would have familiarized students with Sylvester's nomenclature, and have enabled them to feel at home with much that has been written by him and others in this part of the theory of numbers

The author states that this chapter is substantially a paraphrase of the first three sections of the "Disquisitiones Arithmeticæ," the classical work of Gauss, we are inclined to think that advantage would have been gained if the paraphrase had not been quite so close The next succeeding chapters are occupied with "Quadratic Congruencies" and the theory of "Binary Quadratic Forms"

The account given is fairly complete. There are so many proofs of Legendre's celebrated "Law of Quadratic Reciprocity" that it must have been difficult to make a selection A wise choice has, we think, been made of Gauss's third proof as modified by Dirichlet and Eisenstein, the latter's geometrical contribution to the proof taken from the twenty-seventh volume of Crelle is, in particular, of great elegance. Gauss's first proof is also given, as well as references to several others. In the difficult subject of Binary Quadratic Forms, the author keeps well in view the close analogy with the algebraic theory of forms, so many additional restrictions present themselves that a large number of definitions are requisite at the outset, and this circumstance is apt to repel a student who approaches the theory for the first time The definitions, in fact, constitute the alphabet of the science which must be mastered before progress can be expected in the appreciation of the wonderful beauties which are inherent in it In this subject, more almost than in any other, the initial drudgery must not be shirked, and it may be said in favour of the present work that clearness of definition and conciseness of statement help the learner much to get quickly over the wearisome preliminaries

We are glad to see the prominence given to the geometrical methods of Klein and Poincaré, that of the former is based on the theory of substitutions, reminding the reader much of the "Icosaeder", that of the latter s the "Method of Nets," a most ingenious geometrical application throwing light on the theory of "Reduced Forms"

The "Composition of Forms" given in Chapter VI is logically and judiciously developed, by means of the bilinear substitution, u,, to the point of showing the method of tabulating the primitive classes of regular and irregular determinants The chapter on cyclotomy is one of the best written in the book. The discussion of the section of the periods of the roots of unity has engaged the attentions of mathematicians of the first rank since the time of Gauss, so that of necessity much has been written, and while the author states that he has given but an outline of an extensive theory which has not yet been completed, it may be said that the theory as given, with the references to authorities at the end of the chapter, will be quite sufficient to conduct the student bent upon research to the frontiers of the unknown country

The determination of the number of properly primitive classes for a given determinant, applications of the theory of quadratic forms, and the distribution of primes complete the volume Mr Mathews may be congratulated on his resolve to include Sylvester's masterly contraction of Tchébicheff's limits with reference to the distribution of primes, the reader is taken from the "sieve" of Eratosthenes to the work of Legendre, Meissel, Rogel, Riemann, and to the latest researches of Sylvester and Poincaré, of which the ink is scarcely dry English mathematicians will turn with delight to the account given on page 302 of Riemann's great memoir of 1859, which contains the only satisfactory attempt to obtain an analytical formula for the number of primes not exceeding a given numerical quantity

In conclusion, though the sequence of the subject matter may be open to criticism, we regard the book as a most valuable contribution to the small library of higher mathematical treatises that, owing chiefly to the energy and enthusiasm of the rising generation of mathematicians, is being brought together How woefully deficient that library was but a few years since those engaged in research know only too well, and greatly do they rejoice as they see the yawning gaps one by one efficiently filled up Part II of the task Mr Mathews has set himself to accomplish will, we hope, soon appear, and we trust he will be as successful with it as with the present Part I

P A M

THE DARWINIAN THEORY.

Darwin and After Darwin; an Examination of the Darwinian Theory and a Discussion of Post-Darwinian Questions By George John Romanes, M A, LL D, F R S I. *The Darwinian Theory* (London: Longmans, 1892)

WE had hoped ere now to have received the second instalment of this work, and to have dealt with the two volumes in a single critical notice Unforeseen causes, one of them deeply to be regretted, have presumably prevented the appearance of the discussion of Post-Darwinian questions so early as had been anticipated. We therefore propose to give a short expository notice of the present volume, reserving such criticism as we have to offer for a future occasion, when the second volume shall have come to hand

The first section consists of an exposition of the scientific evidences of evolution as a fact independent of the Darwinian theory of the method by which this evolution has been brought about It may be regarded as an expansion of the author's little volume in the "Nature Series," on "The Scientific Evidences of Organic Evolution," published ten years ago. Mr Romanes has spared no pains in the collection and marshalling of his evidence His object is to convince, by the abundance of facts and by logical inferences based thereon, those who still hold by the tenets of Special Creation Whether those who still hold by these tenets are likely to be influenced by the facts or the inferences is a question we do not propose to discuss The author evidently supposes that they are, and has written for them a good many pages in a strain of which we give a couple of examples —"It would seem most capricious on the part of the Deity to have made the eyes of an innumerable number of fish on exactly the same ideal type, and then to have made the eye of the octopus so exactly like these other eyes, in superficial appearance, as to deceive so accomplished a naturalist as Mr Mivart, and yet to have taken scrupulous care that in no one ideal particular should the one type resemble the other" Again, "Although in nearly all the numerous species of snakes there are no vestiges of limbs, in the Python we find very tiny rudiments of hind limbs Now, is it a worthy conception of Deity that, while neglecting to maintain his unity of ideal in the case of nearly all the numerous species of snakes, he should have added a tiny rudiment in the case of the Python—and even in that case should have maintained his ideal very inefficiently, inasmuch as only two limbs, instead of four, are represented?"

The second section of the volume is devoted to the setting forth of the theory of natural selection as it was held by the master This, as was to be expected, is a well-ordered and lucid exposition. We could wish that Mr Romanes had been more careful to avoid all appearance of personifying natural selection He says, for example, "It is the business of natural selection to secure the highest available degree of adaptation for the time being." Such language is highly metaphorical, if not misleading If we can talk of business at all we may say that it is the business of various eliminating agencies, in the struggle for existence, to weed out and exclude from any share in perpetuating their race all those individuals who are too weakly to stand the stress of the struggle. The survival of the fit is an incidental result of the stern business of elimination. It is here that the naturalistic hypothesis differs most markedly from the teleological interpretation of nature In conversation a while since a friend observed to us. Since your school of thought admit that the eye of natural selection is ever on the watch for the slightest improvement in adaptation, why should they hesitate to say with us that it is the eye of Beneficence that is thus ever watchful? The misunderstanding of the naturalistic position here

shown is not surprising. It is due to the too free use of metaphorical language on the part of expounders of the Darwinian hypothesis

In the chapter entitled "Criticisms of the Theory of Natural Selection," an interesting digest is given of the work of Prof Ewart and others on the electric organ of the skate, concerning which Mr Romanes says, "I freely confess that the difficulty presented by this case appears to me of a magnitude and importance altogether unequalled by that of any other single case—or any series of cases—which have hitherto been encountered by the theory of natural selection" And he adds, "So that, if there were many other cases of the like kind to be met with in nature, I should myself at once allow that the theory of natural selection would have to be discarded," by which he means, we presume, that the theory would have to be discarded as offering a solution of such cases

The book contains many excellent illustrations, the series which show the variations due to artificial selection being a noteworthy feature They, and the volume which contains them, will prove of service to those general readers for whom, as the author tells us in his preface, this exposition of the Darwinian theory has been mainly prepared

FERNS OF SOUTH AFRICA

The Ferns of South Africa, containing Descriptions and Figures of the Ferns and Fern-allies of South Africa By Thomas R. Sim 275 pp, 159 plates (Cape Town and Johannesberg J C Juta and Co London Wm Wesley and Son, 1892)

THE present work will be a useful and acceptable addition to our stock of fern books It contains descriptions and plates of all the ferns and fern-allies known to exist in Africa south of the tropic of Capricorn, the same area which is included by Harvey and Sonder in their "Flora Capensis," three volumes of which, including the orders from Ranunculaceæ to Campanulaceæ, have been published. The author won the Jubilee gold medal given by the North of Scotland Horticultural Association, and for many years has filled the post of curator of the Botanic Gardens at King William's Town Several years ago Mr Sim published an illustrated handbook of the ferns of Kaffraria, and now he has extended his area so as to include the whole of South Temperate Africa

The fern flora of the Cape does not show the same richness and remarkable individuality which characterises its phanerogamic flora It is probable that the flowering plants of this area are not less than ten thousand, and the number of large endemic genera and of species is very considerable In ferns we get in South Africa 179 species, out of which 42 species, or something under 25 per cent., are endemic There is no genus that is peculiar to the Cape, of Mohria, which comes nearest, the Cape species, *M caffrorum* extends to Madagascar and Tropical Africa, and two new species have lately been found in the high regions north of the colony. The section Rhizoglossum of the genus Ophioglossum, which differs from the true adder's tongues by having the fertile spike separate from the barren frond, the single species, *O. bergianum*, is peculiar to the Cape. Hymenophyllum is represented by 8 species, Trichomanes by 5, Adiantum by 6, Cheilanthes by 8, Pellæa by 14, Pteris by 7, Lomaria by 5, Asplenium by 25, Nephrodium by 12, Polypodium by 12, Acrostichum by 8, and Lycopodium by 8 species Some of the species, *e g Vittaria lineata*, *Marattia* and the two tree-ferns, are tropical types, some, such as *Cystopteris fragilis* and *Lycopodium clavatum*, are common to Britain and the Cape *Todea barbara* is confined to the Cape and Australia, and abundant in both areas *Lomaria alpina* is a plant of all the three south-temperate areas *Blechnum australe* of the Cape is not, I think, really distinct specifically from *B hastatum*, and is widely spread in South Temperate America

Lomaria punctulata is remarkable for its polymorphic fructification, which is sometimes like that of a Scolopendrium *Asplenium lunulatum* is remarkable for its variability in outline and cutting

Mr Sim gives introductory chapters on the parts of ferns and their nomenclature, on their reproduction and propagation, on their cultivation and the preparation of herbarium specimens, and on the history of the discovery of the Cape species and the books and papers that have been written about them His statistic table on page 34 needs much revision in some of its items He gives the ferns of Madagascar at 144 The number now known in the island is 326 true ferns and 40 fern allies, a total of 366 There are nothing like 683 species and 458 endemic types in Africa and its islands. When I counted them up in 1868 I made the two figures 346 and 127 Since that date probably 100 species have been added Madagascar, Bourbon, and Mauritius are very rich in ferns, but Continental Africa is very poor both in number of species and in peculiar types as compared with Asia and America

The descriptions are carefully drawn up from the study of actual specimens, and by the aid of these and the plates there can be no difficulty for any one, even without any previous botanical knowledge, in making out the name of any reasonably complete specimen of any of the Cape species

Therefore, no doubt, the existence of such a book will give a great impulse to the study of ferns by ladies and others who reside in or visit the Colony

J G BAKER

OUR BOOK SHELF

Newcomb-Engelmann's Populare Astronomie, Zweite vermehrte Auflage Herausgegeben von Dr H C Vogel (Leipzig. Wilhelm Engelmann, 1892)

THE well known Popular Astronomy of Prof Newcomb was translated into German by Rudolf Engelmann, and published in 1881 with considerable additions and alterations, most of which were improvements It was very favourably received on its first appearance in German, probably because it is not only comprehensive, exact, and scientific, but has a fresh and vigorous style, in pleasing contrast to the ponderous German standard works The original translator being dead, the publishers entrusted the work of preparing a new edition to Dr H C Vogel, Director of the Astrophysical Observatory at Potsdam, a task for which he was specially fitted, because astronomical progress during the decade since the appearance of the first edition of the book has been mainly in his special

department. Dr Vogel's chief difficulty has been to keep the book within reasonable limits while bringing it up to date, but he has not been wholly successful in this. By a slight further enlargement of the book he might without difficulty have very much increased its value. A description of the diffraction spectroscope should have been given in the section on spectroscopes; Prof Hale's work in photographing prominences and faculæ should have been introduced; the chapter on Mars is very much behind the times, and some details should certainly have been given of the international scheme for photographically charting the stars.

Dr Vogel has considerably altered the arrangement of the chapter on comets and meteors, and this alteration has led to the curious result that the same woodcut appears as Figs 152 and 165. The chapter on stellar astronomy is also recast, the editor's own latest classification of star spectra being given to the exclusion of all others. The section on variable stars has also been entirely rewritten. These chapters would have been much improved by an account of recent discoveries as to the resemblances between comets, nebulæ, and stars, and of the theory that variable stars are formed of revolving swarms of meteorites. The classification of star spectra which recognises an ascending and descending temperature should have been given, and recent work and theories on temporary stars certainly deserved attention. The bibliography given in the first edition has been omitted in the second, as being too much for the general reader, and insufficient for the student of science. The excellent series of biographical notices in the appendix has been carefully extended to 1891, and completely rearranged. Dr Vogel has adopted the admirable plan of arranging these notices chronologically in order of death, instead of birth, probably on the grounds that all work is largely the result of previous discoveries, and that the later years of a man's life are usually his best and most productive. A series of excellent tables and a full index complete the volume.

The general appearance of the book has been much improved by the use of new woodcuts for the illustrations, and by the substitution of two excellent photographs of nebulæ (those of Orion and Andromeda) for the very unsatisfactory star charts of the earlier edition.

A. T.

The Hemiptera Heteroptera of the British Islands. By Edward Saunders, F.L.S. (London: L. Reeve and Co., 1892.)

IT is now nearly thirty years since Douglas and Scott first made the study of the British Hemiptera Heteroptera possible to ordinary students by the publication of a description of these insects in a volume issued by the Ray Society. The difficulties were then very great, for purely insular ideas in entomology were prevalent, and our hemipterous insects had not been sufficiently compared with continental species. Douglas and Scott did all that was possible at that time and produced a good work that has held the ground as the best published authority on the subject. Very much, however, has been done since that period, and restricted specialists in entomology, as in most other branches of natural science, have exercised unlimited time and patience in studying the classificatory problems of a single family or even of a large genus. Hence in a monograph of to-day the standard of advanced classification and descriptive facility is considerably raised from that which dominated the writings of the earlier authors. Mr. Saunders has not only aimed at this perfection, but has sought to place in the hands of the British student and collector a thoroughly trustworthy handbook by which he may understand and identify his collection, and in this we think the author has altogether succeeded. We must not look for bibliographical references or synonymical notes, the names of the describers of families, genera, and species being only indicated, while the habitats of the species are confined to such localities in the British Islands as are recorded by collectors, and this is perhaps all that can be expected in a local monograph. It is therefore in no spirit of criticism we express a regret that in all faunistic writings the complete recorded distribution of the species is not given. Thus even the purely British collector would not be the worse for learning that *Zicrona cærulea*, to be found in the suburbs of London, is not only widely distributed throughout the Palæarctic region, but is also found in Continental India and in the Malay Peninsula and Archipelago; or that *Ischnorhynchus resedæ*, to be taken even at Hampstead, is common throughout Europe and Siberia, and is also neither scarce in North nor in Central America.

We welcome Mr Saunders's book as a distinct and valuable addition to our insular entomological literature. We also notice that an illustrated edition is advertised, but on the quality of the plates we are compelled to be silent, as the publishers have only forwarded us a plain copy.

W. L. D.

Physical Education. By Frederick Treves, F.R.C.S. (London: J. and A. Churchill, 1892.)

THIS essay is reprinted from the "Treatise on Hygiene" by various authors, edited by Stevenson and Murphy, the first volume of which we recently reviewed (NATURE, vol. xlvi. p. 609). It well deserves to be issued separately, for the author has mastered his subject thoroughly, and sets forth his ideas in a plain, straightforward style which will be cordially appreciated by readers who are especially interested in athletics. Mr Treves is quite as strongly conscious of the evils which may spring from excessive or unsuitable physical exercise as of those which may result from physical exercise being neglected or underrated, so that there is a welcome tone of perfect impartiality in all he has to say about the various ways in which efforts are made to promote health by the use of the muscles. The volume may be confidently recommended to all who desire to understand the conditions under which physical exercise is most likely to be of service.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Geology of the North-west Highlands.

IN the kindly review of my work by Prof. de Lapparent, which appeared in NATURE of 5th inst., there are one or two inaccuracies which I would at once have corrected had I not shrunk from drawing attention, even for purposes of rectification, to an article which I felt to be too eulogistic. Lest, however, my silence be misinterpreted, there is one point on which I wish to say a few words. Prof. de Lapparent, when alluding to the solution of the problem of the geological structure of the North-west Highlands, makes no reference to the distinguished part taken in that subject by Prof. Lapworth. But every one who has followed the progress of geology in recent years is familiar with his work. For myself, I have had no personal share in the discovery. Like most geologists I had accepted the views of Sir Roderick Murchison, and I held to them, until, after the Geological Survey was for the first time extended to Sutherland in 1883–84, I was finally convinced that they were untenable by the brilliant mapping of my colleagues, Messrs. Peach and Horne, who, following Prof. Lapworth's lead, share with him in the glory of one of the greatest achievements of field geology in recent times. My recantation was published in NATURE of November 13, 1884, and the whole history of the investigation of the North-west Highlands up to Prof. Lapworth's latest paper

was sketched in a detailed Report communicated by me to the Geological Society on April 25, 1888 My friend Prof Lapworth has no scientific comrade who has more frankly and practically acknowledged his great geological achievements than I have done ARCH GEIKIE.

January 23, 1893

The Identity of Energy

I AM glad to see that in the introduction to his severely-difficult memoir, published in the *Philosophical Transactions* for 1892, "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field" (p 427), Mr Oliver Heaviside notices and criticizes some ideas of mine, published in the *Philosophical Magazine* for June 1885 and other places, concerning energy

The statements I then made, and to which I still rigidly hold, are (1) that energy has identity like matter, and not merely conservation, (2) that whenever energy is transferred from one body to another, it is also transformed from potential to kinetic, or *vice versâ*

The basis of the first assertion is the fact that energy is always passed on continuously through space, *i e* that its transfer occurs along a definite path, instead of merely appearing in one place and disappearing in another

The law of conservation would be satisfied by disappearance and equal reappearance, the law of identity requires a continuous act of transfer. The latter is true for matter, and I assert that by thinking of a number of instances, it will be perceived true for energy In all mechanical instances, as of belts and shafting, the transfer of energy is obvious, it was not so obvious in electromagnetic actions, between dynamo and motor for instance, until Prof Poynting clearly demonstrated that it was in accordance with Maxwell's principles

Mr. Heaviside objects that we are not able to assert it for gravitational energy Well, that depends on what view we take of gravitation, but I submit that until something more is certainly known about it, the safest plan is not to assert, but to assume, that in this case also what is known in every other case likewise occurs, and to trace the consequences of the hypothesis in the hope that it may lead to some conclusion verifiable or falsifiable by experiment The reason I attach importance to this doctrine of the identity or continuity of transfer of energy is because it greatly simplifies the fundamental mechanical laws, and emphasizes without risk of vagueness the denial of action at a distance

If action at a distance (no matter how minute) can ever occur, then indeed the continuous transfer of energy breaks down But observe that there is no necessity for the transfer to occur at a finite velocity in order to avoid action at a distance, *i e* action without a medium By the thrust of an incompressible pole, energy is transferred from butt to tip just as really as if the compressed and recoiling layers could be demonstrated and its velocity measured So likewise the pull of gravitation may be (and *pro tem* I believe is) transmitted by an incompressible (or nearly incompressible) ether, so that the force is felt instantaneously (or nearly instantaneously) at all distances where matter exists, but that by no means militates against a genuine act of transfer The conservation of matter makes experiments on gravitation difficult; if we could suddenly create or destroy a piece of matter there might be some remote chance of determining the rate at which its gravitative influence was felt Especially if by alternately generating and destroying it we could set up a series of waves of perhaps measurable length

And although this is as yet impossible, many known facts lead us to conclude that if gravitation has any velocity at all short of infinite, it is at least immensely greater than the speed of light. And seeing that the one phenomenon is concerned with the transverse (electric) elasticity of ether, and the other with its longitudinal elasticity, there is nothing surprising in that

By all means, however, as Mr. Heaviside urges, let gravitation be included in general etherial equations whenever possible; and it may perhaps be wise to assume some unknown finite rate of propagation and trace its consequences with the object of verifying or disproving them

So far as I understand, however, this is not unlike what Helmholtz did, by his generalization of Maxwell's electromagnetic theory; with the result that the course of experiment so far has been to justify the simple Maxwellian theory, and to make the longitudinal ether thrust velocity practically infinite.

And now for the second assertion, that whenever energy is transferred from one body to another, it is also transformed, and *vice versâ* This is to me not an opinion, but a demonstrated theorem (as has been shown in the paper referred to), but it must be understood in what sense I consistently use the word body in this connection I do not necessarily mean a visible lump of matter The molecules of a lump are to be regarded as a different "body" to the whole mass, and again, the ether everywhere embathing them is another distinct "body"

But so long as a piece of matter is merely moving through space with all the energy it may happen to contain, I do not consider that a transfer at all There is a transfer of energy in one sense, viz that of locomotion, but there is no transfer from one body to another except when work is done at their point of contact, and energy gained by one and lost by the other, being transferred across their common boundary surface In all such cases of "activity" the energy transferred is necessarily in the first instance transformed, though by means of another transfer it may very speedily be transformed back again, and so speedily sometimes is the re-transformation effected that the intermediate condition has a tendency to get overlooked In wave-motion a transfer and transformation occurs during every quarter period

Mr Heaviside seems to think that the mere convection of energy should be included as one kind of transfer, but surely that is scarcely convenient? So long as energy retains its form and adherence to one body, so long there is no true activity, no work is being done—the energy is simply stored It may be stored in a bent spring, or in a flying bullet, or in a revolving fly wheel It is impossible to have kinetic energy at all without convection, and a distinction must be drawn between the mere existence of energy and the active and useful flux or transfer of the same.

Mr Heaviside further seems to consider circuital fluxes of energy as strange and useless phenomena. But I see no reason in this at all The circulation of matter—for instance in the inner circle of the Metropolitan railway—is, I suppose, considered useful The circulation of commodities is the essence of commerce So does the circulation of energy constitute the activity of the material universe It is the act of transfer that is beneficial (or the reverse), what becomes of a conservative quantity is a minor matter It must go somewhere, and may very well, after a series of transfers, ultimately return to its starting point [Parenthetically I should like to preach here against what I hold to be the pernicious doctrine of (at least amateur) political economists, that because money locally spent is not destroyed, but remains in the community, it does not much matter how much transferring power is permitted or granted to one individual,—as if the money itself were the useful commodity, and not the power of determining its direction of transfer or non-transfer The control of every transfer should be jealously watched, for that is the greedily-desired power]

So long as circuital convection of energy goes on *without* transfer—as, for instance, in the rim of a non-working fly-wheel—so long the energy is merely *stored*, but directly a belt is fitted on with different tensions in its two halves, a portion of the energy is tangentially tapped off, and transfer and activity begin The kinetic energy of the wheel is converted into strain or stress energy of the belt, which then by simple locomotion passes it on to something else. I perceive, however, that there is a slight difficulty about this simple case of locomotive conveyance of stress energy by a really inelastic substance; but only because the details of any infinitely rapid process are difficult to follow I perceive moreover that in many cases it is not worth while to attend to the alternate compressions and motions which constitute a longitudinal pulse, and that the idea of simple locomotion may be conveniently introduced to cover the case of a stressed body moving; but the convenience is I think only attained by shutting our eyes to the essential processes which in all actual matter must be occurring

I trust that Mr Heaviside may find time to notice this letter, and attack anything he disagrees with, in order that the whole matter may become thoroughly clear. OLIVER LODGE

A Proposed Handbook of the British Marine Fauna

I AM obliged to Prof Thompson for his criticism of my scheme, although only one of the points he raises is new to me —as I think it will be to most zoologists—viz that "there are *no* nematophores on the stem" in *Antennularia* I thought *A*

ramosa had nematophores on the stem, *and I think so still* Some of his other remarks are so very obvious as to have scarcely required mention, at any rate to biological readers, a few, however, are just such debateable points as I was anxious to have opinions upon from as many naturalists as possible, and I am glad to know Prof Thompson's. I am glad to say a number of biologists have written to me, since the scheme appeared in NATURE, expressing general approval, and criticising various points of detail, and some of them kindly making offers of assistance in special groups—and without that kind of assistance from specialists I need scarcely say it would be impossible to carry out the work satisfactorily The proposal was first brought before the Biological Society of Liverpool on November 11, and it was only after some weeks of intermittent discussion with some of my friends in that Society (such as Dr Hanitsch, Mr Isaac Thompson, and Mr A. O Walker) who are specialists in certain groups of marine invertebrata, and after correspondence with Canon Norman and other biologists, that I sent the scheme to NATURE, with the view of getting further opinions Consequently some of the debateable matters alluded to by Prof Thompson (limits of British area, introduction of certain non-British forms, specific nomenclature, how to treat records of size and distribution, best terms to use for zones of depth, and, I may add, for relative abundance) have already been considerably discussed The other points raised by Prof. Thompson in connection with *Antennularia* only require a few words I said *A ramosa* was *usually* branched Prof Thompson says it "may sometimes" be unbranched The difference between these statements is slight. As to dimensions, a zoophyte which grows to 12, or occasionally to 24, inches in height, will, of course, be also frequently found of smaller sizes, and it might be the best plan to give the extreme range, say, 1 to 24 inches What I gave was the fair average size of most of the specimens dredged or seen in collections, which I still consider to be 6 to 9 inches.

The rest of Prof. Thompson's contention is practically that there are great difficulties in the way of drawing up such a book of the known British marine invertebrate animals, and that if it is ever done it will be more or less incomplete, because Canon Norman and others (I hope including both Prof Thompson and myself) will continue to find new British animals That is perfectly true—in fact obvious—but the same objection applies more or less to every work on systematic zoology that has ever been published, and I do not consider that because our British Pycnogonids, and some other small groups, are still very imperfectly known, that is any sufficient reason for delaying indefinitely an attempt to deal with the rest of the invertebrata. On the contrary my opinion is rather that an approximation is better than nothing, and that every group, or every family, reduced to "Handbook" form with specific diagnoses and figures must be a distinct gain I hope Prof Thompson will not think that I am trying to dispute all his criticisms, or that I am ungrateful for the trouble he has taken I have no doubt that he could correct me in many details, and give me great assistance in records, &c, of zoophytes, pycnogonids, and other groups, and I hope he will do so W A HERDMAN

University College, Liverpool, January 20.

PROF D'ARCY THOMPSON'S letter raises a question which is, I think, well worthy of Prof Herdman's consideration That a handbook of our marine fauna is needed cannot for a moment be doubted, and the only matter that calls for discussion is one of scope and method, of ways and means Prior to the appearance of Prof Herdman's circular and article I had intended, if possible, to bring this very matter before the British Association at its next meeting, believing that a select Committee of the Association would best be able to further the interests of marine zoology in this respect But, as the matter now stands, I leave any such action very willingly to Prof Herdman's initiative.

Put broadly (although I well know that such a work in Prof. Herdman's hands would by no means have the character of a mere compilation), the question at issue is whether the handbook should be mainly a compilation from existing material, or should express the work of various specialists and be based upon a series of special investigations. For myself I agree with Prof Thompson, and for the same reasons, that the adoption of the latter alternative would be likely to meet our needs most fully and satisfactorily. It would ensure, as far as possible, the equal treatment of the various groups, and would thus give to the book (which is important) a more permanent and authoritative value than could be attained by a book depending upon the personal labours of one zoologist I feel confident that, should Prof Herdman admit the force of this consideration and be willing to edit a handbook in which the diagnoses were drawn up for the various groups by specialists or specially chosen investigators, he would find no difficulty whatever in meeting with willing co-operation

But I hardly see the point of extending the scope of the work to the extent which Prof Thompson would seem to desire We need a handbook for use around the coasts of our own islands To include the fauna of the whole North Atlantic would needlessly add to the size of the work, delay the time of its appearance, and even in the end be incomplete, while it is doubtful whether the advantages would at all outweigh these defects W GARSTANG

Marine Biological Association, Plymouth, January 20

Fossil Plants as Tests of Climate

MR. J. STARKIE GARDNER, in his interesting review of Mr. Seward's valuable essay, makes a statement which I fancy may be misinterpreted at page 268 of NATURE, where he speaks of the fragmentary character of the Arctic tertiary plants, and the inexperience of the collectors He doubtless is referring to the remains of certain supposed "palms and cycads in the Greenland Eocene," but those who have not followed this branch of Arctic research would hardly gather from the review that Prof Heer has determined a magnificent flora of more than 350 species from these northern tertiaries, and that he at once pointed out the absence of tropical and subtropical forms, and the fact that large leaves are not only perfectly preserved up to their edges, but that upright trees associated with their fruits and see is prove them to have grown on the spot "Thus of *Sequoia Langsdorffi*," he writes, "we see not only the twigs covered with leaves, but also cones and seeds, and even a male catkin "[1]

In April 1875 I endeavoured to give an abstract of all that was then known of Arctic geology, in a series of articles that appeared in your columns (NATURE, vol xi pp 447, 467, 492, and 508), and added some general conclusions of my own, which are further accentuated in the joint communications of Colonel Feilden and myself to the Geological Society in 1878, and in the "Geology Appendix" to Sir George Nares' "Voyage to the Polar Sea,' in which expedition Colonel Feilden played a most valuable part I have ever since carefully followed the progress of Arctic research, and am now of opinion that looking to the identity of a large number of species (often extending to the varieties of the same) occurring in the Silurian, Carboniferous, Lias, Oolite, Cretaceous, and Tertiary strata of the Arctic regions, with those occurring in similar strata in Europe and other parts of the world, they point to a common temperature over these areas and probably over the whole world, from Silurian to early Cretaceous times, and that this was the case does not appear to me to be affected by the question as to whether or not these deposits were homotaxeous

In late Cretaceous times commenced *horizontal* variation of cold, or what we now term "climate," though previously *vertical* variation had evidently been present, for the later investigations of Messrs. Blanford appear to place beyond doubt the existence of glaciers in geological times, as was suggested in 1855 by my lamented chief, Sir Andrew Ramsay, but I equally fail to see that the slightest evidence has been anywhere adduced to support the theory of "recurrence of ice-ages," originated by my talented colleague the late Dr Croll, and now supported with a "modification" by Sir Robert Ball.

The facts, whether we look to the history of plant life, or animal life, or the character of the rocks themselves, appear to me to be all the other way, as they disclose nothing resembling the refrigeration that, gradually increasing in the Tertiary epoch, culminated in the Glacial episode, which choked up the North and Irish Seas with an ice-sheet since man has been an occupant of our islands CHAS. E DE RANCE.

H M. Geological Survey, Alderley Edge, Manchester.

Racial Dwarfs in the Pyrenees.

IN consequence of evidence that I had obtained as to the existence of a dwarf race in Spain, I wrote to Mr. McPherson,

[1] "On the Miocene Flora of North Greenland," by Prof Oswald Heer, Translated by R H Scott, F R.S, Brit Assoc, 1867, pp. 53

our Consul at Barcelona, and enclose his reply There have long been rumours of survivals of a dwarf or a prehistoric race existing in parts of Spain, but careful inquiries at Madrid failed to supply any definite information on the subject Last summer on reading over an old number of *Kosmos* (Paris, 1887), I found a brief paragraph referring to a pigmy race having been found in the province of Gerona, Spain, who had slightly Mongolian eyes, yellow, broad, square faces, height from 1 m 10 to 1 m 15, and red hair

An Austrian gentleman recently told me he had seen, in the market-place at Salamanca, some very under sized peasants, with broad faces and mahogany-coloured woolly hair

You will see that these accounts all agree substantially, and that these dwarfs and those of Africa are precisely similar

I have got a deal of information from an old Spanish woman who belongs to a half breed nano family, and who says that there are in such families frequently nanos (or "enanos") who have red tufts of wool, and are as small as ordinary small boys But these tufts of wool are peculiarly characteristic of dwarf races nearly everywhere

I shall write more fully as to my inquiries among half breed nanos, but they are of very secondary interest now that we can find pure racial nanos within easy reach

It is most fortunate that they live in the Valley of Ribas and the Col de Tosas, within a little more than a half-day's journey from Toulouse Some health-seekers or tourists in the South of France may perhaps feel inclined to pay a visit to these little people

Should the suggestion be acted on, and prove satisfactory, a line to myself on the subject, addressed to 28, Pall Mall, would be highly valued R G HALIBURTON

Tangier, January 9

[COPY]

"*British Consulate, Barcelona, December* 10, 1892

"DEAR SIR,—Since I received your letter of November 18 and its enclosures I have endeavoured to ascertain what truth there is in the statement that pigmies, or 'enanos' (not 'nanos') exist in the Valley of Ribas From conversations I had with various individuals who have visited that district it appears certain that a race of men, of about from one metre to one metre and twenty centimetres high, of a darkish complexion (copper-coloured), dark hair and woolly, and flat, broad nose, live in that district, particularly in the 'Collado de Tosas.' They are active, and are generally employed as shepherds. It is also asserted that they are not very intelligent, and that they appear to understand and to make themselves understood with difficulty It would be an easy journey to go to that place from this town. I had no little difficulty in finding out that such a race lived in that place, for many of the persons with whom I have spoken on the subject were evidently confused and confused me, as besides these, evidently racial pigmies, there are in that neighbourhood many 'cretins,' which were at times described to me as if these were the 'enanos' I spoke about I am now certain that there are cretins and pigmies in the Valley of Ribas. It is stated that the 'enanos' are rapidly disappearing, and that latterly many have died of smallpox The men you speak of, who were seen at Salamanca, are, I should say, natives of the Batuecas, or rather of Los Hurdes. These men were discovered in the sixteenth century, and they were then and are even now, in an almost absolute state of savagery" [The remainder as to this race is omitted, as it does not appear that they are nanos.—R G H.]

"Yours very truly,

(Signed) "WM MCPHERSON.

"R G Haliburton, Esq"

British Earthworms

I WRITE to suggest—in connection with the recent letters in NATURE upon this subject—that some one give a thoroughly trustworthy list of British earthworms, with the memoirs in which the species were originally described, and the chief characteristics of each. Dr. Benham would be doing very useful and acceptable work if he were to accomplish this. From what I understand everybody has been making mistakes, and the whole matter is in the utmost confusion. It is very necessary that such a classification should exist, if only for the benefit of those who are working on the earthworm more from a comparative anatomist's than from a specialist's point of view

FRANK J COLE

Zoological Department, Edinburgh, January 12

DANTE'S "QUÆSTIO DE AQUA ET TERRA."

"Quæstio Aurea ac perutilis edita per *Dantem Alagherium*, poetam florentinum clarissimum, de natura duorum elementorum Aquæ et Terræ disserentem"

"Lo, the past is hurled
In twain up thrust, out staggering on the world,
Subsiding into shape, a darkness rears
Its outline, kindles at the core, appears
Verona"—R BROWNING, "Sordello," Book i

"TO all and each who shall see this document, *Dante Alighieri* of Florence, the least amongst true philosophers, wishes health in Him who is the Beginning of truth and the Light

"Be it known unto ye all that whilst I was at Mantua there arose a certain question, the which after having been many times dilated upon rather for vain show than for Truth's sake, still remained undecided Wherefore I, since from boyhood I have been nurtured continually in love of Truth, could not bear to leave the question undiscussed, but I thought fit to show the truth concerning it and to dissolve the arguments adduced to the contrary, both for love of Truth and hatred of Falsehood And lest the malice of many who are wont to fabricate envious lies against the absent should behind my back alter what was well said, I have moreover thought fit to leave written down on paper what I proved, and to set forth the form of the whole disputation"

These are the words with which Dante commences this "golden and most useful" inquiry concerning the nature of the two elements, earth and water The treatise is little known in comparison with the other writings of the poet,[1] but although rejected by Ugo Foscolo and others as "impostura indegna d'esame," its genuineness and importance are now almost universally admitted, and without yielding unreservedly to the enthusiastic opinion of an Italian geologist (Stoppani) that there are more truths relating to cosmology to be found prognosticated, affirmed, and even demonstrated in these few pages of the supreme poet than in all the writings of the middle ages taken together, we may nevertheless acknowledge it to be a work of the greatest interest and importance, and by no means unworthy of the singer of the "Divina Commedia"

It seems to be the last work of the poet's life, written at that period which he himself describes in his sonnet to Giovanni Quirino —

"Lo Re, che merta i suoi servi a ristoro
Con abbondanza, e vince ogni misura,
Mi fa lasciare la fiera rancura,
E drizzar gli occhi al sommo consistoro
E qui pensando al glorioso coro
De' cittadin della cittade pura,
Laudando il Creatore, io creatura
Di più laudarlo sempre m'innamoro"
—Sonetto xliv ed. Fraticelli[2]

Dante was at this time the guest of Guido Novello di Polenta at Ravenna. About the commencement of the

[1] It is, I believe, the only one of Dante's writings that has not yet been translated into English.

[2] "The King by whose rich grace His servants be
With plenty beyond measure set to dwell,
Ordains that I my bitter wrath dispel
And lift mine eyes to the great consistory
Till, noting how in glorious quires agree
The citizens of that fair citadel,
To the Creator I, His creature swell
Their song, and all their love possesses me"
—Rossetti's translation in "Dante and his Circle"

year 1320, he seems to have gone for some unknown reason to Mantua, and there to have entered upon this discussion, which he then completed at Verona. The disputation took place at this latter city on January 20, 1320, as Dante himself tells us, in the church of St Helena (where in recent years the metropolitan chapter have put up a monument in commemoration of the event). All the clergy of Verona were present, except some few who, in the words of Rossetti—

> "Grudged ghostly greeting to the man
> By whom, though not of ghostly guild,
> With Heaven and Hell men's hearts were fill'd."
> —"Dante at Verona."

From a passage which occurs in the course of the treatise, one might almost think that ladies also were present, but let not the reader therefore conclude that the assemblage which listened to Dante's eloquence in that little Veronese temple resembled so many modern philanthropical and other associations in being chiefly composed of ladies and clergymen, for doubtless Can Grande della Scala himself was present to do honour to his former guest, and his poetic fame, which we know to have already spread far and wide, would certainly have brought together as many as the church could hold.

The question to be solved is whether, on any place on the earth's surface, *water* is higher than the *earth*. This question, Dante tells us, was generally answered in the affirmative, and he gives us the five chief reasonings adduced in support of it, of which perhaps the most striking is this one:—

"If the earth were not lower than the water, the earth would be entirely without waters, at least in the uncovered part, and so there would be no fountains, nor rivers, nor lakes. So water must be higher than the earth. For water naturally flows downwards, and the sea is the source of all waters, and if the sea were not higher than the earth, the water would not flow to the earth, since in every natural motion the source of the water must be higher."

Another is this:—"Water seems chiefly to follow the motion of the moon, as is evident in the flow and ebb of the sea, and therefore since the moon's orbit is eccentric, it seems reasonable that water in its sphere should be eccentric too; and another argument shows that this cannot be unless it be also higher than the earth."

Such be their arguments, but sense and reason alike are against them, and Dante proceeds to explain how he will treat the question. First, he will prove that it is impossible that water in any part of its circumference be higher than this emergent or uncovered earth on which we dwell. Secondly, he will prove that this emergent earth is everywhere higher than the surface of the sea. Thirdly, he will urge arguments against his own demonstrations, and then demolish these objections. Fourthly, the final and efficient cause of the elevation and emergence of the earth will be shown. Fifthly, he will demolish the five chief arguments of the other side which he has already stated.

1. It is impossible that water in any part of its circumference be higher than the earth.

There are only two ways whereby water can thus be higher than the earth: either the water must be *eccentric*, or, if it be *concentric* with the earth, it must be *gibbous* in some part. By water being *eccentric*, Dante means the centre of its natural sphere to be out of and different from the centre of the earth; by being *gibbous*, Dante means some part of its sphere to be raised up so as to form a protuberance or hump, just as he considers the earth on which we live to be a protuberance or gibbosity of the spherical surface of the earth.

He now shows by means of diagrams that neither of these things are possible, but first makes these two statements—(1) Water naturally flows downwards; (2) Water is by nature a labile body and has not a boundary of its own, but takes the boundary of the thing in which it is contained.[1]

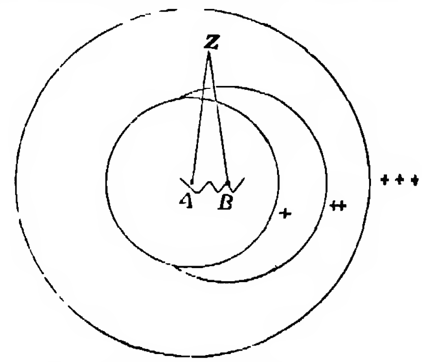
We may compare with this a modern definition of a fluid:—

"A perfect fluid is a body whose form can be changed to any extent, provided its volume remain constant, by the application of a stress, however small, if we allow it sufficient time."—Garnett, "Treatise on Heat."

In the first place, *water cannot be eccentric.*

For if it were so, then three impossibilities would follow—(1) Water would naturally flow both upwards and downwards; (2) water would not be moved downwards by the same line as the earth; (3) an equivocation would arise in speaking of the *gravity* of water and of earth; all which things are seen to be not only false but impossible.

The demonstration *ab absurdo* follows thus:—Let the heavens be the circumference on which are placed three crosses, water the circumference on which are two, earth the circumference on which is one cross.



Let the centre of heaven and earth be at point A, the centre of water at point B. Thus A, being the centre of the universe, is the lowest spot of all, and everything which has in the world a position alien from A must be higher. Now if there be any water at A and the way be open to it, it will naturally flow to its own centre, B, since it is the property of every heavy body to move to the centre of its own sphere. But the motion from A to B is a motion upwards; therefore water will flow *upwards*, which is impossible.

Again, let there be at Z a lump of earth and some water, and let there be nothing to hinder. Then, since it is the property of every heavy body to move to the centre of its own sphere or circumference, the *earth* will move in a straight line to A, and the *water* in a straight line to B, and this, from the figure, must needs be along different lines. This, says Dante, is not only impossible, but would make Aristotle laugh if he were to hear it.

The third impossibility follows thus:—*Gravity* and *levity* are "passions" of simple bodies which are moved with linear motion, and *light* bodies tend upwards and *heavy* tend downwards, by "heavy" and "light" being meant that which has the power of being moved. If now water moved to B and earth to A, since these are simple bodies and heavy, they will be moved down to different centres. If this were so, the word *gravity* would have an *absolute* signification with respect to earth and *relative* with respect to water. This is what the argument amounts to, and so there would be an equivocation of meaning in the word "gravity."

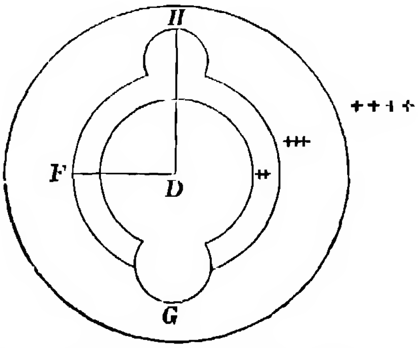
Therefore, *ab absurdo*, water in its natural circumference is not eccentric or out of the centre common to the circumference of the earth.

In the second place, *water cannot be gibbous*.

[1] "Aqua est labile corpus naturaliter, et non terminabile termino proprio."—§ xi.

Let the heavens be where are four crosses, the water where three, the earth where there are two.

Let D be the centre of *earth* and concentric *water* and *heaven* Water cannot be concentric with the earth unless the earth be in some part "gibbous" above the central circumference Let the protuberance of the earth be at G, and at some part of the circumference of water let there be a protuberance of water at H Then let a line be drawn from D to H and another from D to F, it is manifest



that D H is longer than D F, and therefore the summit of one is higher than the summit of the other Since both touch at their summit the surface of the water without passing beyond, it is clear that the water of the protuberance will be higher, with regard to the surface where F is Since, therefore, there is no obstacle, the water of the protuberance will flow down until it become level at D with the central or regular circumference And thus it will be impossible for a protuberance of water to last or even to exist.—Q E D

Dante now brings forward a subsidiary argument to show that probably water has no protuberance out of the regular circumference The protuberance of the earth is sufficient to prove and explain everything, and "Quod potest fieri per unum, melius est fieri per unum quam per plura." So there is no protuberance on the surface of the water, because God and Nature always do what is best and do not work in vain

Since water cannot be eccentric, as was shown by the first figure, nor concentric with a protuberance, as was shown by the second figure, it is necessary that water be concentric and coequal, *i e* equally distant in every part of its circumference from the centre of the world

Thus it has been proved impossible for water in any part of its circumference to be higher than the surface of the earth, and so the first point is completed

We now pass on to the second.

2 This emergent earth is everywhere higher than the surface of the sea This is shown in this way.—

All the shores of the ocean, as well as of the Mediterranean seas, rise above the surface of the sea which bounds them, as is clear to the eye Therefore all the shores are further from the centre of the world, since the centre of the world is also the centre of the sea and the shoreward surfaces are parts of the whole surface of the sea; and since everything that is more remote from the centre of the world is also more high, it follows that the shores everywhere rise above the surface of the sea. And if the shores are higher than the sea, much more must be the other regions of the earth, since the shores are the lower parts of the earth, as we see by the rivers flowing down to them

3. In accordance with the order of the question as at first stated by Dante, he now brings forward various arguments which seem to contradict his demonstrations, and these arguments he then proceeds to demolish They need not detain us here. In the course of the operation there occurs a most interesting distinction between *homogeneous* and *simple* bodies, in which I seem to see a distinct foreshadowing of our modern view of the chemical elements in contradistinction to the ordinary four or five elements of Aristotle and his followers "Corpora enim homogenea et simplicia sunt, *homogenea ut aurum depuratum*, et corpora simplicia, ut ignis et terra" § xviii

But perhaps it might not be out of place to quote here the following passage from G H Lewes's "Aristotle" —"One of the great difficulties in interpreting ancient opinions is to guard against the tendency of reading our fulness of knowledge into their vague expressions We often find in ancient works the precious metal we have ourselves brought with us, as the alchemist often unconsciously put into his crucible the gold, which he afterwards discovered there with surprised delight"—G H Lewes, "Aristotle," x § 170

He thus sets forth the *final* cause of the elevation or emergence of the earth There must needs be a part in the universe where all *miscibilia*—to wit, elements—can come together, this cannot be unless the earth be in some part emergent Thus, although earth, according to its own nature, tends always downwards, it has in it another nature by which it obeys the intention of Universal Nature, and allows itself to be here and there raised up, in order that mixture of the elements may be possible, and thence all things that are subject to generation and corruption may be formed

He further shows that the emergent earth on which we dwell has the form of a semilune, by arguments which he graciously tells us that even ladies can follow—"Manifestum esse potest etiam mulieribus"

4 What now is the *efficient* cause of the elevation or emergence of the earth above the surface of the water?

Dante first shows that neither the *earth* itself, nor *water*, nor *air*, nor *fire* can be the efficient cause Therefore it must be referred to the *heavens* But there are many heavens, and to which are we to refer it? Dante shows that it cannot be referred to the *moon*, nor to the heavens of any of the planets (Mercury, Venus, the Sun, Mars, Jupiter, Saturn), nor yet to the Crystalline Heaven or *Primum Mobile*, the 9th sphere Now, since the only mobile bodies which remain are the Heaven of the Stars, *Cœlum Stellatum*, or 8th circle, we must refer the cause of the elevation of the earth of our hemisphere to that This Heaven of the Stars has at once unity in substance and multiplicity in its virtues or influences, as the poet himself sings —

"Il ciel, cui tanti lumi fanno bello,
Dalla mente profonda che lui volve
Prende l'image, e fassene suggello
E come l'alma dentro a vostra polve,
Per differenti membra, e conformate
A diverse potenzie, si risolve,
Così l'intelligenzia sua bontate
Multiplicata per le stelle spiega,
Girando se sovra sua unitate."
—"Paradiso," ii 130 138 [1]

Dante further refers the elevation of our earth to that region of the Cœlum Stellatum which roofs over this uncovered earth, that is, that this elevating virtue or influence is in those stars which are in the region of the heaven, which is bounded by the equator and the circle which the pole of the zodiac describes around the pole of the world; "whether it elevate by way of attraction as

[1] "The heaven, which lights so manifold make fair,
From the Intelligence profound, which turns it,
The image takes, and makes of it a seal.
And even as the soul within your dust
Through members different and accommodated
To faculties diverse expands itself,
So likewise this Intelligence diffuses
Its virtue *multiplied* among the stars,
Itself revolving on its *unity*"
"Paradiso," ii 130–138, Longfellow's trans

the magnet draws the iron, or by way of impulsion, generating impelling vapours, as in certain mountains." A truly scientific and most suggestive remark!

We may compare the last clause with those well-known lines of the "Inferno," in which is described how the earth, and likewise the mountain of Purgatory were formed when Lucifer fell from Heaven:—

> "Da questa parte cadde giù dal cielo ,
> E la terra, che pria di qua si sporse,
> Per paura di lui fe del mar velo,
> E venne all'emisperio nostro e forse
> Per fuggir lui, lasciò qui il luogo voto
> Quella ch'appar di qua, e su ricorse."
> —"Inferno," xxxiv 121–126[1]

But now it may be asked, Since that region of the heaven moveth circlewise, why did not this elevation happen circlewise? Because, Dante answers, the matter was not sufficient for so great an elevation. Then why was the elevation of the earth produced in our hemisphere rather than in the other? To this, says Dante, we must answer as Aristotle does (in "De Cœlo," book ii) in answer to the question why the heavens move from east to west and not contrariwise, that such questions proceed either from much folly or from much presumption, because they are above our intellect. God made all things for the best, and when He said, "Congregentur aquæ in locum unum et appareat arida," then were the heavens virtuated to act and the earth potentiated to be passive.

"Let therefore men cease," cries Dante, "yea, cease from inquiring into those things which are above their intellect, and let them strive to the utmost of their power to raise themselves to things immortal and divine, and so leave those things which exceed their understanding. Let them listen to Job:—'Numquid vestigia Dei comprehendes, et omnipotentem usque ad perfectionem reperies.'—(Job xi. 7). Let them hearken to the words of the Psalmist: 'Mirabilis facta est scientia tua, et me confortatus est, et non potero ad eam.'—(Ps cxxxviii). Let them hear Isaiah speaking in the person of God to man: 'Quam distant cœli a terra, tantum distant viæ meæ a viis vestris.'—(Is lv 9). Let them hear the voice of the Apostle to the Romans: 'O altitudo divitiarum scientiæ et sapientiæ Dei! quam incomprehensibilia judicia ejus, et investigabiles viae ejus!'—(Rom. xi. 33). Lastly, let them hearken to the very voice of the Creator, saying: 'Quo Ego vado, vos non potestis venire.'—(S John vii. 34). And let these things suffice for the inquiry of the truth before us."

We may most fittingly compare this Dantesque passage with the close of Galileo Galilei's famous "Dialogo intorno ai due massimi sistemi del mondo, tolemaico e copernicano," which I here venture to translate:—

"*Simplicio.* If either of you were asked, If God in His infinite power and wisdom could confer upon the element of water the reciprocal movement which we perceive in it, in another way than by the moving of the vessel containing it, I know that you would answer, that He could have done so in many ways, even unimaginable by our intellect; whence I immediately conclude that, this being so, it would be excessive daring for any one to wish to limit and restrict the Divine power and wisdom to a particular phantasy of his own.

"*Salviati.* An admirable and truly angelical doctrine, to which very conformably answers that other divine doctrine, which, whilst it allows us to dispute about the constitution of the world, adds (perhaps in order that the exercise of human minds be not suppressed nor grow lazy) that we are not to find out the work of His hands. Let therefore the exercise permitted and ordained to us by God make us recognize and so much the more wonder at His greatness, as we find ourselves the less competent to penetrate into the profound abysses of His infinite wisdom.

"*Sagredo.* And this will serve for the last conclusion of our four days' argument."—Galileo Galilei, "Dialogo dei Massimi Sistemi, Giornata quarta."

Dante now briefly deals with the five arguments which he mentioned at the beginning of his treatise as the most important against his theory. These being made short work of, he concludes:—

"This philosophical question was determined by me, Dante Alighieri, the least of philosophers, beneath the sway of that invincible lord, Messer Cane Grande della Scala, for the holy Roman empire, in the illustrious city of Verona, in the church of S Helena, and in the presence of all the Veronese clergy, save some few who, aflame with too much charity, do not admit the postulates of others, and through virtue of humility poor of the Holy Spirit, shun being present at their discourses, lest they may seem to approve their excellence.

"Now this was done in the year from the Nativity of our Lord Jesus Christ, 1320, on Sunday, which the Saviour enjoined on us to venerate for His glorious Nativity and His wondrous Resurrection. The which day was the 7th from the ides of January and the 13th before the calends of February" (*i e* January 20).

I have dealt merely with the chief parts of this Dantesque dissertation. According to Signor A Stoppani ("La questione dell' Acqua e della Terra di Dante Alighieri," in "opp. Lat di Dante," ed Giuliani, vol ii) there are nine truths relating to cosmology, presaged, affirmed, and in part demonstrated. These nine he makes out thus:—

(1) The moon the principal cause of tides.
(2) Equality of the sea's level.
(3) Centripetal force.
(4) Sphericity of the earth.
(5) Dry land simply protuberance of the earth's surface.
(6) Northern grouping together of the continents.
(7) Universal attraction.
(8) Elasticity of vapours a motive power.
(9) Heaving up of the continents.

Let me now add a tenth: A vague foreshadowing of our modern idea of chemical elements as distinct from those of Aristotle, or at least of homogeneous chemical bodies; "Corpora enim homogenea et simplicia sunt; homogenea, ut aurum depuratum; et corpora simplicia, ut ignis et terra."

EDMUND G GARDNER

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[1] "Upon this side he fell down out of heaven;
And all the land, that whilom here emerged,
For fear of him made of the sea a veil,
And came to our hemisphere; and peradventure
To flee from him, what on this side appears
Left the place vacant here, and back recoiled."
—"Inferno," xxxiv. 121–126, Longfellow's trans.

MOROCCO.[1]

MOROCCO has a paradoxical place in the history of exploration; although the only part of Africa fully in sight from the shores of Europe, and dotted with one or two half European coast towns, its interior is more firmly closed to the traveller, sportsman, and missionary than the dense forests of the Congo, or even the shores of Lake Chad. The difficulties in the way are not physical, nor are they wholly political. They arise mainly from the deeply-rooted antagonism in race and creed between the inhabitants of Morocco and all Christendom—this quaint and semi-fossil phrase is still here a necessary and sufficient term. At this moment public atten-

[1] "Bibliography of the Barbary States." Part IV. A Bibliography of Morocco from the earliest times to the end of 1891. By Lieut. Col Sir R Lambert Playfair and Dr Robert Brown.

tion is turned somewhat intently on the political conditions of the Oriental despotism which has so anomalously maintained itself to the west of our prime meridian. Hence the politician has a temporary interest in what would otherwise have appealed mainly to the geographer and man of science, the publication by the Royal Geographical Society of a "Supplementary Paper," the "Bibliography of Morocco." This is a work of splendid thoroughness, almost, if not quite, exhaustive in its list of 2243 titles, and made convenient for reference by two copious indexes of subjects and authors. But it is much more than a catalogue. Comments, judiciously brief, but in some cases of exceptional interest extending to a couple of pages, give information as to little-known authors, or record some striking circumstance in or concerning the books referred to. There is a specially-compiled map, and an introduction which is really an essay on the growth of knowledge regarding Morocco in European countries. With regard to the map, it is explained that only the coast-line has been surveyed. As to the interior:—

"The best mapped districts are laid down solely from running *reconnaissances* or sketch-maps. Positions fixed by astronomical observations are few. Many wide areas have never been visited by any Europeans, and most of the Atlas is at this hour as little known as it was in the days of Leo Africanus. There are cities within a few hours' ride of Tangier, which no person capable of giving a correct account of his observations has visited, and there are others not much farther away, to attempt to enter which—Zarhoun, for example—would, were the intruder detected, be certain death. There is scarcely a river laid down with even approximate accuracy, and, not to enumerate more distant provinces, the entire Riff country, that bold *massif* which is familiar to the thousands who every year sail up and down the Mediterranean, is less explored than many regions in the centre of the continent."

The present population of Morocco is a puzzle almost as difficult, although on a smaller scale, as that of China. The authors of the Bibliography give 4,000,000 as an estimate, but the guesses of various authorities vary between 1½ and 15 millions. The roads shown on the map are mere mule and camel tracks made by the feet of the pack-animals, unaided by any engineer. Ferries are rare, and, of course, bridges are unknown in the interior. The distribution of towns and villages is often at variance with the rules holding for civilised countries. The villages are built out of the way of the main tracks, because people never travel in Morocco for the good of the inhabitants, and it is safer to live off the path of the tax-collector and the Government official, who demands free food and quarters. The great number of place-names on the map of so thinly-peopled a country is due to the fact that the tombs of saints are such important landmarks that they must be indicated, even if only a few persons live beside them. "All the places beginning with 'Sidi' (Lord, master) are either actually tombs or the tomb has formed, as in so many of our cathedral cities, the nucleus of the town or village." "Sok," another affix of frequent occurrence, means market-place, and many of the established sites for periodical fairs are uninhabited between the gatherings of people from far and near. Many of the place-names on the coast exist in two forms at least—the native word and its Portuguese or Spanish translation, Casablanca and Dar-el-beida (both meaning White house) for example. We regret that the authors did not see their way to lay down precise rules for the spelling of Moorish place-names, either by giving a standard transliteration of the Arabic, or a uniform phonetic system. Indeed, even in the introduction a few anomalous spellings are found, *e.g.* *Zarhoun* and *Zerhun*, *Moulai* and *Mowlas*.

The physical geography of Morocco appears to be changing, and the natural conditions of the country are less favourable for agriculture than they were a few centuries ago. The forests have been destroyed with such recklessness that the soil has been dried up and swept away in many places; there is evidence that the rainfall has diminished, lakes have dried, and rivers formerly navigable have become silted up, or alternate as dry tracts of stone and raging torrents.

In one respect alone—the enthusiastic Moslemism of its people—does Morocco show no sign of degeneration. Although the Moors can no longer seize and hold the Christian slaves, whose stories bulk so largely in the bibliography, their hatred and contempt towards "unbelievers" is in no sense abated. Into such a land no Europeans could penetrate far, except in the past as slaves, or now as official messengers of European Powers under special protection, jealously watched and prevented from studying places or people. The last serious attempt at scientific exploration—that of Mr. Joseph Thomson—was again and again almost stopped by the fanatical Kaids, and only his remarkable persistence and daring stratagems carried him as far as he reached. Such stratagems would hardly serve again, and for the present the exploration of the Atlas Mountains, with their half-guessed topography, imperfectly known flora, and unsurveyed mineral wealth is at an end. The futility of disguise as an aid to exploration is fully proved in the records before us, where the ghastly fate of many who tried to pass as Moslems, and the unsatisfactory results obtained by others who escaped alive, are briefly told.

It seems to us that an attempt might well be made to open communications with fanatical Mohammedan countries either by explorers or diplomatic agents of the same faith, and there must be many amongst the educated Mohammedans of India who are well suited for such work. The religious beliefs of a people with whom belief and conduct are so closely related, must be taken into account in dealing with them, just as much as the physical features of a country. And as Arctic sailors have been proved to be the natural explorers in the Antarctic seas, Swiss mountaineers the safest pioneers on New Zealand glaciers, and Canadian boatmen the most expert in shooting the Nile cataracts, so Mohammedan envoys might be expected to make the most favourable impression on the people of Morocco or of the Mohammedan Sudan.

Sir Lambert Playfair and Dr. Brown deserve the heartiest thanks for completing their Bibliography of the Barbary States in such an admirable way, and we do not doubt that the work will be very widely consulted in the immediate future.

THE RATE OF EXPLOSION IN GASES

THE following is an abstract of the Bakerian Lecture on "The Rate of Explosion in Gases," delivered before the Royal Society by Prof. Harold B. Dixon, on January 19:—

1. Berthelot's measurements of the rates of explosion of a number of gaseous mixtures have been confirmed. The rate of the explosion wave for each mixture is constant. It is independent of the diameter of the tube above a certain limit.

2. The rate is not absolutely independent of the initial temperature and pressure of the gases. With rise of temperature the rate falls; with rise of pressure the rate increases; but above a certain *crucial pressure* variations in pressure appear to have no effect.

3. In the explosion of carbonic oxide and oxygen in a long tube, the presence of steam has a marked effect on the rate. From measurements of the rate of explosion with different quantities of steam, the conclusion is drawn that at the high temperature of the explosion wave, as

well as in ordinary combustion, the oxidation of the carbonic oxide is effected by the interaction of the steam.

4. Inert gases are found to retard the explosion wave according to their volume and density. Within wide limits an excess of one of the combustible gases has the same retarding effect as an inert gas (of the same volume and density), which can take no part in the reaction.

5 Measurements of the rate of explosion can be employed for determining the course of some chemical changes.

In the explosion of a volatile carbon compound with oxygen, the gaseous carbon appears to burn first to carbonic oxide, and afterwards, if oxygen is present in excess, the carbonic oxide first formed burns to carbonic acid

6 The theory proposed by Berthelot—that in the explosion wave the flame travels at the mean velocity of the products of combustion—although in agreement with the rates observed in a certain number of cases, does not account for the velocities found in other gaseous mixtures

7 It seems probable that in the explosion wave—

(1) The gases are heated at *constant volume*, and not at *constant pressure*,

(2) Each layer of gas is raised in temperature *before* being burnt,

(3) The wave is propagated not only by the movements of the burnt molecules, but also by those of the heated but yet unburnt molecules,

(4) When the permanent volume of the gases is changed in the chemical reaction, an alteration of temperature is thereby caused which affects the velocity of the wave.

8 In a gas, of the mean density and temperature calculated on these assumptions, a sound wave would travel at a velocity which nearly agrees with the observed rate of explosion in those cases where the products of combustion are perfect gases

9 With mixtures in which steam is formed, the rate of explosion falls below the calculated rate of the sound wave But when such mixtures are largely diluted with an inert gas, the calculated and found velocities coincide. It seems reasonable to suppose that at the higher temperatures the lowering of the rate of explosion is brought about by the dissociation of the steam, or by an increase in its specific heat, or by both these causes

10. The propagation of the explosion wave in gases must be accompanied by a very high pressure lasting for a very short time The experiments of MM Mallard and Le Chatelier, as well as the author's, show the presence of these fugitive pressures It is possible that data for calculating the pressures produced may be derived from a knowledge of the densities of the unburnt gases and of their rates of explosion.

NOTES.

THE forty-sixth annual general meeting of the Institution of Mechanical Engineers will be held on Thursday evening and Friday evening, February 2 and 3, at 25, Great George Street, Westminster. The chair will be taken by the president, Dr. William Anderson, F R S, at half past seven on each evening. The annual report of the council will be presented to the meeting on Thursday, and the annual election of the president, vice-presidents, and members of council, and the ordinary election of new members will take place on the same evening The following papers will be read and discussed, as far as time permits:—Description of the Experimental Apparatus and Shaping Machine for Ship Models at the Admiralty Experiment Works, Haslar, by Mr. R. Edmund Froude, of Haslar (Thursday); description of the Pumping Engines and Water-Softening Machinery at the Southampton Water Works, by Mr. William Matthews, Waterworks Engineer (Friday)

PROF CAYLEY, we are glad to learn, is now convalescent.

WE greatly regret to have to announce the death of Mr H F Blanford, F.R.S. He died on Monday at the age of fifty-eight

PROF MICHAEL FOSTER, Sec R S, has been appointed Rede Lecturer at Cambridge for the present term. His Rede lecture will be delivered early in June

THE Bill for the introduction of a standard time (mean solar time of the fifteenth meridian) was read a second time in the German Imperial Parliament on Monday The measure was accepted without much discussion

AN excellent report on technical education in London has been submitted to the London County Council by a special committee appointed to investigate the subject. The report was prepared by Mr Llewellyn Smith, the committee's secretary, and displays a thorough grasp of the essential conditions of the problem It is proposed that a Technical Instruction Board shall be appointed, and that it shall consist of some members of the Council, and of representatives of the School Board, the City and Guilds of London Institute, the City Parochial Charities, the Head Masters' Association, the National Union of Elementary Teachers, and the London Trades Council The committee think that one third of the amount derived from the beer and spirits duties should be handed over to this body for the provision of adequate technical instruction in all parts of London

THE French Minister of the Interior has established at Marseilles, in connection with the university, an institute for botanical and geological research, and a museum The director is Prof Heckel, who, as well as a curator and a librarian, gives his services gratuitously

IN the year 1793 was published Christian Konrad Sprengel's "Das entdeckte Geheimniss der Natur, im Bau und in der Befruchtung der Blumen," the work which first directed the attention of naturalists to the contrivances which, in many flowers, render self-pollination difficult, and promote the visits of insects to assist cross-pollination The copper-plate illustrations of this work still maintain their character as among the best that have been published in this branch of science. Sprengel was in many respects a forerunner of Darwin, and centenaries have been celebrated on slighter grounds than the publication of this work

THE chief characteristics of the weather during the past week have been its general mildness and dampness, the day temperatures have at times exceeded 50° in most parts of the kingdom, but at night slight frosts occurred towards the end of last week in Scotland and the south-eastern parts of England. The distribution of pressure has been complex, a series of depressions have passed over the coast of Norway from the westward, while an anticyclone lay over the south-western parts of our islands, the reading of the barometer in the south-west being about an inch higher than in the north of Scotland. The passage of the low-pressure systems in the north was accompanied by strong north-westerly winds and gales in Scotland, with hail or sleet in many places. Owing to the disappearance of the anticyclone from the continent, north-westerly winds became prevalent over western Europe, and a rapid rise of temperature occurred there, amounting to 30° in Germany between the 20th and 21st instant During the last few days fresh depressions have approached our north-western coasts, with increasing winds from the south-west, and

a continuance of mild, unsettled weather appeared probable The *Weekly Weather Report* shows that for the week ending the 21st instant there was a large deficiency of rainfall in the west of Scotland, south-west of England, and south of Ireland. The percentage of possible duration of sunshine ranged from 28 in the south-west of England to 7 in the south of England and to 3 in the north of Scotland

THE *Repertorium fur Meteorologie*, vol. xv recently issued by the Imperial Academy of Sciences of St Petersburg, contains a discussion by P A. Muller, of the Ekaterinburg Observatory, at the foot of the Ural Mountains, in the Government of Perm, on the question of the evaporation from a snow surface Several writers, among whom are Drs Bruckner and Woeikof, differ in opinion as to whether the evaporation from a snow surface exceeds the condensation of the aqueous vapour of the air immediately above it The method generally adopted for the decision of the question is to find whether the temperature of the snow surface is above or below the dew-point of the surrounding air, in one case there would be evaporation, and in the other condensation The paper occupies forty seven small folio pages, and the observations were made hourly from December 21, 1890, to February 28, 1891 The result of the investigation shows that according to the temperatures of the dew-point and of the surface of the snow, the evaporation of the snow greatly exceeds the condensation of the aqueous vapour, for the condensation occurred at only 27 per cent while the evaporation occurred at 73 per cent of the hourly observations

PROF FLINDERS PETRIE, to whose introductory lecture at University College, Gower Street, we referred last week, delivered on Saturday the first of his regular course of lectures on the Edwards Foundation He said the Egypt of the early monuments was a mere strip of a few miles wide of green, amid boundless deserts, and beneath a sky of the greatest brilliancy, a land of extreme contrasts of light and shadow, of life and death These conditions were reflected in the art On the one hand was the most massive and overwhelming construction, and, on the other, the most delicate and detailed reliefs. On the one hand, the most sublime and stolid statuary, on the other, the course and accidents of daily life freely treated. On the one hand, masses of smooth buildings that far outdo the native hills on which they stand, gaunt and bare, and, on the other, the vivid and rich colouring in the interiors In consequence of the climate also Egypt is a land of great simplicity of life, and simplicity is especially the characteristic of the oldest Egyptian buildings Speaking of the early Egyptian statuer, Prof. Petrie said that the race represented by them appears as "one of the noblest that ever existed"

AT Leeds, on Monday, Lord Playfair presided at a public dinner, held in support of the Yorkshire College In proposing the principal toast—"The Yorkshire College"—he spoke of the efforts made half a century ago to secure for science the place which rightly belongs to it in the educational system. He was glad, he said, that these efforts had met with a temporary resistance, because if the Universities had at once yielded there would have been no colleges now in our great provincial towns The colleges, he thought, were adapting themselves rapidly and well, upon the whole, to the genius of their several localities Of the Yorkshire College he said that she had fitted herself for the liberal culture and life-work of a great industrial centre. "No doubt her technical courses are peculiar Actual laboratories for spinning, for dyeing, for tanning, for engineering, are novel adjuncts to a college. What does it mean? That you are trying to strengthen and embellish industrial pursuits, as the Universities acted upon the professions when they were obliged to include them. Surely a great town like Leeds is right when it imbues its producers with intellectual knowledge, as well as with technical expertness Such men in future carve out industrial professions for themselves, and illumine them by appropriate culture."

THE interesting address lately delivered by Sir Henry Roscoe on the occasion of the prize distribution at the Birmingham Municipal Technical School has now been issued separately. He describes the report of the first year's work as "more than encouraging." Speaking of the building which is to be erected for technical training at Birmingham, he says:—"You in Birmingham have, in my judgment, taken the right course. You are not going to squander your money by using it for a thousand different purposes You are, I hope, going to do a good thing, and a big thing, in building and equipping a really great institution, worthy of your city and of your well-earned renown as being foremost amongst our towns in educational matters You will have a place of higher technical instruction to which all the Midlands will look up It will be the gathering ground for all the youthful talent of the busy millions of the district It will be here that the future Faradays, and Priestleys, and Watts will get that sound though elementary scientific training which will enable them to pursue that training to its highest point at the Mason College here, or in other colleges elsewhere, which may in the end make both them and their country great"

THE new technical schools connected with University College, Nottingham, which were formally opened the other day, promise to be of immense service, not only to Nottingham itself, but to the wide district of which it is the educational centre A remarkably clear description of the buildings, with plans, is given in a pamphlet prepared for the ceremonial opening The pamphlet also includes an interesting summary of the facts relating to the history of the Nottingham College and its technical department

MR. C F JURITZ, Senior Analyst in the Department of Lands, Mines, and Agriculture, Cape Colony, announces in the *Agricultural Journal*, issued by the Department, that a comprehensive series of investigations with reference to the chemical composition of the various soils of the colony is about to be undertaken The samples of soil are to be collected by one of the officers of the analytical branch of the Department. In the first instance the southern part of the Malmesbury district will be visited, and soils will be taken from several localities representative (*a*) of primary and (*b*) of alluvial soils belonging to the Malmesbury beds of clay slate. Mr Juritz proposes next to collect soils from the more northerly portion of the same district, in the vicinity of Hopefield, for instance, after which the Caledon district will be taken in hand These analyses when completed will afford, he points out, an insight into the general composition of the clay slate soils, lying around the south-western coast of the Colony between Donkin's and Mossel Bays The Government of Cape Colony look upon the proposals that have been made as "a move in the right direction," and have promised their warmest support.

MR KEDARNATH BASU, describing in *Science* some relics of primitive fashions in India, says he does not see the same profusion as he saw ten or twelve years ago, of tattoo-marks and red-ochre or red oxide of lead (*sindur*) over the forehead and crown among the women of Bengal. The rapid progress of female education and the consequent refinement in æsthetic taste are, he says, the causes of the decline of this rude and savage adornment. The people of Behar, the North-western provinces, and other districts, however, still cling to these remnants of savagery. The up-country women, besides tatooing their bodies and painting the head with red paint, bore the lower lobes of their ears,

and insert big and heavy wooden cylindrical plugs, which almost sever the lobes from the ears. The plugs are sometimes as big as two inches in length with a diameter of an inch and a half, and as much as two ounces in weight These heavy plugs pull down the lobes of the ears as far as the shoulders, and give the wearers a hideous look

MR F J BLISS contributes to the new "Quarterly Statement" of the Palestine Exploration Fund a most interesting report on the excavations at Tell-el Hesy during the spring season of 1892 Speaking of the now famous tablet discovered in the course of these excavations, he says:—"On Monday, May 14, ten days before we closed the work, I was in my tent at noon with Ibrahim Effendi, when my foreman Yusif came in with a small coffee-coloured stone in his hand It seemed to be curiously notched on both sides and three edges, but was so filled in with earth that it was not till I carefully brushed it clean that the precious cuneiform letters were apparent Then I thought of a day, more than a year before, when I sat in Petrie's tent at the pyramid of Meydûm, with Prof Sayce He told me that I was to find cuneiform tablets in the Tell-el Hesy, which as yet I had never seen, and gazing across the green valley of the slow, brown Nile, and across the yellow desert beyond, he seemed to pierce to the core, with the eye of faith, the far away Amorite mound As for me, I saw no tablets, but I seemed to be seeing one who saw them!" Mr Bliss also notes that the discovery was a triumphant vindication of Mr Flinders Petrie's chronology—established, not by even a single dated object, but by pottery, mostly plain and unpainted It is announced in the "Quarterly Statement" that the excavations at Tell el Hesy are now being vigorously carried on by Mr Bliss, who has recovered from his serious illness

IT seems that in Yucatan and Central America, as in Egypt and other countries, ancient monuments are held in small respect by certain classes of travellers. According to Mr. M. H Saville, assistant in the Peabody Museum, who writes on the subject in *Science*, enormous damage is being done to many of the most interesting antiquities in these regions The magnificent "House of the Governor" in Uxmal, described as probably the grandest building now standing in Yucatan, is almost covered with names on the front and on the cemented walls inside These names are painted in black, blue, and red, and among them are the names of men widely known in the scientific world. The "House of the Dwarfs" in the same city has suffered in like manner, and many of the sculptures which have fallen from the buildings in Uxmal have been wilfully broken In Copan, when the Peabody Museum Honduras Expedition compared the condition of the "Idols" to day with the photographs taken by Mr A P Maudslay seven years ago, it was found that during that time some of the very finest sculptures had been disfigured by blows from machetes and other instruments. The Stela given as a frontispiece in Stephens' "Incidents of Travel in Central America," vol i., has been much marred by some one who has broken off several ornaments and a beautiful medallion face from the northern side One of the faces and several noses have been broken off from the sitting figures on the altar figured by Stephens in the same volume, opposite page 142, and on some of the idols and altars names have been carved. While excavating in one of the chambers of the Main Structure, members of the Expedition uncovered a beautiful hieroglyphic step, but before they had time to secure a photograph of it, some visitor improved the opportunity while no one was about to break off one of the letters. In Quirigua a small statue, discovered by Mr. Maudslay and removed by him to a small house near the rancho of Quirigua, had the head and one of the arms broken from it during the interval between two visits. This statue was of the highest importance, as it very much resembled the celebrated "Chaac-mol" now in the Mexican Museum, but discovered by Le Plongeon at Chichen Itza. Much mischief is also done by natives, who think nothing of tearing down ancient structures in order to provide themselves with building materials The authorities of the Peabody Museum, to whom the care of the antiquities of Honduras has been granted for a period of ten years, deserve much credit for the efforts they make to cope with the evil They have caused a wall to be built round the principal remains in Copan, and a keeper has been placed in charge with strict orders to allow nothing to be destroyed or carried away

WHAT is the true Shamrock? Most Irishmen are probably of opinion that they can answer the question correctly, but unfortunately they do not all give the same reply Mr Nathaniel Colgan, who has been investigating the subject, collected thirteen specimens from the following eleven counties—Derry, Antrim, Armagh, Mayo, Clare, Cork, Wexford, Wicklow, Carlow, Queen's County, and Roscommon Shamrocks were thus secured from northern, southern, eastern, western, and central Ireland, Mr. Colgan's correspondents in the various counties taking pains to have each sample selected by a native of experience who professed to know the genuine plant All the specimens were planted and carefully labelled with their places of origin, and flowering within some two months later gave the following results eight of the specimens turned out to be *Trifolium minus* of Smith, and the remaining five *Trifolium repens* of Linnæus Cork, Derry, Wicklow, Queen's County, Clare, and Wexford declared for *Trifolium minus*, Mayo, Antrim, and Roscommon for *Trifolium repens*, and Armagh and Carlow, each of which had sent two specimens, were divided on the question, one district in each county giving *T. repens*, while the other gave *T. minus* These results are set forth by Mr Colgan in an interesting paper in the first volume of the *Irish Naturalist*, to which we referred last week Elsewhere in the same volume Mr R L Praeger suggests that authentic specimens of shamrock should be obtained from every county in Ireland, and he adds that he has no doubt Mr. F W. Moore would gladly grow them at Glasnevin Gardens, if Mr Colgan did not care to undertake so large an order Mr Praeger notes that in his own district, North Down, *Trifolium minus* is always regarded as the true shamrock, but that a luxuriant specimen, or one in flower, is generally discarded as an impostor

THE waters of the Great Salt Lake, Utah, are known to vary in salinity at different times Dr Waller, of Columbia College, gives the results of his recent determination of the dissolved salts in the *School of Mines Quarterly* A comparison of his results with those obtained by Gale, Allen, Bassett, and others, shows a constant change of salinity, and a closer examination reveals a variation from place to place This is due to local differences in the amount of evaporation, and to the influx of water, fresh or saline, in many cases from subterranean springs which give no indication of their presence For some of the constituents the water is nearly at saturation point, and differences of temperature are also apt to cause slight differences of composition. The presence of lithium and bromine strengthens Captain Bonneville's conclusions with regard to the basin of the ancient lake called after his name, and now represented by the Great Salt Lake and its lesser neighbours The benches of sand and gravel seen high up on the flanks of the Wahsatch mountains and the Oquirrh range indicate the eastern and western shores of the old lake, whose waters must have covered an area equal to that of Lake Huron, or ten times that of the Great Salt Lake. Successive lowerings of level finally cut off its outlet to the north, by which it used to flow into the Pacific Ocean.

A BEAUTIFUL optical phenomenon, which has not yet been satisfactorily explained, is described by M F Folie in the *Bulletin* of the Belgian Academy It was observed about a mile from Zermatt on August 13 at 8 30 a m "On our right, towards the east, on the steep flanks of the mountains which enclose the valley of the Viège, rose a group of fir trees, the highest of which projected themselves against the azure of the sky, at a height of 500 m above the road Whilst I was botanising my son exclaimed 'Come and look the firs are as if covered with hoar-frost!' We paid the most scrupulous attention to the phenomenon To make sure that we were not misled by an illusion we made various observations, both with the naked eye and with an excellent opera glass" It was observed that not only the distant trees, but those lining the road, glittered in a silvery light, which seemed to belong to the trees themselves, and that the insects and birds playing round the branches were bathed in the same light, forming an aureole round the tops of the trees, somewhat resembling the light effects observed in the Blue Grotto It is suggested that the light was reflected from the snow Since it disappeared as soon as the sun rose above the hill, and has never been seen except in the presence of snow, this explanation appears plausible, but it is highly desirable that further and more detailed observations should be made of this *spectacle féerique*

THE Tasmanian Official Record is henceforth to be issued tri-annually instead of annually, and a handbook has been issued to take its place during the intervening years This hand book (which is described on the title-page as "for the year 1892") contains a brief epitome of the historical portion of the Official Record, and summarises in a convenient form the more important statistical information contained in the detailed tables of the last volume of the general statistics of the colony

MESSRS ASHER AND CO. will publish shortly an English translation of the "Recollections of the Life of the late Werner von Siemens," the well known electrician, and brother of Sir William Siemens Two editions of the German original, published in December last, were issued in the course of a few weeks

THE course of four winter lectures in connection with the London Geological Field Class will this year be delivered by Prof H G Seeley, F R S, on Tuesday evenings, at the Memorial Hall, Farringdon Street, the subject being "The Fossil Reptiles of the Thames Basin" All particulars may be had of the Hon Sec Mr J. H Hodd, 30 and 31, Hatton Garden, E C

THE bacterial purification which takes place in a river during its flow has been recently attributed in part to the process of sedimentation which the micro organisms in the water undergo, but it would seem that yet another factor must be taken into account Buchner, in some investigations which he has recently published ("Ueber den Einfluss des Lichtes auf Bakterien," *Centralblatt fur Bakteriologie*, vol 11, 1892, also vol 12, p. 217) shows that this diminution of the numbers present may be also assisted by the deleterious action which light exercises upon certain micro-organisms A systematic series of experiments was made by introducing typhoid bacilli, *B coli communis*, *B pyocyaneus*, Koch's cholera spirilla, also various putrefactive bacteria, into vessels containing sterilized and non-sterilized ordinary drinking water As a control, in each experiment one vessel thus infected was exposed to light, whilst a second was kept under precisely similar conditions, with the exception of its being covered up with black paper, by means of which every particle of light was excluded. The uniform result obtained in all these experiments was that light exercised a most powerful bactericidal action upon the bacteria in the water under observation. For example, in one water in which at the commencement of the experiment 100,000 germs of *B. coli communis* were present in a c c, after one hour's exposure to direct sunlight *none* were discoverable, whilst in the darkened control flask during the same period a slight increase in the numbers present had taken place Even the addition of culture fluid to the flasks exposed to sunlight could not impair in the least the bactericidal properties of the sun's rays In the flasks exposed to diffused daylight the action was less violent but still a marked diminution was observed In his later experiments Buchner has employed agar-agar, mixing a large quantity of particular organisms, pathogenic and others, with this material in shallow covered dishes and then exposing them to the action of light and noting its effect upon the development of the colonies For this purpose strips of black paper cut in any shape (in the particular dish photographed by Buchner letters were used) were attached outside to the bottom of the dish, which was then turned upwards and exposed to direct sunlight for one to one and a half hours and to diffused daylight for five hours After this the dish was incubated in a dark cupboard At the end of twenty four hours the form of the letters fastened to the bottom of the dish was sharply defined, the development of the colonies having *taken place in no part of the dish, except in those portions covered by the black letters* Some interesting experiments on the same subject have also recently been made by Kotljar (*Centralblatt fur Bakteriologie*, December 20, 1892) In the course of these investigations the author found that of the coloured rays of the spectrum the red favoured the growth of those bacteria experimented with, whilst the violet rays acted prejudicially, although less so than the white rays The exceedingly interesting observation was made that the violet rays actually favoured the sporulation of the *Bac pseudo anthracis*

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr A. Sandbach, a Triton Cockatoo (*Cacatua triton*) from New Guinea, presented by Mr Arthur Harter, a Gannet (*Sula bassana*) British, presented by Mr. F W. Ward, two Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, presented by Mr W H Purvis, two Wanderoo Monkeys (*Macacus silenus*) from the Malabar Coast, a Straw-necked Ibis (*Carphibis spinicollis*) from Australia, four Snow Buntings (*Plectrophanes nivalis*), six Wild Ducks (*Anas boschas*, 3 ♂ 3 ♀) British, purchased, a Meadow Bunting (*Emberiza cia*) European, received in exchange, two Shaw's Gerbilles (*Gerbillus shawi*) born in the Gardens.

OUR ASTRONOMICAL COLUMN

COMET HOLMES.—*Edinburgh Circular*, No 37, announces that Palisa, telegraphing from Vienna, states that Comet Holmes now resembles an 8 m star with a nebulous envelope 20" of arc in diameter

A further observation made by Prof. Schur in Gottingen on January 19 showed that the nucleus was of the 10th magnitude, and could not be considered at all brighter than that magnitude. For the latter observation the air, as regards clearness, was all that could have been desired.

At South Kensington, on January 18, the comet was observed as a hazy star and estimated to be about the 8th magnitude

The following ephemeris is that given by Schulhof —

Date		R A app.			Decl. app		
		h.	m.	s.	°	′	″
Jan	26 ...	1	35	33 0	+33	42	3
	27 .		36	58 7		42	51
	28		38	25·1		43	44
	29 ..		39	52·1		44	43
	30 .		41	19 8		45	46
	31		42	48 1		46	55
Feb	1		44	17 0		48	8
	2	1	45	46 5	33	49	26

On January 30 the comet will lie very nearly between β Andromedæ and β Trianguli, about one-third of the distance from the latter star.

COMET BROOKS (NOVEMBER 19, 1892).—The following ephemeris of Comet Brooks is due to Ristenpart, and is given in *Astronomische Nachrichten*, No. 3142:—

1893	R.A. (app.) h. m. s.	Decl. (app.) ° '	Log *r*.	Log Δ.	Br.
Jan. 26	23 35 8	+40 34.3	0.0921	0.0471	2.94
27	38 53	39 34.1			
28	42 22	38 36.8	0.0950	0.0688	2.62
29	45 37	37 42.2			
30	48 40	36 50.2	0.0981	0.0898	2.35
31	51 32	36 0.5			
Feb. 1	54 14	35 13.1	0.1015	0.1101	2.11
2	23 56 48	34 27.7			

This comet, which will be found to be in the constellation of Andromeda, will lie about $3\frac{1}{2}°$ to the south of ι Andromedæ on January 27.

PHOTOGRAPHIC ABSORPTION OF OUR ATMOSPHERE.—The question of the degree with which our atmosphere absorbs photographic rays has become very important owing to the adoption of photography, so that any work enlightening us on this subject is anxiously listened to. Prof. Schaeberle, who has been making investigations in this direction, has just completed a memoir which is being published by the University of California, but in the meanwhile he has issued a table setting forth simply the final results. The absorption in the following table is expressed in photographic magnitudes, and must be added to the unknown atmospheric absorption at the zenith.

Z.D. °	Phot. Absorp.	Z.D. °	Phot. Absorp.
5	0.00	50	0.44
10	0.01	55	0.56
15	0.04	60	0.71
20	0.07	65	0.89
25	0.11	70	1.12
30	0.16	75	1.45
35	0.21	80	1.94
40	0.28	85	2.68
45	0.35	90	5.00

HARVARD COLLEGE OBSERVATORY.—The forty-seventh annual report of this Observatory, by Prof. Pickering, opens with a reference to the death of Mr. George B. Clark, to whose "genius for mechanical devices, indomitable perseverance, and devotion to the interests of the observatory, we are indebted for the success of many of our most useful instruments." Of the most important matters mentioned in the report are the permanent establishment of an observing station in South America, where the unsteadiness of the air is for the most part eliminated, the construction of a suitable building for the housing of photographs and the approaching completion of the Bruce photographic telescope. The work done with the various instruments during this period has been considerable. With regard to the Draper telescope, as many as 2777 photographs have been taken, while those taken with the Bache instrument number nearly 2000. The Boyden department, which is situated at Arequipa, in Peru, has been making great progress, the results of which have been frequently inserted in *Astronomy and Astro-physics*. The eight surfaces of the objective of the Bruce telescope have, as Prof. Pickering informs us, been ground and polished, and the results up to the present, according to tests made on a star, are very satisfactory. This instrument, when finished, is destined for the Arequipa station.

SOLAR OBSERVATIONS AT ROME.—Prof. Tacchini has issued the results of the observations made with regard to the distribution in latitude of the solar phenomena at the Royal Observatory during the third semester in 1892. From the tabulated statement which he gives the following facts may be gathered.

With regard to the eruptions, these phenomena seem to be quite local to the equatorial regions, the relative frequency being 0.667 and 0.333 for the north and south latitudes respectively. The spots, faculæ, and eruptions have their maxima nearly at the same distance from the equator both north and south, the zones being (± 20°, ± 30°), but the maxima for the prominences extend further north, about latitudes 60° north and south. Prof. Tacchini remarks that in the equatorial zone (+20° – 20°), where the maxima of faculæ, spots, and eruptions are observed, a feeble relative frequency in the prominences is noted, which shows us that we must consider a large number of prominences as the result of conditions "bien différentes par rapport à celles qui déterminent la production des taches dans la photosphère," whilst the prominences are formed simply in the solar atmosphere. As a case in point, he mentions an observation made on August 1 of last year, of a cloud which, starting at a distance of 264", rose to 364" without any corresponding alteration at the surface.

THE TOTAL SOLAR ECLIPSE, APRIL 15-16, 1893.—Writing to M. Flammarion about the scientific expedition sent by the Brazilian Government to study the region of the central plateau and to select a site for the proposed new capital, Dr. Cruls, the Director of the Observatory at Rio de Janeiro, adds the following note:—"About the total eclipse of April 16. Will France send any one to observe it? I beg you to make known through the *Review* (*L'Astronomie*) that the Brazilian Government is willing to send a warship to Ceara, on which foreign astronomers who wished to observe the phenomenon could find a passage."

GEOGRAPHICAL NOTES.

A CHANGE has been made in the arrangements for the expedition to Lake Rudolf referred to on p. 235, vol. xlvii. The expedition is to travel by the Tana river instead of the Juba, although its ultimate destination is the same, and Lieutenant Villiers, instead of accompanying it, has joined Sir Gerald Portal's mission to Uganda.

MR. H. J. MACKINDER, M.A., Reader in Geography at Oxford, delivered the first of a course of ten educational lectures, under the auspices of the Royal Geographical Society, on the relation of geography to history, on the 20th inst. The attendance was largely composed of teachers and University Extension students, to whom special terms were offered. The lecturer treated of "the Theatre of History," tracing the development of accurate geographical knowledge from the earliest times in a series of brilliant generalisations. He dwelt upon the contrast between the knowledge of early Greek geographers regarding the true shape of the earth, and their habitual representation of the regions known to them in a circular form. In the middle ages, amongst the half-learned, the map of the known world was elevated to the highest place, the figure of the globe was forgotten, and the doctrine of a flat earth gained currency. At the geographical *renaissance* the map was adapted once more to the sphere, and the discoveries of Columbus and his contemporaries resulted directly.

THE suggestion of Mr. Joseph Thomson to bestow the name of Livingstonia (vol. xlvii. p. 160) on the British sphere of influence north of the Zambesi, in spite of its singular propriety, has, we fear, failed to convince the authorities in charge of the region, who, it appears, have decided to adopt the cumbrous and scarcely accurate title of British Central Africa.

M. MIZON'S second expedition to Adamawa has been stopped on the Benué by the breakdown of his steamers, and the sudden falling of the water, he being left without means of progress about two-thirds of the way between Lukoja and Yola.

THE French flag has been formally hoisted on the little islands of St. Paul and New Amsterdam in the South Indian Ocean, midway between the Cape of Good Hope and Australia. St. Paul is an interesting instance of a volcanic island, the extinct crater of which forms a wide sheltered harbour communicating with the sea by means of a single narrow channel. It was one of the French stations for observing the transit of Venus in 1874. French fishermen from Reunion had practically taken possession of the islands in the early part of the century, but the fishing-grounds have long been abandoned.

MR. B. V. DARBISHIRE, M.A. (Oxon.), has been appointed Cartographer to the Royal Geographical Society. He has had the advantage of preliminary training in Germany, and under the Reader in Geography at Oxford.

THE APPROACHING ECLIPSE OF THE SUN, APRIL 16, 1893.[1]

I HAD the honour, two and a half years ago, of describing to you the total eclipse of the sun of December 22, 1889, which I had been to observe in the Salut Isles, French Guiana. In spite of very unfavourable atmospheric conditions I was then

[1] Address to the Astronomical Society of France, on November 2, 1892, by M. De la Baume Pluvinel. translated by A. Taylor.

able to take some photographs of the phenomena and to measure the actinic intensity of the corona Two years previously I had been to Russia to observe the eclipse of August 18, 1887, but the bad weather prevented any observations If these expeditions did not succeed as well as I had hoped, they were at least useful in showing me all the difficulties to be met with in such undertakings, and of convincing me that if one wishes to thoroughly avail one's self of the precious moments during which the eclipse lasts, it is necessary to gain a large experience of these phenomena by omitting no opportunity of observing them, and by making a speciality of these expeditions Therefore, after the eclipse of 1889 I determined to go to observe the following eclipse, that of the 16th of next April

This time the phenomenon is visible under particularly favourable conditions On the African coast to the south of Dakar, where the expedition sent by the Bureau des Longitudes will observe, and where I also propose to instal myself, the duration of totality is four minutes thirteen seconds. Moreover, a very important consideration is that we are certain of fine weather At a time when expeditions are being organised in every country in view of this astronomical event, I think it will be useful to draw your attention to the chief questions which should be the object of astronomical study during the next eclipse

You are aware that the passing of the moon before the sun has the inestimable advantage of allowing us to see the circumsolar regions which, under ordinary circumstances, because of their faint light are lost in the general illumination of our atmosphere The regions thus revealed consist of a layer in immediate contact with the sun, the chromosphere, in which are the rosy flames which form the protuberances, and a more or less extensive luminous aureole, the corona. But since the celebrated eclipse of 1868, which marks an epoch in the history of solar physics, we are able, thanks to the great discovery of Messrs Janssen and Lockyer, to study the protuberances at any time, and consequently it is only to the corona that the attention of astronomers turns during total eclipses

An invariable part of the day's programme is the study of the structure of the corona, and the luminous intensity of its various parts We need to have recourse to photography for trustworthy evidence as to this, for photography alone can give a faithful representation of the phenomena, even the best drawings always leave much to be desired Indeed, it is impossible in the space of a few minutes to exactly represent a nebulous mass as complicated as the corona, and without any definite outlines We can judge of the difficulty presented by the drawing of the corona, by remembering that even the most skilful draughtsmen have never yet been able to give us similar drawings of the great Orion nebula, although this may be studied at leisure The brilliancy of the corona varies in intensity so much from one eclipse to another, that it is difficult to determine beforehand the length of exposure needed with given apparatus to obtain as satisfactory a representation of the phenomenon as possible Moreover, the different parts of the corona differ in brilliancy, so that when the photographic action is sufficient to give a good image of the middle part, the lower portions which form the interior corona are over-exposed, while the extreme limits of the aureole are not reproduced. To satisfy all the conditions it is necessary to take several photographs with different exposures

To advantageously discuss the results obtained it is very important that astronomers should place upon each plate a uniform scale to measure the intensity of the photographic action upon it. This intensity is equal to the product of three factors, the effectiveness of the object glass, the length of exposure, and the sensitiveness of the plate If we indicate the useful diameter of the object glass by a and the focus by f, the effectiveness, defined by the international congress of photography, is $100\frac{a^2}{f^2}$ If we take plates of gelatinobromide of silver of normal sensitiveness as our unit, and let t be the length of exposure in seconds, we have the following formula to express the photographic action:—$100\frac{a^2}{f^2}t$ In working with wet collodion plates it is necessary to multiply this expression by $\frac{1}{15}$, and with plates of dry collodion it must be multiplied by $\frac{1}{100}$. The first photographs of the corona, taken with wet collodion, from 1868 to 1878, were obtained with a photographic action not greater than 2. Later, thanks to rapid plates, much greater action could be obtained Thus in 1883 a photograph obtained by M Janssen had received a photographic action equal to 918. On the negative thus obtained, the corona extended to between 30′ and 40′ from the limb of the moon, but on the other hand, details of the parts near the sun were completely wanting

We might ask whether by still further increasing the photographic action we should also extend the limits of the corona? Certainly not! for if the photographic action is too intense, the faint contrast between the extreme parts of the corona and the more or less illuminated sky is no longer appreciable on the negative. We know, indeed, that if we wish to produce the maximum contrast between two half tones we must only use just enough light for the faintest of the half-tones to give a perceptible image In America, Mr Burnham has been engaged in determining the maximum length of exposure necessary to obtain the best representation of the corona, and he has made experiments on this subject by photographing the moon and white clouds on a faintly lighted sky

In 1889, at the Salut Isles, I used five instruments, giving photographic actions varying from 185 to 13, but, doubtless on account of the peculiarly intense illumination of the atmosphere due to the short duration of totality, and the great abundance of water vapour in the atmosphere, the most satisfactory negative was that corresponding to a photographic action of 30 It is very probable that an equally good result might have been obtained with much less photographic action Mr Barnard, to whom we owe the best photographs of the eclipse of January 1, 1889, worked with a photographic action equal to 0 58 This result proves that with the sensitive plates now in use it should be possible to obtain good images of the corona on a large scale by using secondary magnifiers to increase the size of the image given by the object glass In any case we can employ object glasses of two or three metres focal length, which would give images sufficiently large to show all the details of the corona without having resort to enlargement of the plates. Nevertheless, in spite of the use of a long focus, the instrument must remain luminous enough for the time of exposure to be short The displacements of the image on the plate, caused by the imperfect adjustment of the equatorial mounting, or by an irregularity in the clockwork movement, or by the movement of the sun in declination are thus rendered inappreciable.

The photographs, when obtained, should be examined from the following different points of view First of all we wish to find if the corona, which will be observed in the month of April, 1893, at a period of great solar activity, and at an epoch when the south pole of the sun is projected on the visible part of its disc, resembles, as we have every reason to think it does, the corona of 1883, which was studied under the same conditions A great resemblance between the forms of the corona in 1889 and 1878, at the periods of minimum sun-spots, has already been noted, and if it can be established that the corona, seen under similar conditions, presents the same appearance, it will be proved that the diversity of appearance hitherto noticed depends solely upon the state of agitation of the solar surface, and the position of the observer with respect to the solar equator

If the corona should present an axis of symmetry it must be ascertained whether the poles of this axis coincide with the poles of the axis of rotation of the sun, or if, as is more usually the case, the poles of the corona are inclined at some degrees from the poles of the sun, thus resembling the position of the magnetic poles of the earth with regard to its geographical poles If the corona shares in the movement of rotation of the sun, it must be the same with its axis of symmetry, and therefore if we once observe the northern pole of the corona to the east of the northern pole of the sun, we ought to find it after an uneven number of half-revolutions, of the sun to the west of the north pole of the sun To ascertain if this is so or not, it is of the greatest importance to know exactly the orientation of the images upon the photographic plates The most exact and simple method to orient the images is to place the photographic apparatus in the position which it occupied at the moment of the phenomena, and, in the night, to photograph the trails which the stars leave in passing across the field of the lens

If the photographs should show the structure of the corona clearly, we shall be able to study the form of those luminous rays which we notice at the poles of the sun, and of those curvilinear structures which seem to extend from the middle latitudes of the sun. The study of the curvature of these structures will be very useful in verifying the exactness of one of the most favoured theories of the corona, which explains the phenomena

by supposing that matter is thrown out by the sun normally at its surface, and that its projection is turned on one side by the rotation of the sun Mr Schaeberle, of the Lick Observatory, has mathematically studied this theory, and on applying it to eclipses already observed, has been able to report that the curvature of the structures has always conformed with the theory

We must also examine the photographs taken with the longest exposure, to determine whether the dark parts which sometimes separate the luminous structures, and which we can trace to the base of the corona, are entirely destitute of light The existence of these *rifts*, as the English call them, is difficult to explain, if we suppose that the coronal atmosphere entirely surrounds the sun, for in that case we should always see, projected on the plane perpendicular to the line of sight, the coronal matter all round the sun According to Prof Hastings, the presence of these rifts is a confirmation of his theory which ascribes the corona to diffraction, and not to the existence of a material mass

Is the aspect of the corona quickly modified, or are the changes which we notice from one eclipse to another effected slowly? Hitherto we have never proved the difference between the photographs of the same eclipse taken at several hours' interval, and at stations very distant from each other The English astronomers thought of testing this question in December, 1889, and the two English expeditions sent, one to the Salut Isles, and the other to the west coast of Africa, were furnished with photographic outfits as identical as possible, in order to obtain, at an interval of two and a half hours, comparable negatives of the corona Unfortunately the complete failure of the expedition on the African coast did not permit the carrying out of this programme, otherwise it is very probable they would have proved no sensible difference between the negatives at the two stations, for photographs show that the corona of December 22, 1889, was almost identical with that of January 1 of the same year We may say, then, that during the year 1889, a year of quietude on the solar surface, the appearance of the corona did not appreciably change

However, the experiment attempted by the English expeditions needs to be repeated, if not to study the internal movements of the corona, to obtain identical photographs at two different angles, which would enable us, with the aid of the stereoscope, to judge of the *relief* of the corona

Photographs of a total eclipse will not only inform us as to the structure of the corona, but will permit us to measure its actinic brightness We can estimate the relative intensity of different parts of the corona by superposing several photographs, made on the same scale, but obtained with very different photographic actions The outlines of each image would give lines of equal actinic intensity of the corona The absolute intensity may be measured by comparing the opacity of the image on the plate with the opacities produced on the same plate from a source of standard light For this purpose the plates destined for photography are previously exposed on their borders to a standard light for varying periods of time When these plates are developed, a scale of tones which allows a comparison of opacities is obtained at the same time as the image of the phenomena

The spectroscopic examination of the corona confronts us with still more complex and more interesting problems. When we keep the slit of the spectroscope on the crescent of the sun, which narrows more and more in proportion as the moon advances, the spectrum darkens and the dark lines become less and less apparent, then all at once the field of sight is covered with an infinite number of bright lines, which seem to be substituted for each dark line of the Fraunhofer spectrum This phenomenon only lasts two or three seconds Such is the remarkable observation made by Prof Young in 1870 In the preceding year he had tried to prove this transformation of dark into bright lines, but failed because he had arranged the slit of his spectroscope as a radius to the sun, which gave the bright lines too little length to be perceptible With a tangential slit, however, the lines were long enough to be easily recognised

Prof. Young's observations revealed to us the existence round the sun of a layer of incandescent vapours, of relatively low temperature, which, conformably to Kirchoff's theory, produce by their absorbing power reversal of the lines of the solar spectrum It is very probable that the vapours to which the reversal is due are not all situated in the atmosphere which Prof Young has revealed to us, and which has a thickness of only 1000 kilometres If it were so, absorption must be infinitely more intense at the edge of the sun than it is at the centre Nevertheless, the borders of the sun show no trace of this abnormal absorption The observations of M Janssen in 1867 showed this, and it is also proved by photographs of the spectrum of the sun which I took at the annular eclipse of 1890 at Canœ in the island of Crete

It is probable that the reversal of lines is produced in a series of layers whose total thickness is great enough to make the difference of absorption between the centre and limb of the sun inappreciable According to Prof Lockyer the sun should be surrounded by concentric layers of vapours arranged in order of density, which, according to his own expression, envelope the sun like "the leaves of an onion" Prof Young's layer of vapours would comprehend only some of these layers This hypothesis seems confirmed by the observation made by M Trépied in 1882 although he saw "a veritable rain of bright lines in the spectrum," he proved that the coincidence of the bright and dark lines was not complete

Prof Lockyer's theory involves also, as another consequence, the unequal length and width of these bright lines, indeed, the layer nearest to the sun should give short lines corresponding to the thickness of this layer, and as the temperature here must be very high the lines should be rather wide The following layer being seen by projection, and having a thickness equal to the two layers, should give lines twice as long, moreover, this second layer being cooler than the preceding the lines should be narrower The same reasoning applies to the succeeding layers, so that we ought to find, soon after the beginning of the total eclipse, short and wide lines, then long and narrow ones The observations of 1882 confirmed these predictions, and English astronomers wished to repeat the experiment in 1886 Unfortunately the observations of Father Perry and Mr Turner were made under conditions too unfavourable for us to draw any certain conclusion from them. To fully elucidate the question it is necessary to obtain instantaneous photographs of these bright lines The experiment was indeed attempted by English observers in 1883, but they seem to have obtained no result Prof Lockyer proposes during the approaching eclipse to photograph these lines as well as the bright lines of the corona. He intends to use not only an analytic spectroscope, but a prismatic object glass This apparatus will give the monochromatic images of the corona, that is to say, the kind of rings corresponding to each elementary radiation emitted by the coronal light

When we turn the spectroscope towards the corona itself we observe a continuous spectrum, crossed by a bright green line which does not belong to any known element This line, near the line E, corresponds to the division 1474 of Kirchoff's scale, and was at first believed to coincide exactly with a line of iron, but in 1876 Prof Young was able to separate the line 1474 with powerful dispersion, and proved that one of its two components belongs to iron while the other belongs to the coronal matter This line 1474 has been shown in every total eclipse, but its intensity has been very variable and seems always to have followed the fluctuations of solar activity Thus in 1878, a period of maximum spots, the green line was so faintly visible that it escaped all observers except two On the other hand, in 1882, when the solar activity was almost at its maximum, the green line was visible to within 40' from the limb However, we must remember that these estimations made by different observers, observing with very dissimilar instruments, are scarcely comparable, and trustworthy evidence can only be obtained from photographs of the spectrum of the corona. The new plates sensitive to the green will no doubt allow the line 1474 to be photographed in the approaching eclipse

It would be interesting to know whether the intensity of the green line varies with the brilliancy of the different parts of the corona, whether it is completely wanting in the rifts, whether it extends further than the visible corona, whether it has the same width in its whole extent, &c. These observations can only be made by associating with the spectroscope a telescope serving as a finder, in which cross wires have been arranged to indicate at each moment towards what part of the corona the slit is directed The spectrum is observed with one eye while with the other the corona is examined This is the arrangement which M Janssen has always adopted in his spectrum observations of the corona.

If the terrestrial atmosphere is loaded with water vapour, we must expect a general diffusion of the coronal light, and this is

doubtless the reason that on some occasions, as in 1870, the green line is seen beyond the corona—even upon the lunar disc

Prof Hastings, in 1883, examined simultaneously with a special arrangement the spectra of east and west portions of the corona, and proved, conformably to the theory that he propounds, that the green line varied in length during the duration of the eclipse, and that it always extended furthest on the most illuminated side of the edge of the moon. Mr. Keeler repeated the experiment in 1889, and also noted that the length of the green line depends upon the position of the sun with respect to the moon. The question would be worth studying further

The green line is not the only bright line in the spectrum of the corona, the hydrogen lines have also been discovered in it, but these never extend further than about 10′ from the sun's limb Other bright lines in the red and in the violet were observed by M Tacchini and by Thallon in 1882 It was in 1882 also that Prof Schuster obtained the first photograph of the coronal spectrum upon which some thirty bright lines may be counted

In addition to the incandescent solid or liquid matter producing the spectrum of the corona, and the incandescent gases, which give rise to bright lines, there must also be in the circumsolar regions matter reflecting the light of the photosphere, as our own atmosphere does This is proved by the polarisation of the light of the corona, and by the presence in its spectrum of the dark lines of the Fraunhofer spectrum We owe the discovery of these dark lines to M Janssen In 1871 he observed only the lines D and *b*, but, since, in 1883, he has recognised some hundred dark lines, thus showing that the complete Fraunhofer spectrum is found in the coronal spectrum These dark lines are necessarily very faint, for they are drowned in the continuous spectrum As a rule the line D is most conspicuous, although, according to Prof Hastings, if a faint solar spectrum is projected on to the continuous spectrum of a gas flame, it is not the line D, but rather the group *b*, which is by far the most apparent Prof Hastings concludes from this experiment that the continuous spectrum of the corona is richer in green than in orange radiation, since it causes the group *b* to disappear before the line D.

In conclusion I must quote a remarkable observation made by Prof Tacchini in 1883, which, should it be confirmed, would suggest a very fascinating theory of the corona Upon examining the spectrum of one of the sheaves (panaches) of the corona with a considerable dispersion and a wide slit, Prof Tacchini thought he recognised two or three bright bands characteristic of the hydrocarbons, which are always present in the spectra of comets Father Perry in 1886 proposed to verify the observation of Tacchini, but unfortunately could not re observe the bands in question Certainly he used a spectroscope with slightly illuminated cross wires, and when the period of great solar activity had already passed It would be well in future eclipses to devote some seconds to the search for these bands, for, if the presence of carbon were recognised in the coronal atmosphere, it would be a new proof of the analogy which exists between the corona and cometary masses Like comets the corona seems formed of matter subject to a repulsive force on the part of the sun, indeed it is probable that solar gravity does not act upon the corona, for unless this were so, the lower parts, having to support the weight of the upper, would be much more dense than the latter It would thus result that the lines of the coronal spectrum, the line 1474 for instance, would be wider at their bases than at their upper extremities, but nothing of the kind has hitherto been observed Moreover, so that the corona may be visible at 30′ or 40′ from the sun, the coronal matter must necessarily not be too rare in these extreme regions; but even in ascribing an extremely low density to this, we should find upon allowing for solar gravity that the pressure near the sun would have a considerable value, although it is proved that the pressure at the base of the corona does not exceed some millimetres of mercury.

It is also sought to prove the slight density of the middle corona by the fact that it has never offered any resistance to comets, which, on several occasions, have passed through it, but as comets themselves experience no appreciable resistance when they encounter a body it is impossible to tell whether the absence of resistance is due to the comets or to the corona.

The repulsive force which expels the coronal matter from the sun would act in the same manner as electrical force; indeed Prof. Bigelow has noticed that the arrangement of plumes and sheaves round the solar disc, and the curvilinear forms exactly recall the lines of force of an electric field Let us complete the parallel between comets and the corona by noting that the tails of comets sometimes assume the curvilinear form found in the sheaves of the corona The dark parts which divide the tails of comets have also their analogues in the rifts of the corona. To push the comparison still further, it would be very interesting to be able to prove that the corona, like cometary masses, is transparent, and that bright stars can be seen through it Unfortunately it will be impossible to attempt this experiment at the time of the next eclipse

An exact photometric study of the solar surface would perhaps detect the transparency of the corona, indeed if we suppose that the corona presents a certain opacity the parts of the photosphere on which the large sheaves are projected must be less luminous than the parts covered by the polar rays

If the corona is not subject to solar gravity it is scarcely probable that it shares the movement of rotation of the sun, however, it would be useful to try in the coming eclipse to study the question by the spectroscopic method, as M Trouvelot wished to do in 1883 It would be desirable to conduct all spectroscopic observations of the corona by means of photography The instruments which must be used for this purpose should be very luminous (*i e* give bright images), for there is little light available, and the exposures are necessarily short In studying the effectiveness of a spectroscope in the case of an object presenting a large apparent diameter, like the corona, it is seen that the intensity of the spectrum depends entirely upon the width of the slit, and the effectiveness of the object glass which forms the image of the spectrum As to the collimator and the condenser their dimensions are of no importance, provided that the collimator can well receive all the light of the condenser As the object glass which forms the image of the spectrum must have an image long enough to give sufficient length to the spectrum, one is led, in order to obtain great effectiveness, to give this object glass a large aperture, and consequently to use a prism of large size

The visibility of the bright lines depending not only on their brightness, but also on their width, a wide slit must be employed to obtain a good image of these lines, on the other hand, a narrow slit will give a spectrum of great purity, and will show the dark lines The employment of two different spectroscopes is then plainly indicated

It remains for us to speak of the photometric measuring of the corona by optical photometers Bunsen's photometer has already been used for this purpose, but I think that we must henceforth turn to photography to obtain exact results The question should not be neglected, for it is certain that the brilliancy of the corona varies considerably from one eclipse to another Thus Prof Lockyer estimates that in 1878, at a period of quiescence on the surface of the sun, the corona was ten times less brilliant that in 1871

Let us end by pointing to the polariscope observations which hitherto have been far from giving concordant results as to the proportion of polarised light in the various parts of the corona Here also there are new inquiries to be made

Such, gentlemen, are the different problems suggested by the study of the solar corona We will hope that the next eclipse will largely contribute to their solution

MEMORIAL OF SIR RICHARD OWEN

A MEETING was held at the rooms of the Royal Society, on Saturday, to make preparations for the provision of a suitable memorial of the late Sir Richard Owen The Prince of Wales took the chair, and was supported by the Duke of Teck, the President, the Treasurer, and the Secretary of the Royal Society, Lord Kelvin, Sir John Evans, and Professor Michael Foster, the President of the British Association, Sir A Geikie; the President of the Royal College of Physicians, Sir A Clark; the President of the Royal College of Surgeons, Mr T. Bryant, the President of the Royal Academy Sir F Leighton; the Bishop of Rochester, the Dean of Westminster, Lord Playfair, Prof. Huxley, Sir H. Roscoe, M P, Sir F Abel, Sir F Bramwell, Sir G Stokes, Sir H Acland, Sir Joseph Lister, Mr Ericsen, Dr Priestley, Dr Gunther, Dr H. Woodward, Dr Maunde Thompson, Sir W H Flower, Sir Erasmus Ommanney, Sir James Paget, Sir Henry Thompson, Sir Spencer Wells, Sir Edwin Saunders, Sir John Fowler,

Dr E A Bond, Dr. P L. Sclater, Mr Carruthers, and Mr W. P. Sladen There were also present, among others, Sir G M Humphry, Mr Holman Hunt, Mr Ernest Hart, Dr Michael (President of the Royal Microscopical Society), Prof. R Meldola, Mr. O Salvin, and Prof T Wiltshire

The Prince of Wales, in opening the proceedings, said,—I have the great privilege conferred upon me of being asked to take the chair to-day, upon this very special occasion. We are assembled together for the purpose of paying a mark and tribute of respect and appreciation to the memory of a great man of science who has lately passed away from us The name of Sir Richard Owen must always go down to posterity as that of a great man—one who was eminent in the sciences of anatomy, zoology, and palæontology Perhaps I may be allowed to say a word of my own personal knowledge of him It is now thirty-five years since I had the advantage of knowing him When I lived as a boy at the White Lodge, Richmond Park, now occupied by my illustrious relative on my right (the Duke of Teck), I had opportunities of visiting him and knowing him His geniality and his charm of manner to all those who knew him have, I am sure, left a deep and lasting impression Whether he was explaining to you the mysteries of some old fossil bone that had been given him, or whether he was telling one of his vivid ghost stories, one felt that one was under the charm of his presence His method of teaching, as you all know, was earnest and clear in every respect, and it even derived a measure of force from a certain hesitation in his manner His great repute was gained as a zoologist, and in the study, not only of living animals, but of those long extinct, and following the same large range of work as Cuvier, to whom, in the history of science, he may be regarded as a successor One of the great works and interests of his life was the formation of the Natural History Museum, which is now safely established in South Kensington under the able guidance of our friend Sir William Flower It may be within your recollection what great difficulties Sir Richard Owen encountered when he was first appointed Superintendent of the Department of Natural History at the British Museum in 1856 He himself saw in getting that appointment that it was quite impossible that these large collections could be adequately seen unless they were removed to some other sphere In 1862 a Bill was brought in by Mr Gladstone, who took the greatest interest in the matter, while it was vigorously opposed, strange to say, by no less great a man than Mr Disraeli The Bill was lost, though it was eventually, ten years later, carried, and now we have that fine building that we all know and deeply appreciate I may also mention that he took the greatest interest with regard to the colonies, and in trying to obtain from them specimens that would be worthily represented in the Natural History Museum In sanitary matters also he was not behindhand, as was shown by his long intimacy with that distinguished man, Sir Edwin Chadwick. There are several resolutions to be proposed, and you will hear far better and more eloquent remarks from the distinguished gentlemen who will move and second them That is the reason why on this occasion I shall not trouble you with more remarks Allow me only to repeat the assurance of the deep interest I take in this movement for a suitable memorial to the memory of this great man, and how deeply I appreciate having been asked to take the chair on this interesting and important occasion

Lord Kelvin moved —"That it is desirable that the eminent services of the late Sir Richard Owen in the advancement of the knowledge of the sciences of anatomy, zoology, and palæontology should be commemorated by some suitable memorial" He said that, if there was no other reason but the part that Sir R. Owen took in the establishment of the Natural History Museum, and the success that ultimately attended his efforts, he deserved the gratitude of the nation. There was scarcely any branch of the whole of natural history that he had not touched and enriched with the results of his investigations. Three hundred and sixty papers, every one of them valuable, were to be found under his name in the Royal Society catalogue of scientific papers. From these contributions, however, he came back to the Natural History Museum, and he held that every subject of the Queen, in these islands or in the colonies, and every visitor to this country, must feel that he was benefited by the existence of that museum and by the splendid arrangement of its contents.

Prof. Huxley, in seconding the resolution, said that, if he mistook not, there were very few men living who had had occasion to follow the work of the remarkable man whose career they had met to celebrate with more carefulness and attention than he had done It was a career remarkable for its length, for the rapid rise to eminence, and the long retention of high position of the person who was the subject of it It was more than forty years ago since he, as a young man, had occasion to look abroad upon the scientific world of London, in which he was then a complete novice, and to see whether, perhaps, in some small and insignificant corner of it room might be found for him At that time there were four persons whose names stood out amongst the first in the galaxy of scientific men of this country They were Sir John Herschel, Mr Faraday, Sir Charles Lyell, and, last, though by no means least, the famous Hunterian Professor, Owen If he looked abroad amongst the lights of biological science, with which he was principally concerned, there were Johannes Muller in Berlin, Milne Edwards in Paris, Von Baer in St Petersburg, but for quantity, general excellence, and variety of work there was no one who could be regarded as the superior of Owen It was a common impression that Owen was the successor and continuator of Cuvier, and that was largely true The memoirs on the pearly nautilus, on the marsupials, on the anthropoid apes were fully worthy of the author of the "Memoires sur les Mollusques" or the "Leçons d'Anatomie Comparée," while the "Ossemen fossies" had a full equivalent in the vast series of papers upon fossil remains, contained in the publications of the Royal, the Geological, and the Palæontographical Societies But it was also to be remembered that, in another field, Owen was the successor and continuator of the school to which Cuvier was most vehemently opposed—that of St Hilaire and Oken The remarkable contributions to morphology embodied in the works on the archetype of the vertebrate skeleton and on the nature of limbs were able developments of speculative views of another order than Cuvier's Readers of Goethe would remember that he thought the news of the controversy between Cuvier and St. Hilaire far more interesting than that of the Revolution of July, which broke out about the same time Whether that was a just estimate of the relative importance of things or not might be left an open question, but it was the peculiar irony of history to show us in so many quarrels that right and wrong were on both sides And in this particular controversy it had turned out that the right lay neither with Cuvier nor with St. Hilaire, but partly with both and partly with a third party, which at that time hardly existed Whatever might be the ultimate verdict of science in this particular matter, there could be no doubt that it was a distinct aid to progress to have one view of the case stated and illustrated with the unrivalled wealth of knowledge which Owen brought to bear upon it If history confirmed, as he believed it would, the estimate of the broad features of Sir Richard Owen's work, which he had suggested, then it would justify them in endeavouring to preserve the memory of the great results achieved by his stupendous powers of work, his remarkable sagacity in interpretation, and his untiring striving towards the ideal which he entertained

The resolution was then put and agreed to unanimously, as were also those which followed

The Duke of Teck moved —"That the memorial shall consist primarily of a marble statue which shall be offered to the Trustees of the British Museum to be placed in the hall of the Natural History Museum." His Royal Highness said,—There is no doubt, in my mind at least, that this would be the most appropriate place and the most appropriate form in which to erect the likeness of our admired friend It is, so to say, his second home, the home of his later labours, and no better place could be found Besides, I think it is a very nice idea that every one who enters the hall should see first of all the man to whom we owe this inheritance Others have said so much about Sir Richard Owen that it is needless for me to go over the ground again As all of us know so well, what he has been and what he has done will remain in the minds of all who survive him, and, therefore, I will only say that in my opinion the hall, which is a very fine interior, of the Natural History Museum should be the place where the memorial of this great man should be erected

Sir William Flower, in seconding the resolution, said that having twice in his life succeeded Sir Richard Owen, he had had special opportunities of judging of his work, and he might, therefore, be expected to say something about the general character and extent of that work on the present occasion, but after what had been said in the introductory remarks of His Royal Highness, and the speech of Prof. Huxley, than whom no one

was more competent to give an opinion upon the scientific side of the question, there was no necessity for doing so. He could not refrain, however, from speaking upon one point. Among the various characteristics of Sir Richard Owen, one of the most remarkable was his untiring industry, which enabled him to produce an amount of work which was truly prodigious. It could hardly be expected that such a vast series of memoirs on so many diverse subjects, as that which he had given forth to the world during his long life, could all be equal in quality, or that the merits of some of them should not have been the occasion of controversy. He would only refer to one instance of this kind. As long ago as 1837, Sir R. Owen read a paper before the Society in whose rooms they were now assembled, which was published in the Philosophical Transactions, and in which certain remarkable characteristics were stated to exist in the brain of marsupial animals, widely distinguishing them from other members of the class to which they belong. The conclusions apparently established by this paper were generally accepted for nearly thirty years, but in 1865 another memoir was read before the same society, and also published in the Philosophical Transactions, in which a different view was taken both of the nature of the structural peculiarities and of their significance in classification. The views of the author of this second paper have generally found favour until within a few months since, when an independent investigation of the subject, carried on with all the improved methods of modern research, by Dr. J. Symington, has resulted in a declaration in favour of the accuracy of Owen's original description and conclusions. These observations may still require confirmation by others, but as he (Sir W. Flower) was the author of the second paper, he considered it only fitting that he should, at a meeting assembled to do honour to the memory of the great anatomist, from whom, on this point, he had differed so long, call attention to them. He thought this the best contribution he could make to the object for which they had gathered together.

Dr. P. L. Sclater suggested that, in addition, a memorial catalogue of the late professor's writings should be issued, with a portrait and biographical memoir.

Sir James Paget moved that a committee be formed to carry out the preceding resolutions. It would be impossible, he said, to have any better evidence that the resolutions just passed were right than the number and position of those who had offered to serve on the committee, for there was never a more representative list. Headed by the Prince of Wales, the Duke of Teck, the Archbishop of Canterbury, and the Lord Chancellor, it contained nearly 150 of the most prominent workers in all branches of science and many who were the best judges of the influence of science on the general well-being of the nation. He was the oldest person present who had worked with Sir R. Owen, and could remember him on entering St. Bartholomew's Hospital as a student in 1834. He could testify to the influence Owen had exercised in promoting the study of science by showing to all around him how keen his delight was in it, and how in itself alone it might be a sufficient reward. He resisted all temptations to leave science, though he might have been a very successful medical practitioner, and he was one of the first by whom the real reform of sanitary matters was begun in this country.

Sir J. Evans briefly seconded the motion.

Sir A. Clark moved—"That the following list of gentlemen constitute the executive committee: His Royal Highness the Prince of Wales (chairman), His Serene Highness the Duke of Teck, the President of the Royal Society, the President of the Royal College of Physicians, the President of the Royal College of Surgeons, the President of the Linnæan Society, the President of the Zoological Society (treasurer), Sir John Evans, Prof. Michael Foster, Dr. A. Günther, Prof. Huxley, Sir F. Leighton, Sir James Paget, Dr. P. L. Sclater, Mr. W. Percy Sladen (secretary), Lord Walsingham, Mr. A. Waterhouse, R.A., and Mr. Henry Woodward." Sir Andrew remarked that this memorial movement reminded them that nations no more than individuals can live by bread alone. Material prosperity did not constitute the true abiding life of a nation; it was necessary that it should live by ideas; and the nation honoured those who, like Owen, communicated new ideas which spurred others to new courses of activity.

Mr. T. Bryant, in seconding the motion, said the College of Surgeons felt the loss that science had sustained in the death of him who unquestionably was the grand expounder of John Hunter and who, more than any one else, demonstrated the value of the materials John Hunter left behind him. He did more than any one else to call the attention of the scientific world to the museum in Lincoln's Inn, and by additions to it to make it what it is. More than that, at a time when comparative anatomy and biological studies were little thought of he called attention to the value of them, the necessity for them, and the pleasures they would yield. As a young man he attended Owen's lectures, and felt the full force of his quiet enthusiasm, which was altogether independent of the materials embodied in the lectures.

Lord Playfair, in supporting the motion, said that he was the last surviving member of the Health of Towns Commission of 1844, upon which he was brought into continual intercourse with Sir R. Owen, and therefore he knew how much Sir Richard had at heart the advancement of sanitary science. This interest in it he maintained throughout his whole career. He lived close to Sir Edwin Chadwick, and although no two men could be more unlike, they were most intimate friends, and were constantly discussing how to advance the health of the nation. When Sir Richard returned from his interesting expedition to Egypt he told the speaker that he had come back in an unforgiving spirit towards Moses, because though skilled in the learning of the Egyptians, and having derived his chief commandments from those of that ancient race, he missed one important one, "Thou shalt not pollute rivers." Owen, like Prof. Huxley, exercised great influence outside the domain of science. Prof. Huxley had benefited the education of the country, and Prof. Owen had considerable influence in improving the sanitary condition of the country.

Sir W. Flower read a first list of donations, headed with one of £25 by the Prince of Wales.

Sir Henry Acland moved, and Prof. Michael Foster seconded, a vote of thanks to his Royal Highness for consenting to become chairman of the committee, and for presiding on the present occasion.

The Prince of Wales, in responding, said,—I beg to return my warmest thanks to my kind and valued old friend, Sir Henry Acland, for the way he has proposed, to Mr. Michael Foster for the way in which he seconded, and to you all for the kind manner in which you have received this resolution. It has indeed been a labour of love to me to-day to preside on this very interesting occasion, and I think that it has seldom been my good fortune to listen to more interesting or eloquent addresses than those which have fallen from the lips of those eminent gentlemen who have spoken. Nobody will take a deeper interest in the carrying out of this memorial of our lamented friend Sir Richard Owen than myself, and most sincerely do I hope that the great work that is to adorn the Natural History Museum will be worthy of a great sculptor and of the great man that it represents.

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale de Belgique, Nos. 9 and 10. Classe des Sciences.—On some new *Caligides* of the coast of Africa and the Azores Archipelago, by P. J. van Beneden.—On an optical atmospheric phenomenon observed in the Alps, by F. Folie (see Notes).—On a state of matter characterised by the mutual independence of the pressure and the specific volume, by P. de Heen. It is easily shown that the density of saturated vapour at the critical temperature is variable, and depends, at constant pressure, upon the proportion of liquid enclosed in the tube. Experiments were made in order to decide whether this independence of pressure and volume was shown also at other temperatures. The liquid chosen was ether, and the volume of liquid and vapour contained in a sealed tube was read by means of a cathetometer. A series of results showed that during condensation by pressure the density of unsaturated vapour was greater than that of saturated vapour, or that the specific volume increased with the pressure. This is an experimental verification of Prof. James Thomson's pseudo-gaseous state of matter.—On the most complete reduction of invariant functions, by Jacques Deruyts.—Ex-meridian observations made at the Royal Observatory of Belgium from March to October, 1892, by L. Niesten and E. Stuyvaert.—On a new fluorine-derivative of carbon, by Frédéric Swarts. This is a liquid, of the formula CCl_3F, boiling at 24°.7, insoluble in water, and unaffected by sulphuric and nitric acids. Its density is 1.4944, an alcoholic solution of

potash destroys it gradually, forming potassium chloride, fluoride, and carbonate. It was obtained by treating carbon tetrachloride with a mixture of antimony trifluoride and bromine in equal molecular proportions. It is notable that the bromofluoride produced by the mixture acts not as a bromising but a fluorising agent.—On a simplification of some of Tesla's experiments, by H. Schoentjes. Like some recent workers in England, Prof. Schoentjes has found that most of the experiments can be produced, although with lesser intensity, without the bobbin immersed in oil, the discharge exciter, and the condenser, simply by the first Rhumkorff coil, whose dimensions need not exceed 7 × 17 cm.—On a process of sterilisation of albumin solutions at 100° C., by Émile Marchal. Albumin can be easily sterilised at 100° C., without coagulation, by first adding 0.05 gr. per litre of borax, or 0.005 of ferrous sulphate in a 2 to 5 per cent. solution, or 4 to 5 gr. nitrate of urea per litre of 10 per cent. solution. The "incoagulable albumin" thus obtained is perfectly suitable for cultivations.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 24, 1892.—"Memoir on the Theory of the Compositions of Numbers," by P. A. MacMahon, Major R.A., F.R.S.

In the theory of the partitions of numbers the order of occurrence of the parts is immaterial. Compositions of numbers are merely partitions in which the order of the parts is essential. In the nomenclature I have followed H. J. S. Smith and J. W. L. Glaisher. What are called "unipartite" numbers are such as may be taken to enumerate undistinguished objects. "Multipartite" numbers enumerate objects which are distinguished from one another to any given extent, and the objects are appropriately enumerated by an ordered assemblage of integers, each integer being a unipartite number which specifies the number of objects of a particular kind; and such assemblage constitutes a multipartite number. The 1st Section treats of the compositions of unipartite numbers both analytically and graphically. The subject is of great simplicity, and is only given as a suitable introduction to the more difficult theory, connected with multipartite numbers, which is developed in the succeeding sections.

The investigation arose in an interesting manner. In the theory of the partitions of integers, certain partitions came under view which may be defined as possessing the property of involving a partition of every lower integer in a unique manner. These have been termed "perfect partitions," and it was curious that their enumeration proved to be identical with that of certain expressions which were obviously "compositions" of multipartite numbers.

The generating function which enumerates the composition has the equivalent forms—

$$\frac{h_1 + h_2 + h_3 + \dots}{1 - h_1 - h_2 - h_3 - \dots},$$

$$\frac{a_1 - a_2 + a_3 - \dots}{1 - 2(a_1 - a_2 + a_3 - \dots)},$$

where h_s, a_s represent respectively the sum of the homogeneous products of order s and the sum of the products s together of quantities

$$a_1, a_2, a_3, \dots, a_n,$$

and the number of compositions of the multipartite

$$\overline{p_1 p_2 \dots p_n}$$

is the coefficient of $a_1^{p_1} a_2^{p_2} \dots a_n^{p_n}$ in the development according to ascending powers.

It is established that

$$\frac{1}{2}\,\frac{1}{\{1 - s_1(2a_1 + a_2 + \dots + a_n)\}\{1 - s_2(2a_1 + 2a_2 + \dots + a_n)\}\dots\{1 - s_n(2a_1 + 2a_2 + \dots + 2a_n)\}}$$

is also a generating function which enumerates the compositions, the coefficient of

$$s_1^{p_1} s_2^{p_2} \dots s_n^{p_n} a_1^{p_1} a_2^{p_2} \dots a_n^{p_n}$$

being the number of compositions possessed by the multipartite

$$\overline{p_1 p_2 \dots p_n}.$$

The previous generating function may, by the addition of the fraction $\frac{1}{2}$ and the substitution of $s_1 a_1$, $s_2 a_2$, &c., for a_1, a_2, &c., be thrown into the form

$$\frac{1}{2}\,\frac{1}{1 - 2(\Sigma s_1 a_1 - \Sigma s_1 s_2 a_1 a_2 + \dots (-)^{n+1} s_1 s_2 \dots s_n a_1 a_2 \dots a_n)},$$

and hence these two fractions, in regard to the terms in their expansions which are products of powers of $s_1 a_1$, $s_2 a_2$, ..., $s_n a_n$, must be identical. This fact is proved by means of the identity—

$$\frac{1}{2}\,\frac{1}{\{1 - s_1(2a_1 + a_2 + \dots + a_n)\}\{1 - s_2(2a_1 + 2a_2 + \dots + a_n)\}\dots\{1 - s_n(2a_1 + 2a_2 + \dots + 2a_n)\}}$$

$$= \frac{1}{2}\,\frac{1}{1 - 2(\Sigma s_1 a_1 - \Sigma s_1 s_2 a_1 a_2 + \dots (-)^{n+1} s_1 s_2 \dots s_n a_1 a_2 \dots a_n)}$$

multiplied by

$$1 + \Sigma \frac{2(A_{\kappa_1} + a_{\kappa_1}) \dots (A_{\kappa_t} + a_{\kappa_t}) - (A_{\kappa_1} + 2a_{\kappa_1}) \dots (A_{\kappa_t} + 2a_{\kappa_t})}{(1 - S_{\kappa_1}) \dots (1 - S_{\kappa_t})} s_{\kappa_1} s_{\kappa_2} \dots s_{\kappa_t},$$

where

$$S_\kappa = s_\kappa(2a_1 + \dots + 2a_\kappa + a_{\kappa+1} + \dots + a_n) = s_\kappa(A_\kappa + 2a_\kappa),$$

and the summation is in regard to every selection of t integers from the series

$$1, 2, 3, \dots n,$$

and t takes all values from 1 to $n - 1$.

This remarkable theorem leads to a crowd of results which are interesting in the theory of numbers.

The geometrical method of "trees" finds a place, and, lastly, there is the fundamental algebraic identity—

$$\frac{1}{k}\,\frac{1}{\{1 - s_1(ka_1 + a_2 + \dots + a_n)\}\{1 - s_2(ka_1 + ka_2 + \dots a_n)\}\dots\{1 - s_n(ka_1 + ka_2 + \dots + ka_n)\}}$$

$$= \frac{1}{k}\,\frac{1}{1 - k\Sigma s_1 a_1 + k(k-1)\Sigma s_1 s_2 a_1 a_2 - \dots + (-)^n k(k-1)^{n-1} s_1 s_2 \dots s_n a_1 a_2 \dots a_n}$$

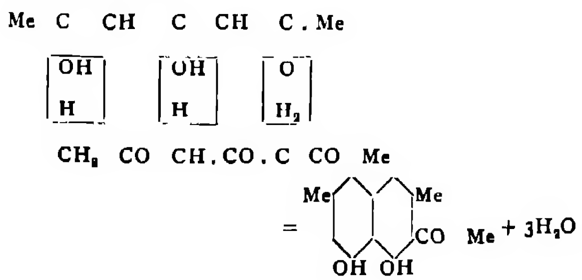
multiplied by

$$1 + \Sigma \frac{k(A_{t_1} + a_{t_1}) \dots (A_{t_n} + a_{t_n}) - (A_{t_1} + ka_{t_1}) \dots (A_{t_n} + ka_{t_n})}{(k-1)(1 - S_{t_1})(1 - S_{t_2}) \dots (1 - S_{t_n})} s_{t_1} s_{t_2} \dots s_{t_n},$$

which reduces to that formerly obtained when k is given the special value 2.

Chemical Society, December 13.—Mr. W. Crookes, Vice-President, in the chair.—The Stas Memorial Lecture, by J. W. Mallet, was read (see this vol. p. 248).

December 15.—Dr. W. J. Russell, Vice-President, in the chair.—The following papers were read:—The identity of caffeine and theine and the interactions of caffeine and auric chloride, by W. R. Dunstan and W. F. J. Shepheard. Various physiologists have concluded that differences exist between theine from tea and caffeine from coffee; the authors have compared the products from the two sources, and consider that their identity is beyond question. The differences in physiological action observed by Mays, Brunton, and Cash can only mean that the alkaloids employed were either impure or administered under non-comparable conditions. On heating an aqueous solution of caffeine aurichloride, a yellow precipitate of aurochlorocaffeine $C_8H_9(AuCl_2)N_4O_2$ separates; the production of this substance is better explained by Medicus' formula for caffeine than by that of E. Fischer.—Studies on isomeric change, ii. Orthoxylenesulphonic acids, by G. T. Moody. 1 : 2 : 3 orthoxylenesulphonic acid, when heated at 115–120° in a current of dry air, undergoes quantitative conversion into the isomeric 1 : 2 : 4 sulphonic acid. The former acid is prepared by sulphonating dibromorthoxylene and reducing the resulting dibromorthoxylenesulphonic acid with zinc dust and sodium hydroxide. A number of derivatives are described.—Studies on isomeric change, iii. Phenetoilsulphonic acids, $C_6H_4(OEt)SO_3H$, by G. T. Moody. Bromophenetoilsulphonic acid, prepared by ethylating parabromophenol and sulphonating the bromophenetoil so obtained, is readily reduced by zinc dust and sodium hydroxide with formation of orthophenetoilsulphonic acid. The latter is completely converted into the isomeric parasulphonic acid on heating for several hours at 100°. Lagai's observations, contradicting the author's previous results, are shown to be erroneous.—Formation and nitration of phenyldiazoimide, by W. A. Tilden and J. H. Millar. Phenyldiazoimide, N_3Ph, is readily obtained by the interaction of nitrosyl chloride and phenylhydrazine in glacial acetic acid solution; on nitration it yields about two-thirds of its weight of the paranitro-derivative (m.p. 74°). Nitrophenyldiazoimide is a convenient source from which to prepare diazoimide.—The production of naphthalene derivatives from dehydracetic acid, by J. N. Collie. The author concludes that the yellow substance which he has previously obtained by the condensation of diacetylacetone (see this vol. p. 238) is probably formed in accordance with the following equation:—



This substance gives a diacetyl derivative which on distillation with zinc dust yields a trimethylnaphthalene. The condensation product closely resembles the acetonaphthols prepared by Witt and Erdmann.—A new synthesis of hydrindone, by F. S. Kipping. Contrary to the statement of Hughes, hydrindone may be easily prepared in large quantities by the action of aluminium chloride on phenylpropionic chloride; 50–60 per cent. of the theoretical yield is obtained, the reaction being represented by the following equation: $Ph.CH_2.CH_2.COCl = Ph\left\langle\begin{matrix}CH_2\\CO\end{matrix}\right\rangle CH_2 + HCl$. The ketone prepared in this way is identical with that obtained from other sources by several chemists; its hydrazone, hydroxime and a nitro-derivative are described. On heating hydrindone with moderately concentrated sulphuric acid a condensation product, $C_{18}H_{14}O$, is obtained; it forms yellowish plates melting at 141.5–142.5°. Phosphoric anhydride converts hydrindone into a yellow crystalline substance, which is apparently identical with the hydrocarbon of the empirical composition C_9H_6, which the author has previously obtained by the action of phosphoric anhydride on phenylpropionic chloride.—The resolution of methoxysuccinic acid into its optically active components, by T. Purdie and W. Marshall. Synthetical methoxysuccinic acid can be resolved into its optically active constituents by crystallisation of the acid cinchonine salts, the salt of the dextro acid being less soluble in water than that of its lævo-isomeride. The separation effected in this way is, however, only partial, the metallic salts obtained after removal of the alkaloid being a mixture of the active and inactive compounds; by taking advantage of the fact that the inactive calcium or acid potassium salt is less soluble in water than its active isomeride, the optically active acids may be isolated. The active acids have a specific rotatory power of about 33° in 5–10 per cent. aqueous solutions and melt at 88–90, whilst the inactive acid melts at 108°. The rotation of the normal ammonium or potassium salt is of the same sign as that of the parent acid; the rotation of the calcium or barium salt is of opposite sign to that of the acid, but varies greatly with change of concentration. The rotation of the barium salt changes sign in very dilute solutions.—Optically active ethoxysuccinic acid, by T. Purdie and I. W. Walker. If fed with nutritive mineral salts the spores of *Penicillium glaucum* flourish in a solution of inactive hydrogen ammonium ethoxysuccinate and consume the lævogyrate acid, leaving the dextro-acid unaltered. On crystallising the cinchonidine salt of the inactive acid, a separation into the lævo- and dextro modifications may be effected, and the oppositely active acid ammonium salts prepared in this way resemble that obtained by means of *Penicillium glaucum*. Close parallelism exists between the methoxy- and ethoxy succinates, with respect to optical activity.—The formation of benzyldihydroxypyridine from benzylglutaconic acid, by S. Ruhemann. Ethyl benzylglutaconate slowly dissolves at 100° in concentrated aqueous ammonia, yielding a solution, from which acids separate benzyldihydroxypyridine. This substance exhibits both basic and acid properties and melts at 184°.—The action of nitrous acid on 1 α-amido 2-β naphthol; a correction, by R. Meldola. The author agrees with the statement of Grandmougin and Michel that β naphthaquinone results from the interaction of nitrous acid and 1-α amido-2 β naphthol.—Note on the action of phenylhydrazine on mono- and di-carboxylic acids at elevated temperatures, by W. R. Hodgkinson and A. H. Coote. On distilling a mixture of phenylhydrazine and phenylacetic acid in equivalent proportion, benzene, aniline and a liquid of the composition $C_{14}H_{12}O_2$ distil over; nitrogen and ammonia are also evolved. As has been previously shown, the hydrazide of the composition $Ph.CH_2.CO.NH.NH.Ph$ is the first product of the reaction; on distilling this substance, NH.NH is split off, and reduces the phenylhydrazine present to aniline and benzene. Somewhat similar reactions occur in the cases of orthotoluic, phenylpropionic, and succinic acids, and are now under investigation.

SYDNEY

Royal Society of New South Wales, September 7, 1892.—Prof. Warren, President, in the chair.—Paper read: The effect which settlement in Australia has produced upon the indigenous vegetation, by A. G. Hamilton [Part I.]

October 5.—Prof. Warren, President, in the chair.—The second part of paper on the effect which settlement in Australia has produced upon indigenous vegetation, by A. G. Hamilton, was read, after which the society's bronze medal and a cheque for £25 were presented to the author.

November 2.—Prof. Warren, President, in the chair.—Dr. William Huggins, F.R.S., was elected an honorary member of the Society. The following papers were read:—Preliminary note on limestone occurring near Sydney, by H. G. Smith.—On a cyclonic storm near Narrabri, by H. C. Russell, F.R.S.—Some folk-songs and myths from Samoa, translated by the Rev. G. Pratt, with introduction and notes by Dr. John Fraser.

PARIS

Academy of Sciences, January 16.—M. de Lacaze Duthiers in the chair.—Swimming movements of the ray fish, by M. Marey. These were investigated by means of chronophotography, ten exposures being made per second. The fish was fixed in position by the head and tail, and the views were taken from the front and the side respectively, the fins being left free

to move The photographs show the successive phases of one entire motion of the fins, which consists of a wave like motion beginning in front Shortly after the anterior portion has been lifted it is depressed, the motion being meanwhile propagated to the lateral portions, and growing in amplitude as the fin grows in breadth Just before the movement dies out near the tail the process recommences in front The periodic time was 0 8 seconds The photographs show a striking likeness to those obtained by chronophotography applied to the flight of birds M Marey intends to study the mechanical effect of the action of the fins upon the water, also by the aid of photography — Microscopic researches on the contractility of the blood-vessels, by M L Ranvier The periœsophagian membrane of the frog was placed on the disc of the slide cell in one or two drops of peritoneal serum It was kept extended by a platinum ring, electrodes of tinfoil were placed in connection, and a cover glass was fixed over the whole with paraffin Thus mounted, the smooth muscular fibres and the internal elastic sheath are well seen On connecting the induction coil with the electrodes, the muscular fibres contract as soon as the current is strong enough At the same time, the folds of the internal sheath become more pronounced and finally touch, thus effacing the passage through the small artery On breaking the current, the artery gradually regains its original diameter If the current is not sufficiently strong for producing a regular contraction, some of the segments contract, while others are at rest But the zone of contraction is never displaced, and, if interrupted, will reappear at the same place on reestablishing the current Nothing corresponding to a peristaltic motion can be produced by direct electrical excitement In none of the experiments, even with the strongest currents, was it possible to detect any signs of contraction in the capillaries —On the sum of the logarithms of the first numbers not exceeding x, by M Cahen —On differential equations of a higher order, the integral of which only admits of a finite number of determinations, by M Paul Painlevé —On linear differential equations with rational coefficients, by M Helge von Koch —Electric waves in wires, depression of the wave propagated in conductors, by M Birkeland (see *Wiedemann's Annalen*, abstract) —On the minimum perceptible amount of light, by M Charles Henry This was estimated by Aubert at $\frac{1}{300}$th of the light of the full moon This is about a thousand times too great, as proved by some measurements made with the zinc sulphide (phosphorescence) photometer previously described The corrected formula for the rate of loss of luminosity of the sulphide is $i^{0\cdot 5}(t - 18\cdot 5) = 1777\cdot 8$, which agrees even with the longest observations, and is theoretically justified by M Henri Becquerel The minimum perceptible amount of light was determined by noticing the time at which the eye, previously kept in the dark for one hour, could only just distinguish the light emitted by the phosphorescent substance, taking care to test for illusions by the successive interposition of ground glass screens The time thus found was four hours, giving an amount of light of 29×10^{-9} standard candles at 1 m If the eye is previously kept in the dark during varying periods, the minimum varies inversely as the square of the time during which it is kept dark —On phosphorescent sulphide of zinc, considered as a photometric standard, by the same Careful tests showed that the light emitted by zinc sulphide at a given instant is independent of the distance of the illuminating magnesium ribbon, of the time of illumination, and of the thickness of the layer, and is also uniform in samples prepared under different conditions, thus exhibiting all the requisites of a secondary photometric standard —On an acid plato nitrite of potassium, by M. M Vèzes.—Decomposition of chloroform in presence of iodine, by M A. Besson —On some ethers of homopyrocatechine, by M H Cousin.—On the determination of phosphorus in iron and steel, by M Adolphe Carnot The new method, based like most others on the employment of ammonium molybdate, differs from them in the mode of separation of the silicon, which is effected by sulphuric acid, in the process of destruction of the carbon compounds, brought about by chromic acid, and in the nature of the final compound, which is not magnesium pyrophosphate, but dry phosphomolybdate of ammonia, which only contains 1 628 per cent. of phosphorus, thus ensuring a greater accuracy in the quantitative estimation.—Losses of nitrogen in manure, by MM. A. Muntz and A Ch Girard.—Researches on the localisation of the fatty oils in the germination of seeds, by M Eugène Mesnard It appears that, except in the grasses, the fatty oil is not specially localised. It is in all cases independent of the starch and the glucose, but it appears superposed upon the albuminoid materials in the reserves of ripe seeds.

BERLIN

Physical Society, December 16, 1892 —Prof Kundt, President, in the chair —Dr Lummer spoke on the principles involved in the use of half-shade polarimeters. He showed that the difference in brightness of the two halves of the field of the instrument depends first on the angle between the two polarising prisms, the less this is the greater being the difference produced by a minimal rotation of the analyzer, and secondly on the power of perceiving minute differences of brightness In connection with the latter he had made some changes in the Lippich instrument which presented some distinct advantages —Prof Goldstein gave an account of some experiments made many years ago, but not yet published He first dealt with the light which appears at the anode, and which, as compared with that of the kathode, has as yet been but little investigated As is well known, a kathode consisting of two metals emits rays of different brightness from its two parts, thus for instance the aluminium emits brighter rays than does the silver When this electrode is used as an anode, the reverse holds good, inasmuch as the anodic light of silver is brighter than that of aluminium The difference is, however, only observed in rarefied oxygen, and does not exist in a hydrogen tube, and is hence due to oxidation of the silver The second set of experiments dealt with Crookes' supposed reciprocatory deflection of kathodic rays of similar direction The speaker had shown, by shielding one of the electrodes, that the deflection is apparent, not real The change in the path of the kathodic radiation is due entirely to the effect of the second electrode upon the rays emitted by the first

CONTENTS.

THURSDAY, FEBRUARY 2, 1893

TROPICAL AGRICULTURE

A Text-book of Tropical Agriculture By H A Alford Nicholls, M D, F L S, C M Z S, with illustrations, pp 312 (London Macmillan and Co, 1892)

THIS text-book is the English edition of a work that has already received high commendation from the Government of Jamaica The Government of this now prosperous colony, in pursuance of a policy (which may well be followed by other colonies) offered a premium of one hundred pounds for the best text-book of Tropical Agriculture adapted for the use of colleges and higher schools in the colony The award was made to Dr Nicholls's manuscript, and after the publication of the work in Jamaica it was adopted also as a text-book by the Government of other colonies, so that its value has been practically estimated beforehand The author's qualifications for the task he has undertaken may be gathered from the following —

"Twelve years ago, when he had to direct his attention to tropical agriculture, there was no practical book that he could turn to for help in all the difficulties that were constantly cropping up in his path Knowing, therefore, the obstacles that usually beset the inexperienced planter who is not content to follow the old grooves of unscientific agriculture, the author has so written the second part of this book as to afford the information he needed greatly in his own planting novitiate This has rendered it necessary to enter into details, which to the experienced agriculturist may appear superfluous, but the book is really intended as a guide to the young and unlearned to whom such details are likely to be of essential service"

As an introduction to tropical agriculture this book supplies a want long felt There are several works of a technical character treating of old and well-established industries such as sugar, tea, coffee, cacao None of these, however, could be adopted as text-books in schools Indeed they all presuppose such a close acquaintance with the principles and terminology of tropical agriculture that they appeal to a very limited class of readers Hitherto, tropical agriculture, to a large extent, has borrowed most of its methods from the agriculture of temperate climates and adapt them, as well as it could, to the very different circumstances of the torrid zone The result has been by no means satisfactory In tropical regions effects follow cause so rapidly that methods admirably adapted to the cold, sluggish climates of northern countries are most injurious when too closely followed in the tropics. As instances we may cite the serious effects on climate following the extensive cutting down of forests, and the wholesale washing away of surface soil from land under permanent cultivation by the destructive influences of tropical rains. The merit of Dr Nicholls's book lies in the fact that its precepts are directly based on his own experience, and he appeals so effectively to the intelligence of his readers that they cannot fail to be instructed The work is divided into two parts:—Part I. deals with the elementary principles of agricultural science and discusses amongst other subjects the origin and composition of soils, the nature of plant life, the controlling influence of climate, the action and constituents of manures, the rotation of crops, the drainage of soils, irrigation, tillage operations, pruning, budding, and grafting. In Part II there is treated the application of these principles to some of the chief of the various cultivations undertaken in tropical countries As examples we may mention that there are detailed accounts given of the methods found most successful in the cultivation of coffee, cacao, tea, sugar-cane, fruits, spices, tobacco, drugs, dyes, tropical cereals, and such food plants as cassava, arrowroot, yams, sweet potato, tania (*Colocasia*)

The book is intended also, according to the preface, to be of service to peasant proprietors, owners of small estates, and to those [European] settlers who from time to time may wish to make their homes in the tropics It is just these people who are now building up the new prosperity of the West Indies by means of what are called "minor industries" or *la petite culture*—which the French have found so remunerative in many of their colonies To guide and instruct the mass of small cultivators in the West Indies has been the dream of the most enlightened Governors, such as Sir John Peter Grant, Sir Anthony Musgrave, Sir William Robinson, and others that have ruled there for the last thirty years The intelligent settlers of European origin can very well take care of themselves but the mass of the small cultivators are black people They have, it is true, received some education, and they are not wanting in intelligence in regard to what concerns their own interests, but their methods of cultivation have, hitherto, been of the rudest and most destructive description They crop the land year after year without any manuring, and when it is thoroughly exhausted they move on, when they can, to fresh land, and treat that in exactly the same way Thus in the black man's system of cultivation the rotation is of land, and not of crops, and the future has to take care of itself This is a relic of the times of slavery, when the negroes were allowed as much land as they cared for—out of reach of sugar cultivation—to grow provisions for their own subsistence It is now necessary to change the whole character of the black man's cultural methods, or the rich and fertile lands still left in the West Indies will be absolutely ruined. Generally only the lowest class of negroes have hitherto been attracted to field work. The education given to these people is responsible for something of this result, for it leads them, in too many cases, to regard labour in the field as degrading, and almost a return to a state of slavery. The sharper and more intelligent boys, when they leave school, are drawn away to seek a precarious existence as clerks in stores or as small shopkeepers, where they seldom do more than copy the weaknesses and vices of the whites, while, according to our author, if they took to the land, and had a right understanding of agricultural methods, they "need never despair of becoming prosperous" In the more advanced colonies, such as Jamaica, there is a disposition to establish industrial schools and train the younger generation in approved methods of cultivation, and lead them to regard the tillage of the soil as a more honourable and remunerative occupation than petty trading We may hope that the claims of industrial education will become more widely recognized, not only in the West Indies but in all our tropical colonies where native races have to be dealt

with In the meantime colleges and schools must prepare competent instructors for the work, and for both teacher and taught this book is an admirable starting-point In it the whole field of small industries is well covered, and the language is clearly expressed and well chosen. As an example of the author's treatment we find under manures (p 49) :—

"The land must be regarded by the planter as a bank in which he has opened an account If he continually draw cheques on the bank, and make no fresh deposit to meet the drain, he will sooner or later come to the end of his capital, and the same argument applies to the soil In cacao and coffee cultivation in the West Indies, particularly on lands of peasant proprietors, one often sees the planter take away crops year after year, whilst he does next to nothing to make up for the heavy drain on the land; and then, after a time he finds he gets very small crops, and he thinks the fault lies with the trees, or that the soil is not adapted to the cultivation, whereas the fault is entirely his own, as he has gone on taking away from the soil without putting anything back." Again, "the great fault hitherto committed by tropical planters has been the confining of their attention to one kind of cultivation on their land If several different crops were taken off alternately, as in a system of rotation, or grown in different parts of the land, where the soil and climate prove suitable, the planter would be in a much better position than he is now, for he would not 'have all his eggs in one basket'"

It is noticed that the valuable services rendered to colonial industries by Kew and by the various botanical institutions in correspondence with Kew are fully recognised Further, the dedication of this first Text-book of Tropical Agriculture to Sir Joseph Hooker is a compliment not only to his own distinguished services, but also to those of his father, for both in their day took the deepest interest in the West Indies It must be gratifying to the late Director of Kew to learn "in the quiet of his retirement that the influence of his work lives on and bears fruit even in the far-away field" of the West Indies

D M

CELLS THEIR STRUCTURE AND FUNCTIONS

Die Zelle und Die Gewebe, Grundzuge der allgemeinen Anatomie und Physiologie Von Prof. Dr Oscar Hertwig (Jena Gustav Fischer, 1892)

TEXT-BOOKS on Histology introduce the structure of the tissues to their readers by a chapter on cells, and the best treatises on Anatomy, either human or comparative, usually devote some pages to the consideration of these, the most elementary of all the tissues. As so many important advances have been made of late years in our knowledge of the structure of cells and their contained nuclei, of the properties of protoplasm, of the division of nuclei and the part played by the nucleus in cell multiplication, and of the influence exercised by cells in the problems of hereditary transmission, the time has obviously arrived for the production of a treatise devoted to the description of the cell in its various aspects, observational as well as speculative. No better expositor of the subject in all its bearings could be found than Prof. Oscar Hertwig, who has himself conducted important investigations on this branch of anatomy. The book now before us treats of the general anatomy and physiology of cells, and is to be followed by a second volume, in which the origin and physiological properties of the tissues are to be expounded, as well as their structure.

After a sketch of the history of the cell theory and of the theory of protoplasm, in which, as is too often the case in German text-books, the names of British observers and authors are conspicuous by their absence, he defines a cell to be a little clump of protoplasm which incloses a specially-formed constituent, the nucleus; a definition which accords with those previously made by Leydig and Max Schultze. He then describes at considerable length the characters of protoplasm, both anatomical and physiological, and the chemico-physical and morphological properties of the nucleus. In a short section he discusses the question, Do elementary organisms exist without nuclei? i.e Can you have little clumps of non-nucleated protoplasm pursuing an independent life? As is well known, Haeckel described organisms of this simple character, as cytodes, and gave Monera as an example, but Hertwig is disposed to think that such non-nucleated organisms have not been definitely demonstrated in the animal kingdom, and he quotes Butschli's observations, which seem to show that even in such micro-organisms as Bacteria a differentiation of a nucleus from surrounding protoplasm can be distinguished

Two important chapters are written on the movements of protoplasm, of cilia, of flagella, of spermatozoa, on contractile vesicles, and on the irritability of protoplasm under the stimulus of heat, light, electricity and several kinds of mechanical and chemical irritants The fifth chapter is devoted to the consideration of the nutritive changes and formative activity in cells Illustrations are given of the power possessed by certain unicellular organisms of taking into their substance and digesting solid bodies of various kinds, and an account is appended of the important observations of Metschnikoff on phagocytosis

Chapters six and seven are occupied with a description of the multiplication of cells, their mode of division, and the method of fertilization The process of karyokinesis is described at some length and in its various phases, in clear and precise language, and with an amount of illustration which enables the reader to follow without difficulty this complicated process The influence exercised by the nucleus, and the part which it plays in the process of cell multiplication, has now been put by the labours of many investigators on a basis of observation, both as regards plants and animals, such as cannot be controverted, and the accuracy of the generalization made half a century ago, both by Martin Barry and John Goodsir, that young cells originate through division of the nucleus of a parent cell, has been amply established

Dr Hertwig also recites observations which seem to show that the nucleus does more than act as a reproductive centre within the cell, but also takes a part in cell nutrition. This function of the nucleus was also contended for by Goodsir, but during the period when protoplasm was regarded as the essential element in nutrition or secretion, the claim of the nucleus to take any share in this phase of cell activity was summarily put aside. Recent observations have, however, shown that

clumps of protoplasm, removed from either a unicellular plant or animal, in which no nucleus is present, although capable of living, and retaining their irritability and power of movement for some time, yet neither grow, nor form a cell membrane, nor have the same power of digesting bodies introduced into their substance, as is possessed by a clump of protoplasm which has retained the nucleus The nutritive activity of the protoplasm would appear, therefore, to be under the influence of the nucleus

The volume concludes with a chapter on the cell in its relation to theories of heredity The author, as is now the prevailing opinion amongst biologists, contends that the nucleus is the conveyer of hereditary properties, and that the offspring is a mixed product of both its parents, derived from the ovum and the sperm cell In the course of this chapter he discusses the views of Darwin, Spencer, Nageli, Weismann, and De Vries, and suggests the employment of the term "Idioblasts" for the minute elementary particles, which Darwin called "gemmules" in his hypothesis of pangenesis, and which he conceived to be capable of transmitting hereditary characters to succeeding generations

THEORETICAL MECHANICS

Elementary Mechanics of Solids and Fluids By A L Selby, M A (Oxford Clarendon Press, 1893)

AT a period when we are bound to recognize the influence exerted by the examinations of the various educational institutions and of those controlled by other more or less influential examining bodies, we may be excused, on the arrival of a new work, for stating whether or not, and to what extent, it is adapted to their requirements. The book before us does not appear to have been intentionally written for examination purposes, and perhaps on this account it will be all the more welcome Its purpose, however, is very distinct It is intended for those students who are desirous of reading mechanics as an introduction to a study of physics So far, therefore, as its suitability for examinations is concerned, we can heartily recommend it to those who wish to qualify in this particular branch of science, while at the same time it will be read with great benefit by that class of students who desire a thorough knowledge of the portions generally included under the head of Theoretical Mechanics

In the study of such subjects as the book treats of, the amount of knowledge which the reader may have of mathematics will, to a considerable extent, be a measure of his success The author expresses a hope that an acquaintance with the elements of algebra and geometry will suffice ; but, while not wishing to reduce the usefulness of the book, but rather to direct it into proper hands in which it will be read with greater advantage, we think it would be nearer the mark to say that a thorough knowledge of elementary algebra and a considerable acquaintance with elementary trigonometry are necessary. Certainly the definitions of the trigonometrical ratios will be found in an appendix, but it will be far better if the student has lived with and used these for some time.

Possessing these requirements, he will appreciate and even admire the broad, yet concise nature of the treatment generally, and with regard to this matter we may say that we are unacquainted with any elementary text-book better calculated to create a desire for precise and full ideas That this is requisite for a study of physics perhaps more than any other subject, no one will deny

The first chapter of the book is occupied with a consideration of Kinematics, and in it will be found a careful exposition of the displacement, velocity, and acceleration to which a body may be subjected, due attention being drawn to what is necessary for a full representation of them The appendix following this contains some geometrical theorems and definitions for subsequent use Then follow the usual chapters on the laws of motion, work, and energy, centre of gravity, moments of inertia, and simple machines A chapter on gravitation will be read with interest, preceded as it is by an explanation of some of the geometrical properties of the ellipse Kepler's laws of planetary motion are dealt with; in addition to other relevant matters which do not usually find their way into elementary text-books.

The subject of elasticity also receives a somewhat more extensive treatment than is usually given to it The various kinds of stress and strain which a body may undergo are explained, together with the relation between stress and strain At the end of the book we find what is included under the second head of the title The various principles and laws which refer to fluids, and some of the machines and instruments which depend on them for their action, are enumerated and explained, while the interesting subject of capillarity has a separate chapter devoted to it

To an appreciative reader it is a source of satisfaction to observe the care the author has exercised when dealing with the important matter of definitions and units—fundamental and derived A chapter on units and their dimensions is furnished at the end.

A good selection of examples, bearing on the matter treated therein, will be found at the close of the chapters

Many portions of the book are characterized by a decided freshness of treatment, and we have little doubt that the careful reader will find many little points which are satisfying, in that they tend to widen the somewhat restricted views he may have previously held, and these will be all the more apparent should his mind be of a mathematical turn. G. A B

OUR BOOK SHELF

Magnetism and Electricity By R. W. Stewart. (London W. B. Clive and Co)

THE book forms one of the University Correspondence College Tutorial Series, and is "primarily written for the use of candidates for the Matriculation, Intermediate Science, and Preliminary Scientific Examinations of the University of London" The author is evidently familiar with the difficulties which usually occur to students, and the best portions of the book are those in which efforts are made to elucidate some of the more general errors The descriptions of apparatus and phenomena are, however, generally rather short and meagre, while the diagrams are frequently inadequate for a work of this sort Little is written to help the beginner to perform experiments for himself ; in fact, descriptions of many important instruments are omitted—for example, the Wheatstone

Bridge—and to students having no access to a laboratory little satisfaction will be given when told "The details of the construction and practical use of the different forms of Wheatstone's Bridge used in the measurement of resistance are best learnt in the laboratory, and for this reason we shall not give any further description of the arrangement"

In many instances the student is driven through a mass of theory before he has a fair idea of the general phenomena, thus in the introductory chapter on "Current Electricity," after a six-line description of a simple cell and current, over two pages are occupied in proving that the effects produced could be explained by the dissociation and procession of the hydrogen and oxygen atoms. The work is generally remarkably free from errors and misprints, but one occurs in the explanation just mentioned The attraction of zinc for oxygen is said to be much greater than that of the copper, while later the zinc is also considered "to *repel* hydrogen *less*" Here, and in many other instances, the words to be emphasised are printed in italics Another mistake will be found on pp 168 and 169, where in comparing, by the method of oscillations, the field due to a magnet with that of the earth, the author starts with the equation $\frac{I+H}{I}=\frac{n_1^2}{n^2}$ instead of $\frac{I+H}{H}=\frac{n_1^2}{n^2}$, and reasoning correctly from this false hypothesis, he deduces false results, while the answer to Ex 8 on this part of the subject appears incorrect Fig 13, p 201, in illustration of Oerstedt's experiment, is not correctly drawn.

The arrangement of "calculations" and examples at the end of each chapter must prove extremely useful to students possessing beforehand an elementary knowledge of the general phenomena, and to such, rather than to the very beginner, the book may be commended H S J

Manners and Monuments of Prehistoric Peoples By the Marquis de Nadaillac Translated by Nancy Bell (N D'Anvers) (New York and London G P. Putnam's Sons, 1892)

A BOOK summing up in a popular style all that is now known with regard to prehistoric man would probably be welcomed by a tolerably large class of readers The present work does not quite supply the kind of summary that is wanted The author does not distinguish with sufficient clearness between the various periods with which he deals, he indulges too freely in talk of a vaguely moralising tendency, and some of his statements do not accord with the conclusions of the best authorities Speaking of the Round Towers of Ireland, for instance, he says, "According to the point of view of different archæologists, they have been called temples of the sun, hermitages, phallic monuments, or signal towers" The reader is thus left to suppose that the question is still open, whereas all competent students of the subject accept the theory of the late Mr. Petrie, a theory which the Marquis de Nadaillac does not even mention However, the author has presented a large number of interesting facts in the course of his exposition, and there are occasional passages in which he brings out very well the attractive elements of some of the more fascinating departments of archæology.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications*]

Two Statements.

IN a letter addressed to the *Daily Chronicle*, dated January 15, 1893, Prof. Karl Pearson makes two statements respecting my opinions and grounds of action:

"As in society at large, so in academic matters, his mode of insuring progress is unlimited individual competition,"

and again

"he is an individualist in all matters"

Seeing that in an essay "On Administrative Nihilism," published twenty-two years ago, and in another on "Government Anarchy or Regimentation," published in 1890, I have done my best to combat the doctrine Prof Pearson attributes to me, I shall be glad to know what justification he has to offer for so grave a misrepresentation. The purpose of it is obvious

T H HUXLEY

Hodeslea, Eastbourne, January 29

A Meteor

THE following is taken from the Pretoria *Weekly Press* for January 7 "A few evenings ago a meteor of unusual size and brilliancy was observed at Bloemfontein shooting right across the eastern sky It looked like a rocket of a greenish colour, and burst in a shower of sparks in the south-east The spectacle was much admired by those who were fortunate enough to witness it"

This meteor, as seen in South Africa, appears to have had many points in common with a similar one seen in England about the same time, and reported by several observers in the daily Press

W L. DISTANT

Purley, Surrey, January 31

"Hare-lip" in Earthworms

ATTENTION has recently been drawn by Prof Andrews (*American Naturalist*, September, 1892) and myself (*Science Gossip*, 1892) to some abnormal conditions of life among the terrestrial annelids. I have now to place on record a totally new appearance, which is, I think, very aptly expressed by the term "hare-lip." The worm which I have had under examination presented the peculiarity figured below, and when alive and in motion suggested to my mind most forcibly the appearance which we associate with the name I have adopted.

The specimen in question belongs to the genus Allolobophora, in which genus, so far as my experience goes, almost all the abnormalities are found The genus Lumbricus, it should be observed, is very seldom, if ever, known to present any of these peculiarities Hitherto the Long worm (*A longa*, Ude)

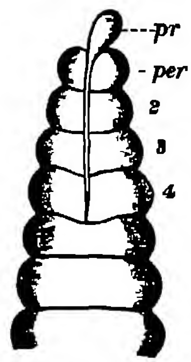


Diagram of the anterior portion of green worm (*Allolobophora chlorotica* Savigny), showing abnormal appearance of lip (*pr*), peristomium (*per*), and three succeeding segments, seen from above, and enlarged.

has been most prolific of bifurcated heads and tails. Now we find the Green worm (*A chlorotica*, Savigny) yielding new features for study. The peculiarities which have presented themselves in former times have usually taken the form of a second head or a supernumerary tail. In this instance there is no off-growth, however, but merely a malformation of the anterior segments. One might have supposed that the peculiarity was due to accidental causes. It would have been easy to suppose that the head had been split, and then the wound had healed, leaving a seam down the middle I observed, however, that each of the three specimens of the Green worm which I received from Cork (Ireland) showed some abnormal feature, and there were other peculiarities in this particular specimen which indicated that we had to deal with a congenital rather than an accidental condition of things.

As this is the first occasion on which such a peculiarity has been recorded or figured, I prefer to leave all speculation as to the cause out of the question. We need a good deal more research before we can deal satisfactorily with the biological problems involved in such appearances. As a help towards this, I bring together here a list of all those works which have come under my own and Prof. Andrews's notice, in which abnormalities in annelids are recorded:—

1. Andrews. "Proc. U.S. Nat. Mus.," vol. xiv., p. 283, 1891.
2. Andrews. "Amer. Nat.," vol. xxvi., p. 725, 1892.
3. Bell. "Ann. Mag. Nat. Hist.," vol. xvi., p. 475, 1885.
4. Bell. "Proc. Zool. Soc., Lond.," 1887, p. 3.
5. Bonnet. "Œuvres d'Hist. Nat. et de Phil.," vol. i., p. 167 seq. 1779.
6. Breese. West Kent Nat. Hist. Soc., 1871.
7. Broome. "Trans. Nat. Hist. Soc." Glasgow, 1888, p. 203.
8. Bülow. "Archiv f. Naturg.," vol. xlix., 1883.
9. Brunette. "Travaux de la Sta. Zool. de Cette," p. 8, Nancy, 1888.
10. Claparède. "Les Chaet. du Golfe de Naples," p. 436, 1868.
11. Fitch. "Eighth Report on Insects of State of New York," appendix, p. 204 seq. Albany, 1865.
12. Foster: Hull Scientific Club, February, 1891. Reported in weekly sup. *Leeds Mercury*.
13. Friend. "Science Gossip," 1892, pp. 108, 161.
14. Grube; "Archiv f. Naturg.," vol. x., p. 200, 1844.
15. Horst. "Tydsch. ned. Dierk. Veren," 2nd ser., D. I., Af. i., p. xxxii., 1882.
16. Langerhaus. "Nov. Act., K.L.C.D. Acad.," vol. xiii., p. 102, 1879.
17. Marsh. "Amer. Nat.," vol. xxiv., p. 373, 1890.
18. Macintosh. "*Challenger* Reports," vol. xii., 1885.
19. Robertson. "Quart. J. Mic. Soc.," vol. xv., p. 157, 1867.
20. Zeppelin. "Zeit. f. Wiss. Zool.," vol. xxxix., p. 615 seq. 1883.
21. Catalogue Terat. Spec. in Mus. Roy. Coll. Surgeons, London, 1872.

HILDERIC FRIEND.

The Zero Point of Dr. Joule's Thermometer

IN the course of a discussion on "Exact Thermometry" I described (NATURE, vol. xli. p. 488) the results obtained by heating thermometers for a considerable time to 280° and 356°, and pointed out by means of a diagram that at 356°, after about ten hours, the rise of the zero point became—at any rate approximately—a rectilinear function of the logarithm of the time, though at 280°, even after more than 300 hours' heating, the rise appeared to be rather more rapid than would correspond to such a simple relation.

Dr. Joule observed the rise of the zero point of a thermometer at the ordinary temperature during a course of no less than thirty-eight years ("Scientific Papers," vol. i. p. 558), and it occurred to me that it would be of interest to ascertain the relation to the logarithm of the time in this case also.

The following table contains the dates of Dr. Joule's observations, the total number of months from the date when the first reading was taken; the corresponding logarithms, the total rise of the zero point in scale divisions (13 divisions to 1° F.), the total rise calculated from the formula $R = 6{\cdot}5 \log t - 4{\cdot}12$, where t is the time in months; and lastly the differences between the observed and calculated zero points.

Date.	Time in Months.	Log t	Total rise of zero point in scale divisions. Observed.	Calculated.	Δ
April 1844	0	—	0	—	—
Feb. 1846	22	1·342	5·5	4·6	−0·9
Jan. 1848	45	1·653	6·6	6·6	0
April 1848	48	1·681	6·9	6·8	−0·1
Feb. 1853	106	2·025	8·8	9·0	+0·2
April 1856	144	2·158	9·5	9·9	+0·4
Dec. 1860	200	2·301	11·1	10·8	−0·3
March 1867	275	2·439	11·8	11·7	−0·1
Feb. 1870	310	2·491	12·1	12·1	0
Feb. 1873	346	2·539	12·5	12·4	−0·1
Jan. 1877	393	2·594	12·71	12·74	+0·03
Nov. 1879	427	2·630	12·92	12·98	+0·06
Dec. 1882	464	2·667	13·26	13·22	−0·04

The agreement between the observed and calculated values is certainly remarkable, and the + and − differences are evenly distributed.

Ten years have now elapsed since the last reading was taken, and if the thermometer is still in existence it would be of great interest to know what further rise has taken place in its zero point. According to the equation the reading should now be 13·86.

SYDNEY YOUNG.

University College, Bristol, January 20.

THE APPROACHING SOLAR ECLIPSE, APRIL 15-16, 1893.

THE total solar eclipse of April 15-16, 1893, is not only one of the longest of the century, but is the last of the century from which we are likely to get any addition to our knowledge of Solar Physics. The longest duration of totality of this eclipse is 4 minutes 46 seconds, and as the path of the moon's shadow lies to a great extent on land, there is a considerable choice of possible stations with long durations of totality. Commencing in the Southern Pacific the line of totality passes in a north-easterly direction and enters Chili at Charañah in 29° southern latitude, crosses the South American continent, and issues at Para Cura, a village near Ceara, at the north-east corner of Brazil, in latitude 3° 40′ south. It crosses the Atlantic at its narrowest part and enters Africa at Point Palmerin, near Joal, almost midway between Bathurst and Dakar, and in latitude 14° north, the shadow finally leaving the earth in the interior of Northern Africa. The eclipse will be observed by several parties of astronomers in Chili, Brazil, and Africa, there being almost absolute certainty of fine weather in Chili and Africa, and a reasonable probability in Brazil.

The English arrangements to observe the eclipse have been made by a joint committee of the Royal Society, the Royal Astronomical Society, and the Solar Physics Committee of the Science and Art Department, South Kensington, Dr. A. A. Common, LL.D., F.R.S., undertaking the duties of Secretary. Two expeditions will be sent from England, one to Africa and the other to Brazil, the expenses being defrayed by a grant of £600 from the Royal Society.

The African expedition will be in charge of Prof. T. E. Thorpe, and will consist of Prof. Thorpe, Mr. A. Fowler, Mr. Gray, and Sergeant J. Kearney, R.E. The Brazilian expedition will be in charge of Mr. A. Taylor, who will have with him Mr. W. Shackleton.

Prof. Thorpe and his party will leave Liverpool by the British and African mail steamer on March 18th, arriving at Bathurst on April 2nd. They will be met at Bathurst by a gunboat kindly placed at the disposal of the expedition by the Admiralty, and will be conveyed at once to Fundium, a station on the Salum River, about sixty miles from Bathurst; this being the station selected by the Committee from the three which were offered by the French Government. The gunboat will remain with the expedition, and the officers and crew will assist in the preparations for and in the actual observations of the eclipse. After the eclipse the party will be taken to Bathurst on the gunboat, and will return to England by a British and African mail steamer, if one is available. From the time-tables of the steamers now published it appears, however, that there will not be any mail steamer available until the end of April, and in this case a cruiser will meet the party at Bathurst and bring them to the Canary Islands or to Gibraltar, from either of which places they will be able to return by mail steamer, arriving in England early in May.

The members of the expedition to Brazil will leave Southampton by the Royal Mail steamer on February 23 for Pernambuco, arriving at the latter place on March 12. They will take passage by the local mail steamers to Ceara, at which place they will arrive about March 20

The Brazilian Government are willing to place a war vessel at the disposal of the foreign expeditions to observe the eclipse, and it is hoped the English observers will be able to avail themselves of the privilege thus gracefully offered The station selected is at Para Cura, on the coast about forty miles west of Ceara, and the party will rely upon obtaining any necessary help from the Brazilian authorities and from local assistants The observers will return from Pernambuco by the Royal Mail steamer due to leave there on April 22, and expect to be in England on May 5

The objects of the expeditions are—

(1) To obtain visual photometric measures of the light of the corona

(2) To obtain photographs of the corona with the four-inch lenses of a little over sixty inches focus belonging to Captain Abney, which were successfully used in Egypt (1882), Caroline Island (1883), Granada (1886), and Salut Isles (1889), in order to continue the series

(3) To obtain enlarged photographs of the corona with small photographic action, so as to show details of the structure of the brightest parts, *i e* those nearest the sun

(4) To measure the photographic intensity of the light of the corona, by direct comparison with standard intensity scales placed on the margins of the plates used for the negatives to be obtained under sections 2 and 3

(5) To obtain photographs of the spectrum of the corona. These spectra will be obtained on three different plans —

(*a*) With integrating spectroscopes, where no collimator is used and the prism or prisms are placed directly in front of the object glass of the photographic camera

(*b*) With ordinary slit spectroscopes, the slit being arranged as a radius of the sun

(*c*) With ordinary slit spectroscopes, the slit being arranged as a tangent to the sun's limb

The first of these objects will be attempted only at the African station; Prof. Thorpe and his assistant, Mr Gray, making the observations Their equipment will consist of a six-inch Simms equatorial of seventy-eight inches focus (lent from Greenwich) fitted with special photometric apparatus lent by Captain Abney The observations will be made on essentially the same plan as that pursued by Prof Thorpe at Hog Island, near Granada, in 1886, separate portions of the corona being compared with a standard glow lamp by means of a Bunsen photometer An integrating box for measuring the total coronal light with as little light from the sky as possible, and an ordinary Bunsen's bar photometer will also be used, these being entrusted to officers of the gunboat.

As regards objects 2, 3, and 4, duplicate apparatus has been arranged for use at the two stations

A photoheliograph mounting from Greenwich has been lent for Brazil, and an exactly similar instrument from South Kensington for Africa. On each of these mountings a specially designed new double tube will be fixed An Abney lens will be mounted in one compartment of each of these tubes, and this, with a focal length of sixty inches, will give pictures on the scale of rather more than half an inch to the moon's diameter In the other compartment a four-inch Dallmeyer photoheliograph lens will be mounted in combination with a specially-constructed two-and-a-half-inch Dallmeyer negative lens of eight inches negative focus; this arrangement giving, with a total length of sixty-eight inches, pictures on the scale of over one-and-a-half inches to the moon's diameter. This latter arrangement is essentially the same as that of Dallmeyer's new telephotographic lens. It will be so arranged that the ratio between the photographic effect of the Abney lens and the new combination will be as 10 : 1

Special plate holders have been made to fit the double tubes, each of these plate holders carrying two plates, which will be exposed simultaneously to the images formed by the Abney lens and the enlarging combination. The six separate exposures, giving twelve photographs, will be so arranged that the longest exposed pictures with the enlarging combination will have received the same photographic action as the shortest exposed pictures with the Abney lens The whole of the pictures will thus form a continuous series, all the short exposures in the series having a direct enlargement of three diameters

In Brazil Mr Taylor will take charge of this double instrument, and in Africa the similar instrument will be entrusted to Sergeant Kearney On the night before the eclipse intensity scales for object 4 will be impressed by the use of standard lights and specially-constructed scales kindly supplied by Captain Abney on all the plates to be exposed to the corona The plates will be developed at the stations as soon as convenient after the eclipse, experience on previous occasions, both by English and American observers, having shown that it is impossible to repack undeveloped plates after exposure in the tropics, and bring them home without serious deterioration

Similar spectroscopic work is to be carried out at the two stations For the integrating spectroscope in Africa Mr. Fowler will use a six-inch objective prism with a six-inch photographic lens of about nine-feet focus, mounted on an equatorial stand, belonging to Prof J Norman Lockyer, and kindly lent for the expedition At the Brazilian station Mr Shackleton will use two three-inch prisms in front of a three-inch photographic lens of about two-feet focus; the spectroscope, which belongs to South Kensington, being arranged horizontally and used with a ten-inch heliostat, also lent by the Science and Art Department Very short exposures will be given at each station at the commencement and end of totality, so as to obtain, if possible, the very numerous bright lines which have been observed in the chromosphere, and exposures of from 5 to 45 seconds will be given during totality

In Africa the radial and tangential slit spectroscopes will be mounted together on the Corbett equatorial stand lent from Greenwich, the spectroscopes used belonging to the Royal Society Mr Fowler and Sergeant Kearney will erect and adjust these instruments, but the actual exposure, which will extend through the whole of totality, will be made by an officer of the gunboat who will be placed in charge of the instrument In Brazil the radial and tangential slit spectroscopes will be mounted horizontally and used with a second ten-inch heliostat lent by the Science and Art Department The erection and adjustment will be made by the observers, but the actual exposure during totality will be entrusted to a local assistant. Orthochromatic plates will be used for all the spectroscopic work, the spectra obtained extending from above D into the ultra-violet.

Briefly summarised, the English programme is as follows —

In Africa —Prof T E Thorpe, assisted by Mr Gray and local assistance—Photometric measures of the visual Intensity of the corona with the equatorial photometer, the integrating photometer, and the bar photometer; Mr Fowler—The six-inch integrating spectroscope; Sergeant Kearney—the Abney and Dallmeyer coronographs, local assistance—the radial and tangential slit spectroscopes.

In Brazil:—Mr Taylor, the Abney and Dallmeyer coronographs, Mr Shackleton, the three-inch two-prism integrating spectroscope, local assistance, the radial and tangential slit spectroscopes

It is not yet decided whether one of the 20-inch mirrors of 45-inches focus specially constructed to photograph the faint extensions of the corona during the eclipse of 1889 (December 21–22) will be taken to Africa If so it will be entrusted to a local assistant. It was originally intended to use one of these in Africa, and it was hoped that one would be used by the Harvard College

Observatory party, which is to occupy a station in Chili, but Prof W. H Pickering writes that difficulties of transport will prevent him from taking the 20-inch mirror he has at Arequipa to the Harvard station, and owing to this and to the already large programme of the English party in Africa there is some doubt whether they will take one of the mirrors April being the middle of the rainy season in Brazil, it is not deemed advisable to send one of the mirrors to that station

The duration of totality at Para Cura is four minutes forty-four seconds, the altitude of the sun being between 70° and 80° At Fundium the totality lasts four minutes eight seconds, the altitude of the sun being about 54°

The Joint Eclipse Committee having arranged the expeditions and the general scheme of work, final details as to the actual operations have been left to a sub-committee consisting of the Astronomer Royal, Captain Abney, Mr H H Turner, Prof Thorpe, Mr A Taylor, and the secretary, Dr Common Prof Lockyer, previous to leaving England for Egypt, determined the exposures to be given by Messrs Fowler and Shackleton with the integrating spectroscopes These, with the final instructions to observers drafted by the sub-committee, will be published in due course

At present very few details are available as to the actual work to be undertaken by foreign observers The Harvard College Observatory expedition to Chili has already been mentioned Prof Schaeberle, of the Lick Observatory, has already started for Chili, and will use a six-and-a-half-inch equatorial, a five-inch horizontal photoheliograph of forty-feet focus, and a Dallmeyer portrait lens He will be assisted by Mr Gale, an amateur, from Paddington, N S W A Chilian party will also observe the eclipse in Chili

At Para Cura there will probably be two or three American parties, one being announced as probably under Prof H S Pritchett, from Washington University, St Louis, and another will probably be brought to that station by Prof David P Todd A Brazilian party will also observe The Bureau des Longitudes, Paris, are sending a complete expedition to Joal, in Africa, under MM. Deslandres and Bigourdan, the latter observer having already started for his station The work undertaken will be to obtain photographs of the corona and of its spectrum M de la Baume Pluvinel will also go to Joal to photograph the corona. At present we have not heard of any Italian expedition, but it is hoped that Prof. Tacchini will be able to arrange to observe the eclipse

A TAYLOR

MEASURE OF THE IMAGINATION[1]

THE first perceptible sensation is seldom due to a solitary stimulus Internal causes of stimulation are in continual activity, whose effects are usually too faint to be perceived by themselves, but they may combine with minute external stimuli, and so produce a sensation which neither of them could have done singly. I desire now to draw attention to another concurring cause which has hitherto been unduly overlooked, or only partially allowed for under the titles of expectation and attention. I mean the Imagination, believing that it should be frankly recognised as a frequent factor in the production of a just perceptible sensation. Let us reflect for a moment on the frequency with which the imagination produces effects that actually overpass the threshold of consciousness, and give rise to what is indistinguishable from, and mistaken for a real sensation Every one has observed instances of it in his own person and in those of others Illustrations are almost needless, I may, however, mention one as a reminder; it was current in my boyhood, and the incident probably took place not many yards from where I now stand Sir Humphrey Davy had recently discovered the metal potassium, and showed specimens of it to the greedy gaze of a philosophical friend as it lay immersed in a dish of alcohol to shield it from the air, explaining its chemical claim to be considered a metal All the known metals at that time were of such high specific gravity that weight was commonly considered to be a peculiar characteristic of metals, potassium, however, is lighter than water The philosopher not being aware of this, but convinced as to its metallic nature by the reasoning of Sir Humphrey, fished a piece out of the alcohol, and, weighing it a while between his finger and thumb, said seriously, as in further confirmation, "How heavy it is!"

In childhood the imagination is peculiarly vivid and notoriously leads to mistakes, but the discipline of after life is steadily directed to checking its vagaries and to establishing a clear distinction between fancy and fact Nevertheless, the force of the imagination may endure with extraordinary power and be cherished by persons of poetic temperament, on which point the experiences of our two latest Poet-Laureats, Wordsworth and Tennyson, is extremely instructive. Wordsworth's famous "Ode to Immortality" contains three lines which long puzzled his readers They occur after his grand description of the glorious imagery of childhood, and the "perpetual benediction" of its memories, when he suddenly breaks off into—

> "Not for these I raise
> The song of thanks and praise,
> But for those obstinate questionings
> Of sense and outward things,
> Fallings, from us, vanishings," &c

Why, it was asked, should any sane person be "obstinately" disposed to question the testimony of his senses, and be peculiarly thankful that he had the power to do so? What was meant by the "fallings off and vanishings," for which he raises his "song of thanks and praise"? The explanation is now to be found in a note by Wordsworth himself, prefixed to the ode in Knight's edition Wordsworth there writes—"I was often unable to think of external things as having external existence, and I communed with all I saw as something not apart from, but inherent in, my own immaterial nature Many times while going to school have I grasped at a wall or tree to recal myself from this abyss of idealism to the reality At that time I was afraid of such processes. In later times I have deplored, as we all have reason to do, a subjugation of an opposite character, and have rejoiced over the remembrances, as is expressed in the lines 'Obstinate questionings,' &c." He then gives those I have just quoted

It is a remarkable coincidence that a closely similar idea is found in the verses of the successor of Wordsworth, namely, the great poet whose recent loss is mourned by all English-speaking nations, and that a closely similar explanation exists with respect to them. For in Lord Tennyson's "Holy Grail" the aged Sir Percivale, then a monk, recounts to a brother monk the following words of King Arthur —

> "Let visions of the night or of the day
> Come, as they will, and many a time they come
> Until this earth he walks on seems not earth,
> This light that strikes his eyeball is not light,
> The air that smites his forehead is not air,
> But vision," &c.

Sir Percivale concludes just as Wordsworth's admirers formerly had done: "I knew not all he meant."

Now, in the *Nineteenth Century* of the present month

[1] Extract from a lecture on "The Just-Perceptible Difference," delivered before the Royal Institution, on Friday, January 27, by Francis Galton, F R S. We hope to give next week an extract on "Optical Continuity"

[2] Knight's edition of Wordsworth, vol. iv p. 47

Mr Knowles, in his article entitled "Aspects of Tennyson," mentions a conversational incident curiously parallel to Wordsworth's own remarks about himself — "He [Tennyson] said to me one day, 'Sometimes as I sit alone in this great room I get carried away, out of sense and body, and rapt into mere existence, till the accidental touch or movement of one of my own fingers is like a great shock and blow, and brings the body back with a terrible start'"

Considering how often the imagination is sufficiently intense to stimulate a real sensation, a vastly greater number of cases must exist in which it excites the physiological centres in too feeble a degree for their response to reach to the level of consciousness So that if the imagination has been anyhow set into motion, it shall as a rule originate what may be termed *incomplete* sensations, and whenever one of these concurs with a real sensation of the same kind, it would swell its volume

This supposition admits of being submitted to experiment by comparing the amount of stimulus required to produce a just perceptible sensation, under the two conditions of the imagination being either excited or passive

Several conditions have to be observed in designing suitable experiments The imagined sensation and the real sensation must be of the same quality, an expected scream and an actual groan could not reinforce one another Again, the place where the image is localised in the theatre of the imagination must be the same as it is in the real sensation This condition requires to be more carefully attended to in respect to the visual imagination than to that of the other senses, because the theatre of the visual imagination is described by most persons, though not by all, as internal, whereas the theatre of actual vision is external The important part played by points of reference in visual illusions is to be explained by the aid they afford in compelling the imaginary figures to externalise themselves, superimposing them on fragments of a reality The visualisation and the actual vision fuse together in some parts, and supplement each other elsewhere

The theatre of audition is by no means so purely external as that of sight Certain persuasive tones of voice sink deeply, as it were, into the mind, and even simulate our own original sentiments The power of localising external sounds, which is almost absent in those who are deaf with one ear, is very imperfect generally, otherwise the illusions of the ventriloquist would be impossible There was an account in the newspapers a few weeks ago of an Austrian lady of rank who purchased a parrot at a high price, as being able to repeat the Paternoster in seven different languages She took the bird home, but it was mute. At last it was discovered that the apparent performances of the parrot had been due to the ventriloquism of the dealer An analogous trick upon the sight could not be performed by a conjuror Thus he could never make his audience believe that the floor of the room was the ceiling

As regards the other senses the theatre of the imagination coincides fairly well with that of the sensations. It is so with taste and smell, also with touch, in so far that an imagined impression or pain is always located in some particular part of the body, then if it be localised in the same place as a real pain, it must coalesce with it

Finally, it is of high importance to success in experiments on Imagination that the object and its associated imagery should be so habitually connected that a critical attitude of the mind shall not easily separate them. Suppose an apparatus arranged to associate the waxing and waning of a light with the rising and falling of a sound, holding means in reserve for privately modifying the illumination at the will of the experimenter, in order that the waxing and waning may be lessened, abolished, or even reversed It is quite possible that a person who had no idea of the purport of the experiment might be deceived, and be led by his imagination to declare that the light still waxed and waned in unison with the sound after its ups and downs had been reduced to zero But if the subject of the experiment suspected its object he would be thrown into a critical mood, his mind would stiffen itself, as it were, and he will be difficult to deceive

Having made these preliminary remarks, I will mention one only of some experiments I have made and am making from time to time, to measure the force of my own imagination It happens that although most persons train themselves from childhood upwards to distinguish imagination from fact, there is at least one instance in which we do the exact reverse, namely, in respect to the auditory presentation of the words that are perused by the eye It would be otherwise impossible to realise the sonorous flow of the passages, whether in prose or poetry, that are read only with the eyes We all of us value and cultivate this form of auditory imagination, and it commonly grows into a well developed faculty I infer that when we are listening to the words of a reader while our eyes are simultaneously perusing a copy of the book from which he is reading, that the effects of the auditory imagination concur with the actual sound, and produce a stronger impression than the latter alone would be able to make

I have very frequently experimented on myself with success, with the view of analysing this concurrent impression into its constituents, being aided thereto by two helpful conditions, the one is a degree of deafness which prevents me when sitting on a seat in the middle rows from following memoirs that are read in tones suitable to the audience at large, and the other is the accident of belonging to societies in which unrevised copies of the memoirs, that are about to be read, and usually in monotones, are obtainable, in order to be perused simultaneously by the eye Now it sometimes happens that portions of these papers, however valuable they may be in themselves, do not interest me, in which case it has been a never-flagging source of diversion to compare my capabilities of following the reader when I am using my eyes, and when I am not The result depends somewhat on the quality of the voice, if it is a familiar tone I can imagine what is coming much more accurately than otherwise It depends much on the phraseology, familiar words being vividly re-presented Something also depends on the mood at the time, for imagination is powerfully affected by all forms of emotion The result is that I frequently find myself in a position in which I hear every word distinctly so long as they accord with those I am perusing, but whenever a word is changed, although the change is perceived, the new word is not recognised Then, should I raise my eyes from the copy, nothing whatever of the reading can be understood, the overtones by which words are distinguished being too faint to be heard As a rule, I estimate that I have to approach the reader by about a quarter of the previous distance, before I can distinguish his words by the ear alone Accepting this rough estimate for the purposes of present calculation, it follows that the potency of my hearing alone is to that of my hearing *plus* imagination, as the loudness of the same overtones heard at 3 and at 4 units of distance respectively, that is as about 3^2 to 4^2, or as 9 to 16 Consequently the potency of my auditory imagination is to that of a just perceptible sound as 16–9, or as 7 units, to 16 So the effect of the imagination in this case reaches nearly half-way to the level of consciousness If it were a little more than twice as strong it would be able by itself to produce an effect indistinguishable from a real sound

Two copies of the same newspaper afford easily accessible materials for making this experiment, a few words having been altered here and there in the copy to be read from

I will conclude this portion of my remarks by suggesting that some of my audience should repeat these experiments on themselves If they do so, I should be grateful if they would communicate to me their results

PROTOCERAS, THE NEW ARTIODACTYLE

LAST year the American Museum of Natural History established a department of mammalian palæontology for the purpose of securing and exhibiting collections from all the tertiary horizons of the west Dr J. L Wortman, well known by his discoveries while associated with Prof Cope, was put at the head of the field work, and under his direction explorations have already been made in the Laramie or Upper Cretaceous, and in three of the great divisions of the tertiary, namely, the Wasatch, the Puerco, and the Lower Miocene or White River

The discovery of the first example of *Palæonictis* found in America was mentioned in NATURE last year From the Puerco are brought remains of about 400 individuals, adding many new facts to the discoveries of Prof Cope From the Laramie are 400 of the small isolated teeth of the kind recently described by Prof Marsh. These are found by the writer to have a distinctly tertiary rather than mesozoic character, and while intermediate between the mesozoic and Puerco species, they decidedly resemble the latter *Meniscoëssus*, for example, about which there has been so much discussion, proves to be a plagiaulacid,

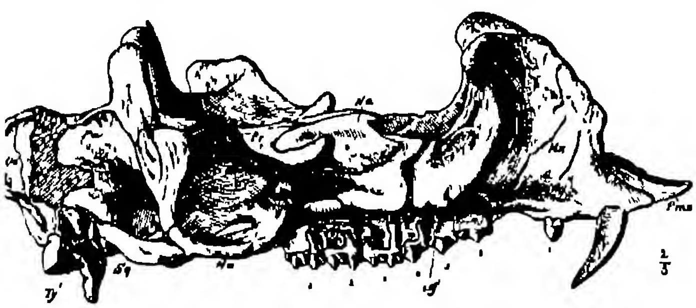


FIG 1 --Side view of skull

and also an ancestor of *Polymastodon*, which is thus shown to be a huge *Plagiaulax*, in which the fourth cutting premolar is reduced

By far the most perfect specimens have, however, been brought from the Lower Miocene, and here it appears that practically a new horizon has been developed, for the collection is full of fresh forms Many of these are new species intermediate between the true White River or *Titanotherium* fauna, and the Middle Miocene, but others are new genera, and represent distinct unrelated forms.

In this Lower Miocene collection are included portions of six skulls and the fore and hind feet of an Artiodactyle, of about the size of a sheep. The most complete skull is here figured exactly as found, and is seen at once to depart from all known Artiodactyles in many important characters. There are no less than four protuberances upon each side of the skull. Hindmost are two processes upon the parietals, which are placed upon the superciliary ridges as they diverge from the sagittal crest. These processes are close together and oval in section, reminding us of the posterior pair of horns in *Uintatherium* rather than of the conical or rounded horns found in the giraffes and some other Artiodactyles. Their position upon the parietal bones is also peculiar. The superciliary ridges extend outwards into two widely projecting plates of bone, which curve upwards above the orbits; these plates are upon the frontals, and the frontals also bear a pair of small conical processes just behind their junction with the nasals But even more exceptional than these parietal and frontal processes are the great vertical plates rising from the maxillaries, slightly recurved, and reaching the full height of the parietal protuberances Seen from above, these plates are found to be not in contact, but to enclose a long deep cleft, representing the anterior narial opening This is bridged over posteriorly by the nasals, which, as shown in the second figure, are extremely abbreviated Correlated with the development of these processes are a number of strong ridges, which form supporting buttresses for the horns These extend, as above described, from the sagittal crest outwards, also from the anterior margin of the orbit forwards This lateral maxillary ridge, as it may be called, terminates in a process just above the infraorbital foramen, and this process, although small, seems to illustrate the remarkable tendency of this little skull to develop osseous projections at every avail-

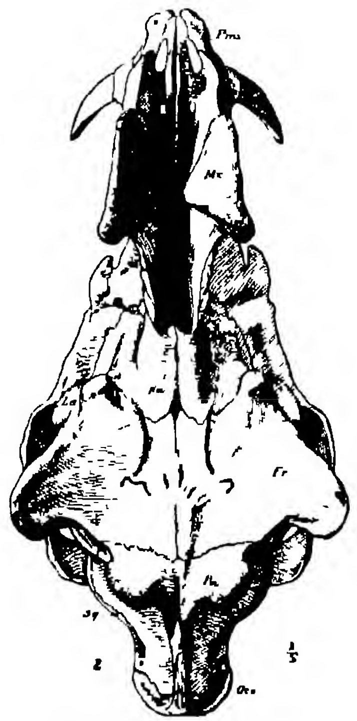


FIG 2 —Top view of skull

able point The character of these projections is different from that found elsewhere among the Artiodactyla, they are not horn-cores, neither are they similar to the processes upon the parietals of the giraffe. The development of these multiple bony protuberances suggests the skulls of Sivatherium, Tetraceros, and other eastern ruminants, but the proportions of the skull are wholly different The olfactory chamber, which is usually so expanded in the Artiodactyla, is here extremely reduced, the nasals barely reach beyond the middle line of the skull

Up to this point the study of the skull appeared to present an entirely new form, but later the other skulls were removed from the matrix, and among them one was found with small canine teeth, entirely lacking all the processes upon the frontals, and giving indications that those upon the maxillaries were either absent or comparatively small The parietals were unfortunately missing, but the idea at once suggested itself that this might be a female skull Two years ago Prof.

Marsh described a small Artiodactyle with a pair of small conical horn-cores upon the parietal bones, which he named *Protoceras celer*, expressing the opinion that it represented a new family Upon the supposition that this type might also be a female of the same species to which the heavily-horned type belonged, the second skull was taken to the Yale Museum, and carefully compared point by point It proved to be identical in every respect In this way the discovery was made that in *Protoceras*, as in so many other Artiodactyles, the male and female skulls differed widely from each other in their cranial armature The male was as described above, the female exhibits merely a pair of very small conical processes upon the parietals, with perfectly smooth frontals, and maxillaries either of the normal type or with smaller protuberances than in the male

The dentition at first suggests relationship to *Tragulus* and *Hyomoschus* The premaxillaries are edentulous as in the ruminants, but in the lower jaw there are four small teeth shaped liked incisors, the outermost of which represents the canine The upper canines are large,

FIG 3—Front view of Skull

pointed, and recurved The molar teeth are of the short-crowned, or brachyodont type, with a distinctly crescentic pattern

The structure of the feet also suggests the Tragulines, in the fact that the fore-foot has four well developed toes, while the hind-foot has two toes with the lateral pair very much reduced As in the *Tragulidæ*, the fore foot and probably the fore limb was very much shorter than the hind foot and limb The hind foot, moreover, shows a tendency to co-ossification both in the metatarsals and in the union of the navicular and cuneiform with the cuboid In many details, however, the feet present marked differences from the older and more recent Tragulines. The oldest of the Tragulines, moreover, is *Leptomeryx*, a contemporary of *Protoceras*, which has an entirely different skull and foot structure.

Taking all these facts together, we are led to support Prof. Marsh's conjecture, based upon the comparatively hornless female skull, that this Artiodactyle represents a new family, the *Protoceratidæ*. We know absolutely nothing either of the ancestors or successors of this type, and this is another illustration of the fact which is constantly being impressed upon us, that our fossil-bearing strata still contain a great number of forms which are at present wholly unknown and unsuspected.

HENRY F OSBORN.

HENRY F. BLANFORD, F.R.S

MR. H. F BLANFORD, whose death was noticed in last week's NATURE, was born in Bouverie Street, Whitefriars, in the City of London, in 1834. He was one of the students who entered the Royal School of Mines at its commencement in 1851, and after distinguishing himself by taking the first Duke of Cornwall's Scholarship, he studied for a year at Freiberg in Saxony In 1855 he and his brother, Mr W T Blanford, received appointments on the Geological Survey of India, and they landed in Calcutta at the end of September in that year Mr H F Blanford remained on the Geological Survey till 1862, when he resigned, his health having suffered from the exposure incidental to geological surveying in India His most important work whilst engaged on the Survey was the examination of the cretaceous beds of the neighbourhood of Trichinopoly, his classification of which, founded to a considerable extent on palæontological data, has been thoroughly confirmed by Dr F. Stoliczka's well known description of the fauna. Mr Blanford had previously, during his first season's work in India, by separating the Talchir strata, with their remarkable boulder bed, from the true coal-bearing, or Damuda rocks, taken the first step in what for so long was one of the most difficult tasks set before the Indian Geological Survey—the stratigraphical arrangement of the complex of beds subsequently known as the Gondwana system

On leaving the Geological Survey he was offered a post in the Bengal Educational Department, and from 1862 to 1874 he was one of the professors of the Presidency College, Calcutta. Soon after 1862 he began to take a keen interest in meteorological questions, and after being for some time a member of a meteorological committee nominated by the government, he was, in April 1867, appointed Meteorological Reporter to the Government of Bengal, and placed in charge of an office established with a twofold purpose, to give storm warnings for the protection of shipping and to collect and record systematic meteorological observations throughout the Bengal presidency Within a short time one most important result was obtained, the meteorological conditions under which cyclones originated in the Bay of Bengal were definitely ascertained, and it became practicable to say when a storm was a probable event, and in what part of the Bay it might be expected, and when a cyclone was impossible, although high winds might prevail Meantime the various observatories of the country were being brought into order, and the observations rendered systematic

In 1874 the Government of India became convinced of the necessity for placing all the meteorological observatories in India in communication with a central office, and Mr Blanford was finally transferred from the educational staff of Bengal and made chief of the new meteorological department, with the official designation of Meteorological Reporter to the Government of India. The new post involved much travelling to visit out-stations, in order to ensure the exact comparison of barometers and other instruments. The organisation of the new department, however, progressed rapidly, and in a few years a series of papers from Mr. Blanford's pen on rainfall, wind directions, and other meteorological phenomena gave evidence to all interested in the science that valuable additions to it were being made by the Indian observations The peculiar geographical conditions of India render its meteorology unusually simple, and of great scientific and practical importance An admirable illustration, both of the peculiarity of Indian meteorology and of the practical results yielded by accurate observations, is afforded by the fact that no sooner was the whole system in working order, than it was found practicable some time before the commencement of the monsoon season, and of the rainfall, upon which in many provinces plenty or scarcity of food depends, to prepare a forecast of the approaching season, and to warn the Government of a possible deficiency of rain in particular parts of the country The forecasts prepared have been found remarkably accurate.

Mr. Blanford retired from the Indian Service in 1888,

and has since resided at Folkestone Of late his health has gradually given way, and he died on January 23, at the age of fifty-eight He was elected a Fellow of the Royal Society in 1880, and was an honorary member of several foreign meteorological societies He was President of the Asiatic Society of Bengal in 1884–85

That he was a man of considerable intellectual power is shown by the somewhat unusual range of scientific questions on which he has left works and papers Besides his geological and meteorological reports, he wrote for the Indian Geological Survey descriptions of the *Nautilidæ* and *Belemnitidæ* of the South Indian cretaceous rocks, and he assisted the late Mr J W Salter in describing the Palæontology of Niti He was also author of several papers on recent mollusca, and amongst his works are two treatises, one on the "Physical Geography of India," largely used as a text-book in Indian schools, and the other "An Elementary Geography of India, Burma, and Ceylon," published as one of Macmillan's Geographical Series

NOTES

WE learn from Sydney that steady progress is being made with the Macleay Memorial Volume, and that it will probably be ready for issue about the end of March

AN announcement comes from Chicago that Mr Eadweard Muybridge, who, it will be remembered, visited this country some time since on behalf of the University of Pennsylvania, will give at intervals, from May to October, in the "Zoopraxographical Hall of the Exposition," a series of lectures on the science of animal locomotion, especially in its relation to design in art.

ON Thursday next, February 9, Prof Patrick Geddes will begin, at the Royal Institution, a course of four lectures on the factors of organic evolution, and on Saturday week, February 18, Lord Rayleigh will begin a course of six lectures on sound and vibration

A TRANSLATION of Prof Weismann's new work on "The Germ-plasm," recently noticed in NATURE, will appear in the "Contemporary Science Series" in the course of a few weeks

LAST week a deputation, representing the New Decimal Association, the Chambers of Commerce and Trades Unions, as well as various scientific institutions, waited upon Sir William Harcourt, Chancellor of the Exchequer, to urge the Government to adopt the decimal and metrical system of weights, measures, and coinage, or to appoint a committee of inquiry into the subject Mr S Montagu, M P, as president of the New Decimal Association, having introduced the deputation, said that forty years ago there was great apathy upon the subject, but since then there had been inquiries by Select Committees and Royal Commissions into the question of the decimal currency, and though the reports of those bodies were satisfactory, no action had followed The system had been adopted in Germany, Austria-Hungary, and Scandinavia; and in England there was now a good popular demand, such as Mr. Goschen said six years ago he was waiting for Men of science like Lord Kelvin, Sir Henry Roscoe, and Sir John Lubbock, and educationists like Sir Philip Magnus and Dr. Gladstone desired the reform in order to economise brain-power; representatives of commerce desired it to assist them in their competition with rival nations; and the working classes were awake to the fact that years of labour were wasted by their children being compelled to learn that which could be rendered unnecessary. Several members of the deputation, including Sir Philip Magnus, having spoken, Sir William Harcourt replied He said that every one who reflected on the question must see the great advantages which attach to the decimal system But the practical difficulties in the way of the proposed change seemed to him for the present to be insurmountable A decimal system was introduced into Europe by the French Revolution That was a time when the whole of society was cast into the melting pot, and they changed, not only their notation, not only their metrical system, but the names of the months and the days of the week The change in Germany took place, not in quiet times, but as a result of the unification of Germany He believed that even in the United States of America the change was made consequent upon the establishment of the Federal system He did not think that the habits of the people could be altered in quiet times This applied very much to the measures as well as to the coinage Sir William was ready as an individual to play his part in forwarding the progress of the decimal system and the metrical system, but the Government could do nothing in the matter The people would have to be prepared for so great a change

IT is worth noting that instruction in the principles of the decimal and metric systems is daily given in public elementary schools, and that this labour—as Mr J H Yoxall, secretary of the National Union of Teachers, has pointed out in a letter to the *Times*—is imposed upon the children without hope of practical good to the community Mr Yoxall contends that if an Act of Parliament were to fix a date of five or ten years hence at which the decimal system should come into legal operation, the work of the schools and the precaution of the mercantile classes would by that time sufficiently prepare the way

A DESTRUCTIVE earthquake occurred on Tuesday morning at the town of Zante Several houses were totally destroyed, many more were partially wrecked, and there is hardly a building in the town which has not sustained damage in one form or another The roof of the prison collapsed during the earthquake, and the guards had to be doubled to prevent the escape of the prisoners The hospital was also so seriously damaged that it was deemed expedient to remove the patients The shocks, which were general, were renewed again and again, and the whole population was thrown into a state of panic

DURING the past week the temperature over these islands has been fairly high, the daily maxima often exceeding 50°, notwithstanding a temporary fall, amounting from 12° to 14° in Scotland and the midland counties of England, on Friday, accompanied by much fog in the south and east of England, while the air has been decidedly humid, the readings of the dry and wet bulb thermometers frequently showing little or no difference These conditions have been due to deep depressions arriving from the Atlantic and passing in close proximity to our western and northern coasts In those parts gales have been of almost daily occurrence, and on Sunday they extended as far as the English Channel. Rain has been frequent, but generally the fall has not been heavy, and the sky has generally been overcast and dull, although on Saturday the weather over the south of England was unusually bright and fine. The *Weekly Weather Report* of January 28 shows that the temperature exceeded the mean in all districts, the greatest excess being 4° in Scotland Bright sunshine also exceeded the mean in some parts of Scotland and in the eastern portion of England, but in other parts of these islands there was a deficiency.

A MAP showing lines of equal magnetic declination for January 1, 1893, in England and Wales, has been very carefully prepared by Mr. W. Ellis, and published as a supplement to

the *Colliery Guardian* of January 6, 1893 The explanatory text states that, as before, the work depends on the magnetic surveys of Profs Rucker and Thorpe Mr Ellis gives a table showing the relation between the diurnal variation of magnetic declination and sun-spots, as determined from the magnetic observations made at the Royal Observatory, Greenwich The general mean at epochs of minima of sun-spots is 7 4 minutes, and at epochs of maxima 11 4 minutes of arc, and other magnetic elements show a similar relation The period between successive epochs of maxima or of minima of sun-spots is well known to be on the average about 11 years, and the author points out the curious fact that the interval between the minimum and maximum is on the average 4½ years, whilst from maximum to minimum it is 7 years The relation existing between sun spot maxima and minima and the diurnal magnetic variation has led many meteorologists to seek for some similar connection with meteorological phenomena, but Mr Ellis states that no such relation has yet been conclusively established

THE report of the administration of the Meteorological Department of the Government of India in 1891–92 shows continued activity and efficiency in all departments of the work, and bears testimony to the interest taken both by the public and by the *employés* The number of observatories maintained by the Government at the end of the year was 165 As regards the actinometric work, an unusual amount has been done, owing to the favourable state of the weather, and the results have been forwarded to the Solar Physics Committee in London The rainfall data are published month by month, and a large number of unsatisfactory rain gauges has been replaced by new ones A larger amount of work under the head of marine meteorology has been done than in any previous year, several clerks are continually employed in collecting data from ships entering the various ports, and these observations have been utilised in preparing daily weather charts of the whole Indian area for a portion of the year The systems of storm and flood warnings have been continued as in previous years, and observations have been taken in certain forests, in order to throw light on the influence of forest growth in modifying the distribution and amount of rainfall, a report upon this subject will shortly be prepared. Among the other papers being prepared for publication we note one on the relation between sun-spots and weather as shown by meteorological observations taken on board ships in the Bay of Bengal during the years 1855 to 1878

AT the meeting of the Royal Botanic Society of London on Saturday a plant of the Sisal hemp (*Agave rigida*) was shown from the Society's gardens. This plant is now extensively grown in the Bahamas and Central America for its fibre The secretary said that until lately, with the exception of two or three fibre plants, as hemp and cotton, commerce depended upon wild plants for its supplies, but so great was the demand now for fibres for papermaking and other uses that it had been found necessary to grow them specially

THE Slojd Association of Great Britain met on Saturday to receive the annual report, to elect officers, and to appoint an examining body It was agreed that "Sloyd" should be substituted for "Slojd" in the name of the Association The system of handiwork which the society is seeking to introduce into schools has already been pretty extensively adopted in this country, especially in the north of England. Mr Harris stated at the meeting that it was being received with approval in many different parts of the world. He had received communications from Napier, New Zealand, and Lahore, India, as to its adoption in these places.

AN American writer who was present at the Galileo Festival in Padua gives a very interesting account of it in the New York *Nation* He refers to the speeches delivered in Italian by Sir Joseph Fayrer and Prof George Darwin, to which we have already alluded "They were," he says, "much appreciated by the audience 'Parla bene!' 'Pronunzia bene!' one heard murmured in tones not devoid of surprise" The greatest orator of the occasion, according to this writer, was Prof Schmurlo of Dorpat, in Russia. "The type of the lonely and ungainly scholar in appearance, he nevertheless spoke a few phrases so ultra-Italian in the ingenious gracefulness of their turn, that the audience went fairly wild with delight"

THE latest instalment of the Transactions of the Institution of Engineers and Shipbuilders in Scotland contains an interesting paper, by Mr E G Carey, on the bridges of the Manchester Ship Canal. The paper is fully illustrated The author notes that practically the whole of the bridge-work for this canal has been constructed in Glasgow from Scotch steel.

THE Smithsonian Institution has issued as one of its bulletins a full and very useful bibliography of the published writings of George Newbold Lawrence, the well-known ornithologist The work has been done by Mr L. S Foster, who gives also a short sketch of Mr Lawrence's career Mr Lawrence's collection of bird skins is of great scientific value It includes about 8000 specimens, and contains some three hundred types of new species of birds The collection was deposited in the American Museum of Natural History, New York City, in May 1887 Mr Foster says that the beneficial influence of the labours of Mr Lawrence, with pen and pencil, on the progress of American ornithology, has been great and undisputed It is particularly among the avifauna of the West Indies, Mexico, Central and South America, that his most strenuous efforts have been exerted

IF we may trust a statement made on the authority of the Tokyo News Agency, it is not surprising that Japan is unwilling to be deprived of the privilege of fishing on the Korean coast The number of Japanese boats engaged in the fishery is said to be no less than upwards of four thousand four hundred, of which about eighteen hundred have licenses Their annual take averages from a million and a half of *yen* to two million value, and it is estimated that with more diligence and improved methods they might easily bring this figure to three or four millions

IT is rather surprising that tobacco has been so little cultivated in Australia. The *Agricultural Gazette* of New South Wales, we are glad to see, has taken up the matter, and in its November number devotes to it a comparatively long and interesting paper. The writer of the article thinks that the climate of New South Wales is admirably suited to the growth of tobacco, and hopes that a sufficient quantity of it may hereafter be produced not only to satisfy local demands, but to open up a large and lucrative export trade

ONE of the curious survivals of ancient prejudices in India is the intense dislike with which many high caste Hindus regard sea voyages. It is even disputed whether a Brahmin who takes a sea-voyage does not lose caste The Maharaja of Mysore has not only emancipated himself from this strange notion, but is doing his best to overcome it in others. He lately made a voyage to Calcutta, and took with him a number of orthodox Brahmins, as well as Brahmin officials of state.

MR WALTER HOUGH, of Washington, notes in *Science*, that among the collections from Mexico, Central and South America, exhibited in the Columbian Historical Exhibition at Madrid, he observed a number of oblong polished blocks of hard stone of unknown use, averaging 3½ inches in length, 2¾ inches in width, and 1¼ inches in thickness. The broad sur-

faces of these stones are plane, bearing a number of grooves parallel to the length, forming ridges like those seen on Polynesian tapa mallets The implements resemble closely, he thinks, those used by many different peoples in beating out fibrous bark for clothing, paper, &c Mr Hough suggests that they may have been used for purposes of this kind in prehistoric times, and that they may give some insight into the manufacture of the paper on which the Mexican codices are painted.

MUD GORGE, on the Hurnai route to Quetta, has been giving much trouble to the engineers engaged in the construction of the new railway. Landslips are frequent, and an unusually bad one has occurred within the last few weeks On this occasion the hill, according to the *Pioneer Mail*, slipped in such a way "as to lift the rails bodily up and turn them over, sleepers uppermost" The mountain is said to be a great porous mass of clayey soil with large boulders imbedded therein, and it sucks in moisture like a sponge. After heavy rain it begins to move downwards, and even in dry weather disintegration goes on with disastrous results to the railway New fissures are reported to have appeared hundreds of yards up the slopes above the line, and each of these indicates that thousands of tons of earth and boulders will sooner or later find a lower level A committee of experts has been appointed by the Indian Government to examine the mountain thoroughly, and the *Pioneer Mail* truly says that "if they succeed in devising a means to conquer it they will achieve a notable feat in engineering"

DR LOW, President of Columbia College, New York, has been stating in the American *Educational Review* his impressions as to the condition and tendencies of the higher education in the United States One of the points on which he strongly insists is that a general college training should be considered necessary before students begin their University education in theology, law, and medicine "The prophetic eye," he says, "can even now discern the day when a college education will be a condition precedent for entrance into the professional schools of the American university This will not mean that only college-trained men will make good practitioners in law or medicine, for example, nor that only college trained men are entitled to a professional education. It will rather mean, I think, that the university will then have fully realised its own obligation to the country to send forth into professional life, in all parts of the land, men of a thorough and wide equipment."

ARCHÆOLOGISTS have observed that in Greek statues the male eye is strongly arched, while the female eye has rather a flattened surface; and referring to accounts by the older anatomists who have affirmed such a difference to exist, they have seen in this a fresh proof of the exact observation of nature by the ancient Greeks. The rule is not without exceptions, for the cornea in the Zeus of Otricoli has quite a flat form Herr Greef recently set himself (*Archiv fur Anat*) to inquire whether such a sexual difference actually exists, and from individual measurement of the radius of the cornea in the horizontal meridian, he gets an average of 7·83 mm for men, and 7·82 mm for women (Donders gives 7 858 and 7 799), so the difference is so small as to be imperceptible to the naked eye. Measurement of other dimensions gave but minute differences also The author concludes that the Greeks (from artistic motives) did not in this case follow nature.

THE difference between the aspect of the sky at full moon and the clear and deep azure observed on a moonless night is explained by M. Clémence Royer in his "Recherches d'Optique Physiologique et Physique" on the basis of some observations made by M. Piltschikoff. In studying the polarising action of the moon on the atmosphere, the latter found that the proportion of polarised light in the nocturnal sky diminishes continuously from the time of the full moon up to that of the new moon, when it becomes zero, subsequently to increase again until the time of full moon There appears to be a struggle between the polarised light of the moon and the so-called natural light of the stars, and the proportion of polarised light sometimes reaches 62 per cent The diffusing power of the atmosphere necessarily varies with the relative proportions of natural and of polarised light, since the latter is not capable of reflection in all directions Hence we see why very serene but moonless nights may yet be relatively very clear, and the sky of a beautiful sombre blue, whereas the white light of the moon, reflected, diffused, and polarised, tends to give the sky a tint of a paler and somewhat greyish blue

AT the last annual meeting of the American Association of Official Agricultural Chemists, the Proceedings of which have just been issued, Mr. N T Lupton referred in his presidential address to the immense phosphate beds in the south-western part of Florida Last winter a visit was paid to some of the localities where deposits are found, and samples were collected for analysis They were of two varieties, which may be called hard and soft The hard variety consists of boulders of moderately hard rock, some of immense size, cemented together with white clay A white and friable mass resembling kaolin is occasionally found This is probably produced by the natural disintegration of the hard rock by rolling, attrition, or concussion The deposits vary in thickness A depth of 20 or 30 feet is not uncommon, and even a thickness of 50 feet has been found As some, especially foreign, manufacturers object to buying phosphates which contain over 3 per cent of oxides of iron and aluminium, large quantities of these materials have accumulated at the mines. A few manufacturers, aware of the agricultural value of South Carolina floats, have established mills in Florida for pulverising these soft aluminous deposits, which are sold to farmers for use without conversion into soluble phosphates. Experiments are now in progress on the Alabama Experiment Station, under control of the chemist, to determine the chemical composition and agricultural value of these soft phosphates when used alone with cotton seed and with cotton seed meal If decomposing organic matter, as is believed, renders insoluble phosphates available as plant food to any considerable extent, Mr. Lupton thinks that the question of cheap phosphates will be solved, and that the American farmer will be enabled to purchase fertilisers at a much less cost than at present

MESSRS W. H ALLEN AND CO have issued the thirty-seventh thousand of Dr M. C Cooke's "Manual of Structural Botany" The book is intended for the use of classes, schools, and private students.

THE February number of *Natural Science* includes, among other things, articles on some problems of the distribution of marine animals, by Otto Maas, on Pasteur's method of inoculation and its hypothetical explanation, by G. W. Bulman, the industries of the Maoris, by J W Davis, some recent researches on insect anatomy, by G H. Carpenter, parasites on algæ, by G. Murray; the underground waste of the land, by H B. Woodward, Owen (concluded), by A. S. Woodward, and the restoration of extinct animals.

THE following are the arrangements for science lectures at the Royal Victoria Hall during February —Feb 7, Mr J Scott Keltie, on Africa and its people, Feb 14, Mr. E Wethered, on interesting objects under a microscope; Feb 21, Mr. J. T. Leon, on breathing and burning, Feb. 28, Dr H. Forster Morley, on chemistry of life

THE additions to the Zoological Society's Gardens during the past week include seven Azara's Opossums (*Didelphys azaræ*)

from the Argentine Republic, presented by Mr Hill, a Rough Terrapin (*Clemmys punctularia*) from Guiana, presented by Mr J J Quelch, C M Z S; an American Milk Snake (*Coluber eximius*) from Tennessee, presented by Miss Winifred M. Middleton, a Virginian Eagle Owl (*Bubo maximus*) from South America, deposited, two Mouflons (*Ovis musimon*, ♂ ♀) from Corsica, received in exchange

OUR ASTRONOMICAL COLUMN

THE NAUTICAL ALMANAC FOR 1896 —The new superintendent of the *Nautical Almanac* office has introduced a much-needed reform into the first almanac, that for 1896, issued under his direction The state of the *British Nautical Almanac* has long been severely criticised as being far from the best possible for navigational purposes both in form and contents, and by no means satisfactory from the astronomical standpoint A letter addressed by the Shipmasters' Society to Dr Hind, the late Superintendent, in November 1891, pointed out the advantage to navigators which would be offered by a work published at a popular price, and without that astronomical information which is of no use to sailors Many low priced almanacs are published, indistinctly printed, and having occasional errors in the figures, and an official trustworthy book was very desirable In consequence of this representation the almanac is now published in two forms—as the complete almanac of former years, price 2*s* 6*d*, and as Part I of the *Nautical Almanac*, specially suited for the use of sailors, price 1*s*

The complete almanac has been revised and added to, many of the recommendations of the *Nautical Almanac* Committee of the Royal Astronomical Society, which reported to the Admiralty in 1891, having been adopted The small short period terms of nutation have been tabulated, and, corresponding to that, additional day numbers are added so as to enable computers to include those small terms in the star corrections. The catalogue of stars from which the moon culminators and stars occulted by the moon are obtained has been revised and enlarged, and the mean places of the stars of this catalogue, which are used during the year, are also included The elements of the occultations are given in a revised form similar to that adopted in most of the other astronomical ephemerides, so that the circumstances of an occultation for any position on the earth's surface can be computed with facility There has been a general revision of the constants used

The small almanac has been arranged by Mr Downing in conference with the Hydrographer As the guiding principle in publishing this was the minimum of change in the parts of the almanac which were to be extracted and published separately, there is still much in the volume that is not needed by sailors, but the omission of which would have necessitated the setting up of fresh type and much extra work at the *Nautical Almanac* office The monthly part is printed unaltered, and consequently contains the sun's and moon's latitude and longitude, which are not required by sailors. The noon ephemerides for the brighter planets, Venus, Mars, Jupiter, and Saturn, the catalogue of mean places of stars, as well as the apparent places of the nine stars used for lunar distances, the eclipse section and the tables for navigation are then given There is no doubt that the issue of this smaller work will confer a real benefit on the shipping community, and that it will soon win its way to popularity

In announcing these changes to the Royal Astronomical Society, Mr Downing expressed the hope of being able, through the economy of time effected by international co-operation in some of the work of the office, to make considerable future additions to the almanac without increasing the burden of the British taxpayer The duplicate work done at Berlin, London, Paris, and Washington involves much waste of energy which might be more usefully expended: and as a step towards this, Mr Downing, last summer, arranged with Prof. Newcomb, of Washington, to co operate in some of the work of their respective almanacs, and the Admiralty have consented to this. It is to be hoped, in the interests of astronomy and of navigation, that the scheme may be greatly extended.

ECLIPSE PHOTOGRAPHY.—The results obtained by M. de la Baume Pluvinel at Salut Isles in 1889 (as given in his lecture which appeared in NATURE last week), when he photographed the corona with photographic actions varying from 185 to 13, and found the photographic action of 30 the most satisfactory, do not agree with those of the English expedition obtained at the same time and place The photographic actions on the plates exposed with the 20-inch mirror of 45-inches focus, by the late Father Perry, varied from 19 75 to 790· as calculated by the formula given by M de la Baume Pluvinel, and in every case increase of photographic action gave greater extension of the corona. Mr Rooney's plates, with the 4-inch lens of 61 inches focus, had been subjected to photographic actions varying from 1 11 to 177 77, and agreed with Father Perry's in giving greater extension with every increase of photographic action. The English results certainly justify the conclusion that greater photographic action is necessary to photograph those faint extensions of the corona which have been seen, but have hitherto eluded attempts to photograph them

Mr Burnham's experiments, alluded to by M Pluvinel, do not assist us in this question A certain absolute amount of light is necessary to give *any* appreciable photographic effect on the plate, and this seems to be the chief difficulty in obtaining photographs of the external corona. In Mr Burnham's experiments he had too much light and had to cut down the exposure in order to get faint contrasts, but there was never any question of not having sufficient light to obtain any photographic effect. Captain Abney finds (Phil. Trans vol clxxx. A, page 314) that an abrupt change of ½ per cent in the intensity of light can be detected on a photograph, hence we may look upon a negative as a drawing built up of 200 different shades Over exposure will of course prevent such faint contrasts as ½ per cent being detected, and under exposure will enable fainter contrasts to be seen, *so long as the limit of minimum exposure necessary to produce any photographic effect is passed*, but the evidence from the English expedition renders it extremely probable that even with the largest photographic action used this limit was not actually reached with the faintest extensions of the corona

COMET HOLMES.—Dr. F Cohn, writing about this comet from the Observatory in Konigsberg on January 17, finds (*Astronomische Nachrichten*, No 3146), with a 6-inch heliometer and a magnification of 65 times, that the nucleus is exactly as a star of the 8th magnitude The correction to the ephemeris given below is, as he has deduced, $\Delta\alpha = -0\ 3s$, $\Delta\delta = -6''$

Dr R. Schorr, of the Hamburg Observatory, puts the nucleus down on the same date as a 7 2 magnitude star with a small nebulosity about it of 5" diameter, but on the 18th he found the comet showed a much larger coma, a measurement giving 87" The stellar nucleus was also estimated as 7 5 magnitude of a diameter 2"

The ephemeris of this comet is from Prof Schulhof's calculations (*Astronomische Nachrichten*, No 3140) —

1893	R A app. h m s.	Decl app ° ′ ″
Feb 2	1 45 46 5	+33 49 26
3	47 16 6	50 48
4	48 47 3	52 14
5	50 18 6	53 45
6	51 50 4	55 20
7	53 22 8	56 59
8	54 55·8	58 41
9	1 56 29 3	34 0 28

COMET BROOKS (NOVEMBER 19, 1892) —The following is an ephemeris for Comet Brooks for the ensuing week —

1893	R A. app. h. m s.	Decl app ° ′	Log *r*	Log Δ.	Br
Feb 2	23 56 48	+34 27 7			
3	23 59 13	33 44 4	0 1050	0 1295	1·90
4	0 1 31	33 3 3			
5	3 42	32 24 1	0 1087	0 1482	1 71
6	5 48	31 46 4			
7	7 48	31 10 4			
8	9 43	30 35 8			
9	0 11 33	30 2 9	0 1167	0·1832	1·40

THE ANDROMEDES.—Although Mr. Maclair Boraston was unfortunate in having bad weather on the nights of November 13 and 14 last, thus obscuring the Leonids, yet the magnificent shower of the Andromedes that he describes in *Astronomy and Astrophysics* for January should have recompensed him somewhat for "the great elevation of the radiant point, combined with a cloudless tropical sky, the absence of moonlight and the unobstructed view of the complete hemisphere, afforded the *ne plus ultra* of astronomical requirement." Observing in

longitude 72° west and latitude 17° north, between 11h 48m and 5h. 48m G.M.T., he deduced the radiant point from 70 short track meteors, and four coincident stationary ones, giving its position as R.A. 28°, decl +36°. Counts being taken at intervals for areas of 60°, about 18 meteors per minute were recorded, thus making a total number of 108 for the entire hemisphere in one minute, or 6480 per hour. As this fall went on continuously for six hours without any sign of the numbers diminishing, we have the number of meteors 38,880, which Mr. Boraston says must certainly be a minimum, as many faint and rapid ones must have escaped notice. A further observation at 8h 48m showed that the action was still being kept up, thus increasing this number to about 60,000. During this display it was remarked that the meteors appeared much brighter when distant from the radiant point than in its vicinity.

A NEW METHOD OF PHOTOGRAPHING THE CORONA.—M. H. Deslandres, in the *Comptes Rendus* of January 23, describes a method of photographing the solar corona without the aid of absorbing media. Sunlight is allowed to fall directly on a system of two identical prisms with parallel and inverted faces placed at a distance apart, such that only a portion of the diverging band from the first is intercepted by the second. After passing through the latter, the rays by recomposition give rise to a well defined coloured image of the sun's disc. On displacing the prisms in a line perpendicular to the line joining them, the image assumes different colours, and on moving them along it, the range of colours intercepted is made to change. The prisms may be replaced by gratings. In a series of experiments carried out during the autumn, nine successive impressions of the sun's image were taken, ranging from the C line till far into the ultra violet. The object was to find the region where the light emitted by the corona showed the greatest photographic difference from that of the diffused sunlight in the atmosphere. As a matter of fact, a halo distinctly separated from the diffused sunlight showed itself on some of the negatives, especially in the ultra violet region, which very probably represented the corona. But to confirm this, simultaneous exposures at different, especially elevated, stations ought to be made, if possible during a total eclipse.

GEOGRAPHICAL NOTES

THE February number of the *Geographical Journal*, in addition to two important papers read before the Royal Geographical Society, and already reported in NATURE, contains a brilliant account by Mr. Conway of the crossing of the Hispar Pass. The views of mountain scenery were bewildering in their extent; from the foot of the valley an unbroken glacier was in sight, stretching downward from the pass forty miles distant. This unrivalled ice-stream was covered for the lower twenty miles with moraines. From the pass a vast snowfield, surrounded by magnificent rock aiguilles, was seen to lie below, and from this the Biafo glacier descended. From the end of the Hispar glacier to the end of the Biafo glacier was a distance of eighty miles, forming the longest snow-pass in the world outside the Polar regions. Mr. Stephen Wheeler communicates a paper on Mendez Pinto, whose early travels in the East seem to have been unduly discredited.

IT is announced that the eminent geographical author M. Elisée Reclus has accepted a professorship in the University of Brussels, and will commence his work there by a course of lectures on comparative geography.

MR. ASTOR CHANLER's expedition to Lake Rudolf, by the Tana, has reached Hameye, the Ibea Company's post at the head of navigation on the Tana—a position accessible in five weeks from the coast, to which camels, oxen, donkeys, and horses can be safely taken. Lieutenant Hohnel, who is attached to the expedition, finds that Commander Dundas has placed the Tana from 20 to 22 minutes of longitude too far west, and he has searched in vain for the mountain ranges reported by Dr. Peters.

IN a recent journey of some duration in the Sakalava plain in the north west of Madagascar, M. Emile Gautier (according to the *Annales Géographiques*) found the soil everywhere to consist of a stiff red clay, weathered into steep sided lumps and chasms overlying sedimentary rocks, but quite similar in colour and character to the red clay which covers the volcanic rocks of the plateau. M. Gautier believes that this clay is identical with the laterite of the Deccan.

MAJOR LEVERSON, the British Commissioner for the delimitation of the frontier between the British South Africa Company's territory and the Portuguese possessions, has returned to this country, after having carried out extensive surveys and made considerable rectifications in the map of a strip of country stretching from the north east corner of the Transvaal northward to Massikesse. The position of the latter point was fixed as 18° 15′ 33″ S., 32° 51′ 24″ E.

MR. MACKINDER gave the second lecture of his course on History and Geography, under the auspices of the Royal Geographical Society, on Friday evening, when he discussed the road to the Indies, showing how the desert route, which led to the growth of Palmyra, was superseded by the ocean route after the successful rounding of the Cape of Good Hope. The theatre of history in ancient times was the region enclosed between the pine forests of northern Asia and the Indian Ocean, divided into separate worlds by a double belt of deserts and steppes.

THE GROWTH OF ELECTRICAL INDUSTRY

ON Friday last Mr. W. H. Preece, F.R.S., delivered before the Institution of Electrical Engineers his inaugural address as President. He said he had completed his fortieth year of continuous service in developing the practical applications of electricity for the use and convenience of man, and it appeared to him that he could not better repay the high compliment the Institution had conferred on him by electing him, for the second time, to be its President than by surveying and criticising the growth of the various branches of electrical industry with which he had been more or less associated during that long period. In the course of his address he dealt with telegraphy, submarine telegraphy, lightning protection, railway signalling, telephony, domestic applications, electro-chemical industry, electric lighting, power transmission, electric traction, and theoretical views of electricity.

Speaking of telegraphy, Mr. Preece said:—The instrument that we have principally developed in England is the automatic fast speed apparatus, based on a principle of preparing messages for transmission by punching, devised by Alexander Bain in 1848, and improved in its mechanical details by Mr. Augustus Stroh in 1866. This has been my special pet, and with the electrical assistance of Mr. J. B. Chapman, and the mechanical skill of Mr. J. W. Willmot, all the ills that telegraphs are heir to have been routed, and the practical speed of working has been multiplied more than six fold. It has been one long continual contest between patient observation, inventive skill, careful experiment, and technical acquirement on the one hand, and resistance, electrostatic capacity, inertia (electro-magnetic and mechanical), bad insulation, impure materials, imperfect workmanship, &c., on the other. But we have, step by step, won all along the line. 75 words per minute have become 500; a possible 130 has become an actual 600. Duplex automatic working over cable lines is possible, and modes of working have been introduced that were thought at one time chimerical and impossible.

The results to which I have referred have not been attained without very special attention to questions of construction and maintenance of the wires, both aerial and submarine, and a very complete system of test is now applied both before and after every line is completed. In the early days of telegraphic communication very rough and crude tests were applied, and the condition of the lines caused serious difficulties; but at the present day we must ascertain the purity of the metal employed, its mechanical strength, its electrical resistance and capacity, its insulation resistance, and the relationship between the latter and the conductor resistance, as well as its speed value. The employment of copper as the conductor suspended on poles in place of iron, which was inaugurated at my instigation in 1884, by a very costly experiment between London and Newcastle, has had a material influence in increasing the speed of working and improving telegraphy. This is due not only to its reduced resistance, but to the absence of electro-magnetic inertia in a long, single suspended copper wire. All our long important telegraphic circuits are now built with copper.

One of the arguments used against the proposed transfer of the telegraphs to the State was the notion that invention would not be fostered by a Government department. This has been entirely falsified. Telegraphy has been advanced in this country

more rapidly by the British Post Office than by any private undertaking, and we have certainly shot ahead of our smart cousins on the other side of the Atlantic, from whom, however, I am proud to say, I learnt so much on my visits in 1877 and 1884. Their engineers are looking to us to develop their inventions, and we have done so They cannot always get them taken up in the States Diplex, quadruplex, and multiplex telegraphy are importations from them, but they have been improved in our service by our own developments, and have now become the staple and the standard modes of working No one has done more to effect this object than Mr M Cooper.

An accident in the drafting of the Act of Parliament of 1868-69 transferring the telegraphs from the hands of private companies to that of the State, has led to a tremendous development of newspaper reporting in England Few people are aware of the immense business done for the press The growth of press messages is shown in the fact that 21,701,968 words paid for in 1871 have grown in 1891 to 600,409,000—an average of nearly 2,000,000 words per day

When Mr Gladstone spoke at Newcastle, at the National Liberal Federation, in 1891, 390,778 words were signalled to different parts of the country This kind of business is not, however, confined to the Post Office The Exchange Telegraph Company, which commenced operations in 1872, working under the license of the Postmaster General, has in London over 800 instruments at work (120 being in newspaper offices), distributing a daily average of 3,381,134 words to various receiving instruments adapted to the requirements of the respective services The financial intelligence, for example, being transmitted over instruments furnished with type wheels containing the various fractions most in use in Stock Exchange quotations The latest form of this instrument prints at the rate of forty words per minute General and parliamentary intelligence are distributed to the clubs over column printers, and legal, sporting, and Parliamentary news to newspapers on specially fast tape printers, capable of delivering, in the hands of skilled operators forty five full words per minute to any number of subscribers simultaneously The news transmitted is chiefly commercial and financial, amounting to 2,775,000 words per day.

To return to the purely State telegraphy Some idea of the growth of the general telegraphic business of the country may be gathered from the following statement, which gives the total number of messages paid for in each year —

1852	211,137
1869	6,830,000
Transfer took place in 1870	
1882	31,345,861
1892	70,215,439

In the course of his review of the history of submarine telegraphy, Mr Preece said —By far the greatest cable corporation in the world is the Eastern Telegraph Company, whose system of 25,376 miles stretches from Cornwall to Bombay, connects the northern and southern shores of the Mediterranean with Malta, and joins up the various other islands of the Mediterranean and the Levant This company, in conjunction with the Eastern Extension and the Eastern and South African Companies, also gains access to Australia and New Zealand on the one hand, and to the Cape of Good Hope on the other, the combined mileage reaching a total of no less than 47,151 This enormous system has all grown up within, practically, the last 23 years

The form of cable has practically remained unaltered since the original Calais cable was laid in 1851 Various sizes of core and armour, and various modes of protection from decay, have been used to suit different routes, but the cable of to day may be said to be typically the same as that used in the English Channel in 1851, and in the Atlantic in 1865

The first cable had gutta-percha as a dielectric, and it is still almost exclusively used for submarine cable core; but the manufacture has so improved in the last twenty years that a core having an insulator weighing 150 lbs per naut, which then had a dielectric resistance of some 250 megohms a naut at 75° F, can now be obtained, giving 2000 megohms at the same temperature. Indiarubber is creeping in, owing to the high price and scarcity of gutta-percha

Next to strong tides, rocky bottoms, anchors, and shallow water, the greatest enemy to submarine cables, more especially in the tropics, has proved to be the teredo of various species; but this depredatory worm has been utterly routed by covering the gutta percha core with a lapping of thin brass tape laid on spirally A remarkable thing about this little insect is that, whereas twenty years ago it was practically unknown in our English waters, it has now gradually spread all round our coasts, with the exception, perhaps, of the North Sea A new cable about to connect Scotland and Ireland is being served with brass tape

With the cables has grown up a fleet of telegraph ships to lay and maintain them' In 1853 the *Monarch*, belonging to the Electric Telegraph Company, was the only ship permanently employed as a repairing telegraph ship, now, in 1893, the cable fleet of the world numbers no less than 37, of which seven belong to Government administrations and the rest to private companies, the Eastern Telegraph Company heading the list with five vessels

Perhaps the most remarkable history of a cable is the following —In 1859 the light cables laid in 1853 from Orfordness to Holland were picked up and replaced by a heavier one A few nauts were sold to the Isle of Man Telegraph Company, and had an extra sheath laid on This cable was submerged between that island and St Bees, where it remained until 1885, when it was replaced by a three-core cable It was again put under water in 1886 as part of the cable between Uist and Harris, in the Hebrides, where it still lies, as good as ever The durability of submarine cables is remarkable That laid between Beachy Head and Dieppe in 1861 is still working, and that laid between Beachy Head and Havre in 1870 has broken within the last month for the *first* time

Despite the enormous growth of submarine cables during these forty-two years, there would appear to be plenty of scope for still further extension The Pacific still remains untouched, and the project is at the present time under consideration to connect our possessions in North America with those in Australia.

The following is the passage relating to telephony —I had the good fortune in 1877 to bring to England the first pair of practical telephones They had been given to me in New York by Graham Bell himself After a series of experiments, I brought them before the British Association meeting, which was held that year at Plymouth Who at that time could have imagined that the instruments, which were then but toys, would, within sixteen years, have become a necessity of commercial, and almost of domestic, life? Yesterday the number of telephones in actual use may pretty safely be put down at a million!

During 1878 Edison devised his carbon transmitter, and Prof Hughes presented his "microphone" to the world These inventions made the telephone a practical instrument of vast commercial importance It may be said to have sprung into existence well-nigh perfect, and the fewness of the actual improvements on the Bell receiver and the Hughes microphone is scarcely more astonishing than the immense number of fruitless attempts at improvement that have been made Even now the original instruments are not easily beaten

The institution of telephone exchanges has led to a development of systems of switching that might fairly be considered a special study in themselves, and the demand for communication between distant places has necessitated the application of much special attention to the method of constructing lines and of arranging circuits.

It is in this latter field that I have been a diligent worker, and the application of the so called "K R" law has proved of material benefit in connection with the problems of long-distance telephony It is a law which implies that the number of signals that can be transmitted per second through any circuit depends solely on the capacity (K) and the resistance (R) of the circuit It is very much the fashion to deny the accuracy of the K R law This is probably the result of ignorance of its meaning or of its interpretation. Some speak of it as empirical, others scoff at it as imaginary, and some sneer at it as an impossible law; but it is a law that has determined the dimensions and speed of working of all our long submarine cables, it determines the number of arms a circuit can carry on the multiplex system, the speed attainable with the Wheatstone system, and the distance to which it is possible to work quadruplex; it is a law that has enabled us to bring London and Paris within clear telephone speech of each other, and which will probably before the year is out enable Dublin and Belfast to speak to London—a message

of peace to Ireland as solid and substantial as any promised political proposal.

The New York and Chicago trunk line is 950 miles long, and it is built with 435 lbs (or No 8 S W G) copper wire. This wire gives a resistance of 2.06 ohms per mile, which is easily verified, but it is said by Mr Wetzler to have a capacity of 0.0158 microfarad per mile, which cannot be verified, and which is absurdly high. 0.0158 microfarad was a measurement made by me in England on an old line, but I have frequently pointed out that owing to the use of earth wires the capacity of our English lines is very much greater than that of American lines. Mr Edison discovered this in 1872 when he came to England to introduce his automatic system. Moreover, I have also pointed out that induction still further diminishes this capacity. The Paris circuit does not exceed 0.005 microfarad per mile. I should estimate the Chicago circuit at 0.004 microfarad per mile, and the K R at 7500, which gives a result that quite accords with the opinions that I have heard expressed by those who have tried the two circuits as to the relative efficiency of the Paris and Chicago lines. My American friends would have done better if they had used thicker wire. I should have specified 600 lbs per mile, but if it had been in England I should have used 1000 lbs, for we cannot dispense entirely with cables and underground work as they have done in the States, and the increased capacity introduced must be compensated for by reduced resistance. As a matter of fact, I once proposed 1200 lbs wire for a circuit between London and Berlin—a distance of 760 miles, including a cable 55 miles long.

The beneficial effect of induction as a negative capacity is observed when working a circuit telegraphically with automatic high-speed apparatus. Thus, on two copper wires 450 miles long, making 900 miles altogether, the speed on each single wire was 120 words per minute, and on metallic circuit—

Loop *viâ* different routes	120 words per minute
,, on same poles	150 ,, ,,

So that the improvement effected by induction was 25 per cent.

There is no difficulty in measuring R of a metallic loop. The Wheatstone bridge determines it at once. There is more difficulty in obtaining K. It cannot be measured directly. But with a metallic loop of copper, partly overhead and partly underground, there are several modifications required, due to electrostatic and electro magnetic induction, which are at present beyond the reach of formulæ, and render it difficult to determine the capacity except approximately from the telephonic effects themselves. Thus the capacity on the London-Paris circuit proved to be only one-half of that obtained by calculation, and every long circuit will require its own K to be determined by comparison with an empirical K R scale. Such a scale I have determined by careful experiment on artificial cables.

I have recently devised a new form of cable which will probably quadruple the rate of telegraph working to America, and I may say with all confidence that there is no theoretical reason whatever why we should not converse between London and every capital in Europe, while it is not impossible to speak even across the Atlantic.

With regard to electric lighting, Mr Preece said that many efforts are being made to utilise the waste forces of nature in producing electric currents for the economical supply of the light. In America, Scotland, Switzerland, Italy, and, indeed, wherever waterfalls are available, electric plant is being installed to convert the energy of the fall into the useful form of electricity. At Tivoli, near Rome, a fall of 165 feet is used to work six turbines of 350 horse-power each, giving 2100 horse power in all. Six high-pressure alternators working in parallel send electrical energy at over 5000 volts pressure to Porta Pia, near Rome, 14.8 miles from Tivoli, through four stranded copper conductors, each having a diameter of 13mm, and bunched into one metallic loop, giving a total resistance of 4 ohms. At Porta Pia the 5000 volts are reduced to 2000, and the currents are distributed to several substations spread over the city, where they are again lowered to the safe pressure of 102 volts, at which voltage the current is supplied to the consumer on the three-wire system. There are 600 arcs and 30,000 glow lamps in use in Rome, but they are not all supplied from Tivoli. Mr Preece inspected this installation only a few days ago, and found everything working smoothly and efficiently under the able guidance of Prof. Mengarini.

Water power abolishes the coal bill, but it must be remembered that the cost of maintenance of machinery and of the erection and upkeep of conductors limits the distance to which the energy of falling water can be economically transmitted. The proposal to light New York by currents generated at Niagara is at present financially absurd. It is doubtful whether it will be commercially advantageous at Buffalo 30 miles away, but it is certain that at Tivoli it can be so applied with advantage and profit.

There is much water power in this country that might be usefully employed. At Worcester it is proposed to use the water of the Teme, a tributary of the Severn, to supply electrical energy to the city—an experiment that will be watched with considerable interest, for the use of water power will solve the difficulty occasioned by light loads during the small hours and daylight. Keswick and Lynton have already been so served, but on a small scale only. There are many towns whose public streets could be brilliantly illuminated by the streams running past them, but there is much fear and distrust to be removed from the minds of our local magnates, and a considerable amount of education necessary before the public will receive the full value of the gifts that nature so freely places at its disposal, and the engineer so thoroughly converts into a utilitarian form.

The following are some extracts from the passage in which theoretical views of electricity are discussed —

In the Presidential address which I delivered to the Society of Telegraph Engineers and Electricians in 1880, I took the opportunity to formulate the theoretical views of electricity that I had acquired at the feet of Faraday. It is not given to every boy to have his great ambitions realised. One of my ambitions as an earnest listener to Faraday's simple and delightful lectures was to be his assistant, and in almost the last investigation he undertook on electric induction in underground wires it was my privilege to see much of him, and to prepare many experiments for him. Early in 1854, at his wish, I carried out for Mr Latimer Clerk certain experiments on the comparative effect of increments of voltage in increasing the rate of transmission of signals through long telegraph circuits. It was found that variation of voltage had no effect. Currents from 31 and from 500 cells sent through 768 miles of gutta percha covered underground wire showed precisely the same velocity. These experiments were sent by Faraday to Melloni, who had prompted the wish, and Melloni ("Faraday's Researches," vol iii page 577) remarked "The equal velocity of currents of various tensions offers a fine argument in favour of the opinion of those who suppose the electric current to be analogous to the vibrations of air under the action of sonorous bodies." This is to be found in the very last contribution inserted in the greatest work ever published on our science, "Faraday's Experimental Researches in Electricity."

Faraday's views were subsequently expounded and extended by Maxwell, who said "Faraday, in his mind's eye, saw lines of force traversing all space, where the mathematician saw centres of force attracting at a distance, Faraday saw a medium where they saw nothing but distance, Faraday sought the seat of the phenomena in real actions going on in the medium, they were satisfied that they had found it in a power of action at a distance impressed on the electric fluids" (Maxwell, "Electricity," vol i page 10).

Since that period I have never regarded electricity as anything else but as a form of energy, and its effects as modes of motion of the molecules of matter and of the ether that fills all space, and during my long apprenticeship of forty years I have never examined one experiment or considered one fact that was not explicable on this theory.

Electricity is energy which is transmitted by matter and through space by certain disturbances the result and the equivalent of work done, and in certain orderly and law regulated forms, called "electro magnetic waves." It is not difficult to conceive the ether carved or the molecules of matter swayed or excited in definite periodic waves. A molecule is subject to all kinds of motion—translation, oscillation, rotation upon its own axis, and revolution about some external axis. Clausius (*Pogg Ann*, clvi p 618) suggested that the atoms or groups of atoms constituting a molecule revolve around one another similarly to planets, and are sometimes nearer to and sometimes further from each other. The difference between the infinitely great and the infinitely little is only one of degree. The motions of the solar system and that of a molecule of water are similar. These motions are imparted to and transmitted by

the ether, and they are taken up again by matter One kind of wave gives us light, another radiant heat, another magnetism, and another electrification The rate at which these waves move is the same, viz 30,000,000,000 centimetres, or 192,000 miles, per second It is only their form and their frequency that differ Matter and ether are subject to strains, currents, vortices, and undulations, and every single electro-magnetic phenomenon can be compounded of or reduced to one or other of these mechanical disturbances Rotation in one direction gives positive electrification . rotation in the opposite direction gives negative electrification A whirl in one direction gives us north magnetism , in another direction, south magnetism Hertz, the experimental exponent of Maxwell's views, has shown the existence of electro-magnetic waves, and has proved their reflection, refraction, and interference The rate of their propagation is the same in ether, air, and conducting wires

The most recent discoveries and deductions are all in accordance with this mechanical theory J J Thomson's views that at high temperatures, in the act of dissociation, all gases, and Dewar and Fleming's conclusion that at low temperatures—in fact, at the absolute zero of temperature—all metals become perfect conductors, might almost have been predicted Hysteresis and Foucault losses are mere wastes of energy, due to molecular friction or to internal work done on the molecules, assisted by bad design and impure material , but, being measurable and comprehensible, their reduction to a minimum has become possible and actual

It is a misfortune that a beautiful hypothesis like Maxwell's electro magnetic theory of light has been discussed almost solely by mathematicians Its consideration has been confined to a small and exclusive class It has not reached the public , and this is to be regretted, for, after all, it is the many, and not the few, that determine the acceptance or refusal of a theory The existence of the ether is now thoroughly comprehensible Light is now regarded as an electro-magnetic disturbance The eye is an extremely sensitive and delicate electro magnetic instrument The difference between luminous, thermic, and electro-magnetic waves is one of frequency and form We thus have to consider the propagation of these waves not only in the conductor and in the dielectric in the direction of the circuit itself, but in the ether at right angles to this direction The former produces currents in the conductor, and the latter induction and secondary effects in contiguous conductors. Thus it is easy to see why electric and magnetic lines of force are at right angles to each other, and each of them perpendicular to the line of propagation of the primary electro magnetic wave, and why the transversal disturbances are secondary waves of electro magnetic energy which can be transformed into electric currents of opposite direction whenever contiguous conductors lie in their path so as to be cut by these lines of force in the proper direction Induction is thus mere transformation of energy whose direction and magnitude are easily calculated

It is by following out this line of thought that I have recently succeeded in sending messages by Morse signals across the Bristol Channel between Lavernock and Flat Holm, a distance of 3 1 miles The electro magnetic disturbances were excited by primary alternating currents in a copper wire, 1237 yards long, erected on poles along the top of the cliff on the mainland The radiant electro magnetic energy was transformed into currents again in a secondary circuit, 610 yards long, laid along the island The strength of these secondary induced currents complied almost exactly with calculations. The results attained, the apparatus used, the precautions taken to separate effects of induction from effects of conduction , the elimination of mere earth currents from electro magnetic disturbances in air, will form the subject of a separate paper, for their proper consideration would be too tedious for an address I allude to them now only to illustrate the existence of one of the greatest proofs of the truth of a theory, viz the practical development and verification of a conclusion predicted from mere theoretical considerations

The oscillatory character of the discharge of a Leyden jar, which was discovered by Henry in 1842, is an admirable proof of this molecular theory If two jars, precisely similar as regards capacity and circuit inertia, be placed near each other with their planes parallel, and one of them is charged and discharged, the other responds sympathetically, as do two similarly pitched tuning-forks when one is excited Professor Oliver Lodge, who has made this field his own, has shown that by varying the capacity of the jars and the inertia of the circuit, oscillations can be produced to give any required rate of oscillation from one to 300 millions per second

In a room or theatre, when these discharges are excited, it is a common thing to see sympathetic sparks upon the spangled walls, and among the metallic objects scattered about The whole place is an electric field, which is violently disturbed at every spark, and everything which is "syntonised," as Oliver Lodge calls it, to the main discharge, responds in this way

It is impossible to account for these effects, which are all cases of transformed kinetic energy, except on the mechanical theory which I have advanced We have a source of disturbance, we have energy transmitted in waves, we have wave transformed into disturbance again Energy passes through its various stages by the motion of matter and the action of the ether Everything is accounted for and nothing is lost Waste energy only means energy in the wrong place

YEZO AND THE AINU

TWO papers on recent travels in the Island of Yezo were read to the Royal Geographical Society on Monday evening Prof J Milne, F R S , whose paper was read by the Secretary, made a journey to the north east of the island by sea in 1891, and returned by land, crossing Yezo almost through its centre He was accompanied by Mr John Revilliod, and travelled with a view to studying the volcanic geology of the regions Landing at Kushiro, interesting on account of the relics of pre Ainu inhabitants, and on account of its coal mines, they ascended the Kusuri river to Shibecha, where there is a great convict prison and sulphur refinery, the raw sulphur being obtained from the volcano Atosanobori, to which there is a railway twenty miles long In this locality the violence of the escape of steam from the boiling springs exceeds anything seen elsewhere in Japan, New Zealand, or Iceland A new road, thirty seven miles long, led from the volcano to Apashiri, on the north-east coast, where a factory for making matches has recently been erected, on account of the abundance of the white-stemmed poplar, the timber of which is much more readily worked in the fresh state than when dried A boat journey was made in a small dug out canoe under rugged cliffs from 500 feet to 1000 feet in height, for thirty miles to Shiritoki, where there is a great sulphur mine From some of the volcanic craters fused sulphur flows like lava, and crystallises in an almost pure state A trip from Nemuro to the nearer Kurile Islands was followed by the main feature of the journey, a ride from Yubets, on the north coast, up the Yubets river, across the watershed, and down the Ishikari river, to the west coast Groups of convicts working on the new roads, which are being made across the island, were almost the only people met with Vast groves of tall bamboo grass everywhere impeded the travellers, and insects of all kinds proved very troublesome There was little or no sign of larger animal life

Mr A H Savage Landor also read a paper He had wandered all round Yezo and up several of the largest rivers quite alone, and with no object save curiosity and the desire to study the Ainu at home The main part of his equipment was a great store of painting material, of which he made good use in portraying both the natives and the scenery of the island The Ainu accessible from Hakodate, who have been frequently visited and often described, are almost all Japanese half-breeds, and much influenced in customs and costume by their southern neighbours The Ainu of the interior and the more distant parts of the coast were very different The true Ainu villages are intensely filthy, and the vermin in them make life almost unsupportable to a stranger, minute black flies, which swarm in incredible hosts, being the worst The people, although good-humoured, are sunk in the most degraded savagery Their marriage customs seem to be summed up in unqualified promiscuity, the Ainu disclaiming any idea of being better than bears or dogs. The Ainu language is poor in words, and many of them show a curious resemblance to words of Anglo Saxon origin, *e g* *Chip*, for ship , *Do*, day , *Mukku*, music , *Pone*, bone , *Ru*, road ; *To*, two , *Wakka*, water. The religious beliefs of the Ainu can hardly be dignified by such a term ; they are merely superstitions. In travelling along the south-west coast there was often considerable danger from the waves washing over the narrow track which wound between the boulders on the beach Fog prevails along the east coast in summer, probably on account of the Kuro-Siwo encountering a cold current off the island. The upper Tokachi river was the

most remote part of Yezo visited, a region which had scarcely been traversed by the Japanese Here the Ainu were found to be more hairy than elsewhere, and to present many Aryan features in their general appearance One peculiar fact brought out by many measurements was the remarkable length of their arms. The measurement across the outstretched arms is always from three to five inches more than the height of the individual The future capital of Hokkaido (the name given to Yezo and the Kurile Islands collectively) is to be erected on the Kamikawa plain, in the very centre of Yezo, and roads are being pushed forward to connect it with all parts of the coast It will, when completed, take the place of the present capital, Sapporo According to Japanese maps, Mr Landor's journey extended to 5000 miles, but his own reckoning puts it as 3800, almost the whole distance was done on horseback

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD —By the death of Prof Westwood on January 2 the University lost one of the most learned of its members, and another link with the earlier study of science in Oxford is gone Prof Westwood became Hope Professor on the foundation of the chair by the Rev F W Hope in 1861, and afterwards devoted his time to the perfecting of the collection which Mr Hope bestowed on the University The collection, which has received considerable additions from other sources, including the Burchell collection, Wallace's types, &c, has attained somewhat unmanageable proportions, and its present quarters are too small for its proper display Whoever succeeds to the chair, it is to be hoped that suitable provision will be afforded to enable him to make the collection of more use to University studies than has hitherto been the case.

In November last an examination for a Radcliffe Travelling Fellowship, thrown open, *pro hac vice*, to all branches of natural science, was held, but the result has not yet been announced It is now announced that an examination will be held during this term for a second Radcliffe Fellowship, the subjects being strictly medical It is believed that the results of the two examinations will be published together at the end of this term There is some dissatisfaction at the delay in announcing the result of the first examination

Prof Ray Lankester has recovered from the illness which necessitated his absence from Oxford last term, and has resumed his lectures on the Vertebrata and a senior course on the Arachnida

The Mathematical Scholarships and Exhibitions have been awarded as follows —

Senior Mathematical Scholar, R C Fowler, B A, of New College

Proxime Accessit, S F White, B A, of Wadham College, to whom the Examiners have awarded Lady Herschell's book

Junior Mathematical Scholar, C B Underhill, Balliol College

Junior Mathematical Exhibition, J F. McKean, Hertford College

Proxime Accessit, W C. Childs, Corpus Christi College

The Duchess of Marlborough has bestowed on the Chemical Department the entire collection of chemical and electrical apparatus belonging to the late Duke The collection, which includes two exceptionally fine spectroscopes, delicate balances, &c., has been brought to the Museum from Blenheim, and forms a valuable addition to the Chemical Laboratory.

Mr. E. L. Collis, of Keble, is President, and Mr M D Hill, of New College, is Treasurer of the Junior Scientific Club this term, and Messrs C H H Walker, of University College, and T H Butler, of Corpus Christi, are respectively Chemical and Biological Secretaries The first meeting is held on Wednesday, February 1, when Mr J E Marsh exhibits some products of the electrical furnace, and Messrs. Finn and Fremantle read papers on East Africa and Hermaphroditism

At a meeting of the Biological Club, on Saturday last, Mr G. C Bourne read a paper on the influence of the nucleus on the cell.

CAMBRIDGE.—The Senate have resolved to appoint a Demonstrator in Palæozoology in connection with the Geological Department. He will have no stipend from the University, but will be remunerated from the fees paid by students.

Dr Allbutt, Regius Professor of Physic, Dr A MacAlister, Professor of Anatomy, and Dr Donald MacAlister, University Lecturer in Medicine, have been appointed to represent the University at the Eleventh International Medical Congress to be held at Rome in September next

Dr W H Gaskell has been appointed a member of the Special Board for Medicine, and Mr C T Heycock a member of the Special Board for Physics and Chemistry Dr Ransome, F R S, Honorary Fellow of Gonville and Caius College, Dr. Corfield, F R S, Professor of Hygiene and Public Health in University College, London, Dr J Lane Notter, Professor of Military Hygiene at Netley, and Dr Thorne Thorne, F R S, Medical Officer to H M Local Government Board, have been appointed Examiners in State Medicine for the Diploma in Public Health during the current year

Sir G G Stokes and Dr Hobson have been elected Examiners for the Adams Memorial Prize to be awarded in 1895

Mr E H Acton, of St John's, and Mr F H Easterfield, of Clare, have been approved as Teachers of Chemistry with reference to the regulations for medical and surgical degrees

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 15, 1892 —"Experiments on the Action of Light on *Bacillus anthracis*" By Prof Marshall Ward, F R S

It is abundantly evinced by experiments that direct insolation in some way leads to the destruction of spores of *Bacillus anthracis*, and in so far the results merely confirm what had already been discovered by Downes and Blunt in 1877 and 1878 [1]

From the fact that an apparent retardation of the development of the colonies on plates exposed to light was observed several times under circumstances which suggested a direct inhibitory action of even ordinary daylight, the author went further into this particular question with results as startling as they are important, for if the explanation given of the phenomena observed in the following experiments turns out to be the correct one, we stand face to face with the fact that by far the most potent factor in the purification of the air and rivers of bacteria is the sunlight The fact that direct sunlight is efficacious as a bactericide has been long suspected, but put forward very vaguely in most cases

Starting from the observation that a test tube, or small flask containing a few c c of Thames water with many hundreds of thousands of anthrax spores in it may be entirely rid of living spores by continued exposure daily for a few days to the light of the sun, and that even a few weeks of bright summer daylight —not direct insolation—reduces the number of spores capable of development on gelatine, it seemed worth while to try the effect of direct insolation on plate-cultures to see if the results could be got more quickly and definitely [2]

Preliminary trials with gelatine plate-cultures at the end of the summer soon showed that precautions of several kinds were necessary The direct exposure of an ordinary plate-culture to the full light of even a September or October sun, especially in the afternoon, usually leads at once to the running and liquefaction of the gelatine, and although the exposed plates eventually showed fewer anthrax colonies than similar plates not exposed, the matter was too complicated to give satisfactory results. Obviously one objection was that the spores might have begun to germinate, and the young colonies killed by the high temperatures

Experiments made in October with gelatine plates wrapped in black paper, in which a figure—a square, cross, or letter—was cut, also led to results too indefinite for satisfaction, although it was clear in some cases that if the plates lay quite flat, the illuminated area was on the whole clear of colonies, while that part of the plate covered by the paper was full of colonies

But another source of vexation arose. After the plates had been exposed to the sunlight for, say, six hours, it was necessary to put them in the incubator (20°-22° C was the temperature used) for two days or so, to develop the colonies, and in many cases it was observed that by the time the colonies were sufficiently

[1] See p. 237 of "First Report to the Water Research Committee of the Royal Society" ("Roy Soc Proc." vol 51, 1892) for the literature on this subject up to 1891

[2] It appears that Buchner (*Centr f, bakt* vol xii 1892) has already done this for typhoid, and finds the direct rays of the summer sun quite effective.

far advanced to show up clearly, liquefaction had extended so far as to render the figure blurred and doubtful

Stencil plates of zinc were employed with, at first, equally uncertain results The stencil plate was fixed to the bottom of the plate culture, outside, and every other part covered with blackened paper the plate was then placed on a level surface, the stencil-covered face upward, and exposed to the direct sunlight. As before, the gelatine softened and in many cases ran, and the results were uncertain, though not altogether discouraging

In November it was found that more definite results could be obtained, and the problem was at last solved

Meanwhile it had already been found possible to obtain sun prints in the following way with agar plates Ordinary agar was heated and allowed to cool to between 50° and 60° C, and was then richly infected with anthrax spores, and made into plates as usual Such plates were then covered with a stencil plate on the lower face—the stencil plate being therefore separated from the infected agar only by the glass of the plate—and wrapped elsewhere closely in dull black paper, so that, on exposure to the sun only the cut-out figure or letter allowed the solar rays to reach the agar

Such plates were then exposed to the direct rays of the October sun for from two to six hours, or they were placed on the

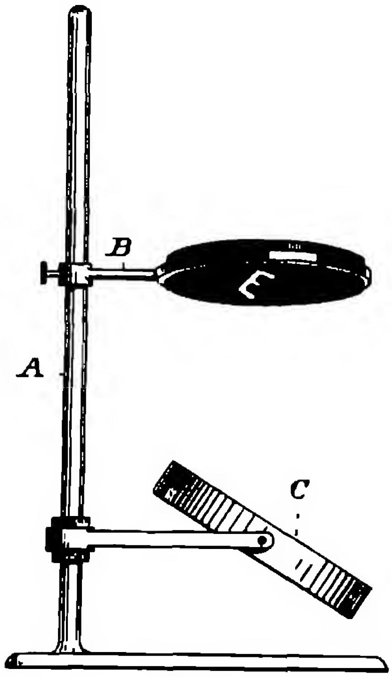


FIG 1

ring of a retort stand, stencil downwards, and the sunlight reflected upwards from a plane mirror below

After the insolation these plates were incubated for at least forty-eight hours at 20° C, and on removing the wrappers the colonies of anthrax were found densely covering all parts of the plate except the area—a letter or cross, &c—exposed to the sunlight. There, however, the spores were killed, and the agar remained perfectly clear, showing the form of a sharp transparent letter, cross, &c., in a groundwork rendered cloudy and opaque by the innumerable colonies of anthrax.

Experiments proved that this was not due to high temperature, for a thermometer with its bulb next the insolated glass rarely rose beyond 14° to 16° C, and never beyond 18° C., and even if the thermometer did not record the temperature inside the plate, this can scarcely have been much higher.

As long as this latter point remained uncertain, however, the experiments could not be regarded as satisfactory; whence it was necessary to again have recourse to gelatine cultures. The gelatine employed began to run at 29° C, and in November it was found that such plates exposed outside, either to directly incident sunshine, or to directly reflected rays, showed a temperature of 12° to 13° C at the insolated glass surface, and even five to six hours exposure caused no running of the gelatine

The following experiment may be selected as a type of the rest —A (Fig. 1) is the upright of an ordinary retort-stand, on the ring B rested a gelatine plate culture of anthrax spores, covered with black paper everywhere except the cut out letter E, seen on its lower face C was an ordinary plane microscope mirror with its arm fitted to a cork on A

The whole was placed in the middle of a field at 9 30 a m on Wednesday, November 30, and exposed to the clear, but low, sunshine which prevailed that day, the mirror being so arranged (from time to time as necessary) as to reflect the light on the E the whole period, until 3 30 p m, when the plate was removed and placed in the dark incubator at 20° C On the following Friday—i e after less than forty-eight hours' incubation—the letter E stood out sharp and clearly transparent from the faint grey of the rest of the plate of gelatine Not a trace of anthrax could be found in the clear area, even with the microscope, while the grey and almost opaque appearance of the rest of the plate was due to innumerable colonies of that organism which had developed in the interval

It was impossible to incubate the plate longer for fear of liquefaction, whence the sceptical may reply that the anthrax exposed to light was only retarded, the experiments with agar show that such is not the case, however, and that if the insolation is com-

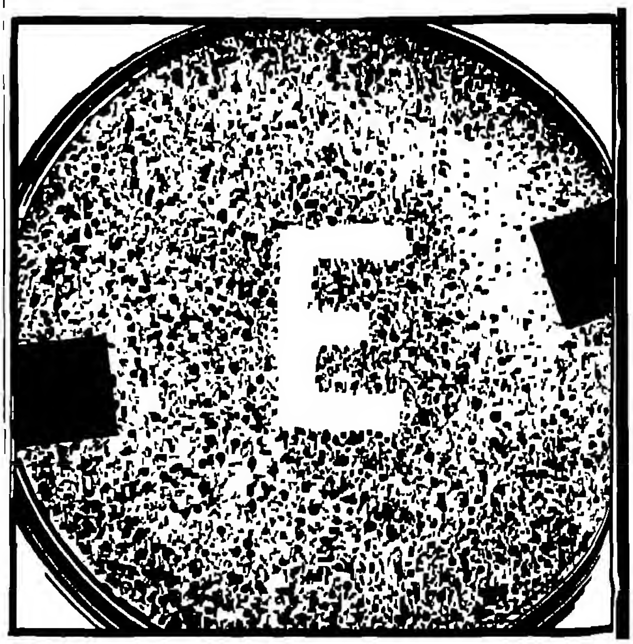


FIG 2

plete the spores are rendered incapable of germinating at all, as proved by removing pieces of the clear agar or gelatine and attempting to make tube cultures from them in all cases where insolation is complete they remain sterile

The chief value of these gelatine plate exposures in November, however, is that they prove conclusively (1) that the rays of a *winter* sun are capable, even if reflected, of killing the spores, and (2) that it is really the solar rays which do this directly, and not any effect of a higher temperature, since the gelatine remains solid throughout

Experience has shown, however, that some precautions are necessary in selecting the anthrax cultures employed for these experiments with gelatine The light certainly retards or kills (according to its intensity or the length of exposure) virulent spores, but if one takes the spores, mixed with vegetative bacilli, direct from a thoroughly liquefied gelatine culture, or from a bouillon culture, the plates are apt to be liquefied too rapidly for the proper development of the light print, evidently because so much of the liquefying enzyme is carried in when inoculating the plates The same danger is run when active bacilli alone are employed

The best method of avoiding these disadvantages has been

found to be the following, and it has the additional merit of enabling us to prove, beyond all doubt, that the ripe spores of *Bacillus anthracis* are really inhibited or killed by sunlight.

A few c c of sterile distilled water in a tube are thoroughly saturated with the anthrax spores taken from an old culture which has never been exposed to light, and the tube placed for twenty four hours at 56° C, this kills all immature spores, bacilli, and enzymes, and leaves us with a crop of the most resistant and fully matured virulent spores

Experiments with such spores have been made to determine the relative power of the different rays of the spectrum to destroy the anthrax.

It is necessary to note first, however, that in experimenting with the electric light, although but few exposures have been made as yet, it is evident that its effects are feebler than those of the winter sun

At present it has only been possible to observe that the inhibiting effects are stronger at the blue end of the spectrum than at the red, and exposures to sunlight passing through coloured glasses confirm this result, but the observations are being continued in the hope of getting a perfectly sharp record of the effects of each set of rays

The following series of experiments are quoted in detail, because they teach several details of importance, in addition to proving the main fact

On December 7 three gelatine plates and five agar plates were prepared with spores from a very vigorous and virulent agar tube of anthrax. The spores, which were quite mature, were not subjected to heat, but simply shaken in sterile water to wash and separate them thoroughly

The three gelatine plates were made at 35° C, the agar plates at 60° C, neither of which temperatures could injure the ripe spores.

The three gelatine plates were labelled *p* 1, *p* 2, and *p* 3, and the agar plates *p* 4 to *p* 8 in order

Immediately after making the plates, all were exposed to the December sun, except plates *p* 4, *p* 5, and *p* 6, and this was done as follows —In each case the plate had a stencil plate with a cut out letter on its lower face, and arranged as described above

p 1, a gelatine plate with a *large* letter M, was exposed, face down, to the light reflected from a mirror (see Fig 1) for three hours on December 7, and for four hours on December 8, the interval being passed in a cold room (*t* about 8°-9° C), and then incubated at 20° in the dark

p 8 was treated in exactly the same manner But this was an agar plate with a *large* W

p 2, a gelatine plate with a *large* H, was exposed and heated in the same way, except that no mirror was used, the latter being upwards towards the sun

p 3, a gelatine plate with a *large* B, was similarly exposed, face up, but a plane mirror arranged to reflect light down upon it

p 7, an agar plate with a *large* E, was treated exactly as the last

There now remain the three agar plates, *p* 4, *p* 5, and *p* 6, to account for

p 4 was placed forthwith in the dark incubator at 20° C

p 5 and *p* 6 were kept for eighteen hours in a drawer, the average temperature of which is almost 16° C, and were not exposed till next day (December 8), when they lay for five hours, face upwards, and with a mirror above them *p* 5 had a *small* E, and *p* 6 a broad but small I to let the light in

After exposure, these also were put in the same incubator with the others

Nothing was visible to the unaided eye on these plates (except *p* 4) until the 11th instant, though the microscope showed that germination was proceeding on the 10th The plate *p* 4, however, had a distinct veil of colonies all over it on the 9th, and this had developed to a dense typical growth by the 11th.

On December 11, at 10 a.m., the state of affairs, as regards the exposed plates, was as follows —

p 5 and *p* 6 showed each a sharp transparent letter—E and I respectively—of clear agar in a dull grey matrix of strong anthrax colonies, which covered all the unexposed parts of the plate

p 1, *p* 2, and *p* 3 showed in each case a perfectly clear central patch, about 1½ inches diameter, with anthrax colonies in the gelatine around These anthrax colonies were the *larger and more vigorous the more distant they were from the clear centre* In other words, the anthrax spores had begun to germinate, and the colonies were growing more vigorously, in centripetal order

On *p* 7 and *p* 8 germination was beginning, but the colonies were as yet too young to enable one to judge of the results

The first point of interest is to account for the pronounced results in the plates *p* 5 and *p* 6, and the want of sharp outlines in *p* 1, *p* 2, and *p* 3, and the explanation seems to be that, owing to the plates 5 and 6 having laid over night at 16° C, the spores began slowly to germinate out, *and were consequently in their most tender condition* when exposed to the sunlight next day

The peculiar centripetal order of development of the colonies on plates *p* 1, *p* 2, and *p* 3 gave rise to the following attempt at explanation After observing that the clear space in the middle was not due to the centre of the plate being raised, and the infected gelatine having run down to the periphery—a possible event with some batches of Petrie's dishes—it was surmised that the *large* letters employed might give the clue

This was found to be the case The solar rays on entering the plate were largely reflected from the glass lid of the plates, and so produced feebler insolation effects on parts of the plate around the letter, these effects were naturally feebler and feebler towards the margin, and so the inhibitory action became less pronounced at distances further and further removed from the centre Those spores, therefore, which were nearest the periphery germinated out first, and those nearer the centre were retarded and more and more in proportion to their proximity to the insolated letter

That this is the correct interpretation of the facts follows clearly from the further behaviour of the above plates

At 10 p m on the 11th—*i e* twelve hours after the morning examination—the plates *p* 1, *p* 2, and *p* 3 exhibited their respective letters M, H, and B quite clearly, in the grey matrix of anthrax which had rapidly developed in the interval, and excepting a slight want of sharpness in the H of *p* 2, the results could hardly have been more satisfactory

In *p* 7 and *p* 8 the *very faint* outlines of the letters were also showing

On the 12th, at 8 30 a.m, the gelatine plates had begun to run, and although the M of *p* 1 was still intact, and very well marked, *p* 2 had liquefied completely, so that the H was a clear patch with blurred outlines in the centre. *p* 3 still showed the outlines of the B, but it was impossible to keep it longer

The main point was definitely established, however, and the treatment of the plates proves conclusively that the spores are not killed by high or low temperatures, *but by the direct solar rays*

These experiments are being continued in order to answer some other questions in this connection

The gelatine and agar after such exposures as have been described are still capable of supporting a growth of *B anthracis* if fresh spores are sown on them, whence the effects described are not merely due to the sub-strata being spoilt as food material

Royal Meteorological Society, January 18 —Dr C. Theodore Williams, President, in the chair —After the report had been read, and the officers and council for the ensuing year had been elected, the President delivered an address on the high altitudes of Colorado and their climates, which was illustrated by a number of lantern slides.—Dr Williams first noticed the geography of the plateaux of these regions, culminating step by step in the heights of the rocky mountains, and described the lofty peaks, the great parks, the rugged and grand cañons, and the rolling prairie, dividing them into four classes of elevations between 5000 and 14,500 feet above sea level He then dwelt on the meteorology of each of these divisions, giving the rainfall and relative humidity, and accounting for its very small percentage by the moisture being condensed on the mountain ranges of the Sierras lying to the west of the Rockies, also noticing the amount of sunshine and of cloudless weather, the maxima and minima temperatures, the wind force, and the barometric pressure Dr Williams quoted some striking examples of electrical phenomena witnessed on Pike's Peak (14,147 feet) by the observer of the U.S Weather Bureau, when during a violent thunderstorm flashes of fire and loud reports, with heavy showers of sleet, surrounded the summit in all directions, and brilliant jets of flame of a rose-white colour jumped from point to point on the electric wire, while the cups of the anemometer, which were revolving rapidly, appeared as one solid ring of fire, from which issued a loud rushing and hissing sound. During another storm the

observer was lifted off his feet by the electric fluid, while the wristband of his woollen shirt, as soon as it became damp, formed a fiery ring around his arm. The climate of the Parks is, however, Dr. Williams considered, of more practical interest, and in these magnificent basins of park like country interspersed with pines, and backed by gigantic mountains, are resorts replete with interest for the artist, the sportsman, the man of science, and the seeker for health. Most of them lie at heights of from 7000 to 9000 feet, and so good is the shelter that usually snow does not long remain on the ground, while Herefordshire cattle in excellent condition are able to fatten on the good herbage, and to lie out all the winter without shed or stable. Dr. Williams predicted for these parks a great future as high altitude sanitaria for the American continent, especially as several of them have been brought within easy distance of Denver, the queen city of the plains, by various lines of railway. The resorts on the foothills and on the prairie plains, at elevations of 5000 to 7000 feet, include, besides Denver, Colorado Springs, Manitou, Boulder, Golden, and other health stations, which can be inhabited all the year round, and where most of the comforts and luxuries of American civilisation are attainable in a climate where not more than half a day a week in winter is clouded over, where the rainfall is only about 14 inches annually, most of which falls during summer thunderstorms, where the sun shines brightly for 330 days each year, and where the air is so transparent that objects twenty miles off appear close at hand, and high peaks are calculated to be visible at a distance of 120 miles. Dr. Williams summed up thus:—The chief features of the climate of Colorado appear to be (1) Diminished barometric pressure, owing to altitude, which, throughout the greater part of the State, does not fall below 5000 feet. (2) Great atmospheric dryness, especially in winter and autumn, as shown by the small rainfall and low percentage of relative humidity. (3) Clearness of atmosphere and absence of fog or cloud. (4) Abundant sunshine all the year round, but especially in winter and autumn. (5) Marked diathermancy of atmosphere, producing an increase in the difference of sun and shade temperatures, varying with the elevation in the proportion of 1° for every rise of 235 feet. (6) Considerable air movement, even in the middle of summer, which promotes evaporation and tempers the solar heat. (7) The presence of a large amount of atmospheric electricity. Thus the climate of this state is dry and sunny, with bracing and energising qualities, permitting outdoor exercise all the year round, the favourable results of which may be seen in the large number of former consumptives whom it has rescued from the life of invalidism and converted into healthy active workers; and its stimulating and exhilarating influence may also be traced in the wonderful enterprise and unceasing labour which the Colorado people have shown in developing the riches, agricultural and mineral, of their country.

Entomological Society, January 18.—Sixtieth Annual Meeting.—Mr. Frederick DuCane Godman, F.R.S., President, in the chair.—An abstract of the treasurer's accounts having been read by Mr. J. Jenner Weir, one of the auditors, the secretary, Mr. H. Goss, read the report of the Council. After the ballot it was announced that the following gentlemen had been elected as officers and Council for 1893:—President, Mr. Henry J. Elwes; Treasurer, Mr. R. McLachlan, F.R.S.; Secretaries, Mr. Herbert Goss and the Rev. Canon Fowler; Librarian, Mr. George C. Champion; and as other members of the Council, Mr. C. G. Barrett, Mr. Charles J. Gahan, Mr. F. DuCane Godman, F.R.S., Mr. Frederic Merrifield, Mr. Osbert Salvin, F.R.S., Dr. David Sharp, F.R.S., Colonel Charles Swinhoe, and Mr. George H. Verrall. The President then delivered an address which, though containing reference to the Society's internal affairs and an allusion to the successful resistance made by naturalists and others to the War Office scheme for establishing a rifle range in the New Forest, consisted for the most part of full obituary notices of Fellows of the Society who had died during the year, special mention being made of Mr. Henry W. Bates, F.R.S., Prof. Hermann C. C. Burmeister, Dr. Carl A. Dohrn, Mr. H. Berkeley James, Mr. J. T. Harris, Sir Richard Owen, K.C.B., F.R.S., Mr. Henry T. Stainton, F.R.S., Mr. Howard Vaughan, and Prof. J. O. Westwood, the Hon. Life President. Votes of thanks to the President and other officers of the Society having been proposed by Lord Walsingham, F.R.S., and Dr. D. Sharp, F.R.S., and seconded by Mr. J. H. Leech and Mr. W. H. B. Fletcher, Mr. Godman, Mr. McLachlan, Mr. H. Goss, and Canon Fowler severally replied, and the proceedings terminated.

Linnean Society, January 19.—General Meeting, Prof. Charles Stewart, President, in the chair.—After the confirmation of the minutes the President referred in suitable terms to the losses sustained by biologic science in the deaths of Sir Richard Owen and Prof. J. O. Westwood, who had been Fellows of the Society for 56 and 64 years respectively.—Mr. George Brook showed photographs of corals which he had lately taken and had reproduced by permanent process at a cost below lithography, with the added advantage of permitting amplification by a hand lens.—The President read a paper on the auditory organ of the angel fish (*Rhina squatina*).—Mr. W. Carruthers, F.R.S., V.P.L.S., then laid before the Society the results of a collection made by Mr. Alexander Whyte in the Malanji country, in the Shire highlands, in October, 1891, and the plants were determined by the officers of the Botanical Department, British Museum, about sixty, or, roughly speaking, one fifth, proving new to science. Whilst Sir J. D. Hooker defined the flora of Kilimanjaro as Abyssinian in character, the Malanji flora displays a much closer relationship to the Cape.—The last paper was by Mr. G. F. Scott Elliot, and was his report as botanist to the Anglo-French Sierra Leone Boundary Commission, in which he gave an account of the economic aspects of the districts traversed.

Geological Society, January 11.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—Variolite of the Lleyn, and associated volcanic rocks, by Catherine A. Raisin, B.Sc. Communicated by Prof. T. G. Bonney, F.R.S. The district in which these rocks occur is the south-western part of the Lleyn peninsula, marked on the Geological Survey map as "metamorphosed Cambrian." Some of the holocrystalline rocks are probably later intrusions. The igneous rocks, which are described in detail in the present paper, belong to the class of rather basic andesites or not very basic basalts; they show two extreme types, which were probably formed by differentiation from an originally homogeneous magma. Corresponding to the two types of rock are two forms of variolite. These are fully described, and their mode of development is discussed. The variolites occur near Aberdaron, and at places along the coast. Their spherulitic structure often is developed towards the exterior of contraction-spheroids, and in this and in other particulars they correspond with those of the Fichtelgebirge and of the Durance. The volcanic rocks include lava-flows and fragmental masses, both fine ash and coarse agglomerate. They are associated with limestones, quartzose, and other rocks, which are possibly sedimentary, but which give no trustworthy evidence of the age of the variolites. Prof. Judd complimented the authoress on the evidently great amount of labour and patient research devoted to this investigation. He thought the occurrence of the spherulitic structure round the surfaces of "pillow like masses," similar to those described by Prof. Dana, was exceedingly interesting, especially when one considered the probably very great antiquity of these Caernarvonshire rocks. He thought, also, the suggestion that early crystallised magnetite grains had formed the nuclei of the spherulites, was a very interesting and probable one. Mr. Alfred Harker, Profs. Bonney, Hull, and J. F. Blake also spoke.—On the petrography of the island of Capraja, by Hamilton Emmons. Communicated by Sir Archibald Geikie, For. Sec. R.S. The rocks of Capraja consist generally of andesitic outflows resting on andesitic breccias and conglomerates. The southern end seems to have formed a distinct centre of volcanic activity, whose products are younger in age and more basic in character than the rocks of the rest of the island, and may be termed "anamesites." The lavas appear to have flowed from a vent at some distance from the cone, which probably occurred here, and gave out highly scoriaceous fragments. In the other parts of the island andesite is almost everywhere formed, with patches of the underlying breccias here and there in the valley bottoms. The chief centre of activity probably lay west of the centre of the island. Petrographical details of the andesites and anamesites, descriptions of the groundmass and included minerals of each, and chemical analyses are given. As regards the age of the constituents, the author arranges them in the following order, commencing with the oldest:—Magnetite, olivine, augite, mica, felspar, nepheline. After the reading of this paper Dr. Du Riche Preller gave an outline of the leading geological and the

analogous petrological features of the several islands of the Tuscan Archipelago, of Corsica, Sardinia, the Carrara mountains, and the Maremma hills The President also spoke

Zoological Society, January 17 —Sir W H Flower, F R S President, in the chair.—The Secretary read a report on the additions that had been made to the society's menagerie during the month of December, 1892 —Mr F. C Selous exhibited and made remarks on the head of a hybrid antelope between the Sassaby (*Bubalis lunata*) and Hartebeest (*B caama*), also a head of a female Koodoo (*Strepsiceros kudu*) with horns, and heads of some other South African antelopes —Mr O Thomas exhibited some examples (from the Baram River, Sarawak, collected by Mr Hose) of the monkey that he had lately described as *Semnopithecus cruciger*, and stated that, in spite of the confirmation afforded by these specimens, Mr. Hose thought that this species might possibly be only an erythrism of *S chrysomelas* —A communication was read from Mr E. Y Watson, entitled "A proposed classification of the *Hesperiidæ*, with a revision of the Genera." This contained a preliminary classification of the *Hesperiidæ*, including the numerous modern genera, which were arranged under three subfamilies according to the sexual differences, the resting posture, the antennæ, the spurs on the hind tibiæ, and the position of vein 5 (relative to veins 4 and 6) of the fore wing The subfamilies were named Pyrrhopyginæ, Hesperiinæ, and Pamphilinæ, and the two last were subdivided into sections without names In all 234 generic names were dealt with, of which 49 were treated as synonyms, while 45 new genera were described Complete diagnoses were given of all the admitted genera —A communication was read by Mr E E Austen, entitled "Descriptions of New Species of Dipterous Insects of the Family *Syrphidæ*, in the Collection of the British Museum, with Notes on Species described by the late Francis Walker" This communication contained descriptions of twenty-three new species belonging to the division *Bacchini*, and of one belonging to the *Brachyopini* (genus *Rhingia*) An attempt was made to divide the genus *Baccha*, as at present existing, into three groups, based chiefly upon the shape and markings of the abdomen The true position of the remarkable genus *Lycastrirhyncha*, founded by Bigot on a species from Brazil, and afterwards cancelled by its author in favour of *Rhingia*, was established It was shown that this genus had nothing to do with *Rhingia*, but was one of the *Eristalini*, closely allied to *Eristalis* It was also shown that the genus *Lycastris*, founded by Walker for a species from India, was not identical with *Rhingia* (as had been likewise suggested by Bigot), but belonged to the *Xylotini*, and was allied to *Criorrhina* A communication was read from Mr. Gilbert C Bourne, containing descriptions of two new species of Copepodous Crustaceans from Zanzibar, proposed to be called *Canthocamptus finni* and *Cyclops africanus* —Mr Sclater exhibited and made remarks on the typical specimen of a rare Argentine bird (*Xenopsaris albinucha*) described by the late Dr Burmeister in 1868

Anthropological Institute, January 24 —Anniversary meeting —Dr Edward B Tylor, F R S, in the chair —The following were elected officers and council for the ensuing year —President, Prof A Macalister Vice Presidents, J G Garson, Chas H. Read, F W Rudler Secretary, C Peek Treasurer, A. L Lewis Council G M. Atkinson, Henry Balfour, E W. Brabrooke, Hyde Clarke, J. F. Collingwood, Prof D J Cunningham, W L. Distant, J. Edge Partington, A J. Evans, H Gosselan, Prof A C Haddon, T V Holmes, R Biddulph Martin, R Munro, F G H Price, Oldfield Thomas, Arthur Thomson, Coutts Trotter, M J Walhouse, Gen. Sir C P Beauchamp Walker

EDINBURGH

Royal Society, January 16 —Prof Copeland, Vice-President, in the chair —A paper, by Dr W. Pole, on the present state of knowledge and opinion in regard to colour blindness, was communicated. He discussed alone the red-green form of colour blindness In such a case the solar spectrum presents only two hues separated by a nearly colourless portion—a mixture of blue and yellow light, giving rise to a gray colour According to Young the three primary colour sensations correspond to red, green, and blue or violet, and Maxwell and Helmholtz, reasoning on this theory, conclude that the colours seen in dichromic vision are green and blue. According to Dr Pole, they are yellow and blue. He asserts that comparisons between normal and abnormal visions show that in general matches of colours made by a normal eye are also matches when regarded by a dichromic eye He concludes that the two dichromic colours are colours known in normal vision He then gives reasons for the conclusion that these colours are normal blue and yellow In answer to the suggestion that the real subjective impressions may differ from what they are supposed to be, he says that the correspondence is proved by a large amount of evidence obtained by comparison with normal phenomena He thinks that the following conclusions may be drawn from the second edition of Helmholtz's work on optics —(1) The original mode of explanation of colour blindness by Young's theory is essentially withdrawn as no longer consistent with modern knowledge The universal concurrent testimony, that the ordinary colour dichromic vision generally corresponds with is normal yellow and blue and white, is no longer disputed, and although there are variations of sensations in regard to red and green, the old ideas of blindness to red and green as separate and contrasting defects are abandoned, (2) that Young's general theory of three fundamental colour sensations is still adhered to, but that the colours are now believed to differ considerably in the spectrum; (3) that dichromic vision might exist consistently with the retention of three fundamentals, (4) that the most prevalent form of dichromatism might be explained by the junction of the red and green fundamentals forming yellow In conclusion, he regretted that the colour vision committee of the Royal Society, in a recent chart dealing with colour blindness, had adhered to the old view held by Clerk Maxwell Sir George Stokes remarked that the fundamental part of Young's original theory was that there were three colour sensations, and though he supposed them to be red, green, and violet, that was not essential Maxwell only chose red, green, and blue, as representative sensations He was doubtful of the wisdom of publishing the charts alluded to lest it might lead to misconception The object of publishing them was to give to the public a general idea of the conclusions derivable from the trichromic theory

SYDNEY

Royal Society of New South Wales, December 7, 1892 —Prof Warren, President, in the chair —The Chairman announced that the Clarke Medal for 1893 had been awarded by the Council to Prof Ralph Tate, of the Adelaide University —A letter was read from the Hon Ralph Abercromby, enclosing a cheque for £100, which he desired to place in the hands of the Council of the Society with the object of bringing about an exhaustive study of certain features of the Australian weather, the particulars to be furnished in a later letter The following papers were read —Observations on shell heaps and shell beds, the significance and importance of the record they afford, by E J Statham —A new mineral from Broken Hill, by C W Marsh (communicated by Prof Liversidge) —Notes on some Australian stone weapons, by Prof Liversidge, F R S —Notes on the recent cholera epidemic in Germany, by Dr. Schwarzbach —Results of observations of Wolf's comet II., 1891, Swift's comet I, 1892, and Winnecke's periodical comet, 1892, at Windsor, New South Wales, by John Tebbutt —On the comet in the constellation Andromeda, by John Tebbutt —Languages of Oceania, by Dr John Fraser

August 17 —*Engineering Section* —C. W Darley in the chair —Papers read —Various systems of tramway traction, by W F How ——November 16 —Some notes on the economical use of steam, by T H. Houghton —Recent bridge building in New Zealand, by A Alabaster

PARIS

Academy of Sciences, January 23 —M Lœwy in the chair —Note on Nicolas de Kokcharow, by M Daubrée —Contributions to the study of the function of camphoric acid, by M A Haller —On the pepto-saccharifiant action of the blood and the organs, by M. R Lépine If blood is poured into several parts of water at 56° C a considerable quantity of sugar is formed in a few seconds, and the formation goes on for about an hour with decreasing rapidity. In cold or lukewarm water sugar is also produced, but its production is for the most part compensated by simultaneous glycolysis. It is also probable that the production of sugar is preceded by that of peptone If an organ which does not enclose glycogen in any perceptible quantity be macerated for about an hour in three or four parts of water, the aqueous extract only contains a very small quantity

of substances capable of reducing Fehling's solution, and hardly any sugar If to this aqueous extract be added a small quantity of peptone, and the whole be kept at 56°C during an hour, a certain quantity of sugar is formed, as proved by fermentation and the phenylhydrazine test Hence the aqueous or glycerine extract contains a ferment which may be termed pepto-saccharifiant It is probable that the formation of sugar is not confined to the liver, as ordinarily supposed, but that several organs play a part in it —Observations of the planet Charlois T (December 11, 1892), made at the Toulouse Observatory, by M B Baillaud —Contribution to the investigation of the solar corona apart from total eclipses, by M H Deslandres (see Astronomical Column) —Observations of the sun made at the Lyon Observatory (Brunner equatorial) during the latter half of 1892, by M Guillaume —On the limitation of degree for the general algebraic integral of the differential equation of the first order, by M Autonne —On Van der Waals's equation and the demonstration of the theorem of the corresponding states, by M G Meslin —Magnetic properties of bodies at different temperatures, by M P Curie —The magnetic permeabilities of a series of diamagnetic bodies, including, amongst others, bismuth, antimony, phosphorus, sulphur, and some potassium salts, were determined by enclosing them in an exhausted glass vessel exposed to a magnetic field, and subsequently repeating the experiment with the glass alone Most of the substances showed a remarkably constant coefficient Water and quartz did not show a perceptible variation with temperature, and potassium nitrate had the same coefficient when solid and when fused That of bismuth, on the other hand, fell steadily up to the point of fusion, and then (at 273° C) abruptly from 0 957 to 0 038, after which it remained constant Electrolytic antimony had a much feebler coefficient than the ordinary variety —Contribution to the study of equalisers of potential acting by flow, by M G Gouré de Villemontée —Luminous phenomena observed at the Lyon Observatory on the evening of January 6, 1893, by M Gonnessiat —A method for measuring objectively the spherical aberration of the living eye, by M C J A Leroy.—On the atomic weight of palladium, by MM. A Joly and E. Leidie —Action of the alkaline alcoholates on camphoric and other anhydrides, by M P Cazeneuve —Modification of arterial pressure under the influence of pyocyanic poisons, by MM Charrin and Teissier.—On some cases of infectious arthrodentary gingivitis observed in animals, by M V Galippe —Primary bedding of platinum in the Ural, by M. A Inostranzeff The native platinum occurs embedded in a rocky matrix consisting of the variety of peridotite known as dunite It is found in Mount Solovieff, which consists of alternate layers of chrome-iron and serpentine —On the existence of overfolds in the Blida Atlas (Algeria), by M. E Ficheur

BERLIN.

Physical Society, January 6 —Prof du Bois Reymond, President, in the chair —Prof. Raoul Pictet gave an account of experiments made by Messrs. Sarasin and De la Rive by which the rate of the electric waves discovered by Hertz had been measured, and their identity with waves of light in the ether determined By using large metallic surfaces sixteen metres in diameter as reflectors, and by allowing the discharge of the primary spark to take place under oil instead of in the air, it was found possible to obtain stationary electric waves in a long gallery and to determine their nodal points. In the discussion which ensued Prof Kundt stated that Dr Zenker was the first person who had explained the photographing of colours by means of stationary waves; that stationary light-waves were first experimentally determined by Dr Wiener, and that Seebeck was the first to take photographs of coloured objects. After Prof H W Vogel, pictures due to the action of li ht were first taken by a doctor named Schulz, in Halle. In 1727 this observer treated a solution of nitrate of silver in a small box with calcium chloride and obtained a greyish precipitate He then covered the box with a lid in which was a hole the shape of some letter, and on subsequently examining the precipitate he saw a dark image of the letter on it. The experiment was found to fail in the dark Schulz hence concluded that the image of the letter was due to the action of light.

Meteorological Society, January 10.—Prof Schwalbe, President, in the chair —Dr Kremser spoke on the imperfection of the means available for the study of atmospheric currents, which, even in the most elevated stations, are profoundly modified by the topography of the neighbourhood The direction and rate of these currents can only be ascertained by observing the motion of a small pilot-balloon of some one cubic metre capacity, a specially constructed theodolite being used for this purpose —Prof Hellmann exhibited a series of photographs of snow crystals taken by Dr Neuhauss, together with the oldest existing figures of these crystals, due to Olaus Magnus in 1455 The chief points of interest shown by these photographs were the not infrequent asymmetry of the crystals and the occurrence on them of small ice lumps

Physiological Society, January 13 —Prof du Bois Reymond, President, in the chair Dr Behring gave an account of the present state of affairs as regards what may be called the blood-serum therapeutists, illustrating his remarks by experiments he had made with serum from an immune horse on mice inoculated with tetanus bacilli A number of mice were inoculated with more or less strong doses of the bacilli Those which had previously been treated with the horse serum did not die, and in many cases where the serum was injected after the inoculation death did not ensue Observations on man are in progress, and will be published as soon as sufficient data are to hand on the treatment of tetanus and diphtheria by the use of serum from immune animals —Dr Hahn, of St Petersburg, gave an account of experiments made in conjunction with Profs Pawlow and Nencki on the action of an Eck's fistula, and the conducting of blood from the portal vein directly into the inferior vena cava Among the various results of the operation he stated that the output of urea was lessened and that of uric acid increased, a result which the experimenters attributed to a cessation in the conversion of carbamic acid into urea due to exclusion of the liver They further found that carbamic acid produced symptoms similar to those exhibited by the animals on which they had operated —Prof Kossel and Dr Raps exhibited an automatic mercurial pump for blood gas analysis

CONTENTS.

THURSDAY, FEBRUARY 9, 1893

THE MILKY WAY

The Milky Way from the North Pole to 10° of South Declination, drawn at the Earl of Rosse's Observatory at Birr Castle By Otto Boeddicker (London Longmans, Green, and Co, 1892)

DR OTTO BOEDDICKER devoted the clear moonless nights for five years, from October 1884 to October 1889, to delineating the Milky Way as it appeared to his unaided eyes at Parsonstown, Ireland His drawings were deposited in the library of the Royal Astronomical Society, and a note accompanying them was read at the meeting of the Society in November 1889 The work now before us consists of four excellent lithographic reproductions of these drawings, a brief introductory preface being added by Dr Boeddicker

The working maps for the drawings were taken from Argelander's "Uranometria Nova," the Milky Way being inserted by means of stump and lead pencil This medium was found very unsuitable for photographic reproduction, and in preparing the lithographic stones for these charts photography was used for the stars, and the Milky Way was introduced by hand work. Mr W H Wesley, the Assistant Secretary of the Royal Astronomical Society, is responsible for this latter portion of the work, and the results are a splendid testimony to his care and skill Dr Boeddicker is to be congratulated upon having secured the services of so excellent an artist

Plate I is a detailed drawing of the Section Cygnus-Scutum, Plate II of the Section Cassiopeiæ, and Plate III of the Section Aurigæ-Gemini-Monocerotis In these plates an attempt has been made to represent accurately the appearance of the galaxy, all the differences of luminosity being represented as they actually appeared to Dr Boeddicker In Plate IV a general view on a smaller scale of the whole Milky Way from the North Pole to 10° south declination is given, the contrast being deliberately exaggerated in order to bring out clearly all the details

The area of the Milky Way indicated on these drawings is very much greater than that on any previously published representations, while for delicate details and faithful reproduction of contrast the plates are unapproached. In many respects Dr Boeddicker's drawings are a new revelation, branches, wisps, and feelers being shown extending from the main body so as to include stars, clusters and nebulæ, and even whole constellations not previously recognized as connected with or forming part of the Milky Way Polaris, γ Arietis, Prœsepe, the Pleiades, the Hyades, the great nebula in Andromeda, and nearly the whole of the constellation Orion, are thus joined to the galactic circle Numerous bright patches, channels, rifts, and interlacing lines of luminous matter hitherto unsuspected are revealed by Dr Boeddicker's long and patient work, and exponents of disc, spiral, and other theories as to the construction of the Milky Way will find considerable difficulty in accounting for the details shown.

It is very difficult to compare drawings of the Milky Way made by different observers without optical aid There are such wide variations in unaided vision, so many peculiarities introduced by long and short sight, by astigmatism, by irradiation in the retina, and by other physical and physiological imperfections, that it may safely be asserted that no two persons get exactly the same naked eye impression of such a vague object as the Milky Way As no details are given about Dr Boeddicker's eyes we are probably justified in inferring that they are practically normal, but we doubt whether any other observer, even with special training, could check or correct these charts with reasonable prospect of convincing the original artist of error in the representation of the Milky Way as it appeared to him Individual peculiarities of sight are minimized by the use of slight optical aid, and two equally experienced observers would be more likely to agree in their delineations of the Milky Way if they used similar telescopes, of say 1-inch aperture, or even ordinary opera glasses Dr Boeddicker's appeal to other observers to "verify and correct" his work will probably bring him plenty of correspondence, but can scarcely lead to any important correction in his magnificent drawings

Dr. Boeddicker considers that "the first step necessary towards the knowledge of the sidereal universe is a thorough acquaintance with the Milky Way as it appears to the naked eye," and hopes that by comparison and the superposition of naked-eye drawings on photographs "some knowledge of the structure of the Milky Way *in the line of sight* may be obtained" This idea is founded on the theory that there is a direct connection between the magnitudes of stars and their distances Littrow's analysis of Argelander's catalogue of stars certainly seemed to justify belief in this connection, but recent work has entirely disproved the hypothesis Measurements of the parallax of stars indubitably prove that some faint stars are near, while some of the brightest are at such distances as to have no appreciable parallax Thus α Orionis, α Virginis, α Leonis, and α Cygni have no parallax, while the 5th magnitude star 61 Cygni has a parallax of between 0″4 and 0″5 Photographs of the Pleiades show that we have in that cluster stars differing by as much as 13 magnitudes at approximately the same distance from us Russell's photograph of κ Crucis plainly indicates a direct physical connection between that star and many stars of the 14th and 15th magnitudes which should, according to the theory, be nearly 1000 times more distant. Streaks of nebulæ connect α Cygni and γ Cygni with long lines and stars of about the 16th magnitude in Dr. Max Wolf's photographs of the Milky Way From considerations of parallax observations of stars and from examination of photographs we are forced to conclude that there is no real connection between magnitude and distance, and that the differences of magnitude of stars are due to differences of size and physical condition. Stars differ enormously in light-giving power, and the actual light emitted by α Cygni must be nearly a million times greater than that from the faint stars directly connected with it and at practically the same distance from us. There is therefore very little chance of adding to our knowledge of the Milky Way "in the line of sight" by superposition of naked-eye drawings on photographs.

In his preface Dr. Boeddicker frequently speaks of

"nebulosity," "nebulous light," and "nebulous matter," when he means luminosity and luminous matter In ante spectroscopic days the terms nebula and cluster were used almost indiscriminately, a nebula being looked upon as simply an irresolvable cluster, and this error still survives in many astronomical text-books and compilations, but Dr Boeddicker should have avoided it. When we consider that the majority of the stars in the cluster which we call the Milky Way are of the Sirian type, we see how misleading is the use of the terms nebulous light and nebulous matter A T

THE THEORY OF SUBSTITUTIONS AND ITS APPLICATIONS TO ALGEBRA

The Theory of Substitutions and its Applications to Algebra By Dr Eugen Netto Translated by F N. Cole, Ph.D (Mich Ann Arbor, 1892)

THE theory of substitutions abstractly considered is concerned with the enumeration and classification of the permutations of a set of n different letters $x_1, x_2, \ldots, x_n$ It is scarcely apparent at first sight that a far-reaching mathematical theory could be built on a basis so simple, still less that there should be any connection between this and the complicated question of the solution of algebraical equations by means of radicals It may be worth while, in order to excite the interest of mathematical readers in the work before us, to mention one or two points in the Theory of Substitutions which will give an inkling of the nature of its connection with the interesting problem just mentioned.

The operation of replacing—say in any function $\phi(x_1, x_2, x_3)$—any permutation of the letters, say x_1, x_2, x_3, by any other, say x_1, x_3, x_2, is called a *substitution*. This operation is denoted explicitly by $\begin{pmatrix} x_1, x_2, x_3 \\ x_1, x_3, x_2 \end{pmatrix}$, or shortly by a single letter s. Thus $s\phi(x_1, x_2, x_3) = \phi(x_1, x_3, x_2)$, and again If t denote the substitution $\begin{pmatrix} x_1, x_2, x_3 \\ x_3, x_2, x_1 \end{pmatrix}$, $t\phi(x_1, x_3, x_2) = \phi(x_3, x_1, x_2)$ We may indicate the successive application of the two substitutions s and t by multiplying the symbols st in the order of application thus $st\phi(x_1, x_2, x_3) = \phi(x_3, x_1, x_2)$ and $ts\phi(x_1, x_2, x_3) = \phi(x_2, x_3, x_1)$ In particular, the repetition of the same substitution may be represented by powers of the symbol, thus $s^2\phi(x_1, x_2, x_3) = \phi(x_1, x_2, x_3)$. The identical substitution $\begin{pmatrix} x_1, x_2, x_3 \\ x_1, x_2, x_3 \end{pmatrix}$ is represented by unity. The total number of different substitutions of n letters is obviously $n!$, consequently, if we form the consecutive powers of any substitution we shall ultimately arrive at a power s^m which will be the identical substitution, m being some positive integer not exceeding $n!$ m is called the *order* and n the degree of the substitution

If among the substitutions of any given degree we can select a set which have the property that the product of any two furnishes another substitution belonging to the set, we obtain what is called a *group of substitutions*. The whole of the $n!$ substitutions of n letters obviously form a group, and the identical substitution by itself forms a group. It is easy, however, to see that in general there are other groups among the substitutions of a given degree Consider, for example, any rational function $\phi(x_1, x_2, \ldots, x_n)$ which is not wholly asymmetric: there must exist a set of substitutions each of which leaves the value of ϕ unaltered A substitution which is the product of any number of these must also leave ϕ unaltered: hence the set in question forms a group. We have here a fundamental point in the theory of substitutions, viz, the existence of a group of substitutions and the correlation therewith of rational functions which are unaltered by all the substitutions of the group The group is said to belong to all the functions which it leaves unaltered, and these functions are said to form a family which is characterized by the group. Thus the group of a wholly asymmetric function is the identical group consisting of the substitution [1], the group of the wholly symmetric functions consists of the whole of the $n!$ substitutions of the n^{th} degree, the group of the alternating functions consists of all those substitutions which are equivalent to an even number of transpositions, and so on It is obvious that every rational function determines a group of substitutions, and it may be shown that, conversely, for every group of substitutions we may construct an infinity of rational functions which are unaltered by the substitutions of the group The significance of this correlation between a group and a family of functions depends on the following important theorem, which is due in substance to Lagrange If ψ be a rational function which is unaltered by all the substitutions of the group of ϕ (in other words, if the group of ψ contain the group of ϕ) then ψ can be expressed as a rational function of ϕ, and the n elementary symmetric functions

$$C_1 = \Sigma x_1, C_2 = \Sigma x_1 x_2, \ldots, C_n = x_1 x_2 \ldots x_n$$

A particular case of this is the theorem that if the groups of ψ and ϕ be identical, then each can be expressed as a rational function of the other, and of the elementary symmetric functions A limiting case of this theorem is the familiar result that every rational symmetric function can be expressed as a rational function of the elementary symmetric functions As a special example consider the the two wholly asymmetric functions $\psi = ax_1 + bx_2$, $\phi = a/x_1 + b/x_2$ these both belong to the identical group, since they are changed by every substitution of the letters x_1, x_2. Hence ψ can be rationally expressed as a function of ϕ, C_1, C_2. The actual expression is in fact:

$$\psi = \{2(a-b)^2C_2 - (a^2+b^2)C_1^2 + (a+b)C_1C_2\phi\}\{-(a+b)C_1 + 2C_2\phi\}/(a-b)^2(C_1^2 - 4C_2).$$

The application of the theory of substitutions is limited in the first instance to rational functions Its use in the theory of the solution of algebraical equations by means of radicals is based on the following important result in the theory of irrational functions Any root of a solvable equation $f(x) = 0$ can be expressed as a rational integral function of certain elements $V_1, V_2, \ldots, V_1$, the coefficients of which are rational functions of the coefficients of $f(x)$ and of primitive roots of unity. The quantities $V_1, V_2, \ldots, V_n$ are on the one hand rational integral functions of the roots of $f(x) = 0$ and of primitive roots of unity, and on the other hand are determined by a series of equations:

$$V_a^{p_a} = F_a(V_{a-1}, V_{a-2}, \ldots, V_v),$$

where p_a is a prime number and F is a rational function of the V—s For example, in the case of the cubic

$x^3 - C_1x^2 + C_2x - C_3 = 0$, if $\Delta = -27C_3^2 + 18C_1C_2C_3 - 4C_1^3C_3 - 4C_2^3 + C_1^2C_2^2$, $S = 2C_1^3 - 9C_1C_2 + 27C_3$, $T = 9C_3 - 3C_1C_2$, the relations in question are

$$V_3^2 = -27\Delta,\ V_2^3 = \tfrac{1}{2}(S + V_3),\ V_1^3 = \tfrac{1}{2}(S - V_3),$$

$$V_1 = x_1 + \omega^2x_2 + \omega x_3,\ V_2 = x_1 + \omega x_2 + \omega^2x_3,$$

$$V_3 = T + 3\omega(x_1^2x_3 + x_2^2x_1 + x_3^2x_2) + 3\omega^2(x_1^2x_2 + x_2^2x_3 + x_3^2x_1);$$

$$x_1 = \tfrac{1}{3}\{C_1 + V_1 + V_2\},\ x_2 = \tfrac{1}{3}\{C_1 + \omega V_1 + \omega^2 V_2\},$$

$$x_3 = \tfrac{1}{3}\{C_1 + \omega^2 V_1 + \omega V_2\}$$

By means of this theorem and certain elementary principles of the theory of substitutions an elegant and simple demonstration can be given of Abel's theorem that the solution by radicals of the general equation of the n^{th} degree is impossible when $n > 4$ see § 217 of the work before us.

Although the theory of substitutions bears, as we have just shown, on some of the oldest and most interesting of the problems of algebra, it has been comparatively little studied, especially by English speaking mathematicians Dr Cole has therefore rendered us a service of great importance by translating one of the standard treatises on this subject Of the three that were at his disposal we think that he has chosen the one most likely to be useful to a beginner While Serret in his "Higher Algebra" and Jordan in his "Traité" treat the theory from an abstract and more general point of view, Dr Netto constantly associates with the substitution the function on which it is supposed to operate This gives a powerful concrete aid to the comprehension of the propositions of the abstract theory and also helps the student to grasp their application The great danger in subjects of such generality is that the stream of theorems is apt to run off the mind of the learner without soaking in, like water off the proverbial duck's back

Dr Netto's book will be found to contain all the ordinary theorems regarding the classification of substitutions, *e g* the existence of groups, transitive and intransitive, primitive and non primitive, simple and compound, the theory of the algebraic relations between the values of multiple-valued functions and between functions belonging to or included in the same family, and also a considerable number of theorems regarding special groups The applications embrace the theory of resolvents in general and of the Galois resolvent in particular, the general theory of the solvability of equations by means of radicals, the theory of the group of an equation and a discussion of the criteria of solvability, besides special applications to the cyclotomic and Abelian equations, and to equations three roots of which are connected by a rational relation

The translation has been admirably done, both from the lingulstic and from the mathematical point of view We found, it is true, here and there passages which were somewhat obscure, but in every case, on comparing with the original, we found the rendering to be absolutely faithful. Such obscurities therefore must be charged either to the author, or to the nature of the subject, or to the idiosyncrasy of the critic, and not to the translator We congratulate Mr. Cole on the successful completion of his arduous task, and heartily recommend the result to every lover of the most ancient and the most beautiful of all the sciences.

G CH

THE BRAIN IN MUDFISHES.

Das Centralnervensystem von Protopterus annectens, *eine vergleichend Anatomische Studie* Von Dr Rudolf Burckhardt. (Berlin R Friedlander und Sohn, 1892.)

THE Mudfishes, Dipnoi, from many peculiarities in their structure, have attracted the especial attention of anatomists and zoologists Important monographs on Lepidosiren have been written by Owen and Wiedersheim, whilst Huxley, Gunther, and Beauregard have described the anatomy of Ceratodus Serres, in 1863, made a contribution to the anatomy of the nervous system of Protopterus, Fulliquet in 1886, and Parker in 1888, have also added to our knowledge of its structure, and now Dr Burckhardt has published a well-illustrated monograph on the central nervous system of *Protopterus annectens* He had obtained an ample supply of this fish from Herr W Jezler, a merchant whose business engagements had taken him to the neighbourhood of Bathurst, Senegambia On more than one occasion Dr Burckhardt had received living fish, so that he was able to study the microscopic anatomy by the use of the most recent technical methods, and has thus added materially to our knowledge of the brain of this animal.

The author found, in the anterior horn of grey matter of the spinal cord, remarkably large nerve-cells, which possessed both branching protoplasm processes and an axial-cylinder process In the lateral and posterior horns nerve cells somewhat smaller in size were seen. The medulla oblongata gave origin to nerves which he names hypoglossal, vagus, glosso-pharyngeal, acusticofacialis, and trigeminus He also describes two slender nerves as abducens and trochlearis, so that the Dipnoi are not, as some have said, destitute of these nerves The cerebellum formed the anterior boundary of the 4th ventricle Large nerve-cells, corresponding to those of Purkinje in the mammalian brain, were not seen The mid-brain was distinct, and gave origin to a root of the trigeminus, to the optic tract and to the oculo-motor nerve grey matter containing nerve-cells was grouped around the aqueduct of Sylvius

Whilst Protopterus corresponded closely with the lowest vetebrates in the regions of the mid and hind brains it presented striking peculiarities in the pineal region The roof of the 3rd ventricle was complicated, and possessed a velum, which represented a middle choroid plexus; a conarium, and a structure like that which Edinger has named "Zirbelpolster" The epiphysis (*Zirbel*) was attached to the skull by the arachnoid membrane.

The fore brain was well developed, and divided into two hemispheres He recognized in it a posterior ventral swelling, which, because it contained cells similar to those found in the dentate gyrus (*fascia dentata*) of the higher brains, he describes as a lobus hippocampi He distinguished a fissure which separated the lobus olfactorius from the pallial part of the hemisphere, so that he harmonizes the fore brain in its fundamental divisions with the mammalian brain as described by Broca and Turner. He directs attention to an elevation ventrad of the lobus olfactorius, which he calls the lobus post-olfactorius. This lobe is also found in the brains of

Selachia and Amphibia, and apparently corresponds to the lobus olfactorius posterior described by His in the human embryo, which forms the anterior perforated spot in the adult human brain As regards its structure the hemisphere possessed central grey matter containing nerve-cells which lay around the hemisphere ventricle, also a mass of grey matter which he calls corpus striatum, whilst in the more posterior part of the ventral region of the hemisphere were nerve cells which represented a cortical layer. In the dorsal region of the hemisphere also cortical nerve-cells were found, which were arranged as an inner and an outer layer The cells of the cortex gave origin to nerve fibres A definite anterior commissure was present, the fibres of which passed on each side into the lobus hippocampi Burckhardt, also, figures, as distinct from the anterior commissure, fibres which he regards as the corpus callosum of Osborn The most important tract of nerve fibres was the basal bundle, which ascended from the spinal cord into the corpus striatum

One of the most interesting chapters in Burckhardt's memoir is that in which he gives an account of the saccus endolymphaticus Wiedersheim had described in 1876, in *Phyllodactylus europæus*, a sac with many branching diverticula, filled with otolith-sand and lying in relation to the choroid plexus of the 4th ventricle Hasse had previously seen in Amphibia a similar structure which Coggi had investigated in the frog Burckhardt has for the first time observed and figured it in Protopterus The saccus communicated by a narrow neck with the sacculus and utriculus of the auditory vesicle, and with its diverticula overlaid the region of the 4th ventricle, and extended as far back as the 1st pair of spinal nerves

The memoir contains a short chapter on the phyletic development of the brain of Protopterus Starting with Selachia, he considers that one line of development has been through Protopterus to Ichthyophis, and thence to the Urodela and Anura; another through Ceratodus to Reptilia and Mammalia, whilst a third line is from the Selachia to the Ganoids and Bony Fishes

OUR BOOK SHELF.

The Chemical Basis of the Animal Body. An Appendix to Foster's "Text-Book of Physiology" (fifth edition) By A Sheridan Lea, M A, D.Sc, F R S (London Macmillan and Co, 1892)

LIKE its parent volume, this well-known appendix has grown in bulk considerably, so that it now constitutes a treatise (separately paged and indexed) on the chemical substances occurring in the body. It contains numerous references to the text of Foster's "Physiology," and so the two may be most profitably read together.

The plan pursued in the present edition is the same as in former editions; the chemistry of the body is described under the headings of the names of the chemical substances. This plan has its advantages It for instance gives a completeness to the description of any particular substance, whereas the other plan of describing the facts of animal chemistry, under the headings of the tissues, organs, and functions involves a certain amount of repetition and the facts relating to any one group, such as the proteids and carbohydrates will be found distributed in different chapters Dr. Sheridan Lea's plan has, however, the disadvantage that it destroys continuity Many of the paragraphs are necessarily short, and one passes from one subject to another with a certain amount of abruptness The style of the writing is, however, interesting and clear, so that this disadvantage is reduced to a minimum The parts that treat the subject in a fuller style, such as those in which ferment action, the origin of urea in the economy, or the relation of hæmoglobin to bile pigment are discussed, are models of lucid writing

The book opens with a description of the proteids and ferments, the most important of physiological substances, but those of which, from the chemical standpoint, we know least The simpler materials found in the body or its excreta are treated next This is the more chemical part of the book, and the author expresses his indebtedness to Dr S Ruhemann for assistance here One doubts whether this part of the work will prove attractive to ordinary students There is no question that all medical students should be educated up to it, but at present organic chemistry and structural formulæ are subjects they are inclined to fight shy of The concluding chapters are again devoted to substances of which we have a physiological rather than a chemical knowledge, namely, the pigments.

The figures of crystals, which form a new feature in the present edition, have been taken from the works of Krukenberg, Kuhne, and Funke One cannot conclude this notice without alluding to the extensive references to literature that are given throughout This will prove a most valuable assistance to all original workers, and to those more earnest students who desire to go deeper into the subject The references are provided with a separate index. They are chiefly to German literature The German leanings of the author are seen also in the spelling of sarkosin, kreatin, &c The final *e* is always omitted in the names of the amido acids It would be a good thing in the future if international uniformity in the names of chemical compounds were adopted In the meantime it seems a pity that Dr Lea has not seen fit to use the spellings recommended by the Chemical Society of London

The author is to be congratulated on having brought his labours to a successful conclusion, and we can pay the present volume no better compliment than to say that it is well worthy of those that have preceded it

W D H

Chambers's Encyclopædia New Edition Vol X (London and Edinburgh W and R Chambers, 1892)

THE editor and publishers of the present work may be cordially congratulated on the fact that it has now been successfully completed A better encyclopædia of like scope does not exist in our own or any other language Nominally it is merely a new edition, but in reality, as the editor claims in the preface, it must be regarded as to all intents and purposes a new work One of the chief difficulties in an undertaking of this kind is to secure that each subject shall have the degree of attention which properly belongs to it, no single subject or group of subjects being permitted to usurp space which ought to be otherwise occupied. The editor has grappled with this difficulty so effectually that few readers will have occasion to complain of any lack of proportion in the length of the various articles Another striking merit of the work is that all important subjects have been entrusted to specialists, so that students may have full confidence in the accuracy of the information offered to them about matters in which they happen to be particularly interested. The space at the disposal of the writers was so limited that what they have to say is not, of course, exhaustive, but it is sound as far as it goes, and is generally presented with most praiseworthy simplicity and

clearness The present volume falls in no respect below the level of those which have preceded it Among the writers of scientific articles are Prof James Geikie, who deals with the triassic system and with volcanoes, Prof Knott, who expounds the principles of thermodynamics, Dr R W Philip, who writes of tubercle, and Sir F Bramwell, who has a paper on water-supply.

Arthur Young's Tour in Ireland (1776–79) Edited, with Introduction and Notes, by A W Hutton Two vols (London G Bell and Sons, 1892)

THIS reprint will be of real service to all who study the evolution of economic conditions in Ireland, and much of it ought also to excite and maintain the interest of the general reader Arthur Young, as every one knows, was a remarkably accurate observer of such things as travellers have opportunities of noting, and his book on Ireland is in its own way hardly less valuable than his more celebrated work on France The work was first published in 1780, in the course of which two English editions and one Irish edition were issued Since that time it has not until now been reprinted as a whole Mr Hutton has done his work as editor admirably, and a most useful bibliography has been prepared by Mr J P Anderson

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

Some Lake Basins in France

A FEW weeks since M Delabecque, Ingénieur des Ponts et Chaussées at Thonon, kindly presented me with a copy of a work issued under his superintendence and to a great extent executed by himself,[1] to which I should be glad to call the attention of students of physiography M Delabecque, commissioned by the French Government, has made a series of soundings of ten lakes in France, near the Alpine region, and this Atlas records the results of his work Contour lines, in most cases 5 metres apart, indicate the forms of the lake basins, the use of varying tints in blue makes these more distinct Chief among the lakes included is the Léman, in the survey of which, as only one shore is French territory, the Swiss engineers have cooperated A copy of this on a reduced scale, and without colours, appeared in Prof Forel's book, "Le Lac Léman" (see NATURE, Nov 3, 1892) Next in importance come the lakes of Annecy and of Bourget, the remainder are situated either in the French Jura or on the margin of the outer limestone zone of the Alps, a little south of the Rhone

Excluding the Lake of Geneva, which was noticed in the article just mentioned, these lakes are especially interesting for their bearing on the difficult problem of the origin of lake-basins Except the Lac de Bourget, none of these can be said to lie in a great mountain valley, or on the probable track of a great glacier. If then their basins have been excavated by glaciers, we might fairly expect the Alps and Jura to be "spattered" with lakes, for no appeal can be made to exceptional circumstances while if the contours of their beds present resemblances to those of the larger Alpine lakes, such as the Lake of Geneva, the same explanation ought to apply in the main to both groups

Without a reproduction of the charts it is impossible to give more than a rough idea of the evidence which they afford, but the following statements may be helpful. As a general rule the lakes deepen as they broaden, the deepest water being commonly found in the widest part If in the course of the lake the shores markedly approach so as to form a kind of "narrow," this corresponds with a submerged neck or "col," which separates the bed into two basins, rising perhaps 10 metres or more above their general level Not seldom the bed of a lake consists of a linear series, three to six in number, of shallow basins, so that a contour line, drawn along the axis of the lake, undulates up and down with an "amplitude" of from perhaps 3 to 5 metres A rather long, blunt-ended oval is the prevalent form of these lakes, but to this there are exceptions So far as can be ascertained the contours of the land above the water line are reproduced beneath it For instance, under the steep slopes of the Mont du Chat the bed of the Lac de Bourget plunges abruptly down to a depth of over 120 m (its greatest depth being about 145 m)

Of the Jura lakes, the Lac de St Point (848 95 m above the sea) is rather more than 6 kilometres long, the general width being rather less than one-tenth of this, a considerable part of its floor is 30 to 35 metres deep, and its greatest depth is about 42 metres It contains no less than 6 basins, parted by "cols" about half-a-dozen metres above their lowest parts This lake is on the course of the Doubs, and lies parallel with the general strike of the Jura, *i e* from N E to S W The Lac de Brenets on the same river, nearly 100 metres lower down, is a narrow, winding lake, roughly 150 metres wide and perhaps 8 or 9 times as long At its upper end is a sharply projecting, rather shallow bay, but the channel of the Doubs can be traced clearly through this, deepening gradually from 5 to nearly 27 metres and the whole lake is evidently only an enlargement of the river

The subalpine lakes are no less interesting, and their testimony generally agrees with that summarised above Want of space forbids us to mention more than the lake of Annecy This is deepest (about 65 m) in its northern and widest part (nearest to the effluent) The sub-aqueous contours on the western side are interrupted, to within about 10 metres from the bottom of the lake, by a prominence, just like a drowned hilly spur The shallowest soundings over this, near its northern (outer) part, are only 3 3 metres, and the ground falls rapidly down from 5 to 55 metres On its northern or "lee" side (assuming a glacier to have followed the course of the water) is a submerged valley over 40 metres deep The Lake of Annecy exhibits another very singular feature Near its northern end the bed deepens very rapidly from 30 to 80 metres, this funnel shaped cavity is less than 200 metres in diameter, and is probably a submerged swallow hole These notes may, it is hoped, suffice to indicate the importance of this work The gratitude of students is due to M Delabecque for supplying them with a valuable group of facts, the collection of which must have entailed great labour These, however, appear to me not to lend themselves very readily to the support of the glacial excavation hypothesis, but to be more favourable to that which regards the larger Alpine lakes as mainly formed by movements of the earth's crust after the erosion of the valleys in which they lie T G BONNEY

[1] "Atlas des Lacs Français, Ministère des Travaux Publics." No publisher's name appears on the sheets, but I am informed by M Delabecque that the Atlas can be obtained at Georg's Library, Geneva.

Dust Photographs

IN Mr Croft's paper on "Breath Figures," printed in NATURE for December 22 of last year (pp 187, 188) he states — "Two cases have been reported to me where blinds with embossed letters have left a latent image on the window near which they lay" The statement is not quite clear as I do not understand whether the letters were in contact with the glass or not

Perhaps it may be interesting to place on record an observation of my own, made a few years ago, which struck me at the time as curious, but which I have not been able to verify since

At the stations of the District Railway there is a useful arrangement by which passengers are informed of the destination of the next train. It consists of a shallow box with glass sides into which by a mechanical contrivance boards are let down on which the names of the stations are painted in white letters on a blue ground The board with the words 'INNER CIRCLE' is most frequently exposed. At night the box is (or was) illuminated obliquely on either side by a tolerably powerful lamp

One night I was waiting for the train at the Victoria Station, There was some dislocation in the service, the destination of the next train was uncertain and the box was empty On glancing at it somewhat sideways I was however astonished to see the words 'INNER CIRCLE' on the glass side of the box in quite clear dark letters on a pale illuminated ground I drew the attention of one of the platform officials to it He saw it with perfect distinctness, and seemed to think he had

noticed it before Of course when the apparatus is in full working order there is little opportunity for doing so

The only explanation I could think of was —(i) that the light of the lamp had produced some molecular change in the paint coating the notice board ; (ii) that this had affected differently the blue and the white paint , (iii) that the same cause had set up some differential electrical condition of the board and the glass , (iv) that a bombardment of particles of the blue paint had taken place on to the glass to which they had adhered , and that (v) the particles so adhering, by dispersing the light, produced the effect of the pale illuminated ground while the spaces occupied by the letters being relatively clean stood out dark

Royal Gardens, Kew, W T THISELTON-DYER
February 1

MR W B CROFT'S paper on Breath-Figures in your issue of December 22 reminded me of some curious impressions of monumental brasses which are to be seen on the walls of Canterbury Cathedral When I saw these impressions a few years ago, it occurred to me that they might have been produced by mere contact, the brass plates having possibly been hung for many years against the walls, in secluded corners, at a time when the Reformers would not let them remain in their proper matrices on the church floor I had forgotten the particulars of these figures, but Dr Sheppard, of Canterbury, has kindly sent me the following notes by favour of Canon Fremantle —"A number of impressions of brasses are in the basement (which is open to the air) under Henry IV 's chantry in the Cathedral A very good impression is on the western column of the crypt of Trinity Chapel . . On the walls appear the shapes of the effigies Sometimes the stone is unstained all over the area of the figure, and surrounded by a broad dark smudge and sometimes the case is reversed, and the figure is the exact negative of the former kind , that is to say, the area of the figure is indicated by an uniform dark tint, whilst the surrounding stone is unstained " Dr Sheppard suggests "that an exact pattern seems to have been made in paper and then fixed to the wall whilst it was brushed over with linseed oil But this does not account for the white effigies on a dark ground "

I would commend these impressions to the notice of those interested in the subject It may be that, though some were made intentionally, others are the result of simple contact

F J. ALLEN

Mason College, Birmingham, February 4

Fossil Plants as Tests of Climate

IN continuation of my recent letter, permit me to call attention to a communication on the bread fruit trees in North America, by Mr F H Knowlton, of the National Museum, Washington, U S , which appears in your American contemporary *Science* for January 13 The forty living species of *Artocarpus* are all confined to tropical Asia and the Malay Archipelago *A incisa*, the true bread fruit tree, and one or two others, are largely cultivated in the tropics. They are small or medium-sized trees with a milky juice, large leathery leaves, and monœcious flowers The female flowers are long club-shaped spikes, which uniting form one large mass known as the "bread fruit," the interior containing a pulp when ripe like new bread

The first fossil bread fruit was discovered in boulder county Colorado in late cretaceous rock, and was named by the late Prof Leo Lesquereux *Myrica (?) Lessigiana*, other fragments he called *Aralia pungens* The subsequent researches, or more perfect specimens of Dr. A S Nathorst, proved these to belong to one species, *Artocarpus Lessigiana* Dr Nathorst is the discoverer of another species closely allied to *A. incisa*, which he calls *A Dicksoni*, which he obtained from the cretaceous flora of Waigatt, West Greenland, which the previous labours of Profs. Heer and Nordenskiold had shown to be of a tropical or sub tropical character, containing as it does numerous species of ferns of the order Gleicheniaceæ, and several species of cycas

CHAS E DE RANCE.

H.M Geological Survey, Alderley Edge, Manchester

Lunar Rainbow in the Highlands

THIS interesting phenomenon (a very unusual one in this latitude) was observed near here on the morning of the 3rd inst , about six a.m The moon was two days past full, and was not shining particularly brightly, being obscured, except at considerable intervals, by driving mist and light clouds. The bow, however, was exceedingly well marked, and formed a singularly beautiful object, stretching as it did completely across the north-western end of Loch Oich, glimmering against the dark background of the mountains, and sinking into the water on the southern shore of the loch The general colour of the bow was yellow deepening into orange, several of the prismatic colours, however, being intermittently visible, especially a tinge of violet on the upper side O S B

The Abbey, Fort-Augustus, N B

OPTICAL CONTINUITY[1]

KEENNESS of sight is measured by the angular distance apart of two dots when they can only just be distinguished as two, and do not become confused together It is usually reckoned that the normal eye is just able or just unable to distinguish points that lie one minute of a degree asunder. Now, one minute of a degree is the angle subtended by two points, separated by the 300th part of an inch, when they are viewed at the ordinary reading distance of one foot from the eye If, then, a row of fine dots touching one another, each as small as a bead of one 300th part of an inch in diameter, be arranged on the page of a book, they would appear to the ordinary reader to be an extremely fine and continuous line If the dots be replaced by short cross strokes, the line would look broader, but its apparent continuity would not be affected It is impossible to draw any line that shall commend itself to the eye as possessing more regularity than the image of a succession of dots or cross strokes, 300 to the inch, when viewed at the distance of a foot Every design, however delicate, that can be drawn with a line of uniform thickness by the best machine or the most consummate artist , admits of being mimicked by the coarsest chain, when it is viewed at such a distance that the angular length of each of its links shall not exceed one minute of a degree One of the apparently smoothest outlines in nature is that of the horizon of the sea during ordinary weather, although it is formed by waves The slopes of *débris* down the sides of distant mountains appear to sweep in beautifully smooth curves, but on reaching those mountains and climbing up the *débris*, the path may be exceedingly rough

The members of an audience sit at such various distances from the lecture table and screen, that it is not possible to illustrate as well as is desirable, the stages through which a row of dots appears to run into a continuous line, as the angular distance between the dots is lessened I have, however, hung up chains and rows of beads of various degrees of coarseness Some of these will appear as pure lines to all the audience , others, whose coarseness of structure is obvious to those who sit nearest, will seem to be pure lines when viewed from the furthest seats

Although 300 dots to the inch are required to give the idea of perfect continuity at the distance of one foot, it will shortly be seen that a much smaller number suffices to suggest it.

The cyclostyle, which is an instrument used for multiple writing, makes about 140 dots to the inch The style has a minute spur wheel or roller, instead of a point , the writing is made on stencil paper, whose surface is covered with a brittle glaze. This is perforated by the teeth of the spur wheel wherever they press against it The half perforated sheet is then laid on writing paper, and an inked roller is worked over the glaze. The ink passes through the perforations and soaks through them on to the paper below , consequently the impression consists entirely of short and irregular cross bars or dots

[1] Extract from a lecture on "The Just Perceptible Difference," delivered before the Royal Institution on Friday, January 27, by Francis Galton, F R S.

I exhibit on the screen a circular letter summoning a Committee, that was written by the cyclostyle. The writing seems beautifully regular when the circular is photographically reduced; when it is enlarged, the discontinuity of the strokes becomes conspicuous. Thus, I have enlarged the word *the* six times; the dots can then be easily seen and counted. There are 42 of them in the long stroke of the letter *h*.

The appearance of the work done by the cyclostyle would be greatly improved if a fault in its mechanism could be removed, which causes it to run with very unequal freedom in different directions. It leaves an ugly, jagged mark wherever the direction of a line changes suddenly.

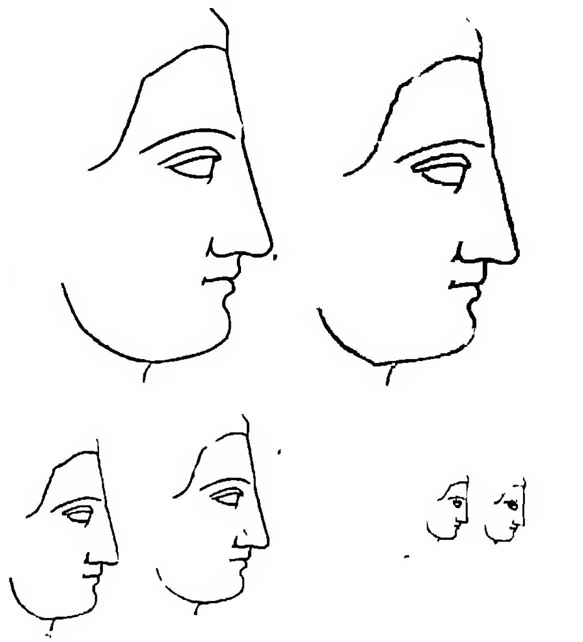
A much coarser representation of continuous lines is given by embroidery and tapestry, and coarser still by those obsolete school samplers which our ancestresses worked in their girlhood, with an average of about sixteen stitched dots to each letter. Perhaps the coarsest lettering that is ever practically employed is used in perforating the books of railway coupons so familiar to travellers. Ten or eleven holes are used for each figure.

A good test of the degree of approximation with which a cyclostyle making 140 perforations to the inch is able to simulate continuous lines, is to use it for drawing outline portraits. I asked the clerk who wrote the circular just exhibited to draw me a few profiles of different sizes, ranging from the smallest scale on which the cyclostyle could produce recognisable features, up to the scale at which it acted fairly well. Here are some specimens of the result. The largest is a portrait of $1\frac{1}{2}$ inches in height, by which facial characteristics are fairly well conveyed, somewhat better than by the rude prints that appear occasionally in the daily papers. It is formed by 366 dots. A medium size is $\frac{3}{4}$ inch high and contains 177 dots, and would be tolerable if it were not for the jagged strokes already spoken of. The smallest sizes are $\frac{1}{3}$ inch high and contain about ninety dots; they are barely passable, on account of the jagged flaws, even for the rudest portraiture.

I made experiments under fairer conditions than those of the cyclostyle, to learn how many dots, discs, or rings per inch were really needed to produce a satisfactory drawing, and also to discover how far the centres of the dots or discs might deviate from a strictly smooth curve without ceasing to produce the effect of a flowing line. It must be recollected that the eye can perceive nothing finer than a minute blurr of one three-hundredth part of an inch in angular diameter. If we represent a succession of such blurs by a chain of discs, it will be easily recognised that a small want of exactitude in the alignments of the successive discs must be unimportant. If one of them is pushed upwards a trifle and another downwards, so large a part of their respective areas still remain in line, that when the several discs become of only just perceptible magnitude, the projecting portion will be wholly invisible. When the discs are so large as to be plainly perceptible, the alignment has to be proportionately more exact. After a few trials it seemed that if the *bearing* of the centre of each disc from that of its predecessor which touched it, was correctly given to the nearest of the 16 principal points of the compass, N., NNE., NE., &c., it was fairly sufficient. Consequently a simple record of the successive bearings of each of a series of small equidistant steps is enough to define a curve.

The briefest way of writing down these bearings, is to assign a separate letter of the alphabet to each of them, *a* for north (the top of the paper counting as north), *b* for north-north-east, *c* for north-east, and so on in order up to *p*. This makes *e* represent east, *i* south, and *m* west.

To test the efficiency of the plan, I enlarged one of the cyclostyle profiles, and making a small protractor with a piece of tracing paper, rapidly laid down a series of equidistant points on the above principle, noting at the same time the bearing of each from its predecessor. I thereby obtained a formula for the profile, consisting of 271 letters. Then I put aside the drawing, and set to work to reproduce it solely from the formula. I exhibit the result; it is fairly successful. Emboldened by this first trial, I made a more ambitious attempt, by dealing with the profile of a Greek girl copied from a gem. I was very desirous of learning how far the pure outline of the original admitted of being mimicked in this rough way. The result is here; a ring has been painted round each



dot in order to make its position clearly seen, without obliterating it. The reproduction has been photographically reduced to various different sizes. That which contains only fifty dots to the inch, which is consequently six times as coarse as the theoretical 300 to an inch, is a very creditable production. Many persons to whom this portrait has been shown failed to notice the difference between it and an ordinary woodcut. The medium size, and much more the smallest size, would deceive anybody who viewed them at the distance of one foot. The protractor used in making them was a square card with a piece cut out of its middle, over which transparent tracing paper was pasted. A small hole of about $\frac{1}{8}$ of an inch in diameter was punched out of the centre of the tracing paper; sixteen minute holes just large enough to allow the entry of the sharp point of a hard lead-pencil were perforated through the tracing paper in a circle round the centre of the hole at a radius of $\frac{1}{4}$ inch. They corresponded to the 16 principal points of the compass, and had their appropriate letters written by their sides. The outline to be formulated was fixed to a drawing-board, with a T rule laid across it as a guide to the eye in keeping the protractor always parallel to itself. The centre of the small hole was then brought over the beginning of the outline, and a dot was made with the pencil through the perforation nearest to the further course of the outline, and this became the next point of departure. While moving the protractor from the old point to the new one it was stopped on the way, in order that the letter for the bearing might be written through the central hole.

A clear distinction must be made between the proposed plan and that of recording the angle made by each step from the *preceding one*. In the latter case, any error of

bearing would falsify the direction of all that followed, like a bend in a wire

The difficulties of dealing with detached portions of the drawing, such as the eye, were easily surmounted by employing two of the spare letters, R and S, to indicate brackets, and other spare letters to indicate points of reference The bearings included between an R and an S were taken to signify directive dots, not to be inked in The points of reference indicated by other letters are those to which the previous bearing leads, and from which the next bearing departs Here is the formula whence the *eye* was drawn. It includes a very small part of the profile of the brow, and the directive dots leading thence to the eye

The letters should be read from the left to the right, across the vertical lines. They are broken into groups of five, merely for avoiding confusion and the convenience of after reference

The part of the Profile that includes U

&c	iiilU	jihi	&c	&c

The Eye

URkkk	kklll	mSVap	ponmn	mmlmm
mlmlm	llmZZ	VnTnn	mnmmm	mmmlm
mmnZZ	Tjjjj	jjkkc	cbmmn	mnnnn
onoo/				

Letters used as Symbols

R S=(. .) Z=end

U, V, T are points of reference

By succeeding in so severe a test case as this Greek outline, it may be justly inferred that rougher designs can be easily dealt with in the same way

At first sight it may seem to be a silly waste of time and trouble to translate a drawing into a formula, and then, working backwards, to retranslate the formula into a reproduction of the original drawing, but further reflection shows that the process may be of much practical utility Let us bear two facts in mind, the one is that a very large quantity of telegraphic information is daily published in the papers, anticipating the post by many days or weeks The other is that pictorial illustrations of current events, of a rude kind, but acceptable to the reader, appear from time to time in the daily papers. We may be sure that the quantity of telegraphic intelligence will steadily increase, and that the art of newspaper illustration will improve, and be more resorted to Important local events frequently occur in far-off regions, of which no description can give an exact idea without the help of pictorial illustration, some catastrophe, or site of a battle, or an exploration, or it may be some design or even some portrait. There is therefore reason to expect a demand for such drawings as these by telegraph, if their expense does not render it impracticable to have them Let us then go into details of expense, on the basis of the present tariff from America to this country, of one shilling per word, 5 figures counting as one word, cypher letters not being sent at a corresponding rate. It requires two figures to perform each of the operations described above, which were performed by a single letter So a formula for 5 dots would require 10 figures, which is the telegraphically equivalent of 2 words, therefore the cost for every 5 dots telegraphed from the United States would be 2 shillings, or £2 for every 100 dots or other indications.

In the Greek outline there is a total of 400 indications, including those for directive dots, and for points of reference. The transmission of these to us from the United States would cost £8 I exhibit a map of England made with 248 dots, as a specimen of the amount of work in plans, which could be effected at the cost of £5 It is easy to arrange counters into various patterns or parts of patterns, learning thereby the real power of the process The expense of pictorial telegraphs to foreign countries would be large in itself, but not large relatively to the present great expenditure by newspapers on telegraphic information, so the process might be expected to be employed whenever it was of obvious utility

The risk is small of errors of importance arising from mistakes in telegraphy I inquired into the experience of the Meteorological Office, whose numerous weather telegrams are wholly conveyed by numerical signals. Of the 20,625 figures that were telegraphed this year to the office from continental stations, only 49 seem to have been erroneous, that is two and a third per thousand At this rate the 800 figures needed to telegraph the Greek profile would have been liable to two mistakes A mistake in a figure would have exactly the same effect on the outline as a rent in the paper on which a similar outline had been drawn, which had not been pasted together again with perfect precision The dislocation thereby occasioned would never exceed the thickness of the outline

The command of 100 figures from 0 to 99, instead of only 26 letters, puts 74 fresh signals at our disposal, which would enable us to use all the 32 points of the compass, instead of 16, and to deal with long lines and curves I cannot enter into this now, nor into the control of the general accuracy of the picture by means of the distances between the points of triangles each formed by any three points of reference Neither need I speak of better forms of protractor There is one on the table by which the ghost of a compass card is thrown on the drawing It is made of a doubly refracting image of Iceland spar, which throws the so-called "extraordinary" image of the compass card on to the ordinary image of the drawing and is easy to manipulate All that I wish now to explain is that this particular application of the law of the just perceptible difference to optical continuity gives us a new power that has practical bearings

POSTSCRIPT —A promising method for practical purposes that I have tried, is to use "sectional" paper, that is, paper ruled into very small squares, or else coarse cloth, and either to make the drawing upon it, or else to lay transparent sectional paper, or muslin, over the drawing Dots are to be made at distances not exceeding 3 spaces apart, along the course of the outline, at those intersections of the ruled lines (or threads) that best accord with the outline Each dot in succession is to be considered as the *central point*, numbered **44** in the following schedule, and the couplet of figures corresponding

11	21	31	41	51	61	71
12	22	32	42	52	62	72
13	23	33	43	53	63	73
14	24	34	**44**	54	64	74
15	25	35	45	55	65	75
16	26	36	46	56	66	76
17	27	37	47	57	67	77

to the portion of the next dot, is to be written with a fine pointed pencil in the interval between the two dots. These are subsequently copied, and make the formula. By employing 4 for zero, the signs of + and − are avoided, 3, standing for −1, 2, for −2, and 1, for −3 The first figure in each couplet defines its horizontal coordinate from zero, the second figure, its vertical one. Thus any one of 49 different points are indicated, corresponding to steps from zero of 0, ±1, ±2, and ±3 intervals, in either direction, horizontal or vertical Half-an-hour's practice suffices to learn the numbers The figures 0, 8, and 9 do not enter into any of the couplets in the schedule, the remaining 51 couplets in the complete series of 100 (ranging from 00 to 99), contain 21 cases in which 0, 8, or 9 forms the first figure only; 21 cases in which one of them forms the

second figure only, and 9 cases in which both of the figures are formed by one or other of them These latter are especially distinctive This method has five merits—medium, short, or very short steps can be taken according to the character of the lineation at any point, there is no trouble about orientation, the bearings are defined without a protractor, the work can be easily revised, and the correctness of the records may be checked by comparing the sums of the small coordinates leading to a point of reference, with their total values as read off directly "

A method of signalling is also in use for military purposes, in which positions are fixed by coordinates, afterwards to be connected by lines F G

BRITISH NEW GUINEA[1]

MR. THOMSON'S work on British New Guinea has been looked for with some impatience Now that it has come it falls short of our expectations We had hoped for a comprehensive work marshalling into order and summarising the observations and investigations made in the British part of New Guinea, by so many missionaries, explorers, naval and government officers and scientific men, for many years Instead of this we find that the book is made up almost entirely of the explorations during the past four or five years of the administrator, boiled down out of the official reports by Mr. J. Thomson, the secretary of the Queensland branch of the Geographical Society of Australasia Throughout the volume there is everywhere evidence that its author is new to literary composition In consequence, the terse and vigorous English of the original reports suffers severely in the process, so much so that we regret that their important parts have not been presented to us as extracts in the explorer's own words. Mr Thomson has himself never visited New Guinea, if we may judge by internal evidence, although his phraseology in many places is not unlikely to lead the reader to suppose that he has had a share in the results presented in its pages Had the author had some personal acquaintance with the country of which he writes he would have formed opinions, we believe, different from many of those he has expressed on his own account throughout the book

The work opens with a sketch "of the historical aspects of the whole of the great Papuan land," but we miss in it the names of many who deserve honourable mention for their contributions to the "making" of New Guinea We find no mention of the investigations of Dr Otto Finsch carried on in all three possessions, of those of Mr O Stone, of the missionaries in Geelvink Bay, of Mr Romilly, of the Special Commissioners Sir Peter Scratchley and the Hon John Douglas, of Mr Milman, and of Commanders Pullen and Field, who have all contributed to our knowledge of different regions

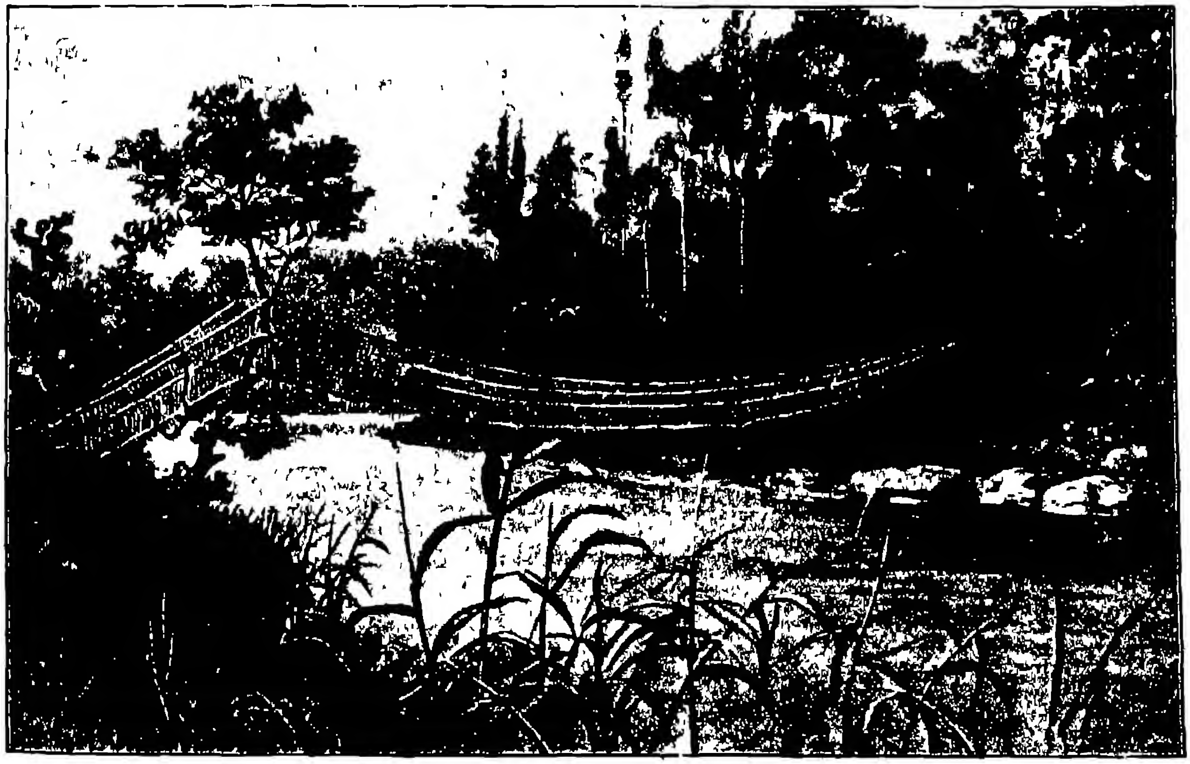


FIG 1 —Native suspension bridge across the Vanapa river

This chapter is prefaced by a quotation from the writings of Plinius Minor.—"It appears to me a noble employment to rescue from oblivion those who deserve to be eternally remembered, and by extending the reputation of others, to advance at the same time our own" These words are the true key-note of the book from which our Brisbane Pliny—Plinius Major—has never once deviated throughout his task It is doubtless no small compliment to any man to have his deeds held up in the light of "eternal remembrance" by one of his fellows, but the task requires the delicate hand of a judicious fellow, and we fear that our Pliny has marred the compliment in the paying. So inspired with veneration for his patron is he that every act of his appears almost extraordinary, and his name too august ever to be mentioned without the humblest obeisance expressed in the constant recapitulation of his titles, dignities, and office, which must be as nauseous to

[1] "British New Guinea" By J P Thomson, F.R S G S, &c (London George Philip and Co., 1892)

that officer as to every reader of Mr Thomson's book In this "noble employment," however, we hope that our historiographer for Papua may reap the reward hoped for by his prototype

The next two chapters deal with Sir William Macgregor's explorations in the Louisiade and D'Entrecasteaux archipelagoes In Chapter IV is an account of the pursuit and punishment of the natives of Chads and Cloudy bays for the murder of European traders visiting their shores The country lying to the south-east and north-west of Port Moresby forms the subject of the following two chapters Speaking of that portion to the south-east Mr Thomson says, "It may not be altogether unreasonable to assume that in the future . . fields once the scene of battle and feudal strife may be beautified by sites of local industry and manufacture, and enlivened by the joyous shouts of merry children and the harmonious peals of village bells" Quite forgetful of this happy picture, which he thinks is reasonable to expect, he sums up in the closing lines of his recapitulatory chapter the climatic aspects of the possession as "of an exceptional character, and their influence on Europeans so severe that very few constitutions can withstand their effect, a feature which will always be a great hindrance to settlement and a constant menace to life"—quite the region likely to produce European homes noisy with the "joyous shouts" of "merry children"! It is difficult to comprehend why Australian writers on New Guinea will so persistently—for Mr Thomson is not the only author who thus sins, nor have we quoted the only specimen of this style of writing in his book—overlaud the capabilities and "the vast natural and artificial resources" of the country, heedless whether they may induce their too trustful readers to embark in hopeless enterprises in this "never, never land"

FIG 2—Highlanders of Mount Musgrave

The seventh chapter, containing an account of Sir William Macgregor's splendid feat of the ascent of Mount Owen Stanley, is naturally the most interesting portion of the book During this expedition almost if not *the* only native bridge yet known in New Guinea was met with It was suspended from trees on each bank, and is very similar in every respect to those built by the Malays of Sumatra and the Dyaks of Borneo How elegant and picturesque a construction it is may be seen by the illustration on page 345

FIG 3.—Fly River natives.

On Mount Musgrave friendly relations were established with the highland tribes, and a photograph of great interest and value, which we are personally in a position to pronounce very characteristic, was obtained by Mr. Goodwin. This also, through the courtesy of the publishers, we are enabled to reproduce here (Fig. 2). Sir William

Macgregor says that the features of these people, which are "remarkably good, indicate more character and strength than those of the coast man, and the cheek bones in many are rather broad and prominent The nose is generally of the semitic type, with nostrils either not arched or much more so than is usual in Papuans The chin and under jaw are stronger" They may be compared with the Fly river people, also here figured (Fig 3)

European names were bestowed on the chief physical features of the country passed through by the expedition "of necessity," because of its "entire unacquaintance with their orthography (*sic*) through limited intercourse with the native inhabitants" This being in Dr Macgregor's case evidently a right and sufficient reason for the nomenclature bestowed, how can Mr Thomson with justice animadvert, as he does on an earlier page, on the fact that "the most important affluents [of the Kemp-Welch river] have received [from Mr Cuthbertson] European appellations? This disregard of the native nomenclature is, in the interests of geography, much to be regretted" However, we are pleased to learn that the European names selected by the administrator have been bestowed "upon the broadest national sentiment, as being compatible with the principles which prompted the bestowal of an English name on the range by the officers of H M S *Rattlesnake*" It is not improbable that the explorer of the Kemp Welch felt the same necessity, and was actuated by the same broad sentiment Evidently the actor here sanctifies the act We must, however, take exception to the statement made by Mr Thomson that it was to the *range* that the name Mount Owen Stanley was given It is evident from observations in his book, that the author is aware of the discussion that followed on the reading of Dr Macgregor's paper on his ascent of the mountain before the Royal Geographical Society in London. On that occasion the president of the society clearly pointed out that this name was bestowed, as has been marked on all maps for forty years, on the *peak*, not on the *range* Throughout the book this imperious disregard for nomenclature is exhibited D Albertis' name of Snake Point in the Fly river has without reason been changed to D'Albertis Junction, Annabel Harbour, close to Boundary Cape, although marked on the official map of Sir Peter Scratchley's voyage to the north-east coast, becomes Douglas Harbour, Fort Harbour, Clayton Inlet in Porlock Bay, and the peaks named on the same occasion, as well as the region delineated by the present writer at the base of Mount Owen Stanley, are also all ignored on the map attached to the volume now being considered One fails to comprehend what principle except personal feeling the author has followed, on the one hand in his agreeing to the change of the thoroughly established Mount Owen Stanley to a new name, and on the other, in his restoring to the Aird river, which had recently been re-christened the Douglas, the name given to it by Captain Blackwood half a century before Not only are these arbitrary changes an unwarrantable violation of the laws of nomenclature, but they are in the remover an illegitimate assertion of authority over previous fellow-explorers, as well as an assumption of an honour to which he has no title.

Mr Thomson has drawn on the face of his map two large red circles, from purely arbitrary centres of the equally arbitrary radius of 6° 8′ 56″, which are tangential somewhere in the valley of the Strickland river. It is impossible to divine their purpose, except perhaps to form a seasonable puzzle for his readers

The writer of this notice feels entitled to remark on the following observation, occurring on page 109 —"Although great care was exercised, the expedition was unable to identify places on the Owen Stanley range, named and described by Mr Forbes We are reluctantly constrained to omit these names." In the Proceedings of the Royal Geographical Society, which Mr Thomson quietly ignores, the writer has already pointed out that along the route by which the administrator approached Mount Owen Stanley, it would have been impossible to have seen the features "named and described by Mr Forbes." Mr Thomson, posing as a court of geographical appeal, has graciously condescended to intimate that if these names had been "judiciously and appropriately applied to well-defined places," they "would have received full recognition" from him "It is also," he continues, "regretable that in describing localities to which he assigns positions, that explorer has omitted to supply the data employed in their determination" To every unprejudiced person it must be evident that the map published by the writer could not have been plotted in England without data, any more than that of Sir William Macgregor, who has not supplied to the general public, so far as the writer knows, the data by which his localities are fixed It will be time, however, to submit to Mr Thomson these data, when it is acknowledged that a back parlour critic of a country in which he has never set foot is a competent judge of either the judiciousness and appropriateness of the names applied, or the accuracy of the localities, or the data on which they are based

Chapters VIII, IX, and X are devoted to an account of the administrator's ascent of the Fly river, and of his visit westwards to the Anglo-Dutch boundary, and the eleventh to his voyage along the north-east coast D'Albertis long ago gave us a very accurate account of his 400 mile navigation of the Fly river Sir William Macgregor carried his flag right to the German territory, and added several unknown rivers and new mountains to the map, but both in this region, as on the north-east coast, his voyages, though they contributed many additional facts, added little essentially new to the observations of his predecessors, except his account of the piratical Tugere tribe, living on our boundary line west of the Fly river, of whom so much had been heard but so little known

This handsome volume, which presents us in a collected form with the record of the important contributions, geographical and biological, of a most energetic officer, to our growing knowledge of New Guinea, would have been more valuable and welcome, even in its restricted range, but for the bias unduly exhibited throughout its pages, the verbiose platitudes by which it is marred, and the extreme looseness of its descriptions, as "Morna [an island] is of the usual formation," "features of oriental type," "the Papuan dialect," and such-like expressions, which are numerous In a long appendix we have a *résumé* of the results of the geological, botanical, and some of the zoological collections made by Sir W Macgregor and others Of these the chapter by Mr Etheridge, Government Palæontologist of New South Wales, is specially valuable. Several important zoological groups, however, such as the birds, are, curiously enough, entirely disregarded Vocabularies of many of the dialects spoken in widely separated districts of the possession are given, and are very valuable, and we sincerely hope that no opportunity may be lost of amplifying them In fine, we regret to feel that this work will not yet relieve those who desire to make themselves acquainted with the accurate and complete history of British New Guinea, from the labour of searching through the original reports of the explorations, not of the administrator alone, but of the many other equally trustworthy workers who have contributed to its records

HENRY O FORBES

NOTES

PROF R VIRCHOW will deliver the Croonian lecture before the Royal Society on March 16, the subject to be the position of pathology among the biological sciences

WE greatly regret to have to announce the death of Mr G M Whipple, Superintendent of the Kew Observatory He died on Tuesday night after a long illness.

THE *Journal of Botany* records the death, on January 18, at Brighton, of Dr Benjamin Carrington, the highest authority on British Hepaticæ

DR H J JOHNSTON LAVIS has been appointed Professor of Vulcanology in the University of Naples A chair of vulcanology existed for some time at Catania, but was abolished on the death of Prof Silvestri

SOME important work with regard to technical education in London was done by the London County Council on Tuesday The Council began the consideration of the recommendations of the special committee appointed to investigate the subject, and adopted the following proposals—that the Council should devote to technical education some portion of the funds from time to time recoverable under the Local Taxation (Customs and Excise) Act, 1890, that, in order to promote efficient and united action, it is desirable that the Council should delegate, so far as is permitted by law, its powers in respect of technical education to a composite body, to be called the Technical Education Board, to be appointed by the Council, partly from its own members and partly from other persons whose co operation is desired, and that the Board should be appointed for a term of three years It was agreed that the City Companies should be asked to contribute to the funds for technical instruction a fair proportion of their corporate income as distinguished from their trust property

ON Saturday the overhead electric railway at Liverpool was opened by Lord Salisbury, who afterwards delivered a very effective speech on the great things which are likely to be achieved for mankind by electricity

THE London Amateur Scientific Society will hold its annual general meeting on Friday, February 10, at 7 30 p m, at the Memorial Hall, Farringdon Street The president will deliver an address, and the officers and council for the ensuing year will be elected At the conclusion of the annual general meeting the ordinary meeting will be held, when objects of interest—botanical, zoological, and geological—will be exhibited

A CONVERSAZIONE was held the other evening at Firth College to celebrate the completion of the additional building The addition comprises new physical and biological laboratories, workshop and class rooms, and considerably increases the accommodation available for teaching purposes The cost, £5,500, has been wholly raised from local subscriptions

ANOTHER disastrous shock of earthquake occurred at Zante on Friday last It was followed by a terrific thunderstorm, accompanied by rain and hail All the ovens in the island were destroyed by the successive shocks, so that no bread or biscuits could be made Thousands of the inhabitants have been made homeless On Monday there were three further shocks. The King and Queen of Greece have visited several of the villages, and have been deeply affected by the scenes of utter ruin and desolation which have everywhere met their eyes. On Tuesday they visited the naphtha springs of the island, which are believed to be the centre of the disturbance The mayor of the village of Deme Elatia, some distance from the town of Zante, telegraphed that a large chasm, from which smoke was constantly issuing, had been discovered near that place

DURING the first part of the past week the weather in these islands was under the influence of barometrical depressions situated in the north-west. Rain fell in most places, and the temperature exceeded 50° in the south and west, and even reached 56° in London On Friday an anticyclone which lay over the Baltic, spread westwards, and under its influence the temperature became much lower, sharp frosts occurring at night over England, the readings on the grass in the southern part falling as low as 17°, but in the north and west the day temperatures were between 45° and 50° The weather in the southern parts of the country became bright and fine with local fogs, which extended as far as central England. During the early part of this week depressions from the Atlantic again skirted our western coasts in a north easterly direction, causing south-westerly gales in the north and west, and a considerable increase in temperature, the maxima on Monday exceeding 50° in Ireland and the extreme south-west of England The depression rapidly increased in intensity, and by Tuesday the warm south-west winds had spread over the whole country, the rise of temperature amounting to over 20° in the south east of England A bright aurora was observed in the north east of Scotland on Sunday night The *Weekly Weather Report* of the 4th instant shows that the temperature exceeded the mean in all districts during that week Bright sunshine did not differ materially from the mean in any district, the percentage of possible duration ranged from twenty five in the south-west, to twelve in the east of England

THE *American Meteorological Journal* for January contains an article by Prof D P Todd bearing upon the selection of stations for observing the total eclipse of April 16 next, together with a map showing the entire region of visibility He has gone to considerable trouble in collecting data, especially cloud observations for the month of April, for the last three years, together with particulars respecting the stations and the best means of reaching them The utility of a systematic examination of the cloud conditions of the eclipse localities is apparent It is only in this way that the best observing stations can be selected

THE meeting of the American Psychological Association at the University of Pennsylvania on December 27 and 28 seems to have been very successful According to a writer in the New York *Nation*, no one who attended the meeting failed to be impressed with the quite unusual enthusiasm of the members and the still more unusual peace and serenity that prevailed in all the discussions This writer is of opinion that, apart from Dr Sanford's observations on dreams, the paper of most general interest was President Hall's account of the history and prospects of experimental psychology in America A "breezy stimulus" was brought to the meeting by Prof Hugo Munsterberg, of Harvard, who has recently gone from Freiberg to be director of the Harvard Psychological Laboratory He stirred up a vigorous discussion upon the very foundations of experimental research This discussion, as well as others, was enriched by the contributions of Prof Titchener, of Cornell The next meeting of the association is to be held at Columbia College, New York, during the Christmas recess, 1893

THE Annual Report of the Botanical Department, Jamaica, has just been published The Director, Mr W Fawcett, F.L S, has a good deal to say about the work of his Department, one of the oldest and most successful in the colonies It was started as long ago as 1777, and ever since, as Mr Fawcett recalls, it has successfully "introduced valuable exotics, and the productions of the most distant regions to the West Indies," and laid the foundations of the present prosperity in place of the poverty which followed the abolition of slavery The work of establishing the Hope Gardens as the headquarters of the Department near Kingston is still kept in view, although the amount allowed for this purpose appears much less than the Director considers desirable, taking into account the present importance of the island A hill garden is looked upon as essential to the development of the high lands in Jamaica, and Mr Fawcett shows that as about one half of the total area of the island is above 1000 feet elevation, it is impossible to ignore the

legitimate claims of those who are engaged in cultural industries above that limit Good progress has been made in the scientific work connected with the herbarium and library, and numerous subjects, such as the extension of grape culture, the distribution of valuable economic plants, experiments in onion and tomato culture, fodder plants for the hills, have received attention. Students from Harvard University were engaged during the year in studying and making collections of tropical plants, and one of these devoted himself to preparing glass models of flowers and fruits with dissections to illustrate the science of botany Two apprentices, natives of Lagos, West Africa, were attached to the Hope Gardens, with the view of qualifying themselves to take charge of botanical stations in their own country

MR. FAWCETT's opinion respecting the practical aims and functions of departments like his are conveyed in the following words "Botanic Gardens in the tropics do the work on the plant side of Agricultural Departments in temperate climates They are in themselves experimental stations, and are much more efficient in introducing new cultural products, and in distributing plants and imparting useful information than most agricultural departments The whole of the Botanic Gardens in the British Empire are more or less in communication with one another, exchanging seeds and publications, and all look up to the Royal Gardens at Kew as to their head for advice and assistance Imperial Federation is already in existence as regards the Botanical Gardens and their work If any special variety of plant or any new culture comes into notice information and plants are sought either directly from the local institutions, or more probably through Kew as the botanical clearing house The Director of Kew has at his disposal the services of experts in every branch of botanical inquiry, and he is always most willing to assist colonial establishments in every way Besides, any intricate question that arises in chemistry, in diseases of plants, in insect pests, in the commercial value of new products, can nearly always be determined by reference to Kew Colonial botanical gardens are therefore not isolated units, but branches of an organisation as wide as the British Empire itself"

THE first part of "A Handbook to the Flora of Ceylon," by Dr H Trimen, F R S, director of the Royal Botanic Garden, Paradenyia, will shortly be published It will be illustrated by twenty-five coloured plates, and the entire work is intended to consist of four similar parts

THE first number of *Erythea*, a new monthly botanical journal for Western America, has been published It is edited by Mr Willis L Jepson, under the direction of members of the botanical department of the University of California

MR T SOUTHWELL records in the February number of the *Zoologist* the occurrence of Sowerby's whale (*Mesoplodon bidens*) on the Norfolk coast On December 19 last he received a telegram stating that a strange "fish" was ashore at Overstrand, near Cromer, and on the following day he and Mr. S. F Harmer, of the Museum of Zoology and Anatomy, Cambridge, went to Overstrand, where they found an adult female of this rare species About 8 a m, on Sunday, December 18, one of the Overstrand fishermen saw from the cliff an object lying in shallow water near the beach, which he at first took to be a log of wood, but soon perceived to be a large "fish." After obtaining assistance, he fastened a noose over its tail and secured it by an anchor, till it was placed on a trolley and drawn up the gangway to a shed on the cliff where the visitors saw it. The animal was alive when first observed, but died before it was taken from the water. Before the arrival of the visitors it had been eviscerated, and a very advanced fœtus removed from it, The total length of the old female, measured in a straight line to the centre of the tail, was 16 feet 2 inches, and that of the young one 5 feet 2 inches, across the flukes of the tail the adult measured 3 feet 8 inches The present, says Mr Southwell, is the nineteenth known example of this remarkable animal, all of which have been met with in the North Atlantic during the present century, but, with the exception of one taken in 1889 at Atlantic City, which came into the possession of the United States National Museum at Washington, and of which no account has, he believes, at present been published, in no other instance has an example in perfect condition come under the notice of a cetologist Individuals or their remains have been found in Scotland and Ireland, but the only previous English example was met with at the mouth of the Humber in September, 1885

COLONEL H W FEILDEN, in the course of an interesting paper on animal life in East Greenland, contributed to the February number of the *Zoologist*, suggests, as he has done before, that the Musk ox might with advantage be introduced into Great Britain He sees no reason why it should not thrive on the mountains of the Highlands of Scotland In the winter season the Musk ox is covered with a long stapled fine wool in addition to its coat of hair This wool is of a light yellow colour, and as fine as silk. Sir John Richardson states that stockings made from this wool were more beautiful than silk ones Young Musk-oxen are very easily reared and tamed, and, Colonel Feilden thinks, there could not be any great difficulty in catching either old or young in Jameson's Land

GOVERNOR FLOWER has recommended that all of the New York State's pecuniary contributions to agriculture should be turned over to Cornell University, with power to apply the same in such a manner as the trustees and faculty of that institution may devise To the New York *Nation* this seems an excellent suggestion The agricultural disbursements from the State Treasury, except the portion specifically set apart as premiums for agricultural fairs, have become, it says, as distinctly a part of the "spoils system" of politics as the work on the canals or the appointments of wardens in the State prisons The Dairy Commission was started with an appropriation of 10,000 dollars for the purpose of suppressing oleomargarine The expenditure has grown to 100,000 dollars per year, while the fight against oleomargarine is not a whit more effectual than it was in the beginning

THE Government of Cape Colony has now at work, in charge of its own experts, eight water-boring diamond drills, and there is a great demand on the part of farmers for the use of the instruments Experiments have been made on twenty seven farms, on twenty-two of which water has been found The *Agricultural Journal* of Cape Colony says that the results have sometimes been astonishingly successful On a farm in the division of Colesberg, for instance, three holes were sunk, the first two unsuccessfully In the third, however, the water was struck, first at 2 feet 6 inches, then at 8 feet 6 inches, then at 16 feet, then 22 feet, then 32 feet 6 inches, and on reaching a depth of 47 feet a stream of water shot up above the ground, gauged at 21,600 gallons in twenty-four hours, delivered through a 1-inch pipe, and with every indication of the supply proving permanent. In most cases the water is of excellent quality Some exceedingly interesting experiments are about to be tried in Bushmanland by the Government Sites are now being selected for a line of boreholes right across the country It is well known that the veld makes splendid sheep runs after occasional rains, and should the experiments prove successful, the value of the land will be greatly increased With respect also to the Government railway grant of 6000 square miles of land in Bechuanaland, it is intended that water shall be bored for there as soon as drills can be set at liberty

PROF O C. MARSH gives in the February number of the *American Journal of Science* an interesting restoration of

Anchisaurus, the skeleton chosen for the purpose being the type specimen of *Anchisaurus colurus*, which the writer has already described This restoration, as shown on an accompanying plate, indicates that *Anchisaurus colurus* was one of the most slender and delicate dinosaurs yet discovered, being only surpassed in this respect by some of the smaller bird-like forms of the Jurassic. The restoration, Prof Marsh thinks, will tend to clear up one point long in doubt The so-called "bird-tracks" of the Connecticut river sandstone have been a fruitful subject of discussion for half a century or more That some of these were not made by birds has already been clearly demonstrated by the fact that the impressions of fore feet, similar to those made by reptiles, have been found with them Although no osseous remains were found with them, others have been regarded as footprints of birds, because it was supposed that birds alone could make such series of bipedal, three-toed tracks and leave no impression of a tail It is now evident, however, says Prof Marsh, that a dinosaurian reptile like *Anchisaurus* and its near allies must have made footprints very similar to, if not identical with, the "bird tracks" of this horizon On a firm but moist beach, only three toed impressions would have been left by the hind feet, and the tail could have been kept free from the ground On a soft, muddy shore, the claw of the first digit of the hind foot would have left its mark, and perhaps the tail also would have touched the ground Such additional impressions the writer has observed in various series of typical "bird tracks" in the Connecticut sandstone, and all of them were probably made by dinosaurian reptiles No tracks of true birds are known in this horizon

THE U S Secretary of the Interior, in his report, just issued, for the fiscal year ending June 30, 1892, refers to a good many subjects of more than passing interest Speaking of Indian educational work during the year, he states that it has been greatly extended and improved The attendance of Indian children in school has increased over 13 per cent, the enrolment for 1892 being 19,793 as against 15,784 in 1889 Five new Indian reservation boarding schools have been established during the present administration, and are in successful operation, and six others are in process of establishment, and it is anticipated will be opened soon Six non-reservation schools have also been established and others are being prepared The standard, character, and ability of all *employés* have been greatly improved, as have also the appliances and equipments for the proper training of Indian pupils and the efficient administration of the Indian school service A uniform system of text-books and course of study has been adopted, and a compilation of the rules for the conduct of the schools has been prescribed The interest in the welfare of the Indians has been constant and the work in their behalf persistent, and the Secretary thinks that this has resulted in their being raised still nearer to civilisation

THE U S Geological Survey, according to the Secretary for the Interior, has had a very marked effect on the mining industries of the country The increase in value of mineral products during the past year was 75,000,000 dollars, and the increase during the thirteen years since the institution of the survey is 300,000,000 dollars. While a part of this development represents the normal growth of the population and industries, the increase is much more rapid than that of population, and is, moreover, accompanied by a decided relative decrease in importations of mining products, indeed, the mining products of the country have more than doubled during the past thirteen years, while the population has increased only 30 per cent. The secretary, therefore, thinks it fair to ascribe a material part of the present industrial activity in extracting and utilising mineral resources to the services of the Geological Survey through its correspondence, and especially through its widely distributed maps and reports. The cost of mineral production during the past year has been reduced about 15 per cent, and during the period since the institution of the survey no less than 40 per cent, a saving to the consumers of mineral products amounting to millions of dollars annually being thus effected A considerable part of this saving must be ascribed to the diffusion of exact information concerning mineral localities by the geological surveys of the Federal Government and several of the States.

DEALING with the state of the Seal Islands, the Secretary for the Interior says that during the season of 1892 only 7500 seals were killed on the islands, and that the diminished number of seals upon the rookeries shows the terrible waste to seal life in the destructive methods employed in pelagic sealing Heroic measures, he maintains, are necessary for the preservation of the sealing industry In 1890 no less than 50,000 seals were taken in the sea, and more than that number in 1891 Every seal taken in the ocean represents many more destroyed, and the 52,087 taken in the ocean in 1891 indicates the destruction of 300,000 more, three-fourths of which were females

THE accumulation of ice in winter, blocking harbours, estuaries, &c, interferes greatly with the commerce of Northern peoples The idea arose to make steamers which should break a temporary path through the ice, and in Gothenburg (Sweden) such a vessel was built in 1881 In the severe winter of 1885 it made a wide passage between that town and Vinga, on the open sea, through an ice-bank about a foot thick, which it charged at a speed of about 8½ knots an hour Christiania has been led to get one of these ice breaking steamers, also Oersen in Denmark, and Stockholm The *Murtaja*, recently built for Stockholm (and described in *Génie Civil*), acts both by its weight in charging the ice bank, and by its spoon-like bow resting on the ice and crushing it. The hull is divided into compartments, those at the bow and stern serving as reservoirs for water, which is transferred from the one to the other by a pump With the stern reservoir full, the draught of water at the stern is about 21 inches, at the bow about 15 inches When the bow rises on the ice the water is quickly brought forward to add to the weight It need hardly be said the bow, and indeed the whole of the hull, are made very strong, the material used being Swedish scrap iron and Martin steel

IT is known that sewage water, spread over irrigation fields, reappears from drains placed at a few feet depth, in a limpid state, like spring water. This water, unlike that of sewers, proves remarkably favourable to fishes, probably because of its dissolved organic matter, which the filtration in the soil has not wholly removed. This fact has been lately observed by Herr Oesten on the irrigation farm at Malchow, near Berlin, where the water is collected in eight ponds, and in these ponds salmon and carp have flourished greatly.

IN determining the thermal conductivities of liquids, two methods have been employed In the one, a column of liquid is warmed at the top and the rate of propagation downwards through the column is observed In the other, the lamellar method, which was first employed by Guthrie, a thin layer of liquid is placed between two conducting surfaces Mr R Wachsmuth has shown, by means of an ingenious piece of apparatus, that in the first method currents in the liquid are unavoidable. The apparatus, as described in *Wiedemann's Annalen*, consisted of a beaker placed inside another containing water. The inner beaker was filled with water and blue iodide of starch, which has the property of suddenly turning colourless when heated to a temperature somewhere between 30° and 70°C according to the degree of dilution. A copper cylinder was placed on the rim of both beakers so that its bottom was in contact with the surface of the emulsion. When steam was

made to pass through the cylinder, a colourless stratum was seen to extend downwards from the surface The separating surface was sharply defined at first, but after a few minutes a number of secondary stratifications appeared, which on close inspection showed wavy outlines Many of them were of a deeper blue, *i e.* cooler, at their upper than at their lower surfaces, so that there was evidence of a vortex-like motion in the liquid. For really trustworthy results Mr Wachsmuth used an arrangement of two copper plates and a thermopile, the lower plate being placed in contact with ice

THE volume on "The Partition of Africa," by Mr J Scott Keltie, which has been for some time in preparation, will be issued in a few days by Mr Stanford. The work, which has been brought thoroughly up to date, is illustrated by a carefully-selected series of facsimiles of early maps, as well as by a number prepared specially to show the present condition of the continent in its many different aspects.

MR A E SHIPLEY, Fellow of Christ's College, Cambridge, and Demonstrator of Comparative Anatomy in the University, has been for some time engaged on an illustrated text-book of invertebrate zoology, which will be published (Adam and Charles Black) early in the spring. It is specially adapted for the use of University students reading for such examinations as the first part of the Natural Sciences Tripos, or for the B Sc. degree in London

MESSRS MACMILLAN AND CO have published a second edition of Mr D E Jones's "Examples in Physics" The book has been carefully revised, and some sixty pages of matter have been added New sets of problems from recent papers have been put in the place of the examination questions at the ends of the chapters

THE first volume of the *Seismological Journal* is now in the press, and will shortly be issued It is uniform in size and in character with the Transactions of the Seismological Society, and will correspond with what would have been volume XVII of those publications had they been continued The yearly subscription for the journal is 5 yen, 5 dollars, or £1 This includes delivery or postage It may be paid by P O O or a draft on any foreign bank in Yokohama Address, John Milne, 14, Kaga Yashiki, Tokio

MESSRS WHITTAKER AND CO have published "The School Calendar and Handbook of Examinations, Scholarships, and Exhibitions, 1893" This is the seventh year of issue A preface is contributed by Mr F Storr.

A DEFINITELY crystallised compound of iron and tungsten of the composition FeW_2 is described by Drs. Poleck and Grützner, of the University of Breslau The crystals of this interesting substance were discovered in drusy cavities of a massive piece of a crystalline iron tungsten alloy containing no less than 80 per cent of tungsten The alloy had been prepared by an electrolytic process from *wolframite* at the works of Biermann's Metal Industry in Hanover, and exhibited in the numerous cavities small but very well formed crystals of a silver-grey colour and exhibiting very brilliant faces They were extremely heavy and of exceptional hardness Upon analysis they yielded numbers corresponding closely with those calculated for the compound FeW_2. Dr. Milch, of the Mineralogical Department of the University, subjected the crystals to a goniometrical investigation, and found them to consist of trigonal prisms whose faces were inclined exactly at 60°, and which were terminated by a basal plane inclined exactly at 90°. Singularly, however, no other faces were ever discovered upon them, so that it was impossible to ascertain to what sub section of the hexagonal system the crystals belonged. The crystals are so hard that they readily scratch topaz, and appear to be of about the same hardness as corundum

THE discovery of these crystals of a definite compound of iron and tungsten, and the fact that they are endowed with such a high degree of hardness, afford a ready explanation of the long known property of tungsten in improving the hardness of steel Berzelius, in his *Lehrbuch*, already remarked that tungsten readily formed alloys with most of the other metals, and in the year 1858 Muchet in this country took out a patent for the employment of tungsten in the manufacture of steel Thereupon the wolfram minerals, previously considered as almost worthless, rapidly came to acquire a considerable value Bernoulli has since shown that tungsten is capable of alloying in all proportions with iron until it reaches a proportion of 80 per cent, when the mass becomes infusible even at the hottest procurable white heat This alloy containing so high a percentage of tungsten, approximating indeed to that (86 4) contained in the crystals above described, exhibits a silver-grey lustre like that of the crystals and possesses almost the same hardness, scratching glass and quartz with ease Latterly the manufacture of this alloy has been carried on at the Hanoverian metal works above referred to, and brought into commerce. There can be little doubt that the remarkable property of tungsten in increasing the hardness of steel is due to the formation of more or less of this compound FeW_2, and the nearer the proportions of the two metals approach to those of the compound itself the more nearly does the resulting alloy approach in hardness to that displayed by the crystals of FeW_2 above described

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Capt U Cooke, a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Lady Fleming, a Brush-tailed Kangaroo (*Petrogale penicillata*, ♂), two Black striped Wallabys (*Halmaturus dorsalis*, ♀ ♀) from New South Wales, presented by Mr Wilberforce Bryant, a Mauge's Dasyure (*Dasyurus maugei*) from Australia, presented by Mr Robert Hoare, a Red and Yellow Macaw (*Ara chloroptera*) from South America, presented by Mr. H H. Dobree, a Grey Parrot (*Psittacus erithacus*) from West Africa, presented by the Executor of the late Mrs Bolaffe, an Æthiopian Wart Hog (*Phacochærus æthiopicus*, ♂) from Matabeleland, South Africa, deposited, two Chukar Partridges (*Caccabis chukar*, ♂ ♀) from North-west India, presented by Major Ingoldsby Smythe, fourteen Prairie Marmots (*Cynomys ludovicianus*, 6 ♂ 8 ♀) from North America, an Arctic Fox (*Canis lagopus*) from the Arctic Regions, two Rufous Tinamous (*Rhynchotus rufescens*) from Brazil, purchased, three Black and Yellow Cyclodus (*Cyclodus nigro luteus*), three Diamond Snakes (*Morelia spilotes*), a Short Death Adder (*Hoplocephalus curtus*), a Purplish Death Adder (*Pseudechis porphyriaca*), a North Australian Banded Snake (*Pseudonaia nuchalis*) from New South Wales, received in exchange

OUR ASTRONOMICAL COLUMN

COMET HOLMES (1892 III)—During the past week no very important change has taken place in the appearance of the comet, the following is the current ephemeris —

Ephemeris for 12h M T Paris

1893	R A app. h	m	s	Decl app °	′	″
Feb. 9	1	56	29 3	+34	0	28
10	1	58	3 3		2	18
11	1	59	37 8		4	12
12	2	1	12 8		6	9
13		2	48 3		8	9
14		4	24 4		10	13
15		6	0 9		12	20
16	2	7	37 9	34	14	30

Mr Fowler writes from South Kensington —"The comet on February 6 was a very dim nebulosity without sensible nucleus."

COMET BROOKS (NOVEMBER 19, 1892) —The following is the ephemeris for Comet Brooks for the ensuing week —

Ephemeris for 12h M T Berlin

1893	R A app h m s	Decl app ° ′	Log r	Log Δ	Br
Feb 9	0 11 33	+30 2 9	0 1167	0 1832	1 40
10	13 19	29 31 2			
11	15 1	29 0 9			
12	16 40	28 31 8			
13	18 15	28 4 0	0 1252	0 2152	1 16
14	19 47	27 37 3			
15	21 17	27 11 6			
16	22 44	26 46 9			

SPECTRA OF PLANETARY NEBULÆ AND NOVA AURIGÆ —In the December number of the *Memorie della Società degli Spettroscopisti Italiani*, among many interesting communications, is one by M Eugen Gothard, relative to the great similarity between the spectra of the late Nova and the planetary nebulæ By the aid of a 10½-inch reflector and a 10-inch objective prism, together with Schleussner's orthochromatic plates, he has been able to obtain these photographs, the wave-lengths of the lines of which are given in the table below In the memoir copies of the photographs on a somewhat larger scale are given, that of the Dumb bell nebula (G C No 4447) showing the image of the nebula itself, just as if no prism had been used The wave-lengths of the Nova given in this table were obtained from photographs taken on September 27 with 2h 15m exposure, and on October 28 with 3h exposure, and, in M Gothard's words, "gave the surprising result that the spectrum of the new star perfectly agrees with that of the planetary nebulæ "

The following is the table of the wave lengths, lines I, II, VI, and VII representing the nebula lines, and III, IV, and V the hydrogen lines —

		I	II	III	IV	V	VI	VII
(1) G C No 4447	—	502	—	434	411	396 5	386 5	373
(2) " 4964		501	470	434	409	397	386 5	
(3) " 4373	—	502		434	410	396 5	386 5	373
(4) " 4514	—	502		434	410	396 5	185 7	371
(5) " 4628	—	501	468	434	408 5	396	386 5	372
(6) N G C " 7027		500 7	464	434	410	395	185 7	—
(7) " 6891	—	502	—	434	410	396	386 5	372
(8) " 6884		500 5		434	—	395	186 5	—
(9) Nova	582	500	464 2	434	407 7	395	385 5	372

SUN SPOTS AND MAGNETIC PERTURBATIONS IN 1892 —In an article under this heading in *Astronomy and Astrophysics* for January M Ricco brings together the facts relative to these two phenomena, the magnetic perturbations being taken from the photo magnetographs of the United States Naval Observatory As the author describes in detail both kinds of observations, and in addition, a tabulated statement of the records, we cannot do better than abridge the table, by omitting the numerical statements as to the magnitudes of the spots and perturbations, leaving our readers to refer if necessary to the journal itself

In the column "spots" this means principal spots, E denotes extraordinary, V L, very large, L, large, M, medium, S, small, and N, none

Transit Centre Meridian	Spots	Helio-graphic latitude	Time of Maximum	Mag Perturbations	Retardation in time. h
Jan 4, 2 p m	V L	+20	Jan 6, 4 a m	V L	38
Jan 28, 3 p.m	L	−16	Jan 29, noon	L	21
Feb 2–4	N	—	Feb 2–4	S	—
Feb. 12, 4 a m	E	−30	Feb 14, 1 a m	E	45
March 1–5	N	—	March 1–5	M	—
March 7, 2 a m	N	—	March 7, 2 a m	L	—
March 10, 2 p m	E	−29	March 12, 11 a m	V L	45
April 23, 8 p m	L	+11	April 25, 11 p m	L	51
April 24, 4 p m	L	+16	April 26, 1 p m	L	45
May 1–2	N	—	May 1–2	M	—
May 16, 5 p m.	E	−16	May 18, 6 p m	E	49

From this table some very interesting facts may be gathered Out of the eleven cases which M Ricco gives, no less than seven instances occur where the passage of the spots over the central meridian is followed by a terrestrial magnetic disturbance, and not only this, but the magnitudes of both vary directly The point which the author wishes to emphasize most is the apparent constancy of the interval of time between these two phenomena, and an important fact is that at both appearances of the great February spot the same retardation occurred In the above table, with the exception of January 29, the mean interval is 45½ hrs, "thus indicating a velocity of propagation from the sun to the earth of about 913 kms per second," or "more than 300 times less than that of light "

NEW MINOR PLANETS —Photography seems to be rapidly increasing the number of our minor planets, that is to say, if the announcements really refer to new ones Wolf and Charlois between them have discovered five this year, the former two (1893 B and C), the latter three (1893, A, D, and E)

THE LUNAR SURFACE —At the present day the general idea with regard to the peculiar features of the moon is that they are the results of stupendous volcanic actions, the number and activity of which surpassed anything that we can imagine Owing to the extraordinary circularity in the craters, ring plains, walled plains, and to the well-known fact that many of the craters have not the raised lava floor half way up or near the summit of the cone, which is such a typical terrestrial characteristic, doubt as to their volcanic origin has often been raised In a small pamphlet which we have received from Mr S E Peal, Sibsagor Assam, the author suggests a "theory of glaciation" in the light of recent discoveries with regard to the maximum surface temperature, and also to the non viscosity of ice at low temperatures, together with the admitted possibility of snow existing on the moon The author assumes the moon to be constituted somewhat like our earth, and at one time to have been at a higher temperature, having an atmosphere, water, &c, and draws attention to the facts that there are no polar caps, that colour is conspicuous by its absence, "a feature quite opposed to terrestrial experience, except at the poles," and therefore "may not the entire globe be swathed in snow?", and the absence of river valleys and drainage sculpturing, indicating that a piling up of dry material has taken place in opposition to a fluvial erosion At the time when the lunar globe had so far cooled down as to be practically rigid, the tidal action would gradually turn all continents and land surfaces into shoals, and at the temperate stage of development the growth of the polar caps would be restricted to the shallows, extending from them as the temperature became reduced This advancing sheet of ice would sometimes be deformated by submarine heat vents resulting in a large or small bay, depending on the magnitude of the vent Extending seawards the "horns of the bay would meet around and enclose this area of higher mean temperature, converting it into a lagoon" Nocturnal radiation and solar heat alternately would perhaps freeze and thaw the ice formed thereon, and with a rare atmosphere and intense cold aqueous vapour would arise from "the water (floe-covered) floor during the day at least, and be carried over the ice edge by diffusion when the fall in temperature would precipitate it into snow, thus gradually forming a vast rampart" Century after century would see the level floor gradually lowered, and the ramparts increased in height The author accounts for all the peculiar forms of craters, walls, &c, by different local conditions (i e land or water or submarine vents), but they are all the result "of water floors left in a slowly extending glaciation of the crust."

GEOGRAPHICAL NOTES

AT the French Congress of Learned Societies, which meets on April 4 at the Sorbonne, the section of historical and descriptive geography, is to be devoted specially to the early geographical conditions of France, and to the work of French travellers. The programme includes the consideration of the earliest traces of human habitations, maps of caverns, &c, and proceeds to classify existing dwellings according to their situation and altitude Local names in danger of falling out of use are to be collected, and the limits of the old districts such as Brie, Beauce, Sologne, &c, to be investigated in order to place on record the geographical conditions which led to their formation

IN the *Scottish Geographical Magazine* for February Mr J G Goodchild gives a most interesting description of a large scale topographical model of the site of Edinburgh, which he has recently constructed. The model, which is on exhibition

in the Museum of Science and Art, Edinburgh, is based upon Bartholomew's map of Edinburgh on the scale of 15 inches to a mile, but the altitudes are taken point by point from the large town plans of the Ordnance Survey The model is in many ways original in its mode of construction Its object is purely geographical, having been suggested by a leading citizen as a method of showing the contrast between the circuitous roads and frequent steep gradients of the old coaching days, and the straighter and more level lines of communication by which modern engineers have overcome the restraint of physical configuration

IN the same number of the *Scottish Geographical Magazine* there is a paper on the Deserts of Atacama and Tarapaca, read to the Society by Mrs Lilly Grove, and some interesting notes on South Eastern Alaska by Prof J J Stevenson, illustrated by a map.

MR. H J MACKINDER's third educational lecture for the Royal Geographical Society was given on Friday night, the subject being the belt of Steppe which traverses Asia from west to east He showed how the distinctive physical and climatic conditions of the Steppe favoured the growth of nomadic nations, every man of whom was a member of the most mobile cavalry force which ever existed Pastoral pursuits and marauding were natural to the Steppe peoples, and the descent of their hordes on the settlements bordering the Steppe were turning points in the history of surrounding nations. Reference to the successive periods of conquest by the Scythians, Huns, Turks, and Mongols showed the power of these nomads on the affairs of other countries, and until the advent of the Steppe bred Cossacks no western power has ever secured control of the central Asian plains

FOLLOWING on the death of Captain Stairs we have to record the death of his fellow-officer in the Emin relief expedition, Mr R H Nelson Mr Nelson returned to Africa, and was in charge of the district of Kikuyu in Ibea, when he succumbed to an attack of dysentery on December 26, 1892

THE INSTITUTION OF MECHANICAL ENGINEERS

THE first general meeting for this year of the Institution of Mechanical Engineers was held on Thursday and Friday evenings of last week, the 2nd and 3rd inst , in the theatre of the Institution of Civil Engineers

There were two papers set down for reading, as follows — "Description of the experimental apparatus and shaping machine for ship models at the Admiralty Experimental Works, Haslar," by R. Edmund Froude, of Haslar , "Description of the pumping-engines and water-softening machinery at the Southampton Waterworks," by William Matthews, waterworks engineer

After the disposal of the usual formal business, the President (Dr. William Anderson) referred to the International Engineering Congress which was to be held in Chicago during the month of August next He had received a letter from Mr James Dredge, of London, who had been elected honorary president of the congress. Every one, Dr Anderson said, knew of Mr Dredge, so there was no occasion for him to say anything further on that head , but he trusted that English engineers would take steps necessary to a creditable representation

The next business was an alteration in the bye laws, the chief referring to the class of membership Hitherto the institution has consisted of members, associates, and graduates The two latter classes are, however, of small importance and practically the institution is composed of full members. The qualification for membership was that the candidate should be an engineer not under twenty four years of age , so that a member might be a Great George Street magnate, or the head of a big engineer ing firm, down to a draughtsman or the foreman of a machine shop, supposing of course he were an engineer and not simply a mechanic or artisan. These conditions of equality do not appear, however, to meet the views of the council of the Institution, so there are to be two classes of engineers on the register, the big and the little These are to be known respectively as members and associate members, but as far as we can see the broad distinction is that the member has achieved success whilst the associate member has still his way to make Honour to whom honour is due is a good maxim, but it may be doubted whether the practically self-elected council of an irresponsible body should be the arbiters, not only of fame, but of professional status

Resolutions embodying the proposed changes were moved from the chair, and carried unanimously It need not be said that the new rule is not retrospective

These matters having been settled, the secretary proceeded to read Mr Froude's paper describing the apparatus in the Haslar establishment, over which he presides To make clear the details of mechanism given would be quite impossible without the aid of drawings These were supplied at the meeting in the shape of wall diagrams, but as members had not an opportunity of studying them beforehand, there were very few who were able to keep up with the reading of the paper, excepting those who already knew all about the matter This is too often—we may say generally—the case in meetings of the technical societies , excepting always the Institution of Civil Engineers Before this Society a paper is read on one evening, and, if its importance be sufficient it is discussed during three sittings, each a week apart Members have therefore an opportunity of grasping the details of the papers read, and preparing what they have to say beforehand It is for this reason that the discussions before the Civil Engineers have always been instructive

Mr Froude's paper deals with but a fragment of its subject, but it takes the part which was more especially of interest to his audience namely, the mechanical details involved in the apparatus used for testing the models by which a forecast is made of the performance of future naval vessels It is well known that these forecasts are made possible by the late Mr Froude's discovery of the law of "corresponding speeds," so that the speed, with a given power, of the full sized ship can be deduced from the performance of the model The way in which the late Mr Froude carried out his investigations, and how the original experimental works grew up at Torquay, under the wise encouragement of the Admiralty, are well known to all interested in physical science It would be difficult to overestimate the good that has followed this work , for one thing it has done much to put us on an equality with our old rivals, the French—long, indeed, our masters in the science of ship design Perhaps there is nothing upon which we could better found our claim to naval supremacy—in this long era of naval peace—than the possession of the only naval testing tank of its kind It is a distinction we shall probably not long be able to boast, for the Russians, Italians, and Americans all contemplate constructing establishments of a like nature

The paper commences with describing the principal features of the present Admiralty experiment establishment at Haslar As at the former works at Torquay, the chief object consists of a long covered water-way, in which models of ships are towed to ascertain their resistance The towing is done from a dynamometer carriage driven at definite speeds by a stationary engine working a wire rope The models are made of hard paraffine, generally about 14 feet long, and something upwards of 1 inch in thickness as finished. They are cast in a mould with an allowance of about ¼" for finishing the shape The latter operation is done by hand, guidance grooves being cut in the model, so that the exact form may be preserved The working of this shaping or copying machine, and the way in which it enables the lines of a drawing to be translated into model form, constitute one of the most interesting parts of the installation The water-way, canal, or tank at Haslar is nearly 400 feet long, and of nearly uniform section throughout The sides are of concrete and vertical, and the railway, on which the dynamometer carriage runs, is bedded on the tops of the side walls of the water-way, in place of being suspended over the water from the roof, as in the original design The experimental carriage, which has to be nearly 21 feet gauge, is a trussed structure Its principal peculiarity consists in the fact that the members of the several trusses composing it are wooden trunks or boxes about 4" square in cross sections, made of ⅜" deal, and put together with screws and shellac varnish. At the joints formed by the intersection of the various members of the trusses, the sides of the boxes are made to overlap one another over a large area, providing a large surface for screwing and for the adhesion of the shellac varnish The dimensions of the boxes forming the several members of the girders are designed so as to bring the sides of the boxes into the right planes to suit these overlaps The whole structure thus provided is remarkably rigid and light The general design of the carriage is arranged so as to leave clear a sort of central alley provided with a railway, the rails of which are close to the sides

of the alley The object of this secondary railway is to carry the smaller carriages, on which are mounted the actual experimental apparatus of different kinds, so that these may be adjusted on this railway to any desired position fore and aft on the main carriage The carriage is driven by means of wire rope from a stationary 10" Tower spherical engine, a high power being required so as to start the truck quickly for high speed experiments. The ordinary speeds range between 100 and 500 feet per minute, for some classes of models experiments are occasionally made up to about 850 feet per minute or nine and a half miles per hour The truck has been run at over 1200 feet per minute, or about fourteen miles per hour The governor, by which the speed of the engine is regulated, is a very interesting and ingenious piece of mechanism, which has been modified from the design of that which was used on the engine at Torquay There are two symmetrical bell cranks carrying weights, and attached to each other by links, having slotted holes so as to allow the bell cranks to have a very small range of freedom of angular motion. When a given speed of rotation is reached, the centrifugal force of the weights overcomes the tension of a spiral spring, provided for the purpose, and the governing action is brought into play in the following manner —There is a hooked rod, by means of which the increase in the angular altitude of the weights (due to centrifugal force) brings a friction disc break into play, which in turn has the effect of extending a spiral spring connected with the engine throttle valve, which is thus closed so as to shut off steam. It will be easily seen how much more delicate an adjustment this device gives than the old Watt governor with the balls acting directly on the valve The extension of the spring, and the consequent distance of departure of the throttle valve from its full open position are proportional to the frictional turning movement applied to the stationary wheel, which movement is itself proportional to the pressure brought to bear upon it by the bell-cranks, in other words it is proportional to the excess of the speed above that at which the centrifugal force of the weights just equals the tension of the spiral spring To give greater sensitiveness of action the bell cranks are not hung on pin joints but on flat springs after the fashion of a clock pendulum, safeguards being provided in case of the springs breaking With the Torquay governor, which was similar in principle to that described, although differing in appearance, the adjustment was so delicate that a variation of speed in the running of the carriage of half a foot per minute was seldom exceeded even at the highest speeds The value of working against the resistance of spiral springs will be noticed in this mechanism, their steadying action being especially valuable It would be impossible for us to attempt to describe the mechanism constituting the copying apparatus of the model shaping machine, and we can only hope to give a mere outline of the general principles A rough hollow model of the ship to be constructed is cast in paraffine wax, a material which is found to lend itself most perfectly to the necessities of the experiments The drawing from which the operator has to work is stretched on a table, and the grooves representing the water lines are copied from the drawing by means of the mechanism These grooves are formed by a pair of revolving cutters, the fore and aft motion being communicated to the model whilst the cutters move laterally One cutter is on each side—for of course full models are required—and they approach or recede symmetrically in such accordance with the longitudinal travel of the model as to trace in plan upon it the intended horizontal section This due accordance of the lateral motion of the cutters with the longitudinal motion of the model is accomplished by the operator so regulating the cutter motion as to maintain a tracer in contact with the corresponding water line on the drawing. By suitable mechanism the drawing itself is made to imitate the longitudinal travel of the model, while the tracer imitates the lateral travel of the cutters. In the Torquay machine the tracer was guided by an adjustable template set to the curve of each water-line, but afterwards the tracer was made to follow the line on the drawing by the operator In the present machine the cutters are raised or lowered to get the different water-lines. The cutters run at 2700 revolutions per minute. The grooves having been cut, the surplus material is removed by hand

We shall not follow Mr Froude in his description of the further details of the mechanism, as it would be unintelligible without the drawings by which he illustrated his description. The various arrangements are, however, fully worthy of study by all who are interested in ingenious mechanical devices, but we must refer our readers to the printed transactions of the institution, in which the diagrams will appear when the volume is published. There is also a weighing machine, which is necessary to obtain the actual dead weight of the model, so that the amount of ballast required to get the necessary displacement corresponding to trial draught may be determined This machine will weigh up to 1000 lbs with great accuracy, and is similar in principle to an ordinary chemical balance, except that it is a steel yard, having one arm 6 inches and the other 5 feet in length.

The discussion on this paper was opened by Mr W H White, the Director of Naval Construction, who is the official head of the Admiralty department, of which the Haslar establishment forms a branch Mr. White spoke of the advantage these model experiments had been to the navy, saying that the great advance in the speed of ships which had been obtained of late years would not have been reached to the full extent had it not been for the model experiments carried out at Torquay and Haslar by the late Mr Froude and his son, the author of the paper. Mr J I Thornycroft also pointed out the great economy that had been made in expenditure upon navy ships by finding out beforehand what the proposed vessel would do, and what was required in the way of power to reach that performance Mr Thornycroft made especial reference to the ingenuity of the device whereby a line on the drawing, which might not be quite accurate, would be made to give the desired result in the model, and this without an expensively constructed apparatus Various other speakers having been heard, and Mr Froude having briefly replied, so far as there was anything to reply to, the meeting adjourned until the next evening

On the members assembling on Friday evening, the 3rd inst, the president, Dr Anderson, again occupied the chair, and Mr Matthews's paper on the Southampton waterworks was read This contribution is interesting, as it describes what we understand is the largest water softening plant yet installed The quantity of water that can be satisfactorily dealt with is from 2¼ to 2½ million gallons per day of 24 hours Of course the principle of softening hard water by lime is very far from new, but it has made slow progress, in spite of the vast quantities of hard water, otherwise unobjectionable, that there are in the chalky southern half of our island This limited application of a means whereby a bad water in one respect can be made a good one in all respects does not appear, to judge by the proceedings of last Friday, to spring from any inherent defect in the system—beyond that which would arise from the disposal of the refuse lime in crowded cities—but rather from the carelessness of public authorities and water supplying companies to the wants and comforts of the people at large

The meeting terminated with the usual votes of thanks, the President announcing that the summer meeting would be held this year at Middlesborough on Tuesday, August 1, and the following days

THE SEVEN IMAGES OF THE HUMAN EYE

IT is well known that in the human eye, besides the refracted image, which serves the purposes of vision, there are formed three reflected images known under the name of "Purkinje's images" M Tcherning has discovered three additional ones, so that the total number is brought up to seven [1]

In its passage into the interior of the eye each ray of light has to pass through the cornea, the aqueous humour, the crystalline lens, and the vitreous humour before finally arriving at the retina. At the surface of each of these constituents the ray is liable to be partially reflected, thus giving rise to four reflected images. These were all seen and described by Purkinje at the beginning of the century, but only three were observed by Helmholtz and others These three can be easily observed by two persons on holding a lighted match between their eyes, and moving it about so that the reflections seem to come from the pupil. One of them, that reflected by the front of the cornea, is much brighter than the two others, which are formed by the front surfaces of the crystalline and the vitreous humour respectively The fourth image is due to reflection from the posterior surface of the cornea It may be discovered by careful observation of the brightest image by means of a magnifying glass. As

[1] See *Séances de la Société Française de Physique*, Avril-Novembre, 1892

it approaches the border of the pupil, and especially as it passes on to the iris, it is seen to be accompanied by a small, pale, but well-defined image, which always lies between the first image and the centre of the pupil, the distance between them decreasing as they move towards the centre, where they finally coincide By means of the ophthalmophakometer—an instrument consisting of three incandescent lamps and a telescope arranged on an arc of 86 cm radius—it was found possible to measure the radii of curvature of all the reflecting surfaces The foci of the two reflecting surfaces of the cornea were found to coincide, a fact which accounts for the coincidence of the two corresponding images at the centre of the pupil, and for Helmholtz's failure of finding the fainter one

It is evident that since the light reflected from the successive surfaces does not fall upon the retina, it is lost for visual purposes But a comparison of the percentages of loss in the case of the eye, and in that of a simple lens tells greatly in favour of the former as an optical instrument In the eye the percentage of useful light is 97, in a simple lens 92, and in a compound optical instrument correspondingly less But the light reflected by any of the internal surfaces is also liable to be reflected back into the eye or the optical instrument, with the effect of superimposing a more or less faint patch of light upon the image on the retina This is termed the noxious light (*lumière nuisible*) by M Tcherning In a simple lens this amounts to ⅓ per cent, whilst in the eye it is as low as 0·002 per cent But faint as it is, it is capable of giving rise to two light impressions due to double reflection, one at least of which has been actually observed in the human eye "The easiest way of observing it," says M Tcherning, "is to look straight forwards in a dark room, holding a lighted candle in the hand about 20 cm from the line of vision On moving the candle gently from side to side a pale image of the flame is seen on the opposite side of the line of vision, distinct enough to show that it is inverted, it moves symmetrically to the candle with respect to the line of vision The rays which form this image have undergone, besides several refractions, two reflections, one at the posterior surface of the crystalline and another at the front surface of the cornea" Another image was expected to be formed by a similar reflection at the anterior surface of the crystalline It was found in an artificial eye, but not in the human sense-organ However, an easy calculation of the optical system of the eye explains this circumstance The focus of the reflected rays is very near the crystalline lens itself, so that they must be much dispersed by the time they reach the retina To enable the image to be formed on the retina, the object would have to lie between the cornea and the crystalline, but on attempting to form a luminous point at that place by optical means it is found that the "useful rays" fill the eye to such an extent as to render everything else invisible

It is found that different eyes differ in their capacity of seeing the first of the two additional subjective images Short-sighted people find it very indistinct unless the candle is held close to the eye, or convex glasses are used As the maker of optical instruments utilises the accessory images for testing the degree of polish and the accurate centreing of the lenses, so the physician is enabled to make valuable inferences from them as to the structure and condition of the eye he is examining, and the additional images discovered by M Tcherning appear to be of considerable physiological importance E E F d'A

A BOTANIST'S VACATION IN THE HAWAIIAN ISLANDS

SOME weeks ago we reprinted from the *Botanical Gazette* (Indiana) a part of the first instalment of Prof. D H Campbell's interesting account of his vacation in the Hawaiian Islands. The following is the chief portion of the second and concluding instalment, published in the January number —

Beside visiting the isle of Oahu, I made short trips to the islands of Hawaii and Kauai. The former, the largest of the group, and the only one where volcanic action is still going on, is reached by steamer in about thirty-six hours from Honolulu. On the way, the islands of Molokai, Lanai, and Maui are passed. The first, a barren-looking and forbidding spot, is the location of the leper settlement, to which all persons afflicted with leprosy are sent as soon as their condition becomes known.

Maui, the largest of the islands next to Hawaii, consists of two portions connected by a narrow isthmus The whole eastern half is nothing more nor less than the body of an immense extinct volcano, ten thousand feet high, and with a crater nearly ten miles across The other end of the island is an older formation This island is said to be very interesting botanically, but, unfortunately, my time did not permit me to visit it.

Very soon after sighting Maui, the three great mountain masses of Hawaii began to loom up The day was clear, and the whole formation of the island became visible It consists of three great volcanic cones, of which only one is now active The highest summit, Mauna Kea, is nearly 14,000 feet above the level of the sea; the next, Mauna Loa, lacks but a few hundred feet of this, yet so great is the breadth of these masses that one fails to realise their immense height Our first landing was at Mahukona, on the leeward side of the island, a most forlorn expanse of bare lava with scarcely a trace of vegetation, except a few unhappy-looking algaroba trees planted about the straggling buildings that constituted the hamlet

We lay all day at this inhospitable station, not getting away until evening A beautiful sunset and a fine glimpse of the peak of Mauna Kea glowing with the last rays of the sun, form my most pleasant recollections of this desolate place

What a change the next morning! On awakening we found ourselves entering the harbour of Hilo Here everything is as green as can be imagined, and luxuriant vegetation comes down to the very ocean's edge The town is built on a bay fringed with cocoa-nut trees and embowered in a wealth of tropical vegetation Owing to the great annual rainfall (about 180 inches), as well as to the fact that Hawaii is the most southerly of the islands, the vegetation here is the most luxuriant and tropical found in the whole group I remained in Hilo for six days and collected some most interesting specimens Through the kindness of Mr. Hitchcock of Hilo, I was enabled to spend the night at his camp in the woods near the town, and the greater part of two days collecting in the vicinity The forest here is most interesting Mr Hitchcock was starting a coffee plantation and has cut trails through the woods in several directions, so that collecting was very convenient There is great danger of losing one's self in these woods where there are no trails, as much of the forest is an almost impassable jungle In these moist forests ferns and mosses luxuriate, and every trunk and log is closely draped with those beautiful growths Flowers are almost entirely wanting, a fact repeatedly observed by collectors in tropical forests I saw here fully developed specimens of tree-ferns The finest of these were species of Cibotium Many had trunks from fifteen to twenty feet high, and some must have been fully thirty The most beautiful were some with trunks ten to fifteen feet high, as these were more symmetrical and had finer fronds than the taller ones. I measured the leaves of one that had fallen over, and roughly estimated the length as eighteen feet. I have no doubt that specimens fully twenty feet long could be found These giant fronds, arching high over one's head as one rides on horseback under them, present a sight at once unique and beautiful Growing upon the trunks of these ferns were many epiphytic species, the most peculiar of which was *Ophioglossum pendulum*, with long strap-shaped leaves, a foot or two long, and a spike of sporangia sometimes six inches long Exquisite species of Hymenophyllum and Trichomanes, the most ethereal of all the fern tribes, with almost transparent, filmy leaves, were common, sometimes completely enveloping the trunks of the trees Of the terrestrial ferns, which abounded everywhere, two were especially notable as representing groups unknown in the United States. One of these, *Gleichenia dichotoma*, forms extensive thickets on the borders of the forest, and in the Hilo district extends down almost to the sea-level. The other, *Marattia Douglasii*, a very large fern with leaves eight to ten feet long in well grown specimens, has fleshy dark green leaves, and thick stipules sheathing the base of the leaf stalks. Several species of Lycopodium and Selaginella were common, and a good variety of mosses and liverworts. In these forests wild bananas are common, and most magnificent plants they are Sheltered from the wind, the superb great leaves develop to their full size, without being torn in the least, and the whole plant is a study of beautiful form and colour

Coffee is being extensively planted in this region as well as upon the lee side of the island, and as the quality of the berry

is exceptionally fine, this promises soon to be a leading industry in the islands.

About Hilo especially, but common also elsewhere, was a very conspicuous black fungus, that covered the leaves completely in many cases, and attacked indiscriminately a great variety of trees

From Hilo I proceeded to the volcano of Kilauea, some thirty miles distant, and about 4000 feet above the level of the sea As this volcano has so often been the theme of travellers' descriptions I will not linger over it In the vicinity are many interesting plants, among them a species of Vaccinium with sub acid yellow and red berries something like cranberries These "ohelo" berries are much esteemed, and are especially good when cooked Some two miles from the volcano is a superb grove of koa trees, the largest trees I saw anywhere in the islands One of these standing alone, and with magnificent spread of branches, must have been ten feet in diameter The road to the volcano lies for much of the way through a fine forest In the lower part the ohia trees were loaded with their beautiful crimson fruit, and present a very showy appearance Of flowers, the species of Ipomæa were the most conspicuous, but the scarlet flower-bracts of Freycinetia were conspicuous at times, for here this latter plant may often be seen running to the tops of the tallest trees

The glory of this road, however, is *the tree-ferns*, which all along excite one's admiration The carriage road is not yet completed, and about thirteen miles must be done on horseback Of this more than a mile is over a corduroy road made out of the trunks of ferns! Such a road, if not very durable, is yet very pleasant to horses As these trunks lay prostrate, in the damp atmosphere, most of them were already sending out new fronds, and in due course of time the road will be fringed with a hedge of great fern-leaves Indeed, in some of the more open parts of the road farther down, where the ground is completely occupied by a small tree-fern growing in dense thickets, as these are grubbed out to make way for cultivation, their trunks are piled up to form fences, and soon sprout out so that they make a beautiful and close hedge of fern-leaves

On leaving the volcano I went down on the other side of the island The rain being almost entirely intercepted by the mountains, this leeward side is very dry, and the ride to Punaluu, where we were to take the steamer, was not especially pleasant Vegetation is very scanty, and nothing particularly interesting was noted in this line. The soil on this side of the island, especially in the district of Kona, is very fertile, and when water can be had, produces magnificent crops of all the tropical staples, pine apples, cocoa nuts, coffee, sugar, &c, all especially fine, and we feasted on these cocoa nuts and pine-apples as we sailed along this picturesque, if somewhat barren, coast

A short, flying trip was made to the Island of Kauai, the richest botanically of all the islands, as it is the oldest geologically According to Hillebrand, not only is the number of species larger than in the other islands, but the species are more specialised Here I saw several species of the curious woody Lobeliaceæ, of which there are several genera that form either shrubs or small trees I saw several species of Cyanea, with stems six to eight feet high, with long leaves crowded at the top of the stem and many white or purplish flowers, much like those of Lobelia, but somewhat larger and less open

As in all the islands, there is on Kauai a great difference between the windward and leeward sides I drove for about thirty miles along the windward side of this island through some of the most beautiful scenery of all the islands. Near the sea were rolling plains and hills, with here and there groves of Pandanus and Hau—the latter a dense spreading small tree with large yellow hibiscus flowers—and at one point we drove through a magnificent grove of kukui trees, the finest I saw anywhere As we reached that part of the island which is most fully exposed to the moisture-laden trade-winds, vegetation became extremely luxuriant. Numerous valleys with clear streams flowing down them, their bottoms given up to rice plantations, were to be seen here, with the rice in all stages, from the young spears just standing above the water to golden-yellow patches of ripe grain At Hanalei, my destination, I found excellent accommodation and a delightful bathing beach, the latter especially attractive after a thirty-five mile drive over dusty roads Hanalei is beautifully situated on a picturesque bay, with bold mountains rising directly back The next morning a native was hired to go with me into the woods, and the day was spent in collecting. The variety of trees, as well as other phænogams, is much greater here than in Hawaii, the ferns, also, were very fine. Here I obtained a prize in a fine lot of the prothallia and young plants of Marattia, as well as some other interesting things

Want of space forbids going into details, but no botanist visiting the islands can afford to miss Kauai

In position, the Hawaiian Islands are unique, being more isolated than any other land of equal area upon the globe More than 2000 miles separates them from the mainland, and 1860 miles from the nearest high islands Of purely volcanic origin, thrown up from an immense depth, they have always been thus isolated As might be expected, the flora is very peculiar, more so than in any other country According to Hillebrand, of 800 species of spermaphytes and pteridophytes that are strictly indigenous, 653, or 75 per cent, are endemic. Taking out the pteridophytes, the spermaphytes show over 81 per cent, and the dicotyledons over 85 per cent that are found only in this group

For a thorough study of this very curious flora, a long time would be necessary, as many species are extraordinarily local, and many of the most interesting localities are very difficult of access The islands differ extremely among themselves, and exhibit in a most interesting manner the correspondence that exists between the variety and differentiation of forms and the ages of the islands The formation of the islands has proceeded from north to south, and Kauai, the northernmost of the large islands of the group, is also the oldest and much the richest botanically, especially as regards spermaphytes, and, according to Hillebrand, the genera and species are more differentiated Hawaii, the southernmost of the islands, is much the poorest in forms, although in the Hilo district the conditions are most favourable for a luxuriant development of forms.

In the latter island is the last active volcano of the group, Mauna Loa, with its two craters, of which the well-known crater of Kilauea is the great sight of the islands, and visited constantly by tourists from all parts of the world

A few days after my return to Honolulu from Kauai, and six weeks from my first arrival there, I boarded the *Monowai*, the through Australian steamer bound for San Francisco, which was reached in due season after an uneventful passage And so ended my first trip to the tropics

INSTRUMENTS FOR THE EARTHQUAKE LABORATORY AT THE CHICAGO EXPOSITION

THE first earthquake instrument ever invented, a drawing of which is shown on the wall, is in all probability that of Chōkō, dating from the year A D 132 The first instrument used for keeping systematic records in Japan was Palmieri's modification of the contrivance sketched out by the late Robert Mallet Since this not only have all forms of seismographs and seismoscopes employed in Europe and America been employed, but many special forms have been designed in Japan, with the result that rather than Japan borrowing from Europe and America, these countries are using inventions which had their origin in Japan A few of these instruments are exhibited in this laboratory. The main feature in their construction is that they all work from "*steady points*," and for small earthquakes at least, we can say with confidence that the diagrams they yield are absolute measurements of the earth's motion From diagrams written on stationary plates we know the extent and the direction of the principal vibrations in a shock, but when the movements are recorded on a moving surface, we know the period or the rapidity with which the movements follow each other. From these latter diagrams the acceleration or suddenness of movements may be calculated, and the factors given to engineers enabling them to construct to resist known forces, rather than simply building strongly because an earthquake is strong

INSTRUMENTS EXHIBITED

1 *Seismograph writing on a glass disc* —Here we have horizontal pendulums writing the earth's motion as two rectangular components on the surface of a smoked glass plate. The vertical motion is given by a vertical spring lever seismograph The rate at which the plate revolves is accurately marked by an electrical time ticker. The movements of the latter are governed by a pendulum swinging across and making contacts with a small vessel of mercury.;

The revolving plate is kept in motion by clockwork, which is set in motion by an electric seismoscope (See No 8)

2 *Seismograph writing on a drum*—In this instrument the record is written on a band of paper, the diagram being less difficult to interpret because it is written to the right and left of a straight line and not round a circle

3 *Seismograph writing on a band of paper*—In this instrument not only is the diagram written along a straight line but it is written with pencil,—the trouble of handling smoked paper being therefore avoided When the earthquake ceases, the drum ceases to revolve, but if a second or third earthquake should occur, it is again set in motion By this means a series of earthquakes may be recorded, the resetting of the instrument being automatic

4 *Seismograph without multiplying levers*—This instrument is intended to record large motions, the horizontal levers not being prolonged beyond the steady points to multiply the motion For large earthquakes, when the ground is thrown into wave like undulations, special instruments which measure tilting are employed

5 *Duplex pendulum seismograph.*—In this case a steady point is obtained by controlling the motion of an ordinary pendulum with an inverted pendulum The record consists of a series of superimposed curves written on a smoked glass plate

6 *Mantelpiece seismometer*—This is intended for the use of those who simply wish to know the direction and extent of motion as recorded at their own house It is a form of duplex pendulum, and it gives absolute measurements for small displacements

7 *Tromometer.*—This is one form of an instrument which is used to record movements which are common to all countries, called earth tremors Every five minutes, by clockwork contacts and an induction coil, sparks are discharged from the end of the long pointer to perforate the bands of paper which are slowly moving across the brass table If the pointer is at rest, then a series of holes are made following each other in a straight line, but if it is moving, the bands of paper are perforated in all directions round what would be the normal line of perforations

The earth movements which cause these disturbances are apparently long surface undulations of the earth's crust, in form not unlike the swell upon the ocean

A more satisfactory method of recording these motions, which has been used for the last two years, is by a continuous photograph of a ray of light reflected from a small mirror attached to a small but extremely light horizontal pendulum

8 *Electrical contact maker*—These instruments are delicate seismoscopes, which on the slightest disturbance close an electric circuit, which, actuating electric magnets, set free the machinery driving the recording surfaces on which diagrams are written.

9. *Clock*—At the time of an earthquake the dial of this clock moves quickly back and forth and receives on its surface three dots from the inkpads on its fingers. It thus records hours, minutes, and seconds, without being stopped

10. *Model of an earthquake*—The bent wires represent the path traced by an earth particle at the time of the earthquake of January 15, 1887 The numbers indicate successive seconds This model was made by Prof S Sekiya.

11. *Safety lamps.*—These are lamps which if overturned are at once extinguished. One of these is a European invention and the other Japanese.

12. *Pictures*—The pictures on the walls show the effects of the Great Earthquake of October 28, 1891, the devastation following the Eruption of Bandaisan in 1887, and several of the more important volcanoes in Japan. They were made by Prof. W K. Burton.

JOHN MILNE, F OMORI
Seismological Laboratory, Imperial University of Japan, Tokio.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Last Term the Board of Faculty of Natural Science recommended that an honour examination in Natural Science should be instituted, bearing the same relation to the Final School that Moderations bear to the Final School of Literae Humaniores. The recommendation of the Board was not unanimous, and on the matter coming before the Hebdomadal Council last week, it was put aside on the ground of want of unanimity among the various scientific departments There was much to be said both for and against the proposed examination It would probably have raised the standard of the chemical and physical work done by biologists, but would have forced an additional subject on the chemists and physicists, which they were very unwilling to assent to

CAMBRIDGE.—The Adams Prize has been awarded to Prof J H Poynting, F R S., late Fellow of Trinity College, for a memoir on the methods of determining the absolute and relative value of gravitation and the mean density of the earth

The Professor of Pathology (Mr Roy) gives notice that on Thursday, February 9, a lecture and demonstration will be given by Dr Hafkine, of the Pasteur Institute, on his method of conferring immunity against Asiatic cholera The lecture will be delivered at the Pathological Laboratory at 4 30, and will be open to members of the University

The office of Esquire Bedell has been rendered vacant by the death of Mr F C. Wace, a distinguished mathematician, formerly Fellow and Lecturer in Mathematics at St John's College, and thrice elected Mayor of the Borough of Cambridge

SCIENTIFIC SERIALS

Wiedemann's Annalen der Physik und Chemie, No 1—Essay towards an extension of Maxwell's Theory, by Hermann Ebert The author obtains expressions for dispersion and absorption of waves of the order of light-waves analogous to those obtained by Goldhammer, and shows that they may be derived from Maxwell's fundamental conceptions by applying them to the case of rapidly changing displacements.—A new kind of magnetic and electric measuring apparatus, by G Quincke. These are made of glass, ebonite, and wood No screws are used in their construction, and they are claimed to cost a tenth of the price of ordinary instruments, with equal accuracy In each of them the needles are suspended at the hollow centre of a vertical circular glass disc—On a null method for measuring the dielectric constants of conducting liquids, by Friedrich Heerwagen—On a phenomenon analogous to Newton's rings observed during the passage of Hertz electric plane waves through plane parallel metal plates, by Ludwig Boltzmann The author removes an apparent contradiction between Maxwell's theory and Hertz's observation that even excessively thin metal plates do not transmit electric waves a few decimetres long, by showing that this is not due to absorption, but to the limiting conditions at the surfaces of separation deducible from Maxwell's formulæ—On a medium whose mechanical properties lead to the equations propounded by Maxwell for electromagnetism, by L. Boltzmann—On some questions concerning Maxwell's theory of electricity, by L Boltzmann—The index of refraction of electric rays in alcohol, by H O G Ellinger—On the electrification of air in glow and brush discharges, by Ad. Heydweiler.—On the calculation of magneto optic phenomena, by P. Drude.—Spectra of aluminium, indium, and thallium, by H Kayser and C Runge—On the infra-red spectra of the alkalies, by H Kayser and C Runge. A criticism of Benjamin Snow's work on the same subject—Investigations concerning interior conduction of heat, by Richard Wachsmuth.—On the absolute value of the thermal conductivity of air, by A. Winkelmann—On a modification of the transpiration method suitable for the investigation of very viscous liquids, by C Brodmann The substance was made to pass from a funnel-shaped reservoir through a capillary tube into a beaker standing on one pan of a chemical balance. The time was noted at which the amount of liquid passed into the beaker was large enough to overcome the counterpoise in the other pan, and to disturb the equilibrium, and further small weights were added and similarly dealt with. The temperature was kept constant by a spiral water-pipe and felt jacket, and local differences and variations of level and buoyancy were corrected for The liquid experimented upon was glycerine, and the temperature curves were hyperbolas.—Notes on M Cantor's thesis on capillary constants, by Th. Lohnstein—Note on the purification of mercury, by W. Jaeger

Notes from the Leyden Museum—Of volume xiv numbers 1 and 2 were published in April, and numbers 3 and 4 in July last Edited by Dr. F. A. Jentink, this volume contains 282 pages and ten plates. The notes on Mammals are, by the editor on *Semnopithecus pyrrhus*, Horsfield, and on *Pithecia melanurus*, S. Muller (Pls. 3 and 4) In volume xii. Dr Jentink,

p. 222, gave a note about this latter very rare, nearly forgotten, and often misunderstood little rodent, figured by Alfred Duvaucel in F Cuvier's great work, the "Histoire Naturelle des Mammiferes." Cuvier could give no indication of its size, nor of its native country, guessing that "qu'il est originaire des provinces du Nord de Bengale, si ce n'est des parties occidentales de Sumatra." Dr S Muller, in 1834, obtained a specimen in Java, to the northern side of Mount Gede, and named the species This, and another specimen from Sumatra (also collected by Muller) are both in the Leyden Museum as stuffed specimens The skulls of these two specimens were detected in the Leyden Museum by Oldfield Thomas, and were included by Jentink in his catalogue of 1887, though with a query But all doubt on the subject was removed at the date of this paper, and now the animal has been taken alive by Mr J. D Pasteur on the northern slope of the Goenong Gedeh, Java, an account of which capture is given in a very graphic translation of a letter to Dr Jentink On birds there are papers by J Buttikofer on the specimens of the genus Tatare in the Museum, on the specific value of Levaillant's "Traquet Commandeur," and on the collections of birds sent by the late A T Demery from the Sulymah river, West Africa, pp 13-30 In this last paper 96 species are recorded, ten of which are new to Liberia, on *Batrachostomus poliolophus*, n sp from W Sumatra, by Ernst Hartert, on a weaver finch from Sumatra, and on a collection of birds from the islands of Flores, Sumba, and Rotti, by J Buttikofer, and on the birds of Sumba, by A H Meyer About fish there is a note by Dr Th W van Lidth de Jeude on *Orthragoriscus nasus*, Ranzani, which had been washed ashore in November, 1891, at Callantsoog A figure from a photograph is given — M Schepman describes a number of land and fresh water mollusca from Soemba, Timor, and other East Indian islands, several new species are diagnosed —Dr J G de Man continues his Carcinological studies in the Leyden Museum, and in No 6 describes several new species which are figured A very important contribution to our knowledge of the echinoderms is made by Dr Clemens Hartlaub's paper on the species and structure of the hard parts in Culcita; nine species are carefully described, their geographical distribution is given, *Culcita grex*, M T, is figured from a photograph, and a fairly complete bibliography is appended. The rest of the papers are descriptions of new forms of insects.

No 1 of vol. xv, dated as January, 1893, but published October 30 last, contains a review of the genus Rhipidura, with an enumeration of the specimens in the Leyden Museum A key to the 75 species now known is given—five are described for the first time M E Buchner has a note on the occurrence of *Mellivora indica*, Kerr, in the Trans Caspian district, on two supposed new species of Pentadactylus, by M Schepman There are also several papers on new forms of insects

SOCIETIES AND ACADEMIES.

LONDON

Royal Society, January 26 —"On the Three Bar Motion of Watt" By William Brennand Communicated by C B Clarke, F R S

"Further Researches in Connection with the Metallurgy of Bismuth" By Edward Matthey, F S A., F C.S, Assoc Roy Sch Mines Communicated by Sir G G. Stokes, Bart, F.R S

Paper IV —"Bismuth, its Separation from Arsenic"—In melting large quantities of bismuth containing arsenic it was found that the surface of the metal being exposed to the air arsenical fumes appeared, and that as the temperature of the metal was raised the arsenic came off in dense white fumes (As_2O_3) An alloy of bismuth containing 0 65 per cent of arsenic was carefully operated upon and freed from the whole of its arsenical contents, the temperatures being noted at which the separation takes place. When raised to a temperature of 513°C and maintained at this for a short period, the bismuth was found to be absolutely free from arsenic.

Paper V "Bismuth, its Separation from Antimony"—Whilst engaged in fusing some 400 or 500 kilogrammes of bismuth containing antimony it was noticed that a peculiar oily film formed on the surface of the alloy, which on being removed and tested was found to contain a considerable percentage of antimony. By continuing the operation and removing the film from time to time as it formed, the melted metal became bright, and was then found to be perfectly free from antimony. A quantity of about 350 kilogrammes of bismuth containing 0 80 per cent of antimony was melted and the temperature observed at which the antimony separated as described By maintaining a constant temperature of 458° C. the whole of the antimony separated, leaving the bismuth free from any trace of this metal The temperatures were determined by the pyrometer of M. H le Chatelier

Physical Society, January 13 —Prof G F Fitzgerald, F R S, President, in the chair —Mr F W Sanderson read a paper on science teaching In this communication the author considers the methods of teaching physical science, and remarks that other sciences may best be treated in some different manner. The method recommended is one found suitable in public schools where boys may remain till about the age of nineteen In elementary and secondary schools modification would be necessary with a view to making it more immediately useful, whilst in university and technical colleges other methods might be preferable The object of his public school method was to make physical science a definite means of education, rather than to produce skilled physicists Certain mathematical subjects, such as arithmetic, geometry, and algebra, should be taught before physics is begun, and taught in such a way as to aid subsequent physical work In teaching arithmetic it is deemed desirable to distinguish between the science and the art of it, and to have separate hours for instruction in each The subjects included in each part are described in some detail in the paper No existing arithmetic satisfies the author's requirements Geometry is considered of the first importance, practical geometry and the use of instruments forming the best introduction to the subject It is recommended that the elementary part be taught by the mathematical master with a view to formal geometry, *e g* Euclid As most practical geometries consist of isolated constructions they are useless for teaching the subject in a scientific manner A number of problems suitable for a graduated introductory course are given After elementary geometry, mensuration may be taken up with advantage, the facts being verified by drawing to scale, measuring, or by weighing, but no rules being given Trigonometry of one angle may then be commenced Here also free use should be made of the drawing board, each pupil finding the sines, cosines, and tangents of angles by drawing and measurement, and making tables Quite independent of the mathematical class the author has been in the habit of carrying boys on the engineering side through a course of graphical analytical geometry, in which they draw straight lines and the quadratic curves, &c., from their equations, solve simultaneous linear equations, quadratics, cubics, &c Other geometrical constructions follow The subject as to what branches of science should be taught in the different departments of a school is then considered, and schemes are given for the classical, modern and commercial, science, and engineering sides Some general principles which have been kept in view in arranging the physical teaching are next described In the first place the fundamental experiments and observations on which each scientific law is based are explained to the pupils, and when possible the experiments are performed by the boys in the laboratory Secondly, from the experiments the laws are stated as precisely as possible, the form of statement depending on the knowledge possessed by the class. The problem of expressing a law mathematically from its most fundamental statement is then fully considered Thirdly, mathematical deductions from the laws are followed out, and the pupils perform experiments to verify the results, and thus confirm the laws Fourthly, a course of exact physical measurements is given, which includes mensuration, hydrostatics, mechanics, sound, heat, electricity, and light. A first and second year's course is arranged in each subject, and in both years all the boys work the same experiment at the same time This necessitates multiplication of apparatus, but being of a simple character in the lower forms where the pupils are numerous it is not prohibitive. It is also stated that boys get better results with comparatively rough apparatus, if large, than with delicate and expensive instruments About half the time devoted to physics is spent in the laboratory Mathematics is introduced, as far as can be done without straining the pupils too much, and with young classes appeal is made to experiment where the strictly logical argument would be difficult to follow. Instead of teaching the applications of science as done in some technical schools, the author's method is to teach pure science, and let the applications come in as

illustrations. At the end of the paper detailed lists of experiments for practical courses in electricity and optics are given Samples of the apparatus used were exhibited at the meeting, those for optics being particularly simple and ingenious — Prof A. M Worthington said his experience led him to a very hearty agreement with Mr. Sanderson on all essential points, and he thought there was now a close agreement amongst teachers as to the best methods. He therefore wished to ask, Had not the time now come at which the Physical Society might usefully endeavour to exert direct influence on science teaching? As the scientific instruction of a person who intends following a scientific calling is generally divided into stages, and conducted in different places under different teachers, he thought it was desirable that those in charge of his training at each stage should say up to what point his instruction should be carried before he reaches them Other matters in which the society might do useful work were (1) reporting on text-books and condemning the bad ones, and (2) furthering the adoption of the decimal system. At present, he said, an enormous extension in the teaching of physical science is taking place, and it seemed within the power of the Physical Society to place itself at the head of the movement Another point which required to be settled was the relative importance of physics and chemistry at different stages of a student's education —Mr. L. Cumming agreed with the general principles laid down by Mr Sanderson In attempting to carry out such schemes numerous difficulties presented themselves, especially where the science master had not control over the subdivision of the boys' time He had tried teaching the science of arithmetic to boys in the lower forms, but the results were not encouraging, for he found very few who could do much in it They seemed to devote themselves much more readily to concrete problems and the art of manipulation of rules Graphical statics was very valuable. As regards experimental lectures, he believed them to be very important, especially in junior classes For scholarship boys a different method had been tried with success. Instead of performing lengthy experiments completely before the class, the essential parts were gone over, and for the minor points the results obtained in experiments made before or after the lecture were given, so that all the data for reducing the results were to hand This saved considerable time He had hoped Mr Sanderson would say something about the slide rule, and wished to learn his opinions on its use —Dr Stoney said he was very much struck with the methods of teaching brought forward by Mr Sanderson, and remarked that his own work would have been considerably lightened if such a scheme had been developed many years ago Experimental methods were very valuable, provided the inaccuracies of measurement be kept in view. Plotting curves was also very instructive, and might be made a means of furnishing the fundamental notions in the differential and integral calculus As to the introduction of chemistry, his experience went to show that this should be done at an early age Dynamics should also be begun early.—Mr. W B Croft thought that if the Society did make rules to regulate the teaching of physical science, these rules should not be too strict, for the ages and aims of boys might differ widely. At Winchester the science teaching was carried out on the lines recommended by a committee of the Royal Society appointed to consider the subject (Leaflets showing the scheme adopted were here distributed to members.) The object of the scheme was not merely to make science a means of education, but an integral part of the education of the pupils He also made a point of keeping the lecture experiments up to date —Mr. Rentoul said dynamics should not be taught as a mathematical subject, but experimentally. He thought it of the first importance that boys should learn how to find out facts for themselves, and for this practical work was essential. —Prof. Ayrton remarked that the conditions under which science was taught differed in different places. He himself taught with the object of enabling the persons under instruction to improve the industry For this purpose he believed the analytical method more suitable than the synthetical one advocated by Mr. Sanderson It also had the advantage of being more scientific, for it was more natural, being, in fact, that used by children from birth, for they had no other means of learning the nature and properties of their surroundings. In his first year's technical course the work was synthetical, whilst in the third year the students, having analysed existing apparatus, were taught to devise new or improved forms, and hence the work became more synthetical —Mr F J. Smith said it was important that students be taught to measure by the balance, micrometer, spherometer, and as soon as possible He also inquired how far Mr Sanderson's pupils could help themselves in making the apparatus required for the simple experiments —Dr Gladstone agreed with many points in the paper Lately he had had to do with schemes for improving the teaching in elementary schools Children were naturally philosophers, but at present their curiosity was considered objectionable and sternly repressed Efforts were now being made to alter this state of things Kindergarten classes in infant schools were a step in the right direction. It was very difficult to introduce analogous methods in the higher standards, but natural science had now obtained a footing Although the methods of teaching adopted might be those suitable for pure science, care should be taken to put in practical illustrations, for when suitably chosen they are sources of great interest to children —Mr. Sanderson, in reply, said the slide rule was used throughout the course Mechanics was taught by actual machines, such as pulley blocks, screw jacks, &c The boys made some apparatus, but to make all would require too much time —The President, when proposing a vote of thanks to the author of the paper, said that in Ireland the opinion that boys and girls cannot be taught science greatly predominated They found considerable difficulty in getting any continuation of the kindergarten teaching sanctioned. Possibly drawing might be allowed, but this seemed all they could hope for at present He wished to emphasise the fact that in such schools the object was education, and practical applications of science were not important except in so far as it created an interest in the subjects At present scientific teaching was in an experimental stage, and as in other things, progress is made by trial and error Many different methods were being tried, and it was important to know which were successful and which failures. He thought the Physical Society might be useful in collecting information on the subject by issuing a circular of questions to science teachers, and subsequently drawing up a report on the subject

Royal Microscopical Society, December 21 —Dr R Braithwaite, President, in the chair —After the formal business necessary to be done at the meeting preceding the annual meeting, the Society adjourned as a mark of respect to the lately deceased Sir Richard Owen, K C.B , the first president of the Society.

January 18 —Dr R Braithwaite, President, in the chair —This being the annual meeting the President gave an address on the development of mosses and sphagnums, illustrating his subject with drawings and slides under microscopes in the room —On the Rev Canon Carr proposing, and Mr. W T Suffolk seconding, a hearty vote of thanks was given to the President for his interesting address —The annual report and the treasurer's statement of accounts having been read and adopted, the following were elected as officers and council for the ensuing year, —President Mr. A D Michael, Vice-Presidents Dr R Braithwaite, Mr. F Crisp, Mr James Glaisher, and Prof. Charles Stewart, Treasurer Mr W. T Suffolk, Secretaries Prof F Jeffrey Bell, Dr. W. H Dallinger, Ordinary Members: Dr Lionel S. Beale, Mr A W. Bennett, Rev. Canon Carr, Mr E Dadswell, Mr C Haughton Gill, Dr R G. Hebb, Mr G C Karop, Mr. E M Nelson, Mr T. H Powell, Prof. Urban Pritchard, Mr F H Ward, and Mr. T Charters White.

OXFORD

University Junior Scientific Club, February 1.—The President in the chair —At the conclusion of private business Mr J E Marsh gave an exhibit of some products of the electric furnace He had brought for the inspection of the club some specimens, from M Moissan's laboratory, of fused lime and uranium reduced from the oxide. He explained the construction of the furnace, and the methods of using it and of obtaining the temperature of the arc. He further commented on M Berthelot's views as to the limit of temperature of the furnace, pointing out that the maximum value was that of the temperature of vaporisation of carbon, and that in all cases this was obtained. After a short discussion Mr F. Finn, who has just returned from Africa on a worm-hunting expedition, described the incidents of his journey His remarks were illustrated by a number of lantern slides showing scenes on the coast, chiefly at Mombasa and Zanzibar. His first stay was at Lamu, where he did not get any worms, the natives misunderstanding his signs and bringing bones. He described his impressions of Zanzibar at some

length, being agreeably surprised at the place Near here he obtained several reptiles and birds which are now in the Zoological Gardens His chief collection was made at Mombasa, however He speaks very highly of the hospitality of the Europeans on that coast —Mr F G Fremantle read a paper on Hermaphroditism, confining his attention to human beings He divided his subject into various classes, ranging from complete, or almost complete, neutrality of sex, to those cases where either male or female characteristics preponderated, concluding with some cases of pure deception The paper was illustrated with diagrams, and a large number of cases were cited in support of the statements made He showed that a perfect hermaphrodite both physiologically and anatomically could not exist, either the male or female characters preponderating in every case After a short discussion the club adjourned until February 17

CAMBRIDGE

Philosophical Society, January 30 —Prof T McK. Hughes, President, in the Chair —Mr Bateson exhibited a dog's skull, lent by Mr J Harrison of Northampton, in which the upper canines were bigeminous, each having two crowns both in the plane of the arcade —The following communications were made:—On a new fern from the coal measures, by Mr A C Seward The specimen described as a new species, *Rachiopteris Williamsoni*, resembles in certain particulars the genus *Myeloxylon*, but possesses distinctive characters not previously recognised in fossil fern petioles *Rachiopteris Williamsoni* may be briefly described as a petiole with scattered vascular bundles, those near the periphery appear to be rather collateral than concentric in structure, but the larger bundles have a more decided concentric arrangement of the xylem and phloem Each group of xylem elements is surrounded by a ring of small secretory canals The hypoderm is like that of *Myeloxylon*, and gum (?) canals are abundantly distributed in the ground tissue On the intestinal movements of *Daphnia*, by Mr W B Hardy — On Urobilin, by A Eichholz, Emmanuel College In this communication a new method of urobilin extraction was described, by which the pigment is preserved in the state of chromogen The properties of urobilin in normal and febrile urines were recapitulated in order to compare urobilin with the reduction products from bilirubin and hæmatin. The communication was then devoted to a description of experiments devised to settle the question as to the possibility of artificial production of urobilin from bilirubin and hæmatin. After pointing out how Maly's hydrobilirubin differs from true urobilin, and how consequently the identity of Hoppe Seyler's and Neucki and Sieber's urobilin from hæmatin reduction becomes doubtful, it was shown, in spite of statements to the contrary by McMunn and Le Nobel, that it is possible by complete reduction of both bilirubin and hæmatin to obtain substances in each case accurately resembling urobilin

PARIS

Academy of Sciences, January 30 —M de Lacaze-Duthiers in the chair —On some objects made of copper of a very ancient date, discovered in the course of M Sarzec's excavations in Chaldæa, by M Berthelot M de Sarzec has unearthed some relics of the most ancient Chaldæan civilisation, which confirm M Berthelot's views as to the existence of an age during which pure copper was used instead of bronze, the latter being introduced after the rise of the commerce in tin A fragment of a small votive figure, found among the foundations of an edifice more ancient than that of the King Our-Nina, was assayed for copper and chlorine by means of nitric acid. It contained neither silver, bismuth, tin, antimony, zinc, nor magnesium, only traces of lead, arsenic, and sulphur, and 77 7 per cent of copper, the bulk of the rest consisting of alkaline earthy carbonates and silica. Its composition resembles that of the statuette of the Chaldæan King Goudeah, and also that of the sceptre of the Egyptian King Pepi I, of the sixth dynasty, showing that in those early times tin was not known in the two most ancient homes of civilisation —On the diurnal variations of gravitation, by M Mascart A barometric tube enclosing a column of mercury 4 5m in length, balanced by the pressure of hydrogen contained in a lateral vessel, has been kept surrounded by earth for several years at the Parc Saint-Maur Observatory, only the short upper end emerging from the ground. A study of the daily motions of the column by means of photographic registration has recently, apart from the slow and steady changes due to inevitable differences of temperature, shown sudden variations lasting from 15 to 60 minutes, which can hardly be explained otherwise than as due to corresponding variations in gravitation. They have been as high as 1/20 mm, or 1/90000 The differences of sea level from high to low water would only produce 1/5th of this variation. The phenomena, if due to subterranean displacements, would be specially interesting in volcanic districts —On solar statistics for the year 1892, by M Rod. Wolf —On the pathogenic properties of the soluble substances formed by the microbe of contagious bovine peripneumonia, and their value for the diagnosis of the chronic forms of this disease, by M S Arloing —The H and K lines in the spectrum of the solar faculæ, by Mr George E Hale — On the differential equations of a higher order, the integral of which only admits of a given number of determinations, by M Paul Painlevé —On ordinary linear differential equations, by M Jules Cels.—On the systems of linear differential equations of the first order, by M. Helge von Koch — On the theory of spherical functions, by M E. Beltrami —Decomposition of alkaline aluminates in presence of aluminium, by M. A Ditte —Electrometric study of acid triplatohexanitrite of potassium, by M M Vèzes —Action of water vapour upon perchloride of iron, by M G Rousseau — On two combinations of cuprous cyanide with alkaline cyanides, by M E Fleurent —On the composition of some hydrated alkaline phenates, by M de Forcrand —Researches on the acid salts and the constitution of the colouring matters in the rosaniline group, by M A Rosenstiehl —Analysis of medicinal creosotes, gayacol, by MM A Béhal and E Choay —On an apparatus for the quantitative determination of precipitates by an optical method, by M E Aglot —On the pre-existence of gluten in wheat, by M Balland —The evolution of the intestinal gregarinas of the marine worms, by M Louis Leger —Origin and multiplication of Ephestia Kuehniella (Zeller) in the mills of France —On the perithecæ of *Uncinula spiralis* in France and the identity of the American and European *Oidium*, by M G Couderc —Histological researches on the *Uredines*, by MM P A Dangeard and Sapin-Trouffy —New geological observations in the French Alps, by M W Kilian

CONTENTS.

THURSDAY, FEBRUARY 16, 1893

QUALITATIVE CHEMICAL ANALYSIS

Qualitative Analysis Tables and the Reactions of certain Organic Substances By E A Letts, D Sc, Ph D, F R S E., F C S, &c (Belfast Mayne and Boyd, 1892)

THE author in his preface says, "Every teacher has his own methods—acquired not only from his experience, but also largely through the researches of others—and this book embodies mine" Therefore the volume cannot fail to be welcome to those who take an interest in the teaching of analytical chemistry But it is surprising to find that Prof Letts has until quite recently followed the old method of dictating reactions and methods to his students, and allowing them to work from their own notes For the last fifteen years there has been no lack of text-books of qualitative analysis, and Prof Letts has found, what probably all teachers of the subject are aware of, that students rarely take accurate notes But, however exact they may be, every one knows that manuscript is not so easily deciphered nor so readily referred to as a printed page

The methods of work given are, of course, more or less on the ordinary lines The final test for bismuth depends upon the production of its black suboxide, and this reaction has much to recommend it, though probably many would prefer the oxychloride reaction The use of ammonium molybdate as a separative reagent in qualitative analysis we do not consider advisable for many reasons, but no complaint can be lodged against it on the score of its accuracy

There can be no doubt whatever that both Prof Letts and his students will find considerable advantage in the use of boldly-printed statements of methods But the author begins his preface by stating that although the book has been written chiefly for his own students, he will be glad if it prove of service to others also This lays the volume open to general criticism, and prompts us to complain that it is neither so clear nor so systematic as it might have been As to the want of clearness, there are a few expressions that can easily be altered in a second edition, and these we lay no particular stress upon. For example, at page 27, in the description of Bunsen's dry tests, we read:—"The charred end of the match is next moistened with fused carbonate of soda." At page 40 it states that the solution "is mixed with its own volume of chloride of ammonium" One assumes this to be a solution, but if so the strength of it is not given, and we fear that the bulk of the solution to which it is to be added will be likely to vary enormously according to the peculiarities of the student and the character of the substance he is at work upon.

The more important want of clearness may be exemplified by taking the case of a student who has Epsom salts given to him as a simple salt. This can hardly be called an out-of-the-way substance, but so far as we can discover, the student in following these tables would examine it by the following series of operations. Heating on platinum wire to see the colour of the flame. Heating on a borax bead in the outer and inner flames Heating on a carbonate of soda bead Heating on charcoal (if a white mass resulted, which with cobalt nitrate gave a "faint pink," the metal might be recognised here, but as magnesium sulphate does not readily yield this reaction in most cases the student would pass on). Heating on charcoal with sodium carbonate Heating in a glass tube closed at one end Repeating with bisulphate of potash Repeating with black flux Repeating with magnesium wire He would then dissolve the substance in water, and test a part of the solution for ammonia by heating it with caustic alkali Then heat a part on a platinum wire for the flame colouration, a test that has already been done on the solid, and then pass on to the examination of the solution in the ordinary way for the base, and finally search for the acid if it is not already found It may be taken for granted that this fiddling about with the substance is not intended, but the volume does not appear to contain directions as to how to go more directly to work

The want of system that we complain of is acknowledged by the author himself in picking out certain parts and labelling them as "systematic" If the whole were systematic this distinction would obviously be meaningless As this fault exists in many of the text-books and in much of the teaching that we have had experience of, we are tempted to make a few general remarks upon the matter without special reference to the volume under notice

That qualitative analysis is often regarded as a very unimportant branch of chemistry, may account for its comparative neglect One constantly meets with students who are able to perform quantitative operations of not too complex a character with commendable accuracy, and that can with a little guidance do many sorts of "research work," but are wholly unable to perform with certainty a qualitative analysis of a comparatively simple substance They may happen to find most or all of its constituents, but they have no confidence in their result, they do not feel sure that they have missed nothing, or indeed that everything they have found is unmistakably present, and generally they have little if any idea of the degree of accuracy of their work. They cannot distinguish between a principal constituent and one that is present in a comparatively small proportion This incompetency must be ascribed very largely to the fact that students are too often urged on to work that a casual observer might regard as more important. The foundation is neglected for the sake of the superstructure

But having regard only to that amount of practice in qualitative work that still remains possible for the average student, there is too often a lack of method that is surprising if not disastrous. As a rule, it is considered desirable to get first an idea of the general character of the substance given for examination by a few dry tests, but these, as often done, are not only of no use, but serve in a conspicuous manner to train the student in the making of careless and imperfect observations, and in the dodging about from one operation to another with no idea of the proper sequence or inter-dependence of the various parts of the work. In the analytical examination of even the simplest of substances, from the

time when the student receives it until he has made his last note, every operation ought to be in an order for which very definite reasons can be given, and the completed work ought to be of such a character that anything added to it would be superfluous, anything taken from it would leave it imperfect, and any change in the order of its various parts would be to its detriment. This character of work is generally sought after in the separation of metals from a solution, but the rest of a qualitative analysis, namely the preliminary examination and the testing for acids, is too often a collection of odd operations, which, if the student is lucky, will lead him sooner or later to the desired result, but if he is unlucky may fail to do so through no fault of his own.

CHAPMAN JONES.

POPULAR LECTURES ON PHYSICAL SUBJECTS

Gemeinverständliche Vorträge aus dem Gebiete der Physik. Von Prof. Dr. Leonhard Sohncke. (Jena: Gustav Fischer.)

IT is a matter of common remark that the books on scientific subjects which reach us from Germany are, as a rule, so special and detailed in character as to be totally devoid of interest, except to those immediately concerned with the subjects of which they treat. This being the case, it is all the more refreshing to meet with such a collection of popular addresses as Prof. Sohncke has gathered together in the volume before us. He has not restricted himself in his choice of subjects to any one branch of physics; on the contrary, the nine lectures of which the book is made up represent as many different divisions of natural philosophy, and were delivered quite independently before various audiences in Germany.

The first lecture of the series bears the somewhat obscure title, "What then?" and was suggested by a great strike among the coal-miners of Westphalia, which led to a temporary cessation of the German coal supply. The author depicts what would be the consequences if the world's coal supply were exhausted, in terms almost as pathetic as those of Prof. Jevons which moved an English Parliament to appoint a commission on the subject. But recognizing that, after all, coal is only stored up solar energy, Prof. Sohncke endeavours to look at the brighter side of the question by discussing the possibility of utilising the sun's energy in other forms, and so enabling man to remain "lord of creation" even in those days when the entire available coal supply of the world reposes on the shelves of some scientific museum.

Equally spontaneous is the lecture on "Migratory Mountains," in which an account of a holiday visit to the north-east corner of Germany gives an opportunity of describing the formation and movements of the mammoth sand-dunes in that locality.

Of the other lectures, that entitled "The revolution in our views concerning the nature of electrical actions" will probably commend itself to most readers because it treats of a subject now exciting general interest. It contains a short history of the arguments and experiments which led to the substitution of the ether theory of electrical action in the place of the older action-at-a-distance theories. While admitting the existence of a medium which transmits both optical and electrical disturbances, the author thinks it more probable that gravitation is a true action-at-a-distance, and in so doing he tacitly denies that a medium is a necessity. The notion of an empty space is so foreign to English men of science of this generation, that we certainly consider Prof. Sohncke's summing-up of the question to be worthy of attention. He says:—"Even if we could finally succeed in proving that action-at-a-distance is really the result of a transmission through some medium, we must not suppose that all difficulties are then removed. For the process of such a transmission is by no means simple, and cannot be explained without further assumptions; on the contrary, very formidable difficulties arise even here. Directly we try to give a concise explanation of the compression of a body and its subsequent expansion when performing elastic vibrations, we find that a choice must be made between two assumptions equally hard to accept. Either matter is itself capable of compression and expansion, or else it consists of separate vibrating atoms to which we must assign the property of exerting mutual forces on each other at a distance."

From a purely scientific standpoint, the lecture on "Newer theories of atmospheric electricity and thunderstorms" is undoubtedly the most valuable of the series, the subject being one on which Prof. Sohncke can speak with some authority. After describing the older theories of the origin of electrical charges in the atmosphere, he discusses those newer ones which were suggested by the discovery of Hertz that ultra-violet light facilitates the discharge of electricity from a charged body. Of these the best known is that of Arrhenius, who supposes the air, ordinarily a dielectric, to be rendered feebly-conducting by the action of light. According to this theory, the earth is negatively charged, and when its atmosphere is illuminated some of the charge is conducted away to the clouds. The conduction must be electrolytic, otherwise the air would become charged. Prof. Sohncke objects to this theory mainly on the ground that the discharging action of light cannot be considered as due to the air in any way, since it is manifested only when the light vibrations fall on, and are absorbed by, the negative electrode. Further, it is not easy to see how elementary gases such as oxygen and nitrogen can be electrolytes. In concluding he defends his own theory, according to which atmospheric electricity is produced when a cloud laden with particles of ice meets another charged with water drops, the electrification being due to the friction of ice against water. In support of his view the author quotes the fact that hailstones are found to be electrified on reaching the ground.

The appearance of a volume like the present one invariably gives rise to some regrets that the whole earth is no longer of one language and one speech, but we hope that some friend of popular science may be induced by the contents of the book to furnish a translation for English readers.

JAMES L. HOWARD.

BRITISH JURASSIC GASTEROPODA

A Catalogue of British Jurassic Gasteropoda, comprising the Genera and Species hitherto described, with references to their Geological Distribution and to the Localities in which they have been found By W H Hudleston, M A, F R.S., F.G S, and Edward Wilson, F G S 8vo, pp xxxiv+147 (London Dulau and Co, 1892)

NEXT in importance to a monograph on any group of fossils is a catalogue of the species giving their distribution, their synonymy, and references to the figures and descriptions The value of such a catalogue is enormously increased when, as in the present case, the authors have made a prolonged and careful study of the subject The late Prof John Morris was able, with scarcely any help from other workers, to publish a critical catalogue of all British fossils; the first edition appeared in 1843, the second in 1854 But since that date so much progress has been made in palæontology that the accomplishment of such a task by any one man would now be an impossibility Prof Morris always hoped to bring out a third edition of his work, and after his death a committee was formed to carry out this project But the labour appears to have been too great and the committee soon ceased to exist This is greatly to be regretted, for although the work must of necessity have been distributed among various authors, a certain amount of uniformity in treatment would at any rate have been secured and publication hastened

In the preface we are told that Mr Hudleston is mainly responsible for the Oolites and Mr Wilson for the Lias Under the term Jurassic the authors include everything from the Lias to the Portland-stone the Rhætic beds, although not regarded as strictly Jurassic, are treated in the supplement The total number of gasteropods recorded by Samuel Woodward from these formations in 1830 was only 89, whereas in the present work the number given is 1015 Of these 15 come from the Rhætic, 314 from the Lias, 681 from the Oolites, and 5 from the Lias and Oolites In the Lias the gasteropods are characterized by the species belonging to comparatively few genera. Although, as far as genera are concerned, the Lias shows considerable affinity to the Oolites, there is nevertheless a great break in the continuity of the species, only five being common to the Lias and Oolites Gasteropods are most abundant in the calcareous beds, so that the Lower Oolites have yielded by far the larger number of forms, the Inferior Oolite being richer than the Great Oolite In the Middle and Upper Oolites there is a decided decline in the gasteropods, especially of the argillaceous beds

After the introductory remarks the authors give a valuable bibliography of the British Jurassic Gasterpoda, and then a list of the genera, in which each is placed in its proper family and reference given to the original description. By the use of different type the genera are divided into four classes, (1) those fully accepted by the authors, (2) those accepted with doubt, (3) those given as Jurassic by other authors but not accepted, (4) synonyms. In the catalogue proper the authors have adopted Morris's plan, each page being divided into two columns, in the larger are given the name of the species, the references, the synonyms, and the cross-references, in the smaller the geological horizon and the more important localities, the locality first named being that from which the type was obtained or the first place from which the species was recorded in Britain The dates of publications are often omitted, but since they can be found in the bibliography this is not very inconvenient except in the case of serials The present *locale* of types is not given, although this would have been a comparatively easy matter, especially since so many catalogues of types have been recently published

With regard to the orthography the authors have kept to the older and more usual method For instance, the capital initial is used for species when derived from proper names, and the single *i* for the genitive is not always adopted Thus we find a considerable variation in the terminations, such as, *Cricki* (p 124) *Crickii* (p 77), *Waltoni* (p 42) *Waltonii* (p 139), *Suessea* (p 29) *Suessii* (p 138), *Wrightii* (p 46) *Wrightianus* (p 70) These are, however, purely matters of opinion and do not in any way detract from the great value of the work, which exhibits so much painstaking accuracy and sound criticism H WOODS

OUR BOOK SHELF

The Year-Book of the Imperial Institute of the United Kingdom, the Colonies, and India, and Statistical Record of the Resources and Trade of the Colonial and Indian Possessions of the British Empire Compiled chiefly from official sources First issue 1892 Issued under the authority of the Executive Council, and published by John Murray, &c Large octavo pp xvi and 824.

THE Imperial Institute has lost no time in issuing a handsome and comprehensive year-book, compiled by the Librarian, Mr J R FitzGerald, who has diligently and successfully gathered together a stack of varied information bearing on the purposes of the Institute It is a question which time alone can answer whether amongst the many admirable year-books of statistics, commerce, and the colonies which have established themselves as annuals of proved utility, there is room for a new and bigger book overlapping their information, and containing few, if any, novel features. It would be out of place to discuss this question in a notice which ought to be confined to the scientific aspects of the work The object of the year book, as expressed in the preface, is to deal "statistically with the physical geography, the natural resources, and the industries and commerce of the Colonies and India," and with certain other related facts It would not be fair to criticise severely the first issue of so large and comprehensive a compilation, but it would help towards the attainment of the compiler's aim if the description of the physical geography of the regions touched upon could be made as full as the historical introductions, and as statistical as the commercial tables More notice ought to be taken of the geology and the character of the soil in the colonies where geological surveys are in progress, and climate certainly deserves better treatment We do not think space would be wasted in giving the mean monthly temperatures and rainfall for the average year, and for two extreme years, at a few representative stations in the larger colonies This information cannot indeed be found in any existing books, but must be worked out from original records which exist abundantly, and are rarely made available to practical workers.

The treatment of natural resources might also be

improved by a firmer grasp of scientific principles The commercial statistics are, as might be expected, much fuller, better arranged, and more serviceable than those relating to physical geography, but we imagine that few members of the Imperial Institute, likely to make use of the book, are without the original records relating to their own department The difficulty of proportion and perspective is rather seriously apparent in the treatment of India, which has to be passed over more lightly than the colonies, because equal detail would involve the sacrifice of much space Thus the great internal trade of India is scarcely touched upon, and the wants and tastes of consumers in the ultimate Indian market, by whom imports are finally absorbed, are not laid before the British merchant

Beneath Helvellyn's Shade By Samuel Barber (London Elliot Stock, 1892)

THIS book consists of notes and sketches in the Valley of Wythburn, and is brightly and attractively written Perhaps the best chapters are those on clouds, the various forms of which have been carefully studied by the author. He has also many interesting remarks on various aspects of Cumberland scenery, on the customs of the people, and on antiquities Occasionally, perhaps, Mr Barber adopts too much the tone of a preacher, but his impressions and ideas are for the most part fresh and vivid The book will especially please those who have themselves felt the charm of Wordsworth's country

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications*]

Dr Joule's Thermometers.

RESPECTING the question asked by Mr Young (NATURE, vol xlvii p 317), I am glad to have an opportunity of stating that shortly after Joule's death I obtained the sanction of his son to examine the scientific apparatus that were left in his house

I found a number of thermometers, and amongst them the two chiefly used by Joule in his researches These thermometers have been placed in my charge for the present. I have made careful comparisons of them with a standard of the "Bureau international des Poids et Mesures," and therefore indirectly with the air or hydrogen thermometer A standard issued by the Technische Reichsanstalt has also been used as a check I spent a good part of last winter on the work and am now only waiting for an opportunity to repeat some of the measurements. The results will be published in due course, and I think will prove of interest As Joule compared his thermometers with one used by Rowland, we shall in this way have an indirect comparison of Rowland's air thermometer with those by which the Berlin and Paris standards have been independently fixed

One question arises on which I should be glad to have some information, and I should be grateful to any of your readers who could help me. The glass of which Joule's thermometer is made does not behave like the English glass now in use; and it would be important to know the probable composition of glass used in England about the year 1840 for thermometric purposes. As my experiments are not concluded I do not wish to speak with too great a certainty; but I believe it will be found that if we could return to the glass of Joule's thermometer, we should have a substance as well and possibly even better adapted to the manufacture of thermometers than the modern Jena or French thermometer glass.

I am sorry I cannot give a very definite answer to Mr Young's question Joule does not, as far as I know, anywhere give the actual readings of the freezing point, but only its changes. Rowland, in quoting the comparison between Joule's thermometer and his own, gives 22 62 as the actual reading of Joule's zero I have not at the present moment access to Rowland's paper, and have no note of the date at which this comparison was made (either 1879 or 1880)

Such a formula as that given by Mr Young can, however, only have a limited application The zero of a thermometer depends on the temperature at which the thermometer has been kept previous to its immersion into ice, and with properly annealed thermometers the secular changes are much smaller than the temporary ones. Last winter Joule's thermometer showed changes in zero from 23 51 to 23 00 on the arbitrary scale, the original temperatures varying from 7° to 30°.

All observations lead to the conclusion that the secular changes of a thermometer gradually vanish, so that the zero corresponding to any temperature approaches a limit Mr. Young's formula would make the zero rise indefinitely

ARTHUR SCHUSTER.

Dust Photographs and Breath Figures

YOUR two correspondents on February 9 add interesting instances of these phenomena. I am sorry that one of my statements was not clear In saying "Two cases have been reported to me where blinds with embossed letters have left a latent image on the window *near* which they lay," I meant to describe them as not in contact

I have questioned my neighbour Dr. Earle again as to his case The plate-glass window of an hotel in London has on the inside a screen of ground glass lying near but not touching upon the latter are the words "Coffee Room" in clear unfrosted letters. One day as he was at breakfast the screen was taken away, but the words were left plainly visible on the window, and no washing would remove them. The other case is curiously similar, but each narrator was ignorant of the other's tale A friend, Mr Potter, asked me if I knew whether a house in which he was lodging had been an hotel, for on misty days they saw "Coffee Room" on one of the windows I remembered the house had been an hotel two or three years previously, and there had been brown gauze blinds with gilt letters.

Mr Thiselton-Dyer's observation appears not so much akin to these two as to the dust picture of a water-colour drawing of which I spoke in my former paper

I look forward to seeing the effects at Canterbury

Winchester College, February 13 W B CROFT

Fossil Plants as Tests of Climate

MR DE RANCE'S note relating to the above subject in NATURE, p 294, mentions that "Heer has determined a magnificent flora of more than 350 species from these northern tertiaries, and that he at once pointed out the absence of tropical and subtropical forms" My contention, founded on an attentive study of his determinations and of the original specimens in London and Dublin, and to some extent in Copenhagen, is that not fifty, or perhaps not the half of fifty, of these determinations are entitled to the smallest weight, and again that though at first he saw nothing subtropical in the flora, he subsequently declared the presence of palms, &c., upon utterly insufficient data. While, however, wishing to rid the "magnificent" flora of 300 or more useless and misleading encumbrances, I am far from wishing to depreciate the extraordinary significance and value of that which remains, and which clearly shows that in early Eocene times the coast of Greenland supported in certain places forests which included the redwood, the plane, and even the magnolia, associated with many more northern forms. This is consistent with the tropical vegetation existing during a part of the possibly contemporary lower tertiary period in the south of England. Both facts are sufficiently inexplicable, but there is no occasion to magnify the difficulties they present As to the Greenland floras they have not been proved to contain any forest trees that might not, and which in fact do not, flourish in their modern representatives, when planted in certain favourable spots on the west coast of Ireland, and even of Scotland. We are not even obliged to assume that Greenland as a country was characterised by such vegetation, for this might be as erroneous as to regard Ireland or Scotland as countries generally characterised by forests of arbutus. The flora of a country is in fact most likely to be preserved in its most sheltered spots, in lake bottoms like parts of Killarney, or where small rivers quietly steal into the tidal waters of deeply recessed bays like those of Bantry and Kenmare, in forest pools like some in the Mount Stewarts' woods of Bute, and

in the backwaters and marginal pools of the lower reaches of larger rivers, we are not only entitled, but we are bound to consider this to have been the case in Greenland, and to base our estimate of its climate in the lower tertiaries upon this view and no other. Now what geologists and physicists ought to do, and what they resolutely won't do, is before going farther afield for cause and effect, to take the map of the world on Mercator's projection, and consider how far, if the Atlantic were a closed ocean to the north, as we know it must have been, the required climatic conditions would be produced The difference between the arbutus nooks of Ireland on the one side and the desolation of Labrador on the other is brought about solely by ocean currents At the period of the Greenland floras the arctic currents were excluded, and consequently the whole Atlantic basin was filled with the circulation of equatorial and temperate waters only The distribution of plants and animals renders it extremely probable that during much of the tertiary period, the antarctic waters were equally excluded from the Atlantic by land connecting Africa and South America. What, under these circumstances, would happen to the climate of the Atlantic littoral? It would, it appears to me, be more philosophical to dispose of this question, which is supported by a weight of evidence, before invoking shifting of the earth's axis, or other hypothetical causes supported by none. J STARKIE GARDNER

London, February 13

An Optical Phenomenon

IN NATURE, vol xlvii p 303, you mention that "a beautiful optical phenomenon, which has not yet been satisfactorily explained, is described by M F Folie in the *Bulletin* of the Belgian Academy" From what follows, it is evidently the same as that described in Tyndall's "Glaciers of the Alps" (Murray, 1860), p. 177 *et seq* Tyndall gives a description of it in a letter from Prof Necker to Sir David Brewster, from which I quote the following —"You must conceive the observer placed at the foot of a hill between him and the place where the sun is rising, and thus entirely in the shade, the upper margin of the mountain is covered with woods, or detached trees and shrubs, which are projected as dark objects on a very bright and clear sky, except at the very place where the sun is just going to rise, for there all the trees and shrubs bordering the margin are of a pure and brilliant white, appearing extremely bright and luminous, although projected on a most brilliant and luminous sky You would fancy you saw these trees made of the purest silver"

Prof Necker says that he saw it at the Saleve, which is not so high above the Lake of Geneva as some of our British mountains above the sea, and has no permanent snow near it, so that M. Folie's suggestion, that it is due to light reflected from snow, must be wrong I have seen it from the Konig-See, near which I believe there is no permanent snow

This appearance is always to be seen under the circumstances described, when the sky is clear and bright enough. I had read of it in Tyndall's book, and when in the Alps I sought for and found it I have often seen a distant approach to it produced by furze bushes, quite near, seen against sunlight, and by leaves against moonlight JOSEPH JOHN MURPHY

P S —Ruskin somewhere describes this phenomenon.

Belfast, February 6

Foraminifer or Sponge?

A PAPER by A Goes "On a peculiar type of Arenaceous Foraminifer from the American tropical Pacific, *Neusina Agassizi*," has just been published in the "Bulletin of the Museum of Comp Zoology, at Harvard College," vol xxiii No 5, in which the author describes some remarkable forms dredged by the *Albatross* expedition in the Pacific of Central America. They are supposed to be foraminifera, are of leaf like shape, measure up to 190 mm in breadth, and are marked by concentric lines of growth Their interior shows a stroma, consisting of fine chitinous threads, enclosing sand and *débris* of shells. Without wishing to recapitulate all the various points of structure, I will only say that there can be no doubt that these forms belong to Hæckel's deep sea keratosa (see *Challenger* report, vol. xxxii.) from the tropical Pacific, and I should think that *Neusina Agassizi* is identical with *Stannophyllum zonarium*, Hæckel I happen to have here a *Challenger* specimen of this latter species, kindly lent to me by the Manchester Museum, and its microscopic examination convinces me of the identity of the two forms.

University College, Liverpool R. HANITSCH.

Unusual Origin of Arteries in the Rabbit

TOWARDS the close of last month Prof W N. Parker reported in your columns an abnormality in the veins of the rabbit, and although the same interest does not attach to it, it may be worth while recording an unusual arrangement of the vessels arising from the aortic arch In the case which has just come under my notice, the two carotids arise together from the arch, at the point usually occupied by the innominate artery, while the right subclavian artery arises beside the left subclavian, which occupies the usual position PHILIP J WHITE.

University College of North Wales, February 7

Holmes's Comet

ON February 11, 10h to 10h 35m, I re-observed this object with powers of 40 and 60 on my newly-silvered 10-inch reflector The comet was in the same field as β Trianguli and south preceding that star I found it fairly conspicuous The nucleus, or brighter portion of the head, presented a distinctly granulated appearance Applying a power of 145, single lens, I saw that it really consisted of a number of very small knots of nebulosity, so closely approximating the stellar form that they might readily have been mistaken for one of the very faint, barely resolvable clusters in which the components are only to be caught by glimpses The multiple nucleus was involved and surrounded with feeble nebulosity, and a faint tapering tail flowed from it in a N E direction I believe that outlying this there was an excessively faint fan-shaped tail, but could not be absolutely certain

The sky was not good, being lighter than usual, with suffused mist On February 12, at 10h 15m, I picked up the comet again, but details were invisible, owing to the veil of thin cloud overspreading the N W sky at the time

Bristol, February 13 W F DENNING

HELMHOLTZ ON HERING'S THEORY OF COLOUR

THE following translation of the critical account given by von Helmholtz of the colour-theory of E Hering, in the new edition of his *Handbuch der Physiologischen Optik*, commencing at page 376, has been made by Prof. Everett for NATURE The translator aims at clearness rather than literal rendering, and three obvious misprints in the paragraph on the transformation of coordinates have been corrected "Lambert's colour-pyramid" is another name for the "cone of colour" described in Maxwell's papers and in § 1074 of Everett's "Deschanel"

This much-talked-of theory is a modification of Young's theory, which, by the choice of other fundamental sensations, endeavours to give better explanations of what it regards as immediate facts of internal observation It assumes three elementary sensations, related to three different parts of the nerve-apparatus or "visual substance" Two at least of these physiological processes exhibit the opposition of positive and negative One of the three "visual substances" gives in the condition of excitement the sensation of white, and in the condition of rest the sensation of black. The second gives the two sensations of blue and yellow, which are accordingly designated "opposed colour-sensations" The third gives the other pair of "opposed colour-sensations," red and green But by "red" is denoted not the colour usually so called, but the complementary of green, which is purple.

It is possible to specify "elementary sensations" (in the sense in which we have previously defined the term) which would correspond to Hering's elementary sensations, and would be capable of giving by their combination all other colour-sensations. If we take three rectangular axes of coordinates, x, y, z, as the edges of Lambert's colour-pyramid, x corresponding to red, y to green, and

z to violet, Hering's coordinates u, v, w will have the values

$$u = \frac{x+y+z}{\sqrt{3}},\quad v = \frac{x-z}{\sqrt{2}},\quad w = \frac{x-2y+z}{\sqrt{6}}$$

u denoting the white element, and being measured along the axis of the pyramid; w denoting the red-green element, and being measured at right angles to the axis of white, in the plane containing the green edge of the pyramid; v denoting the yellow-blue element, and being measured at right angles to the plane of u, w.

Positive values of w correspond to purple red, and negative values to green. Positive values of v correspond to yellow, and negative values to blue.

I give these equations in this definite shape for the purpose of showing, by a definite system of representation, that the arbitrariness which attends the choice of three colours, in terms of which the rest are to be specified, affords sufficient latitude to admit of the employment of three such different specifying elements as are adopted by Hering.

If only positive values of x, y, z are to be admissible, the expression for u shows that every kind of light must excite the white sensation positively, and consequently that no kind of objective light can produce a pure sensation either of the red-green or of the yellow-blue kind. Hence the pure unmixed "opposed colour-sensations" are such as we never have had or can have, and are separated from all colour-sensations that we have ever had by a much wider gap than the pure sensations which Young's theory supposes, although these latter extend somewhat beyond the range of objective colours. By subjecting portions of the retina to special influences (as we shall explain in treating of after-images) we can at least approximate to Young's elementary sensations, while these same methods, when we attempt to approximate to Hering's pure sensations, give results opposite to what his theory would lead us to expect.

Hering assumes, in accordance with the brief expression of his theory in the above equations, that white light excites only the white-black visual substance and excites it always positively, that yellow light, besides doing this, excites the blue-yellow visual substance, as does also blue light, but in opposite sense. On the other hand, when blue and yellow lights are in exact equilibrium, they have no action on the blue-yellow visual substance.[1] Similar remarks apply to the excitements of the red-green visual substance by red and green light.

The sensation of luminosity is identified by Hering with the sensation of white. He accordingly maintains that the pure sensation of blue or of yellow involves no sensation of luminosity. I must confess that personally I can form no conception of a colour which has no degree of less or greater luminosity, and therefore think such an abstraction not tolerable in a system which, on other points, makes its appeal to the immediate testimony of inner consciousness, and claims by this means to establish its superiority to other systems.

Differences of intensity must, however, occur in the opposed colour-sensations if they involve no difference of brightness. In comparing saturated blue with equally luminous pale blue, Hering would regard the white sensation as equally intense in both, but the blue sensation as stronger in the saturated blue.

As the physiological basis of the "opposed colour-sensations" Hering takes the two opposite processes of organic change, namely, the decomposition of the organic mass by activity, and its restoration under the influence of the circulation of the blood, which carries oxygen stored up in it and feebly united with it. The former process is called *dissimilation*, and the latter *assimilation*. Which of the two opposed sensations corresponds to dissimilation and which to assimilation is left undecided, both in the case of blue-yellow and of red-green. The physiological improbabilities of this assumption have in part been pointed out already, and we shall return to the subject in treating of after-images.

This assumption of double nerve-working was originally applied by Hering to the white-black visual substance also. At the present time he adheres to the hitherto-received doctrines of nerve-physiology to the extent of holding that, in the case of this substance, all light excites only dissimilation and the sensation of white, and on the other hand want of light produces only assimilation and restoration of excitability. That during this latter process a sensation of darkness is experienced, all are agreed. The difference is purely theoretical. According to the older view, which I have defended, we must, in order to perceive that there is luminosity in a particular part of the field of view at a given time, be able to distinguish at another time that this perception is wanting. This perception that a sensation which might be there is not there contains in itself a testimony as to the condition of the organ at the time, which is different from all sensations of incident light, and in this sense we call it also a sensation—the sensation of darkness.

Hering, on the contrary, maintains that the sensation of black must have its own special physiological basis of excitation, and seeks it in assimilation, going on in the white-black visual substance.

From the foregoing account the reader will gather that Hering's theory, if we overlook its physiological views, is able to explain all hitherto established facts of colour mixture as well as, but not better than, Young's theory. It differs only in its special choice of elementary excitations, and this choice, if we admit negative values of them, suffices for expressing the facts, just as any axes of co-ordinates suffice for a problem of solid geometry.

Hering's objections to Young's theory reduce themselves, in his latest statement, to the following:—

"In the Young-Helmholtz theory, the assumption of the three elementary colour-sensations is *à priori* repulsive, because these sensations are not presentable, and notoriously, according to necessity, now one set and now another set of elementary colour-sensations are assumed."

As to this, I have already remarked that the fundamental sensations of Young's theory, in so far as they differ from objective colours, can be approximated to, by the method of partial fatigue of the retina, much more closely than Hering's pure opposed-colour-sensations. If different upholders of Young's theory have made different assumptions as to the three primary colours, and have assigned different weights to various facts which bear on the distinction, this affords no justification whatever for the imputation that they have changed their assumptions according to necessity. It is always better to acknowledge existing doubt than to dogmatise.

Hering goes on, "If the excitations belonging to the three elements have correspondingly distinct physiological causes, one would expect that these sensations would have something special about them."

This they have, in my opinion, in the prominent glow of colour-saturation, for which, again, the theory of opposed-colours furnishes no basis of explanation.

He continues, "Yellow gives, for example, much more the impression of a simple or elementary sensation than violet, and yet we are told that the latter is an elementary sensation and the former a mixture of simultaneous sensations of red and green, or at least, in some way, the product of the simultaneous existence of the principal excitations corresponding to these two elementary sensations."

What a deceitful test apparent inner consciousness is in such matters, we can see from the examples of two

[1] This was a point which Hering left doubtful in the earlier statements of his system, so that it was not clear whether he assumed three or six independent variables. According to his more recent explanations the statement given in the text may fairly be said to represent his view.

such authorities as Goethe and Brewster, both of whom believed that they saw in green the blue and yellow, of which, being misled by experience with pigments, they believed it to be composed.

He goes on, "Helmholtz says, quite correctly, 'so far as I see, no way has been found of determining one of the elementary colours except the investigation of colour blindness' This investigation has notoriously not confirmed Young's theory"

This would, even if it were true, be in itself no argument against the admissibility of the theory The theory of colour-blindness seems, as we shall shortly see, to be a particularly hard crux for Hering's theory, while the hitherto well-established facts of red-blindness and green-blindness admit of comparatively easy and perfect explanation by Young's theory

He adds, "And the three sets of fibres, which, however, as Helmholtz remarks, are not essential to the theory, have hitherto been sought for in vain"

This objection applies to Hering's theory as much as to Young's

The reader will easily convince himself that these objections are of no weight whatever He follows them up by an enumeration of contradictions and inaccuracies which he professes to have found in Grassmann's and my own explanation of Newton's law of colour-mixture, and partly also in that of Kries, errors which, even if they existed, would in no way tell against Young's theory, but only against its interpreters Here, however, the obscurity seems to me to lie on the side of our opponent

These objections arise out of the fact that, in mixtures of a saturated colour with white, the tint of the mixture sometimes seems changed (pale red for example approaches more to rose, and pale blue to violet), and that, on the other hand, with increase of intensity, the colours of the spectrum appear sometimes paler, sometimes yellower But if we speak of those elementary excitations which, from the point of view of Newton's law, are alone entitled with certainty to the name of elements, as being able to coexist without mutual disturbance, then the only sensation which can with certainty be regarded as corresponding to the coexistence of a white and a red elementary sensation is that which comes into existence under the simultaneous influence of the corresponding white and red lights The term "elementary sensation" is in this connection to be taken, of course, not in the narrow sense of Young's hypothesis, but in the wider sense above explained—the sense in which we speak of linear relations between colour-sensations and linear superposition of elementary-sensations. In the domain of colour-mixture we know nothing of any elements but these superposable ones, and if we would preserve a constant meaning for our colour-equations we must interpret them in this sense, as I have explained above. This is what H Grassmann and myself have always done

Moreover, erroneous estimates of the difference between a pale and a more saturated colour are liable to be made, and hence those colours which are really most diluted with white do not always appear the palest If, without sufficient experience of colour-mixture, we only guide our judgments by similarity of sensations, we are liable to make mistakes as to which colour contains white The question of the power of perceiving differences will therefore arise. Further, it is found that colours of very strong luminosity do not differ so much from one another in the sensations they produce as colours of moderate luminosity,—a fact which finds its explanation in Young's theory, of which it is a natural consequence Colours when highly luminous appear more similar to one another and more similar to white We express this by calling them pale as compared with colours of feebler luminosity I have, however, already mentioned that the law of superposability ceases to be applicable when the luminosity is excessive

Nevertheless, in view of the fact that simple colours of high luminosity are always as saturated as colours of such luminosity can be, it is not necessary, or rather it is not correct, to designate them as less saturated The true statement is that differences of tint become more uncertain at high intensity- an uncertainty which attaches also to the estimation of the intensity itself, as has long been known

If Hering's sensation of white and opposed-colour-sensations are truly to deserve the name of elements or constituent parts of sensation (as he plainly intends, since he assigns to them special visual-substances) either he must acknowledge them as the elements deducible from the law of addition, or else they are purely hypothetical processes of whose existence and superposability no one knows anything His polemic against Grassmann and me then amounts to this—that at a time when his hypothesis had not been propounded we did not speak in the sense of it

Hering seems to regard as the chief point of superiority of his own hypothesis its closer conformity with the names which have established themselves in language—names which, as I have explained above, relate rather to the colours of material bodies than to the colours of light To this circumstance it is, in fact, indebted for a certain amount of popularity and facility of apprehension He himself assumes that these names have sprung from an immediate perception of the simple elements of sensation by a kind of inner consciousness, and thinks that he has thus very certain and immediate knowledge of the pure red-sensation, the pure white-sensation, and so on

In his publication of 1887 he has discussed the possibility of assuming, instead of three or six simple processes of sensation, a larger and perhaps indefinitely great number, and a corresponding number of "elementary powers" for the several kinds of objective light He, however, gives the geometrical representations of such actions in such a manner that practically these powers all depend on three independent variables On the other hand, as regards these independent variables, which are the most important factors in the problem, he gives as good as no clue to them, he only seeks to remove them as far as possible from the sphere of physiology For my own part I am able to understand this whole series of descriptions only as meaning that an arbitrary number of visual substances can be assumed to exist in the brain, and that their respective strengths of excitation are different functions of the same three independent variables, each visual substance being unaffected by the excitations of the rest, and the excitation of each being susceptible of direct apprehension in consciousness I do not think it is necessary, in this book, to go further into such hypothetical views

Hering especially claims the credit of opening up the way to understanding colour-blindness. He makes all dichromasy depend upon a single cause, namely want of sensibility in the red-green visual substance The difference between red-blindness and green-blindness is, according to him, attributable to different colourations of the media of the eye, partly of the yellow spot of the retina, partly of the crystalline lens

These colourations are chiefly met with in the sick or the very old, and, when occurring in otherwise useful eyes, are not of such strength that they could bring out conspicuous deficiency of brightness in different parts of the spectrum

The colouration of the yellow spot of the retina takes effect in a very limited but very important part of the field of view, and in only a narrow band of the spectrum The most trustworthy observations on the influence of the wave-length of the incident light upon the strength of the red and green excitations, have been made with

kinds of light not liable to be absorbed in notable degree by the yellow pigment On the whole, it is accordingly found that this pigmentation is subjectively influential only in cases in which the rays in the neighbourhood of the line F play a prominent part, as, for example, in a certain mixture of this blue with red (mentioned on page 354) which, if it looks white when our eyes are directly fixed upon it, will show blue predominant when we look in a slightly different direction

As far as hitherto-known facts go, it appears very improbable that Hering's theory of dichromasy can be carried through Nevertheless, further observations in this direction are very desirable. The influence which the colouration of the yellow spot has in individual eyes can be estimated by comparing the appearances of colour-mixtures in the centre of the field of view with their appearances very near the centre Such comparisons will show with certainty where such influence is present and where it is absent

The following is a summary, by Prof Everett, of two passages from the new edition of Helmholtz's "Physiological Optics," which are important as supplementing the foregoing critique of Hering's theory —

In discussing the results of experiments for determining the exact positions of the three elementary sensations with respect to actual colours, in Newton's diagram or in Lambert's pyramid, Helmholtz represents the results by a triangle with the three elementary sensations at its corners, and with the colours of the spectrum plotted along a curve which lies entirely in the central portion of the triangle He says, p 457 —

"This curve shows that every simple colour excites simultaneously in the trichromic eye the three nerve-elements which are sensitive to light, and excites them with only moderate differences of intensity If we then hypothetically refer all these excitations to the presence of three photo-chemically alterable substances in the retina, we must conclude that all three of these must have nearly the same limits of sensibility to light, and must show, in the rates of their photo-chemical actions for the different wave-lengths, only secondary variations of moderate amount Similar variations, arising from the presence of foreign substances, from substitutions of analogous atom-groups, and so on, occur also in other photo-chemically alterable substances as used in photography, for example, in the different haloid salts of silver"

In a mathematical discussion of colour-blindness, commencing at p 458, he points out that in dichromic vision there must be a linear relation between the three independent elements of trichromic vision, and in Lambert's colour pyramid there must be a certain line through the vertex, such that any plane drawn through it is a plane of uniform colour Newton's diagram of colour may be regarded as contained in any plane which cuts the axis of the pyramid, and it is very important to determine the point in which the above-mentioned line cuts such a plane, for any line in Newton's diagram that passes through this point is a line of uniform colour to the dichromic vision in question Experiment shows that it always lies outside the triangle of actual presentable colours

Addendum

Prof. Everett adds the following remarks of his own on the present position of the problem of colour vision.—

On the one hand, it is established, as a fact of experiment, that the excitation of colour-sensation in the normal eye depends upon only three variables, and that their effects are superposable, so as to admit of being expressed by equations of the first degree, otherwise called linear equations. The simplest choice of three variables is that adopted in Young's theory, because it only requires positive val[illegible] of the variables.

On the other hand, the various colours regarded as subjective appearances do not naturally class themselves under a threefold heading Yellow does not look as if it consisted of red and green Colour-sensations as known to us in consciousness are not threefold but manifold

The two facts taken together seem to imply two successive operations intervening between the incidence of light and the perception of colour The first operation is threefold, and may consist (as above suggested by Helmholtz) of the photo-chemical decomposition of three different substances The second operation consists in the effects of the first operation upon a complex organism, and the distinctions of colours as we see them arise out of the nature of this organism

The number of independent variables required for specifying the condition of a system is a very different thing from the number of well-distinguished states in which the system can exist For example, the state of a given mass of water-substance is completely determined if its volume and temperature are given, and therefore depends on only two variables But the number of its well-distinguished states is three In like manner colour depends on three variables, but the number of well distinguished colours, besides white, may be said to be seven, namely the six principal colours of the spectrum and purple

What differences of condition in the organism correspond to these eight distinct appearances in the field of view, and how these different conditions are produced by the three primary excitations, are problems awaiting solution.

AUTOMATIC MERCURIAL AIR-PUMPS

OF late years, and more especially during the last decade, men of science have devoted much thought and ceaseless energy to the invention of an apparatus which should admit of the automatic working of mercurial air-pumps Of the numerous inventions brought forward, the ingenious apparatus of Schuller and Stearn are especially deserving of mention

But notwithstanding the present extensive employment of the mercurial air-pump in science as well as in technics these appliances are neither much known, nor have they been used to any great extent, although they are of great importance, and would probably be very advantageous This may be explained by the fact that they are wanting in the necessary simplicity and trustworthiness, without which the advantages of automatically working mercurial air-pumps are somewhat doubtful

We shall describe now an apparatus for the perfectly trustworthy and automatic working of mercurial air-pumps, as well as the shape of the glass pump used in connection with it, which, while possessing the greatest possible simplicity, admits of the highest rarefactions hitherto known

The figure shows the automatic apparatus in connection with an improved Toepler mercurial air-pump. The glass ball H is connected on the one hand by flexible tubes with the pump Q, on the other hand by the tube L with the accumulator M. The water-pipe K runs into the bottom of the accumulator, and by means of a specially-constructed three-way cock K can either be connected with the hydrostatic pressure-pipe K_1 or the discharge-pipe K_2

If water under pressure is admitted through the tubes k_1, K and k into M, the air contained in M is compressed This air again exerts a pressure through the tube L on the mercury contained in H, and drives it into the pump Q. As soon as the mercury has risen sufficiently high and the cock K is reversed, the compressed air forces the water out again through k, K, and k_2, and the mercury

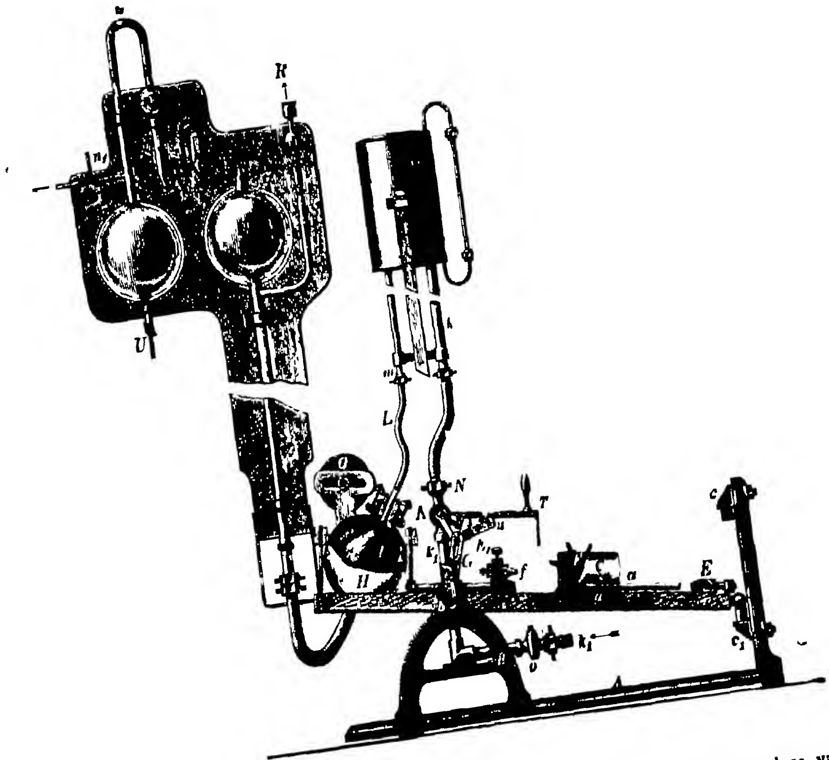
falls down on account of its own weight] out of the pump Q back into the ball H.

The reversing of the three-way cock, and therewith the automatic action of the pump, is effected in the following manner.—The ball H rests on a frame D, revolving about the axis b, and the motion of which is limited by the ledges c and c_1. A lever G is attached to the frame not far from the axis, and by means of a peg, when the balance D reverses its position, also turns the cock. When the ball H is entirely filled with mercury the balance D rests on the upper ledge c. If the pump is set in motion the left side of the balance D becomes lighter in proportion to the amount of mercury forced out of the ball H into the pump, until at last the weight C on the right-hand side becomes heavier, and the balance thereby attains the position shown by the figure. The three-way cock is also reversed by this motion

the adjusting of the height of the mercury can be easily and accurately done up to a centimetre.

It goes without saying that every mercurial air-pump not provided with cocks can be worked by the apparatus just described. But the improved construction of the Toepler pump, drawn likewise in projection in the figure, has proved to be especially practical. The following is a description of its automatic working:—

If the cock t_1 is connected with an hydrostatic air-pump, the ball Q of the pump and the space R, which is to be evacuated through the tube S, is pumped out up to the tension of the vapour. The mercury then rises in the tube R almost to the height of the barometer above its level in the ball H. If the automatic apparatus is then set in motion, the mercury enters the ball Q and the tube S, thus cutting off the connection with R, while any further rising of the mercury



Thus, as already described, the water current is now cut off, the water present in M flows out through K_2, and the mercury goes back from the pump Q into the ball H.

During the tipping over of the balance, however, the sliding weight C has run down its inclined plane to a ledge, E, so that it now exerts a pressure on the lever arm. Its momentum is so calculated that the mercury in the pump must have fallen to the point p, and flowed back into the ball H before it again overweighted, and moves back the balance. The weight C then slides back again to the left until it rests against its left ledge, and the play of the pump recommences. It will easily be seen that the height to which the mercury rises in the pump, the mass of the sliding weight being a constant quantity, depends only on its final positions, and that, therefore,

in the tube S is prevented by a glass valve v, it passes through the first V-tube r_1 filling the little vessel r_2 and rises through s_1 into the ball n, driving before it the air which was before shut off in Q. At this moment so much mercury has been forced out of the ball H into the pump Q, that the balance is turned, the mercury flows back out of Q into H, forming vacua in r and Q, as the little mercury-threads remaining in the side-tubes r_1 and s_1 form shut-off valves. As soon as the mercury has fallen below the entrance-point of S into E the pressure in R and Q become equal, the denser air flowing out through S into Q. The time during which Q is connected with R may be determined at will by changing the right ledge of the sliding weight. Then the balance again changes its position, the mercury rises in

V, and so on When the pump has made a few strokes in this manner, a lever T is let down, so as to rest on the ledge *u* The wheel F provided with six pegs is now turned a tooth farther each time the weight C slides from the left to the right, and the ledge-peg *f*, which when the lever was raised caught each time into a notch of the peg-wheel, rests for the length of five strokes of the pump against the circumference of the wheel, and does not catch into the notch until the sixth stroke As the rising of the quicksilver in the pump is in the inverse proportion of the momentum of the counter-weight in its left final position, if the ledges and peg *f* are rightly placed, it will when ascending be driven five times into the little hollow space r_2 and only at the sixth into the ball *n* In consequence of this the little air bubbles are accumulated in the highly evacuated space r_1 in which they ascend owing to the slight counter-pressure, and forming larger bubbles, and having easily overcome the somewhat greater counter pressure of the mercury column r, they rise into the ball P

All these manipulations are performed *entirely automatically* by the apparatus At the same time that the toothed wheel has commenced working (*i e* when the volume of air pumped out by the pump has sufficiently diminished) the vessel P is entirely cut off from the hydrostatic air-pump by the cock t_1, thus ceasing to act The mercury of the pump is entirely shut off on *both sides* from the exterior air, and only in contact with perfectly *dry* air After stopping the pump, concentrated sulphuric acid may be sucked up into P, which dries up entirely The mercury is shut off from M by a caoutchouc bag, I

The following experiments were made at the Physical Institute of the University of Berlin

400 c cm (cubic centimetres) were evacuated to 1 1000 m m in ten minutes, 4000 c cm. = 4 litres, in an hour

The highest rarefaction hitherto obtained has been about from 1/6000,00 – 1/800,000 m m = to about $\frac{1}{4560000000}$ – $\frac{1}{608000000}$ atmospheres

The pump is supplied by Messrs E Leybolds Nachfolger, Cologne (Germany) AUGUST RAPS

CRYSTALLISED CARBON

IN the course of some researches on the properties and modes of formation of the various forms of carbon, M Henri Moissan has succeeded in reproducing the variety of diamond known as *carbonado*, or black diamond, and has even obtained some minute crystals of the colourless gem. An account of his results in the *Comptes Rendus* of February 6 is followed by an article on the reproduction of the diamond, by M Friedel, and some congratulatory remarks by M Berthelot

As long ago as 1880 Mr Hannay[1] indicated the formation of diamond-like crystals on heating under high pressure, in a tube of iron, a mixture of lithium, lamp-black, essence of paraffin, and bone oil It was then supposed that the nitrogenous compounds of the last substance played the most important part. In M Moissan's new process carbon obtained from sugar is dissolved in a mass of iron, and allowed to crystallise out under high pressure. To produce this pressure the expansion of iron during condensation is utilised The carbon is strongly compressed in an iron cylinder closed with a screw-stopper of the same metal A quantity of soft iron, weighing about 150 or 200 gr, is melted in the electric furnace in a few minutes, and the cylinder is plunged into the molten mass The crucible is at once taken out of the furnace and splashed over with water. When the external crust is at a red heat the whole is allowed to cool slowly in air.

The metallic mass thus obtained is attacked by boiling hydrochloric acid until all the iron is removed There remain three forms of carbon graphite in small quantity, a chestnut-coloured carbon in very small needles, such as has been found in the Cañon Diablo meteorite, and a small quantity of denser carbon which has to be further isolated For this purpose the mixture is treated alternately with boiling sulphuric and hydrofluoric acids, and the residue decanted in sulphuric acid of density 1 8 It then contains only very little graphite, and various forms of carbon After six or eight treatments with potassium chlorate and fuming nitric acid, the residue is boiled in hydrofluoric acid and decanted in boiling sulphuric acid to destroy the fluorides It is then washed and dried, and bromoform is employed to separate out some very small fragments denser than that liquid, which scratch the ruby, and, when heated in oxygen at 1000°, disappear

Some of these fragments are black, others transparent The former have a rough surface, and a greyish black tint identical with that of certain carbonadoes, they scratch the ruby, and their density ranges from 3 to 3 5 Some pieces have a smooth surface, a darker colour, and curved edges The transparent fragments, which appear broken up into small pieces, have a fatty lustre, are highly refractive, and exhibit a certain number of parallel striæ and triangular impressions

During combustion in a current of oxygen at 1050°, some of the fragments left cinders of an ochreous colour, usually preserving the original form of the small crystal—just as in the combustion of impure diamonds

As indicated already by Mr Sidney Marsden,[1] silver heated to 1500° in presence of sugar carbon is found to contain on cooling some black crystals with curved edges M Moissan has found that high pressure is indispensable He heated silver till it boiled briskly in contact with carbon, and found that a certain quantity of the latter was dissolved By suddenly cooling in water, a portion of liquid silver, cooling inside a solid crust, was subjected to a very high pressure No diamonds were formed, but rather a large crop of carbonadoes of densities ranging from 2 5 to 3 5, thus forming a series connecting graphite with diamond Bromoform separated a carbonado, which scratched the ruby and burned in oxygen at 1000° A quantitative determination of this reaction showed that 0 006 parts of this substance gave 0 023 of carbonic acid

M C Friedel describes an experiment in which he obtained a black powder capable of scratching corundum by the action of sulphur on molten iron containing 4 per cent of carbon But the question of the production of diamond powder by this means is as yet an open one

M Moissan is continuing his researches on the solubility of carbon in iron, silver, and their alloys It is to be hoped that he will soon be able to exhibit artificial true diamonds of a more imposing size

[1] Proc. Roy Soc., vol xxx. p. 188.

[1] Proc. Roy Soc Ed 1880, vol. ii. p. 20.

LINES OF STRUCTURE IN THE WINNEBAGO CO METEORITES AND IN OTHER METEORITES[2]

THE ground and polished surface of a Winnebago Co. meteorite showed to me some interesting markings Subsequent examination revealed like markings in other meteorites Perhaps these markings have been described. If so I have no recollection of the description, and therefore it seems worth while to call attention to them

The polished surface of a small Winnebago stone, three or four square centimetres in area shows several hundreds of bright metallic points. The larger iron particles in this surface have great varieties of shapes—the smaller

[2] Reprinted from the February number of the *American Journal of Science*

ones are usually mere points When seen with a lens, or even at a distance from the eye suited to distinct vision there does not appear to be any regular structure or arrangement of the bright points But if the surface is so held as to be a little beyond the place of distinct vision, and at the same time, turned around in such a way as to reflect always a strong light to the eye, either skylight or lamplight, there appear lines of points across the polished surface of the stone, which suggest very strongly the Widmanstaetten figures on metallic meteorites At times, as the stone is turned, no lines can be detected Again one set of parallel lines or two sets crossing each other become visible Some of the sets are very sharply manifested, and some are so faint as to leave one in doubt whether the lines are real or only fancied There are on the surface in question six or eight of these sets of lines

A second surface was ground nearly parallel to the first, at about one centimetre distant from it, and like lines appeared on this parallel surface Some of the lines, but not all of them, corresponded in direction in the two surfaces Four more surfaces approximately at right angles to the first surface, and corresponding to the faces of a right prism, were then ground, and upon these surfaces the like sets of lines appear with more or less distinctness

A slab of a Pultusk stone 6 × 7 centimetres shows over its entire surface like markings Something like a curvature of the lines appears in one instance, but in general the lines run straight from side to side of the slab The slab is six millimeters in thickness, and most of the sets of lines have the same directions upon the two sides

A Hessle stone, a small slice from the Wold Cottage stone, one from Sierra di Chaco, one from a Sienna stone, a fragment from the Rockwood stone, and a slice from the Rensselaer Co stone, all show with more or less clearness the like markings Of three microscope slides of the Fayette Co meteorite one shows them clearly, a second shows traces of them, the third not at all

A considerable number of the ground surfaces of meteoric stones in the Peabody Museum also show these markings For example, a triangular surface of a Weston stone, 8 or 10 centimetres to each side, exhibits them very well

These markings are such as we might expect if the forces which determine the crystallisation of the nickel-iron of the iron meteorites also dominated the structure of the rock-like formations of the stony meteorites and the distribution therein of the iron particles The relation of quartz crystals to the structure of graphic granite is naturally suggested by these meteorite markings.

H. A. NEWTON

THE LATE THOMAS DAVIES, F.G.S

MR. THOMAS DAVIES, who died on December 21 last, was born on December 29, 1837, in the neighbourhood of London, and was the son of Mr William Davies, F.G.S., of the Geological Department of the British Museum. His early education was of a very elementary character, and the period of his school-life was brief: finding town-life irksome, and yearning for freedom and adventure, he took to the sea at the age of fourteen, and during the next four years led a roving life, visiting China, India, and various parts of South America. He was then prevailed upon by his father to adopt a more settled mode of existence, and on the separation of the Department of Mineralogy from that of Geology was appointed in 1858 a third-class attendant at the British Museum under Prof Maskelyne, to whom the care of the minerals had been assigned, in the following year he added to his responsibilities by marriage

During the next nine years, save for a short interval when Dr Viktor von Lang was an assistant in the Department, Mr Davies was the sole helper of Mr Maskelyne in the arrangement and examination of the mineral collections, during this time Mr Maskelyne effected a thorough change in the classification and arrangement of the minerals, and in labelling with localities the large number of specimens that were without any descriptions except what could be traced out in old catalogues In this work, and in the cleaning and arranging some tons of specimens, of which many were entirely valueless, the patient and intelligent aid of "young Davies" alone rendered it possible to carry out the preliminary operations As the collection grew into orderly arrangement, the registration and labelling of specimens was entrusted to him by Mr Maskelyne It was thus that he gradually acquired an eye-knowledge of minerals which has rarely, if ever, been surpassed His perception of the peculiarities of a specimen was remarkably quick, while his remembrance of individual specimens was almost marvellous It was particularly in the habit, the locality, the associations and modes of occurrence of mineral species that he concentrated his interest, and to his knowledge in this direction his earlier training, under the eye of Mr Maskelyne, in the labelling of the minerals, accumulated in the cases and drawers of the collection, very largely contributed

In the early years of Mr Davies's museum life Mr Maskelyne was further engaged in the study of thin sections of meteorites, and initiated Mr Davies into a knowledge of the microscopic characters of rock-forming minerals, a mode of investigation then almost unknown In this direction his quickness of perception and excellence of memory had full scope for play, and Mr Davies soon became extremely skilful in the microscopic determination of minerals in rock-sections, and in the recognition of peculiarities of rock-structure Few practical petrologists approached him in this faculty

Nor did he neglect to improve his general education With this end in view he attended the evening classes at the Working Men's College in Great Ormond Street, and in the course of time acquired a knowledge of both French and German He was also familiar with plants and fossils, a knowledge largely derived from his father

His remarkable qualifications attracted the early attention of Mr. Maskelyne, and in 1862 were officially recognised in his promotion by the trustees from the grade of attendant to that of transcriber or junior assistant In 1880 he was promoted to the grade of first-class assistant By a remarkable coincidence his father, Mr William Davies, who had long been renowned for his large practical knowledge of important branches of palæontology, and especially of fossil fishes, and had likewise begun museum life as an attendant, obtained the same promotion on the same day. In the same year Mr Davies was awarded the balance of the proceeds of the Wollaston Fund by the Council of the Geological Society as a testimony of the value of his researches in mineralogy and lithology Still later, in 1889, the name of *Daviesite* was given to a new mineral "in honour of Mr. Thomas Davies, who has now been associated during upwards of thirty years with the British Museum Mineral Collection, and whose mineralogical experience and Breithauptian eye have ever been willingly placed at the service, not only of his colleagues, but of every one who has been brought into relationship with him"

He became a Fellow of the Geological Society in 1870, and was an early member of the Mineralogical Society of France.

His published work was not voluminous, it relates almost exclusively to the microscopic characters of the pre-Cambrian rocks. He contributed, however, the bulk of the articles on mineralogy and petrology for "Cassell's Encyclopædic Dictionary," and for some years edited the *Mineralogical Magazine*

Mr. Maskelyne, for whom he was right-hand man, and almost sole working helper during upwards of twenty years, looks back with fond regret on the uninterrupted happiness of their association According to my own experience of the last fifteen years, he was an excellent colleague, always cheerful, good-tempered, and kind-hearted, ever ready to help in any direction, however much it might interfere with the particular work he had immediately in hand At home he was an enthusiastic gardener, wet or fine, absolutely reckless of weather, he was at work from early sunrise, and could boast the possession of one of the best managed gardens in the neighbourhood His love of fresh air and the bustling east wind never left him, even after recovery from the long illness which two years ago had taken him to the verge of the grave, he did not hesitate to show the greatest contempt for the protection of an umbrella, and notwithstanding the remonstrances of his friends, might still be occasionally seen enjoying the beating of the wind and rain on his unprotected face

He was an Original Member of the Mineralogical Society, and Foreign Secretary for several years preceding his death

Mr Davies leaves a widow and nine children to mourn his loss L FLETCHER

NOTES

AT the last meeting of the Council of the Mineralogical Society, it was resolved to initiate a "Thomas Davies Memorial Fund" on behalf of the widow and children of the late Mr Thomas Davies, F G S, of the British Museum The following gentlemen have consented to act as an Executive Committee.—Prof. N. S Maskelyne, F R S (chairman), Dr Hugo Müller, F.R.S (treasurer), Mr H A Miers, F G S (secretary), Prof. T G Bonney, F R S, Mr L Fletcher, F R S, Dr Henry Hicks, F R S, W H Hudleston, F R S, Prof. J W Judd, F R.S, Mr F W Rudler, F G S, Mr. F Rutley, F G S, Rev Prof T Wiltshire, F G S, Dr Henry Woodward, F R S Subscriptions for the fund should be sent to Dr Hugo Müller, 13 Park Square East, Regent's Park, London, N W

AN extra meeting of the Chemical Society will be held on February 20, at 8 p.m., the anniversary of the death of Herman Kopp, when a lecture will be delivered by Prof T E Thorpe, F R.S Lord Playfair will be in the chair.

AN International Botanical Congress is to be held during the Columbian Exposition at Chicago Prof C. E Bessey will receive communications on the subject.

M P DUCHARTIE has been elected president, and M L Guignard first vice-president, of the Botanical Society of France for the year 1893

THE annual public meeting of the University College Chemical and Physical Society will be held at University College, Gower Street, on Friday, February 24. The chair will be taken at eight o'clock by Prof F. T. Roberts, and Prof Watson-Smith will deliver an address on diseases incident to work-people in chemical and other industries.

MR THOMAS BRYANT, president of the Royal College of Surgeons, delivered the Hunterian oration on Tuesday afternoon in the theatre of the college, in the presence of the Prince of Wales and the Duke of York and a large and distinguished company. Mr. Bryant began by thanking their Royal Highnesses for their presence on the special occasion of the centenary of the death of John Hunter, the great founder of scientific surgery. In the course of his oration Mr. Bryant said that the whole world of vegetable and animal life was Hunter's subject, but that his main objects were the improvement of surgery by the elucidation of pathology, the examination of the causes which determine any departure from the normal type, whether of form or function, and the study of the means which nature adopts for the healing of wounds and the repair of injuries It was one of his special merits that he raised surgery out of the position of a a poor art, based on empirical knowledge and practised too much as a trade, to establish it firmly as a high and elevating science, at the same time raising its practitioners in the social scale, and doing as much for medicine as for surgery, for he considered them inseparable He made the profession scientific by basing it upon the widest knowledge of the structure and functions of all living things, and educed therefrom laws and principles for the guidance of future generations in their study and treatment of disease in any of its forms This alone should render him worthy of the thanks of civilised mankind.

MR GEORGE MATHEWS WHIPPLE, whose death we briefly recorded last week, had done much solid and valuable work in various departments of physical science Among the subjects in which he was especially interested were wind force and wind velocities, and throughout the greater part of his life, as the *Times* has said in a brief sketch of his career, he was constantly carrying on experiments with a view to determine wind force and to find out what were the best instruments for securing accurate results. He improved the Kew pattern magnetic instruments, he designed, among other instruments, the apparatus for testing the dark shades of sextants, and at various periods he was associated with Captain Heaviside, Major Herschel, and General Walker, in carrying on pendulum experiments for the determination of the force of gravity The magnetic part of the report of the committee appointed by the Royal Society to investigate the Krakatoa eruption and the subsequent phenomena was prepared by Mr Whipple, and valuable papers were from time to time submitted by him to the Royal Society and the Royal Meteorological Society He was fifty years of age at the time of his death He entered the Kew Observatory in 1858, became magnetic assistant in 1862, and was appointed superintendent in 1876. This office is one of great and growing importance, and we trust that a capable successor may be found The Kew Observatory is the central standardising station of the Meteorological Office, and numerous magnetical observatories in other countries are similarly connected with it New instruments are tested there, and experiments are made, and it has now grown into an institution where the verification of scientific instruments of many kinds, including thermometers, sextants, telescopes, watches, and recently photographic lenses, is carried on on a large scale, as described in the annual report of the Kew committee to the Royal Society

THE Rev F O Morris died at Nunburnholme, in Yorkshire, on Friday last, at the age of eighty-two. He was well-known as a popular writer on science, and did much to create and foster interest in some branches of natural history, especially in ornithology Among his many books were "A History of British Birds," issued in six volumes from 1851 to 1857, and his "Natural History of the Nests and Eggs of British Birds," published in three volumes in 1853. In 1854 he was presented to the rectory of Nunburnholme, which he continued to hold until his death.

A DESTRUCTIVE earthquake has taken place in the island of Samothrace. All the buildings are said to have been destroyed. Renewed shocks, accompanied by loud subterranean rumblings, have also occurred at Zante.

ON Sunday a shock of earthquake was experienced in New Zealand. It caused little damage, but was felt in both the North

and South Islands, being most severe at Wellington and at Nelson

THE weather of the past week has been very stormy and damp in most parts of these islands, scarcely a day has passed without gales being reported On Friday, the 10th, the wind force was especially strong, on the north-east coast of Scotland and in the English Channel, and on Tuesday another deep depression had reached our northern coasts from off the Atlantic, accompanied by strong gales The United Kingdom was situated between two areas of high barometer readings, one of which lay over Scandinavia and the other over France and Spain With this distribution of pressure, the conditions were favourable to the passage of cyclonic disturbances within our area, and although the storms were not of exceptional violence in the southern districts, they were so relatively, as the winds have been peculiarly quiet during the last twelve months Temperature has been a little above the mean for the season, the daily maxima often exceeding 50°, but on Sunday the highest day readings were below 40° over the north-east of England, while a sharp frost occurred in the north of Scotland, the minimum temperature registering 20° On the continent the temperature has been much lower than in this country; at Haparanda, at the north of the Gulf of Bothnia, which lies in the area of the high barometric pressure over Scandinavia, a temperature of minus 37° was recorded on Friday and Saturday Rainfall has been of daily occurrence at most stations, although the amounts measured have generally been light, while hail and sleet have occurred in many places. With Tuesday's storm, however, the rainfall exceeded an inch on the west coasts of Ireland and Scotland By the *Weekly Weather Report* of the 11th instant it appears that the rainfall for that week was greatly in excess of the mean in the north and west of Scotland, and to a less extent in the east of Scotland, the north of Ireland, and the western parts of England Bright sunshine exceeded the mean in all districts, the greatest amounts, 32 to 38 per cent, being recorded in most parts of England

THE recent numbers of *Ciel et Terre* (Nos 21 23) contain interesting articles on ozone The observation of this element by meteorologists has been almost given up in most countries, owing chiefly to the difficulty of obtaining comparable results by the methods at present in use, although its importance for invalids and others as a purifier of the atmosphere is generally acknowledged And at a recent meeting of the Royal Meteorological Society, regret was expressed at the discontinuance of these observations D. A Van Bastelaer, in conjunction with the Royal Observatory of Brussels, maintained a system of ozone observations at 150 of the stations belonging to the Society of Public Medicine in Belgium during the years 1886–91, which is probably the most complete investigation into the subject which has been made The values found for the various stations are given in a tabular form, and M Van Bastelaer found that there are continual and sudden variations in the records from hour to hour, between morning and evening, and from one day to another, but that the mean values for any locality remain nearly constant. Isolated values are of no use, a long series of observations is necessary for any results of importance to be arrived at. The air at stations near the sea coast contained, as is usually supposed, the greatest amount of ozone

THE Indiana Academy of Science lately held at Indianapolis its eighth annual meeting, the president being Prof J. L. Campbell, of Wabash College, Crawfordsville, Ind. There was a large attendance, and no fewer than ninety-two papers had been prepared, most of which were read. The first volume of the Academy's Proceedings was distributed at the meeting.

THE *Kew Bulletin* continues, in the January number, its series of articles on the food grains of India, one of the subjects being Kangra Buckwheat (*Fagopyrum tataricum*, Gærtn, var. *himalaica*, Batalin) The typical plant is cultivated throughout the higher Himalayas, but more especially on the western extremity, and at altitudes from 8000 to 14,000 feet The yield in India cannot yet be estimated, but the *Bulletin* says there can be little doubt that the seeds are singularly rich in nutrient constituents This is confirmed by the conclusions of Prof Church with regard to a sample he has examined

THE January number of the *Kew Bulletin* contains also the fourth decade of new orchids, the fourth of "Decades Kewenses," papers on fruit growing at the Cape and the clove industry of Zanzibar, and miscellaneous notes

PROF R SHIMEK is now investigating the flora and the geology of Nicaragua, along the route of the canal, under commission from the State University of Iowa Dr Terracciano, of Rome, is about to renew his investigation of the flora of Erythrea, the Italian colony on the Red Sea Dr K. N Denkenbach is commissioned by the Natural History Society of St Petersburg to investigate the flora of the Black Sea

MR R THAXTER proposes in the *Botanical Gazette* the establishment of a new order of Schizomycetes, the Myxobacteriaceæ, somewhat intermediate in its characters between the typical Schizomycetes and the Myxomycetes It comprises the genus Chondromyces, placed by Berkeley, in his "Introduction to Cryptogamic Botany," under the Stilbacei, and two new genera, Myxobacter and Myxococcus The order consists of mobile rod-like organisms, multiplying by fission, secreting a gelatinous base, and forming pseudo plasmode like aggregations before passing into a more or less highly-developed cyst-producing resting state, in which the rods may become encysted in groups without modification, or may be converted into spore-masses

AT the meeting of the Royal Botanic Society on Saturday, one of the branches of the flowering stalk of *Fourcroya selloa* was shown from the Society's conservatory. This is a Mexican plant allied to the aloes, and like them it flowers only once during its life The plant, which has been in the conservatory for upwards of twenty years, late last autumn threw up a flower spike which in a very short time grew to a height of 30 feet, and, passing through the glass roof, rose for some feet into the open air It could not, of course, resist the frosts and fogs of winter. The flower-buds dropped unopened, when immediately from each node a number of young plants appeared This mode of reproduction is found in only a few varieties of plants, and is especially valuable in relation to the cultivation of Fourcroyas as a source of commercial vegetable fibre

THE Newcastle Literary and Philosophical Society will have no very pleasant associations with the memory of its hundredth anniversary, which was celebrated on Tuesday of last week During the following night the society's premises caught fire and were greatly damaged. Much injury was done to the library, where many most valuable books were destroyed.

THE fifth and sixth parts of the fifth volume of the *Internationales Archiv für Ethnographie* have been issued together in a single number It includes the second part of Dr W Svoboda's interesting study (in German) of the inhabitants of the Nicobar Islands; a paper (in French) by Désiré Pector on the volume by Dr Hyades and Dr Deniker (noticed some time ago in NATURE) on the ethnography of a part of Tierra del Fuego; a suggestive essay (in German) by Dr. T Achelis, on the psychological importance of ethnology; and the second part of Dr. Schmeltz's careful contributions (in German) to the

ethnography of Borneo. The first and last of these papers are admirably illustrated A valuable paper on the Ainos, by David MacRitchie, of Edinburgh, has been published as a supplement to the fourth volume of the *Archiv* This paper is accompanied by, and contains full descriptions of, a series of coloured reproductions of most interesting pictures of Aino life by Japanese artists, who have naturally a keener perception of the characteristics of their savage neighbours than can be attained by Western visitors Mr MacRitchie seeks to show that the Ainos display "unmistakable traces of a near descent, by at least one line of their ancestry, from the most crude form of humanity"

MESSRS SAMSON AND WALLIN, Stockholm, are about to issue what promises to be an important and interesting work, by F R Martin, on the Siberian Antiquities of the Bronze Age, preserved in the museum of Minousinsk. Nearly 900 objects in copper and bronze will be represented in the plates, which, according to the prospectus, are being prepared with the greatest care The antiquities of which these objects are selected specimens were collected in 1874 by M Nicolai Martianow from mounds in the steppes of the Upper Yenisei They are the finest provincial collection in the Russian Empire, and M Martin found much to interest him in classifying and photographing them The present volume will be the first of a series of works on the ethnography and archæology of Western Siberia by the same writer

THE third volume of "A Journal of American Ethnology and Archæology," edited by J Walter Fewkes, has been issued It contains an interesting "outline of the documentary history of the Zuñi tribe," by A F Bandelier, and "somatological observations on Indians of the south-west," by Dr H F C Ten Kate It is worth while to note that in Dr Ten Kate's opinion the study of physical anthropology among the North American Indians does not tend to demonstrate that their types are exclusively American It rather shows, he thinks, that they present only the characteristics of "the Mongolian or so called yellow races" "I do not mean,' he says, "that the American aborigines are Mongolians in the strict sense of the word, or that America has been populated from Asia Where the Indians came from I do not know, but my position is as follows —The American race is, somatologically speaking, not a type, but has characteristics which can only be called Mongoloid"

PROBABLY no living sportsman has shot more big game in South Africa than Mr F. C Selous, who for years was more at home in a waggon or a tent somewhere in the far countries of Africanderland than in the towns and settlements of the Cape Colony or the Transvaal. He has nearly completed an account of eleven years' sport and travel, which will be shortly published by Messrs Rowland, Ward and Co, of Piccadilly It will be fully illustrated, and will include a variety of general information on subjects of interest in connection with the latest development of South African exploration

MR. ELLIOT STOCK has published the third volume of "The Field Club," a magazine of general natural history for scientific and unscientific readers, edited by the Rev Theodore Wood. The volume contains many articles which are well fitted to awaken interest in various aspects of natural science

WE referred lately to Dr D G Brinton's opinion as to the relation between nervous diseases and civilisation As his view has been called in question by Dr Rockwell, he returns to the subject in *Science*, supporting his own conclusions by a reference to a paper contributed by Dr I C Rosse, professor of nervous diseases at the Georgia Medical College, to the *Journal of Nervous and Mental Disease* for July, 1891 In this paper Dr Rosse cites many authorities to prove that there is as much nervous disease at low as at higher stages of civilisation, and perhaps more In the district of Columbia, for example, the decedents among the coloured people from nervous diseases often exceed those of the white population by thirty-three per cent Dr Rosse is inclined to believe that a sudden change in the social habits and condition of any race, at any stage of advancement, will result in a prompt development of neurotic disease A high civilisation, which is stable, excites such a condition less than instability in lower grades

AT the meeting of the Field Naturalists' Club of Victoria in November a paper presenting a list of species of Victorian butterflies was communicated It had been prepared by Messrs F Spry and Ernest Anderson, and embodied the results of work carried on during many years The *Victorian Naturalist* says the paper was "received with great satisfaction, and will prove of extreme value to the Victorian lepidopterist"

MR H L CLARK records in *Science* what he calls "a bit of satisfactory evidence" as to the rate of speed in the flight of certain birds He thinks that this is often greatly exaggerated He was travelling lately on the Baltimore and Ohio Railway, up the valley of the Potomac, when he saw a great many wild ducks, which are admitted to be among the strongest flyers in America It so happened that, on rounding a sharp curve, the train flushed a pair of buffle-heads, which started up stream at full speed On watching them he found that, instead of their leaving the train behind, the train was actually beating them, and he is confident that their rate of speed was not equal to that of the train "We kept alongside of them," he says, "for nearly a minute before they turned back down stream Careful calculation showed that the train was running at about thirty seven miles per hour, so that the rate of speed for those wild ducks would be about thirty-six I hope that others may have some evidence on this question of speed in flight which will throw more light on the subject"

AN interesting illustration of the tendency of inorganic matter to simulate the forms seen in organic is afforded by some specimens of hæmatite from a mine in Lake Superior district It is described in the *American Geologist* as a fibrous red hæmatite, compact and tough-looking, and the radiating filaments or fibres towards their summits are seen to spread out like some frondescent vegetable growths It would seem that in process of increase these fibres, starting from different but slightly distant points, and having a tendency to expand, soon began to interfere with one another The line of contact, which became a plane as growth continued, is marked by a more or less distinct plane of separation This frondescent hæmatite, in addition, is pierced by a number of peculiar channels which seem to date from the time of development of the crystals It is noticed that these run, in general, perpendicular to the fibrous structure, and lie in or across the planes of contact of two oppositely spreading frondescent growths. These appear to mark in the first instance the vacancies left by the first contacts of overarching growths from opposite directions. These branches then interfered with the free circulation of air, and interrupted and permanently stopped the development of these fibres beneath the overspreading canopy

IT was shown by Ferraris some time ago (and the fact was of great practical importance) that by means of two simple alternating currents acting in fixed spirals, a rotating magnetic field could be produced, which by inductive action set in rotation a copper cylinder or other conducting body brought into the field. Also an iron cylinder, cut through so that the Foucault induction currents could not be formed, was rotated by virtue of so-called magnetic hysteresis. Further studies in this direction have been made by Signor Arno, using electric instead of magnetic forces, and a dielectric body instead of a magnetic

He thus succeeded in rotating a hollow cylinder of mica, or other insulating substance, hung by a silk fibre, in the space enclosed by four vertical curved copper plates, to which the requisite differences of potential were communicated. An account of these interesting experiments (described to the Accademia dei Lincei) will be found in the *Naturwissenschaftliche Rundschau*, No. 3, 1893.

Prof. R. C. Schiedt has been making some interesting observations on oysters, and at a recent meeting of the Philadelphia Academy of Natural Sciences Prof. Ryder reported on his behalf that oysters which had the right valve removed and were exposed to the light in this condition, in a living state for a fortnight or so, developed pigment over the whole of the epidermis of the exposed right mantle and on the upper exposed sides of the gills, so that the whole animal from this cause assumed a dark-brown colour. Animals so exposed not only attempted to reproduce the lost valve and hinge, but also partly succeeded in so doing, even re-establishing the insertion of the diminutive pedal muscle upon the inner face of the imperfectly reproduced right valve, which was deformed owing to the lack of support of the right mantle, because of the removal of the original right valve. As a consequence the right mantle was rolled up at the edge, and this deformation of the mantle was reflected in the attempted regeneration of the lost right valve. The pigment developed during exposure to light in the mantle and gills in oysters with the right valve removed, which were kept alive in the aquaria at Sea Isle City by Prof. Schiedt, was wholly confined to the epidermis as it normally is at the mantle border in the unmutilated animal in nature. The inference to be drawn from these facts is that the development of pigment in the mantle and gills was wholly and directly due to the abnormal and general stimulus of light over the exposed surface of the mantle and gills, due to removal of the right valve, and that the mantle border, the only pigmented portion of the animal, is pigmented because it is the only portion of the animal which is normally and constantly subjected to the stimulus of light.

Mr. D. Cleveland, of San Diego, California, contributes to *Science* an article in which he states some curious facts regarding the trap-door spider (*Mygale henzii*, Girard), which is widely diffused in California. Behind San Diego there are many hillocks about a foot in height and three or four feet in diameter. These hillocks are selected by the spiders, Mr. Cleveland suggests, because they afford excellent drainage and cannot be washed away by the winter rains. A suitable spot, which always consists of clay, adobe or stiff soil, having been chosen, the spider excavates a shaft varying from five to twelve inches in depth, and from one-half to one and a half inches in diameter. This is done by means of the sharp horns at the end of the spider's mandibles, which are its pick and shovel and mining tools. The earth is held between the mandibles and carried to the surface. When the shaft is of the required size, the spider smooths and glazes the wall with a fluid which is secreted by itself. Then the whole shaft is covered with a silken paper lining, spun from the animal's spinnarets. The door at the top of the shaft is made of several alternate layers of silk and earth, and is supplied with an elastic and ingenious hinge, and fits closely in a groove around the rim of the tube. This door simulates the surface on which it lies, and is distinguishable from it only by a careful scrutiny. The spider even glues earth and bits of small plants on the upper side of the trap-door, thus making it closely resemble the surrounding surface. The spider generally stations itself at the bottom of the tube. When, by tapping on the door, or by other means, a gentle vibration is caused, the spider runs to the top of its nest, raises the lid, and looks out and reconnoitres. If a small creature is seen, it is seized and devoured. If the invader is more formidable, the door is quickly closed, seized, and held down by the spider, so that much force is required to open it. Then the spider drops to the bottom of the shaft. When the door of the nest is removed, the spider can renew it five times—never more than that. From forty to fifty cream-coloured spiderlings are hatched from the yellow eggs at the bottom of the nest. When these have attained only a fraction of their full size—before they are half grown—the mother drives them out into the world to shift for themselves. After a brief period of uncertainty they begin active life by making nests, each for itself, generally close to "the old homestead," sometimes within a few inches of it. These nests are always shallow and slender, and are soon outgrown. When the spider attains its full size it constructs a larger nest.

An interesting paper concerning the supposed volatility of the element manganese is contributed by Prof. Lorenz and Dr. Heusler, of Gottingen, to the current number of the *Zeitschrift für Inorganische Chemie*. Although the melting point of the metal is known with tolerable certainty to be about 1800° – 1900°, much higher than that of iron, no information has yet been acquired concerning its boiling point. Profs. Lockyer and Chandler Roberts, however, so long ago as 1875 pointed out that the metal was volatile at the temperature of the oxy-hydrogen blowpipe; and M. Jordan, in a communication to the *Comptes Rendus* in the year 1878, reported that in the manufacture of highly manganiferous spiegeleisen near Marseilles, a deposit very rich in manganese was usually found in the cooler portions of the furnace. Moreover, M. Jordan stated that during the casting of ferro-manganese red flames are produced, from which a heavy fume is deposited containing a large percentage of manganese. M. Jordan subsequently heated ferro manganese to a white heat in a crucible in his laboratory, and ascertained that a diminution in the percentage of manganese actually occurred. These observations were considered somewhat surprising, inasmuch as the melting point of manganese is so high, in the neighbourhood of white heat, and it would appear that this volatility must be exhibited even at the melting point itself.

Prof. Lorenz and his colleague have therefore conducted a series of experiments with the view of ascertaining whether manganese is really volatile *per se*, or whether the volatility is due to the intermediate action of carbon monoxide (derived from the carbon usually present) in forming a volatile but dissociable compound of a nature similar to nickel- and iron carbonyl. It was first definitely proved that carbon monoxide does not combine with manganese below the temperature of 350°, a fact which M. Guntz has recently independently pointed out. Experiments were then made at higher temperatures, using a new form of combustion furnace, designed by Prof. Lorenz and fully described in the *Zeitschrift*, in which each individual burner is supplied with a blast capable of being regulated, the whole apparatus being equivalent to a row of blowpipes which will rapidly raise a thick porcelain tube up to a white heat. In the first series of these high temperature experiments coarsely powdered manganese containing seven per cent. of carbon was heated to whiteness in a glazed porcelain tube in a current of carbon dioxide, in order that nascent carbon monoxide might be produced in contact with manganese by the reduction of the carbon dioxide by the carbon present. After half-an-hour's heating the tube was allowed to cool in the stream of carbon dioxide and then broken, when it was found that a large quantity of the manganese had volatilised and condensed again further along the tube, in the form of a thick black deposit somewhat resembling zinc dust. Upon repeating the experiment with a current of carbon monoxide, a similar result was obtained. Hence manganese is certainly volatile in carbon monoxide. But it was afterwards found that equally good deposits of manganese dust were obtained when a current of

either hydrogen or nitrogen, neither of which combine with manganese, were employed It is therefore evident that manganese does not resemble iron and nickel in forming a volatile compound with carbon monoxide, but that the volatility is a property of the element itself, and is singularly manifested even at the temperature of the melting point

SOME of the more interesting captures recently made by the dredging staff of the Marine Biological Association at Plymouth are the Actinian *Chitonactis coronata*, the Nudibranchs *Berghia cærulescens* (new to Britain), *Amphorina cærulea*, and *Lamellidoris oblonga* in considerable numbers, and the handsomely marked rare spider-crab, *Stenorhynchus egyptius* The alga *Halosphæra viridis* has been present in all townettings since October; and *Noctiluca*, though in small numbers, is now generally present The breeding season of a large number of Invertebrata has already commenced, and the sea swarms with Copepod and Cirrhipede Nauplii, and with Polychæte larvæ Species of the following genera are breeding —The Hydroids *Halecium*, *Plumularia*, *Sertularella*, *Hydrallmania*, the Actinians *Chitonactis* and *Actinia*, the Nemertine *Lineus obscurus* (larva of Desor), *Phyllodoce maculata* and other Annelids, the Molluscs *Capulus hungaricus*, *Lamellaria*, *Buccinum*, *Purpura*, many Nudibranchs, and the Decapod Crustacea *Crangon*, *Pandalus*, and *Palæmon*, *Carcinus*, *Cancer*, and *Eurynome*

THE additions to the Zoological Society's Gardens during the past week include a Fallow Deer (*Dama vulgaris* ♂) European, presented by Mr B L Rose, a Great Eagle Owl (*Bubo maximus*) European, presented by Mr Adolphus Drucker; two Gold Pheasants (*Thaumalea picta* ♀ ♀) from China, presented by Miss Forster, nine Snow Buntings (*Plectrophanes nivalis*) British, presented by Mr T E Gunn, an Egyptian Cobra (*Naia haje*), two Hoary Snakes (*Coronella cana*), from Victoria West, Cape Colony, presented by the Rev G H R Fisk, C M Z.S., three European Pond Tortoises (*Emys europæa*) European, deposited, a King Snake (*Coluber getulus*) from North America, received in exchange.

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF APRIL 15–16, 1893 —The following particulars of the phenomena of the total solar eclipse of April 15–16, 1893, have been supplied to the Eclipse Committee by Mr A M W Downing, Superintendent of the *Nautical Almanac* office, for the use of the English observers at the eclipse stations to be occupied in Brazil and Africa —

Brazil. Longitude 38° 50′ W Latitude 3° 20′ S

		d h. m s.	Contact from N point	Contact from vertical	Sun's altitude
Eclipse begins	April	15 22 18 14	136° W	19° W	62°
Totality begins		15 23 40 51	Duration 4m. 43 1s		
Totality ends		15 23 45 34			
Eclipse ends		16 1 11 40	45° E	84° W	68°

Local mean times

Senegambia. Longitude 16° 30′ W Latitude 14° 15′ N.

		d. h m s	Contact from N point	Contact from vertical.	Sun's altitude
Eclipse begins	April	16 1 5 3	130° W	156° E	73°
Totality begins		16 2 27 59	Duration 4m. 12·3s		
Totality ends		16 2 32 12			
Eclipse ends		16 3 48 1	57° E	24° W.	35°

Local mean times.

REMARKABLE COMETS.—Bearing this title, Mr. Lynn has written a small book, in which he gives a short survey of the most interesting facts that have occurred in the history of cometary astronomy. As he remarks in the preface, the scope of the work is almost purely historical; but we are sure there are many who will peruse these few pages with great pleasure, for the author has brought together these facts and presented them to the reader in a concise and plain style We may mention that figures relating to elements of orbits, &c., are at a minimum, Mr Lynn simply restricting himself to bare accounts The author concludes by giving a list of the dates at which some of the comets may reappear, from which we make the following extract —

Date		Period in years.	
1893	Summer	6½	Finlay's Comet
1894	Winter	3⅓	Encke's ,,
1896	Spring	7½	Faye's ,,
,,	,,	7	Brook's ,,
1897	,,	6½	D'Arrest's ,,
,,	,,	5½	Swift's ,,
1898	Summer	5½	Winnecke's ,,
,,	Autumn	7	Wolf's ,,
1899	Spring	33¼	Comet of 1866
,,	Summer	13¾	Tuttle's Comet
,,	,,	7	Holmes's ,,

The comet of 1866, as many of our readers well know, is identical with the meteoric stream through which we pass in November, so we hope that we shall be visited by a fine display

COMET HOLMES (1892, III) —Comet Holmes seems to have become somewhat dimmed during the past week, but we nevertheless give the ephemeris for the benefit of those who wish to follow it a little longer

Ephemeris for 12h M T, Paris

1893	R A app h m s	Decl app h m s
Feb 16	2 7 37 9	+34 14 30
17	9 15 3	16 42
18	10 53 2	18 58
19	12 31 5	21 16
20	14 10 3	23 37
21	15 49 5	26 1
22	17 29 1	28 26
23	2 19 9 2	34 30 54

COMET BROOKS (NOVEMBER 19, 1892) —This comet lies in the southernmost part of the constellation of Andromeda, just south of ε Andromedæ, and the following is the current ephemeris —

Ephemeris for 12h M T, Berlin

1893	R A app h m s	Decl app ° ′	Log r	Log Δ	Br
Feb 16	0 22 44	+26 46 9			
17	24 8	26 23 2	0 1343	0 2445	0 97
18	25 30	26 0 3			
19	26 50	25 38 3			
20	28 8	25 17 1			
21	29 23	24 56 7	0 1438	0 2711	0 83
22	30 37	24 37·1			
23	0 31 49	24 18 2			

RELATIVE POSITIONS OF STARS IN CLUSTER χ PERSEI —Volume xxx part iv of the Transactions of the Royal Irish Society contains the results of the investigations of Sir Robert Ball and Mr. Arthur Rambaut, with respect to the relative positions of 223 stars in the cluster χ Persei as determined photographically. The instrument used throughout was a 15-inch silver on glass reflecting telescope, mounted according to Cook's standard equatorial pattern. For the adjustment of the plate (the size used here being 3¼ × 3¼) and mirror Dr. Johnstone Stoney's collimator was employed, this method ensuring the exact perpendicularity of the photographic plate to the axis of the collimator. The negatives were measured with an instrument made by the same firm, and after the same pattern as that used by Prof Pritchard, at Oxford, this instrument being supplied with the means of measuring either rectangular or polar coordinates, the former of which has been adopted here throughout In this memoir the authors treat in detail, by means of figures and formulæ, the equations for orientating the plate for measurement, for computing the differences in Right Ascension and Declination from the centre of the plate, for correcting the relative apparent positions of the stars for effects of separation, observation, nutation, and procession, &c. The measures here given have been obtained from one photograph taken with an exposure of ten minutes, the images under the microscope being susceptible "of very accurate measurement" That only

one negative has been employed is due, as the authors say, to pressure of other work and to necessary alterations in the instrument, but they hope to repeat the investigation next autumn In the table showing the positions, the authors compare their results with those of Vogel and Pihl, and they find that a small difference, depending on the adopted position of the fundamental star, is apparent between the former's declinations, while Pihl's right ascensions differ slightly, though systematically, this discrepancy being due very probably to the different methods of determining the parallels. The memoir concludes with a map showing the relative positions of the stars plotted direct from the x and y coordinates

L'ASTRONOMIE —The February number of this journal contains many articles of interest Prof Stanislas Meunier gives an account of a meteorite that fell in Algeria, this meteorite has proved to be of iron, containing as much as 91 32 per cent, and a polished surface, when treated with an acid, showed the well known Widmannstatten figures M Flammarion, in addition to an account of "Les Pierres Tombées du Ciel," with reference to "Les Anciens Volcans de la Lune," lately advocated by Prof Coakley in *Astronomy and Astrophysics*, gives the fourth out of six chapters dealing with the question, "Comment Arrivera la fin du Monde" M J Fényi, director of the Observatory of Kalocsa, gives an account of the enormous solar eruption (383,000 kilometres high) that occurred on October 3 last, while a short note on some curious appearances undergone by comet Swift includes six drawings by M Lorenzo Kropp, taken between March 18 and April 25, and the three photographs taken at the Lick Observatory by Mr Barnard, all of which indicate the results of tremendous actions, whether they be due to the influences of different forces, "attraction, repulsion, chaleur, électricité, or changements d'état, qui agissement sur ses astres gazeux dans leur voisinage du soleil" M Weinck of Prague describes the results of his examination of the Lick negatives with reference to the lunar crater Flammarion, and gives a drawing (which, by the way, can be well seen by half closing the eyes) of its surroundings, together with the three new craters. This number also includes a general summary of the meteorology of the preceding year, the results being given in diagrammatic form, bringing out clearly the diurnal and monthly changes

JUPITER'S FIFTH SATELLITE —Mr Barnard, who has been continuing his observations with respect to the fifth satellite of Jupiter, communicates the results he has obtained to the *Astronomical Journal* (Nos 285-86) The values of the elongation distances deduced from the measures at elongations are, for eastern elongation, 48″ 089 (± 0 061), and for western elongation, 47″ 621 (± 0 176), the probable errors of a single determination being ± 0″ 23 and ± 0″ 47 respectively These values are equivalent to the following distances —

E.	elongation	112,500 ± 143 miles
W	,,	111,412 ± 412 ,,

The values for the period he gives as

		h	m	s
September 10–October 21	P =	11	57	23·72
September 10–October 28	P =	11	57	23 30
September 10–November 20	P =	11	57	22 73

the mean, when proportional weights are applied, being—

11h. 57m. 23·06s

Among some other figures which Mr Barnard gives are —

Hourly motion	30° 111
Velocity in orbit	16·4 miles per second
Equatorial Hor. Par	21° 51′
Distance from surface of Jupiter	67,000 miles (about)

While working at this satellite he has also been led to measure the equatorial and polar diameters of Jupiter himself, and the following numbers show the values he has deduced, the observations being made through smoked glass :—

Equatorial diameter	89,790 ± 65 miles
Polar ,,	84,300 ± 80 miles

GEOGRAPHICAL NOTES

THE *Times* Berlin correspondent furnishes some interesting notes of Dr. Baumann's recent journeys in the region of the Nile sources, which confirm Mr Stanley's identification of the Mountains of the Moon In Urundi the kings were supposed to be lineal descendants of the moon, and the white traveller was hailed as being the returned ghost of a lately-deceased chief On September 11 the expedition crossed the Akenyaru, which is not, as supposed, a lake, but a river, though the name "Nyanza" is often applied to it Dr Baumann also discovered that the so called Lake Mworengo is in reality a river which flows into the Akenyaru, and came to the conclusion that there was no extensive sheet of water in Ruanda or North Urundi. On September 19 Dr Baumann arrived at the source of the Kagera (Alexandra Nile), which rises at the foot of the precipitous and wooded hills which form the watershed between the basins of Rufizi and the Kagera This mountain chain is known to the natives by the name of the "Mountains of the Moon," and is held in peculiar reverence by them Here Dr Baumann maintains the real source of the Nile to be, for if "it be acknowledged that the Kagera is the chief feeder of the Victoria Nyanza, it follows that the headwaters of the Nile can be none other than those of the Kagera itself in the Mountains of the Moon in Urundi, within the boundaries of German East Africa"

THE often-discussed scheme of an expedition to the North Pole by way of Franz Josef Land has been revived by Mr F. G Jackson, who proposes to lead an expedition next summer, if the means for equipping a ship are forthcoming Mr. Jackson's plan is to travel with a small party, and establish a chain of depots northward from the most northerly accessible landing-place in Franz Josef Land He would remain during winter in the most advanced post, and push on each summer with dog sledges, until the pole is reached The plan rests on the hypothesis of Franz Josef Land extending to the pole, just as Dr Nansen's rests on the hypothesis of a transpolar current, but the evidence of the great extension of the land is not very satisfactory Mr Jackson's previous Arctic experience is not stated, nor is there any indication given as to whether he intends to travel at his own expense or to appeal for pecuniary help

THE British South African Company have reserved the Zimbabwe Ruins and the area within a radius of one mile from the top of Zimbabwe Hill for archæological and scientific purposes, and no settlements, farms, or mines will be permitted within that radius

A BEAUTIFULLY illustrated report on the regulation of Swiss torrents, by the late M de Salis, has recently been published by the Swiss Government The natural erosion and surface change which go on at the present day so rapidly among the steep slopes of a mountainous country as to be frequently cataclysmic in their intensity, have to be avoided or endured in inhabited regions A frequent source of floods is the damming up of a large river by the mud and stones brought down by a freshet in a small tributary The method of combating this effect is to build a succession of weirs, and cut a parallel canal so that the sediment is caught and the overflow regulated before the escaping water reaches the main valley.

MR. MACKINDER'S fourth Royal Geographical Society's educational lecture, delivered last week, dealt with Central Asian trade- and travel-routes, under the title of "The Gates of India and China."

TWENTY YEARS IN ZAMBESIA.

MR F C SELOUS, the famous hunter and explorer of South Central Africa, gave a summary of his travels to the Royal Geographical Society on Monday evening His address was illustrated by an exhibition of unusual interest in the tea-room, where a large collection of stuffed specimens of the characteristic African mammalian fauna was arranged Photographs and various objects illustrative of the rapid development of Mashonaland since the Chartered Company took possession were also shown.

Mr. Selous commenced his African wanderings in 1871, and except for occasional visits to England he has travelled and traded in that continent ever since In 1872 he and some companions penetrated into Matabeleland to hunt elephants, and had an amusing interview with the chief, Lo-Bengula. Although at that time not an explorer in the scientific sense, the accurate memory of his early wanderings over the country enabled Mr.

Selous to successfully guide the Pioneer Force of the Chartered Company in 1890, when they took possession of Mashonaland

With regard to the health of Zambesia he says —"Owing to severe exposure to wet and cold during several days and nights, in the early part of 1872, I got an attack of fever and ague in Griqualand so that I was handicapped before starting for the interior This fever and ague was exactly what I have seen people get on the high plateau of Mashonaland, during the last few years, from similar exposure to rain and cold It took me some time to shake off, and was still in my system when I reached Matabeleland, but the attacks only came on when I halted anywhere for a few days During November and December, 1872, hunting down in the low hot country towards the Zambesi, I was again very much exposed to wet, and on several occasions lay out all night long, without any shelter, drenched through with such heavy rain that it put out the largest fire and converted hard ground into a swamp I naturally again got soaked with fever poison, but as long as I remained hunting the disease did not show itself Directly I got back to Bulawayo it broke out, and during a month or so I had several sharp attacks By that time, however, my sound constitution had choked all the fever germs, and from that day until in 1878, when very severe exposure in Central Africa once more filled me up with malarial poison, I do not remember ever to have had one single hour's illness, or to have taken one drop of medicine The life I led was, however, if a very hard, at any rate, in many respects, a very healthy one, for the most part I ate nothing but meat and Mashona rice, and drank nothing but tea, usually without milk and sugar—not because I like it so, but because those adjuncts were unobtainable"

North of the Zambesi Mr Selous made several journeys among the Batongas, and spent a wretched rainy season, almost without equipment, on the Manica table land After the rains the country looked charming The young grass, thanks to the recent heavy rain, had shot up one foot or eighteen inches in height over hill and dale, every tree and shrub was in full leaf, and everything looked green, and fresh, and smiling Many of the shrubs on the edge of the hills bore sweet smelling flowers, and, as on all the plateaus of the interior of Africa, small but beautiful ground-flowers were very abundant

Interesting observations were made on some of the northern rivers The curious phenomenon of the steady rise of the waters of the Chobe and Machabi—an outlet of the Okavango—was observed from the first week in June until the last week in September, when they commenced to recede That the Okavango and the Upper Kwando are connected on their upper courses, there can be little doubt, as the waters of the Machabi went on rising suddenly *pari passu* with the Chobe, until the end of September, when both commenced to recede simultaneously

The explanation of this remarkable phenomenon is difficult, as there are no snow mountains at the sources of the Kwando and Okavango rivers and the Zambesi, which rises in the same latitude, decreases steadily in volume from day to day during the dry season like almost all other rivers in South Central Africa Besides the channels which still become annually filled with water from the overflow of the Chobe and Okavango river systems, there are many others which are now quite dry, but in which the natives say they once used to travel in canoes

From 1882 the journeys acquired additional geographical importance, and Mr Selous proceeded to rectify the maps of Mashonaland laid down by earlier travellers, taking constant compass bearings, sketching the course of rivers, and fixing the position of the junction of tributaries. The value of this work was made manifest in a magnificent large scale map of the country, drawn as well as surveyed by Mr. Selous, which was used to illustrate the lecture It would be impossible, without practically reproducing the whole address, to do justice to the immense variety and solid value of the contributions to African geography made by this most energetic of pioneers, or to the thrilling adventures, the recital of which was listened to with breathless attention and greeted with the heartiest applause With the exception of a treacherous night attack made upon his camp by the Mashuku-sumbwe, led by a few rebel Marotse, in 1888, he had never had any other serious trouble with the natives During his twenty years' wanderings he went amongst many tribes who had never previously seen a white man, and he was always absolutely in their power, as he seldom had more than from five to ten native servants, none of whom were ever armed.

THE DISTRIBUTION OF POWER BY ELECTRICITY FROM A CENTRAL GENERATING STATION

ON Friday evening, the 3rd inst, Mr A Siemens delivered at the Royal Institution an interesting lecture on the ways in which science is applied to practice In the course of the lecture he made the following remarks on the distribution of power by electricity from a central generating station —

Before entering further into this, let me remind you that the earliest magneto-electric machines were used nearly sixty years ago for the production of power I will mention only Jacobi's electric launch of 1835 as an example It must, therefore, be considered altogether erroneous to ascribe the invention of the transmission of power to an accident at the Vienna Exhibition in 1873, when, it is said, an attendant placed some stray wires into the terminals of a dynamo machine, it began to turn, and the transmission of power was first demonstrated As a matter of fact, Sir Wm Siemens once informed me, that his brother Werner was led to the discovery of the dynamo electric principle by the consideration that an electro-magnetic machine behaved like a magneto electric machine, when a current of electricity was sent into it, viz both turn round and give out power It was, of course, well known that a magneto electric machine produces a current of electricity, when turned by mechanical power, and Werner concluded that an electro magnetic machine would behave in the same manner We all know that he was right, but I relate this circumstance only as a further proof that the generation of power by electric currents has been a well-known fact long previous to the Vienna Exhibition

Another well-known instance of transmission of power to a distance is furnished by the magneto-electric ABC telegraph instruments, where the motion at the sending end supplies the currents necessary to move the indicator at the receiving station

As an illustration of the distribution of power by electricity, I will briefly describe some radical alterations that have been made at the works of Messrs Siemens Brothers and Co, by the introduction of electric motors in the place of steam engines

[A diagram on the wall showed in outline the various buildings in which work of different kinds is carried on with the help of different machines]

Electric motors are supplying the power, sometimes by driving shafting to which a group of tools is connected by belting, and sometimes by being coupled direct to the moving mechanism Each section of the works has its own meter, measuring the energy that is used there, and all of them are connected by underground cables to a central station, where three sets of engines and dynamos generate the electric current for all purposes There are two Willans and one Belliss steam engines, each of 300 horse-power, coupled direct to the dynamos, and running at a speed of 350 revolutions per minute Room is left for a fourth set, but including some auxiliary pumps and the switchboards for controlling the dynamos and for distributing the current, the whole space occupied by 1200 horse-power measures only 32 × 42 feet Close by are the condensers and three high-pressure boilers, which have replaced some low pressure ones formerly used for some steam engines driving the machinery in the nearest building

The advantages that have been secured by the introduction of electric motors may be briefly stated under the following heads —

1 Various valuable spaces formerly occupied by steam engines and boilers have been made available for the extension of workshops, and these are indicated on the diagram by shading.

2 By abolishing to a great extent the mechanical transmission of power a considerable saving is effected in motive power, which is especially noticeable at times when part only of the machinery is in use

3 As the electric motors take only as much current as is actually required for the work they are doing, a further saving is effected, and at the same time the facility with which the speed of the motors can be altered without their interfering with each other presents a feature that is absent from mechanical transmission

4. The big steam engines being compound and condensing, produce a horse-power with a smaller consumption of fuel than the small high-pressure steam engines scattered throughout the works.

5 The numerous attendants of the old steam engines and boilers have mostly been transferred to other work, only a few of them are required at the central station, and one or two men can easily look after all the electric motors used in the various parts of the works

Elsewhere equally favourable results have been obtained by the introduction of electrical distribution of power, and in this respect I beg to refer you to a paper read before the German Institution of Civil Engineers by Mr E Hartmann in April of last year, and to a paper read by Mr Castermans before the Society of Engineers in Liège, in August last, in which he compares in detail various methods of transmission of power, of which the electrical one was adopted for a new small arms factory.

We may therefore take it for granted that the advantages alluded to above have not resulted from local circumstances at Woolwich, but that they can be realised anywhere by the adoption of the electric current for distributing power from a central station

At first sight this result appears to be of interest only to the manufacturer, but the development of this idea may lead to far-reaching consequences, when we consider that cheap power is one of the most important requisites for cheap production

While power was generated by steam engines the cost of producing one-horse power varied a good deal in the different parts, and the various owners could not have obtained their power on equal terms, those possessing the largest steam engines having a distinct advantage This inequality is done away with altogether when the power is distributed by electricity, as the current can be supplied for large or small powers at the same rate per Board of Trade unit It is therefore clear that the establishment of central stations for the generation of electricity on a large scale will bring about the possibility of small works competing with large works in quite a number of trades where cheap power is the first consideration

Another circumstance favouring small works is the diminution of capital outlay brought about by the employment of electric motors Not only are the motors cheaper than boilers and steam engines of corresponding power would be, but the outlay for belting and shafts is saved, and the structure of the building need not be as substantial as is necessary where belts and shafting have to be supported by it A commencement has already been made in this direction by the starting of electric light stations, where the owners do all in their power to encourage the use of the current in motors, in order to keep the machinery at their central station more uniformly at work. The introduction of electricity as motive power will apparently present a strong contrast to the effect steam has had on the development of industries for the reasons already stated, and in addition there are many cases where the erection of boilers and steam engines, or even of gas engines, would be inadmissible on account of want of space or of the nuisances that are inseparable from them Motive power will therefore be available in a number of instances where up to the present time no mechanical power could be used, but the work had to be done by manual labour or not at all.

You may have noticed that I have confined my remarks hitherto to the case of distributing electricity over a limited area, but that I have not yet discussed the question of transmitting power to a great distance

Theoretically we have been told over and over again that the motive power of the future will be supplied by waterfalls, and that their power can be made available over large areas by means of electric currents. As a prominent example the installation is constantly mentioned by which the power of a turbine at Lauffen was transmitted over a distance of 110 statute miles to the Frankfurt Exhibition with an efficiency of 75 per cent. No doubt this result is very gratifying from a purely scientific point of view, but unfortunately in practical life only commercially successful applications of science will have a lasting influence, and in this respect the Lauffen installation left much to be desired. On the one hand science tells us that the section of the conductor can be diminished as the pressure of electricity is increased, and it appears to be only necessary to construct apparatus for generating electricity at a sufficiently high pressure so as to reduce the cost of a long conductor to reasonable limits. On the other hand, experience shows that at these high potentials the insulation of the electric current becomes a most difficult problem, and for practical purposes difficulty means an increased outlay of money.

MAGNETICAL AND METEOROLOGICAL OBSERVATIONS MADE AT THE GOVERNMENT OBSERVATORY, BOMBAY, 1890, WITH AN APPENDIX

THIS volume, we are informed, is the thirtieth of the series of "Bombay Magnetical and Meteorological Observations," extending the previous record from 1845 to 1889, up to 1890 At this well-organized observatory, under the direction of Mr Charles Chambers, continuous registration of the different magnetical and meteorological elements is maintained by means of automatic recording instruments, of which there are five sets, the magnetographs (three), the barograph, the thermograph, the pluviograph, and the anemograph, all being photographic records excepting that of the anemograph, which is mechanical In addition eye observations are also made, including the usual meteorological observations of weather and other phenomena Daily values for 1890 are given of atmospheric pressure, temperature of the air, rainfall, wind and cloud, with some further discussion of the anemometric results, five day means of meteorological elements are also given In the magnetic section is found observations of absolute horizontal force, magnetic declination and dip, at short intervals throughout the year And in the appendix is contained a collection of the monthly values of declination and horizontal force from 1868 to 1890, accompanied by a discussion of the secular changes of these elements In regard to declination the results show the eastern magnetic declination to have increased during the early years of the series, arriving at a maximum at about the middle of the period, and decreasing in the later years Taking the annual values of declination to be represented by the formula $\delta = at^2 + bt + c$, it is found that the maximum easterly declination occurred in 1880, with value 0° 57′ 17″ This actual observation of the turning-point at this place, in the long cycle of change, is very interesting The horizontal force values are similarly discussed, but in this case the values are generally progressive There is no discussion of diurnal inequalities, but these were elaborately treated in a previous volume Magnetic observatories in tropical and southern regions are valuable Many exist in Europe with others scattered over different parts of the northern hemisphere, generally publishing with regularity their results, but there is a want of similar establishments in southern regions There are magnetic observatories at Batavia, Mauritius, and Melbourne, but we do not get from them all that might be desired England possesses no regularly maintained southern establishment of this kind A magnetic observatory existed many years ago at the Cape of Good Hope, which, long since destroyed, we believe, by fire, was never again reorganized, which was unfortunate The attention of the Magnetic Committee of the British Association was several years ago drawn to the question of re establishing the Cape Magnetic Observatory, and in the Report of the Committee for the year 1891 it is stated that a representation had been made to the Admiralty as to the desirability of so doing An efficient magnetic observatory in such a position, with regular publication of the results, would provide information of great value for the discussion of various questions in magnetic phenomena that now arise. It would be well also if the study of earth currents were taken up at some of the magnetic observatories in different parts of the world by continuous photographic registration thereof, for the better elucidation of the physical relation that may exist between magnetic and earth current variations, in regard to which our knowledge seems at present to be so imperfect

BACTERIA AND BEER

THE examination of water for micro-organisms since the publication by Koch in 1881 of his beautiful process of gelatine-plate cultures has come more and more into general use, as the public has gradually become cognisant of its value for hygienic and practical purposes But whilst affording much valuable information on many subjects, Hansen has pointed out, as far back as 1888, that as applied to the examination of waters for brewing purposes it cannot be considered wholly satisfactory Working on lines suggested by Hansen, Holm has recently published a paper, "Analyses biologiques et zymotechniques de l'eau destinée aux brasseries" (*Compte-rendu des travaux du laboratoire de Carlsberg*, vol iii, Copenhagen, 1892), in which he describes a large number of investigations on brewing waters examined by Hansen's method, and in which the relative merit for brewing

purposes of Koch's and Hansen's processes is also discussed It is obvious that the organisms to be feared in a brewery are those which will flourish in wort or beer, and that the mere knowledge of the number of bacteria in any given water as revealed by gelatine plate cultures is but of little use Hence Hansen and his pupils reject for such examinations gelatine-peptone, substituting sterilised wort and beer as a culture material. An interesting table is given showing the different bacteriological results obtained in the use of gelatine-peptone, gelatine to which wort had been added, wort alone, and beer For example, whereas a particular brewing-water yielded by gelatine-peptone about 8000 colonies per c.c., the majority of which were bacteria, gelatine mixed with wort gave about 14, all being moulds, in wort 5 4 were found, consisting of bacteria and moulds, whilst sterilised beer gave only 0 8 for the c c, and only moulds Holm points out that to estimate the value of a water for brewing purposes a note should also be made of the rate at which the organisms develop in the wort or beer, for should signs of growth only declare themselves after four or five days in the laboratory under favourable conditions of temperature and in the absence of competing forms, it is not unnatural to expect that their vitality, under the more rigorous conditions imposed during brewing operations, would be so far impaired that their development, if taking place at all, would only be accomplished with great difficulty Although instances occurred in which even after the lapse of seven days growths first made their appearance, yet in the majority of cases the incubation of the wort-flasks for one week was sufficient Holm is of opinion that the use of other culture materials besides wort is unnecessary, as all the organisms which successfully develop in beer can also grow in wort Moreover, it was found that in the process of sterilisation to which the beer was submitted a considerable proportion of its alcohol was lost, thus diminishing its natural bactericidal properties A beer containing 5 to 6 per cent of alcohol, after sterilisation, had this reduced to 2 8 per cent, although it even then proved a very unfavourable medium for the development of ordinary water bacteria As a practical outcome of his experiments Holm emphasises the necessity of a careful selection of the site for the erection of the water reservoir attached to a brewery The reservoirs of the old brewery at Carlsberg are placed in the immediate vicinity of the storehouses for grain and malt, consequently in this water a far larger number of moulds were met with than in the water examined from differently situated reservoirs supplying the laboratory and another brewery But although moulds usually predominate, yet they are not so much to be feared as the bacteria, more especially those which are found in the fermentation chamber, for although they are unable to assert themselves to any considerable extent in the beer preserved in the store cellar, yet when it is drawn off and thus aerated, and the temperature raised by its transference to bottles or small casks, these organisms can develop with an astonishing rapidity, and produce great mischief

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Dr. Shore, of St John's College, late Examiner in Physiology, has been elected a member of the Special Board for Medicine, Dr. A Macalister, F R S, St John's, has been appointed an elector to the Professorship of Chemistry; Dr Ferrers, F R S., Master of Gonville and Caius, an elector to the Plumian Professorship of Astronomy, Prof. Newton, F R.S., Magdalene, an elector to the Professorship of Anatomy; Dr. Phear, Master of Emmanuel, an elector to the Professorship of Botany, Dr. R D Roberts, Clare, an elector to the Woodwardian Professorship of Geology, Mr P. T Main, St. John's, an elector to the Jacksonian Professorship of Chemistry, &c.; Mr. R. T. Glazebrook, F.R.S., Trinity, an elector to the Professorship of Mineralogy; Mr F Darwin, F R S, Reader in Botany, an elector to the Professorship of Zoology and Comparative Anatomy; Mr W. D Niven, F.R S, Trinity, an elector to the Cavendish Professorship of Physics, Dr Phear, an elector to the Professorship of Mechanism; Prof. Liveing, F R S, St John's, an elector to the Downing Professorship of Medicine; Dr P. H. Pye-Smith, F R.S, an elector to the Professorship of Physiology; and Sir G. M. Humphry, F.R.S., an elector to the Professorship of Pathology

SCIENTIFIC SERIALS.

American Journal of Science, February —Isothermals, isopiestics, and isometrics relative to viscosity, by C Barus The substance experimented upon was marine glue, and its viscosity at different pressures and temperatures was measured by a transpiration method, the substance being forced through steel tubes 10 cm long and 0 5 to 1 cm in diameter under pressures as high as 2000 atmospheres It was found that in proportion as the viscosity of a body increases with fall of temperature, its isothermal rate of increase with pressure also increases. Speaking approximately, the rate at which viscosity increases with pressure at any temperature is proportional to the initial viscosity at that temperature, and, conversely, the rate of decrease with temperature is proportional to the actual temperature and independent of the pressure An interesting result is that in high pressure phenomena at least 200 atmospheres must be allowed per degree Centigrade, in order that there may be no change of viscosity —"Potential," a Bernoullian term, by Geo F Becker —Datolite from Loughboro, Ontario, by L. V Pirsson —A new machine for cutting and grinding thin sections of rocks and minerals, by G H Williams —Stannite and some of the alteration products from the Black Hills, S D, by W. P Headden —Occurrence of hematite and martite iron ores in Mexico, by R. T Hill, with notes on the associated igneous rocks, by W Cross —Cæsium lead and potassium-lead halides, by N L Wells.—Ceratops beds of Converse County, Wyoming, by J B Hatcher — Use of planes and knife-edges in pendulums for gravity measurements, by T C Mendenhall. The employment of a pendulum to which the plane is attached instead of the knife-edge presents several advantages The plane may be accurately adjusted at right angles to the rod by simple optical methods A pendulum carrying a plane instead of a knife-edge is vastly less liable to injury, and the knife-edge being no longer an integral part of the vibrating mass can be reground or replaced at will The length of the pendulum is more capable of accurate determination, since the error introduced by the yielding of the edge under pressure is eliminated The disadvantage due to the uncertain position of the axis of oscillation can be mechanically got rid of by a proper construction of the raising and lowering apparatus, and experiment shows that the period in the course of twelve sets of swings of an hour each does not vary by as much as one part in a million The best angle for the knife edge was found to be about 130°, the material used being agate —Preliminary note on the colours of cloudy condensation, by C Barus If saturated steam is allowed to pass suddenly from a higher to a lower temperature in uniformly temperatured, uniformly dusty air, a succession of colours is seen by transmitted white light which, taken in inverse order, are absolutely identical with the colours of Newton's rings of the first two orders.—Lines of structure in the Winnebago Co meteorites and in other meteorites, by H. A Newton (reprinted in this issue) —Preliminary note of a new meteorite from Japan, by Henry A Ward —Restoration of Anchisaurus, by O. C Marsh (see Note, p. 349).

American Journal of Mathematics, vol. xiv. No 4 (Baltimore, 1892) —The main object of the note on the use of supplementary curves in isogonal transformation, by R. A. Harris (pp. 291–300), is to show how the problem of representing one plane conformably upon another, using any real function of the variable, may be made to depend upon the problem of constructing supplementary curves from given tracings of the corresponding principal curves. It is well illustrated by four carefully drawn figures In her memoir (pp 301–325) on the higher singularities of plane curves, Miss C. A. Scott goes over ground to some extent previously occupied by Profs Cayley and H. J S Smith in writing on the same subject (*cf* also papers by Brill and Nother in the *Math. Annalen*, vols. ix. xvi. xxiii) Nother's results are presented in analytical form, "involving no dependence on geometrical ideas even when geometrical terms are used." The author brings out his results more clearly by making use of Dr Hirst's method of quadric inversion. The text is accompanied by twenty-seven drawings of curves. Mr. W. H. Metzler, writing on the roots of matrices (pp 326–377), employs a modification of Dr. Forsyth's method of proving Cayley's "identical equation" ("Messr of Mathematics," vol. xiii.) to prove Sylvester's law of latency and Sylvester's theorems. He also investigates the existence of roots of matrices for different indices, and in particular the roots of nilpotent matrices. A

careful analysis of the contents is prefixed to the memoir Dr F N Cole (pp 378–388) discusses the simple groups from order 201 to order 500, and arrives at the conclusion that "the possible orders of simple groups of compound order between 201 and 500 are reduced to 360 and 432" The volume closes with a note (p. 389) by M M. D'Ocagne, correcting a slight mistake in a memoir by him in the 1888 volume, entitled "Sur certaines courbes," and the title page and index

SOCIETIES AND ACADEMIES

LONDON

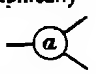
Royal Society, February 2 —"On a Meteoric Stone found at Makariwa, near Invercargill, New Zealand" By G H F. Ulrich, Professor of Mining and Mineralogy in the University of Dunedin, N Z Communicated by Prof J W Judd, F R S

The specimen described in this memoir was found in the year 1879 in a bed of clay, which was cut through in making a railway at Invercargill, near the southern end of the Middle Island of New Zealand Originally, this meteorite appears to have been about the size of a man's fist, and to have weighed four or five pounds, but it was broken up, and only a few small fragments have been preserved The stone evidently consisted originally of an intimate admixture of metallic matter (nickel-iron) and of stony material, but much of the metallic portion has undergone oxidation Microscopic examination of thin sections shows that the stony portion, which is beautifully chondritic in structure, contains olivine, enstatite, a glass, and probably also magnetite, and through these stony materials the nickel-iron and troilite are distributed The specific gravity of portions of the stone was found to vary between 3 31 and 3 54, owing to the unequal distribution of the metallic particles A partial chemical examination of this meteorite was made by the author and Mr James Allen, but the complete analysis has been undertaken by Mr. L. Fletcher, F.R.S, of the British Museum The analysis, which when finished will be communicated to this Society, has gone so far as to show that the percentage mineral composition of the Makariwa meteorite may be expressed approximately by the following numbers nickel-iron 1, oxides of nickel and iron 10, troilite 6, enstatite 39, olivine 44.

Physical Society, January 27 —Walter Baily, Vice President, in the chair —Prof. S P Thompson, F R S, made a communication on Japanese magic mirrors, and exhibited numerous specimens showing the magic properties. Referring to the theory of the subject, he said the one now generally accepted was that proved by Profs. Ayrton and Perry in 1878, who showed that the patterns seen on the screen were due to differences in curvature of the surface The experiments he now brought forward fully confirmed their views. Brewster had maintained that the effects were due to differences of texture in the surfaces causing differences in absorption or polarisation, but the fact that the character of the reflected image depended on the convergency or divergency of the light, and on the position of the screen, showed this view to be untenable Another proof of the differing curvature theory was then given by covering a Japanese mirror with a card having a small hole in it. On moving the card about, the disc of light reflected from the exposed portion varied in size, showing that the curvatures of portions of the surfaces were not the same. The same fact was proved by a small spherometer, and also by reflecting the light passing through a coarse grating from the mirror, the lines being shown distorted. To put the matter to a test demanded by Brewster, he had a cast taken from a mirror by his assistant, Mr. Rousseau; this had been metallised, silvered, and polished, and now gave unmistakable evidence of the pattern reflected from the original. The true explanation of how the inequalities of curvature were brought about during manufacture had also been given by Profs. Ayrton and Perry, but there were some questions of detail on which difference of opinion might exist. The late Prof. Govi had noticed that warming a mirror altered its possibilities. A thick mirror which gave no pattern whilst cold developed one on being heated, was shown to the meeting. Prof. Thompson also showed that a glass mirror having a pattern cut on the back developed magic properties when the mirror was bent. When made convex the reflected pattern was dark on a light ground, and when made concave, light on a dark ground. Warming ordinary mirror-glass by a heater whose surface was cut to a pattern gave similar effects. Very thick glasses could be affected in this way On passing a spirit lamp behind a strip of mirror, a dark band could be caused to pass along the screen illuminated by light reflected from the mirror By writing on lead foil and pressing the foil against a glass mirror by a heater, the writing was caused to appear on the screen Prof Thompson had also found that Japanese mirrors which are not "magic" when imported, could be made so by bending them mechanically so as to make them more convex In conclusion, he showed a large mirror 15″ × 11″, the reflection from which showed the prominent parts of the pattern on its back with the exception of two conspicuous knobs, these knobs gave no indication of their existence Prof Ayrton said the simple mechanical production of the magic property described by Prof Thompson led him to think that some experiments on "seeing by electricity" by the aid of selenium cells which Prof Perry and himself made some years ago, might lead to some result if repeated with thinner reflectors Speaking of the effect of scratching the back of a Japanese mirror, he pointed out that if metal be removed by pressure a bright image was seen, whilst if removed chemically a dark image resulted. Since the original paper on the subject was written he had been led to modify his views as to the effect of amalgamation, for some time ago he showed the society how brass bars were bent if one edge be amalgamated, thus proving that enormous forces were developed He now regarded amalgamation as an important part of the manufacture Mr Trotter inquired if it had been proved that there was no difference in the metal in the thick and thin parts? One would expect the thin parts to be harder and polished away less. After some remarks by Mr. J W Kearton and Major Rawson, Prof Thompson said the magic effects produced by heating the back of a glass mirror remained for a short time after the heater was removed The question of whether differences in hardness of the thick and thin parts of a mirror were of consequence in the production of the magic property had been tested by using sheets of brass thickened by pieces soldered to the back as mirrors, and found to be unimportant. Prof Ayrton also described an experiment pointing to the same conclusion —Mr W F Stanley read a paper on the functions of the retina—(1.) The Perception of Colour Referring to Young's three nerve theory of colour-sensation, the author said Prof Rutherford had pointed out that there was no necessity to assume that different nerves conveyed different colour-sensations, for as a telephone wire would transmit almost an infinite variety of sound vibrations, so the nerves of the retina were probably equally capable of conveying all kinds of light vibrations Prof Rutherford had further pointed out that the image of a star could not possibly cover three nerve-terminals at once, and therefore could not be seen as white if Young's theory was correct The author then described Helmholtz's experiments with a small hole in a screen illuminated by spectrum colours For red illumination the greatest distance at which the hole could be seen sharply defined was 8 feet, and for violet 1½ feet When the hole was covered with purple glass, or with red and violet glasses superposed, and a bright light placed behind, the eye, when accommodated for red light, saw a red spot with a violet halo round it, and when focussed for violet light, saw a violet spot with circle of red These experiments the author thinks show that the chromatic sense in distinct vision under critical conditions (i e where a single nerve or a small group of nerves is concerned) depends on the colours being brought to foci at different distances behind the crystalline lens He also infers that the same focal position in the eye cannot convey simultaneously the compound impression of widely separated colours Helmholtz's observations are further examined in the paper, and a series of zoetrope and colour disc experiments described which tend to show that the eye cannot follow rapid changes of colour. Changes from red to violet could be followed much more quickly than from violet to red. The red impressions were, however, more permanent The observed effects were found to depend on the intensity of the light, and also on the distance of the eye from the coloured surface. Summing up his observations, the author infers that by systems of accommodation of the eye, the colours of the spectrum are brought to focus on special parts or points of the rods or cones of the retina, such focal points being equivalent, by equal depths or distances from the crystalline lens, to a focal plane formed across the whole series of nerve terminals. That all the rays of light from an object, or part of an object, of very small area and of any spectrum colour, will converge to

a point upon a nerve terminal, and that this terminal will be most excited by the light At the end of the paper Dr Stanley Hall's views of nerve structure are examined Captain Abney thought the results of the zoetrope experiments were what one would have expected when pigmentary colours were used To be conclusive, such experiments must be conducted with pure spectrum colours The statement about the size of star images being less than that of a nerve terminal would probably need revision Speaking of colour vision, he said the modern view was to regard light as producing chemical action in the retina, which action gave rise to the sensation of colour On the author's theory he could not see how colour-blindness could be explained Mr Trotter said he understood Helmholtz to have proved that nerves could distinguish quantity, but not the quality of a stimulus Since the speed at which stimuli travelled to the brain was about 30 metres a second, the wave length of a light vibration, if transmitted in this way, would be very small Taking Lord Kelvin's estimate of the minimum size of molecules of matter, it followed that there must be many wave lengths in the length of a single molecule This, he thought, hardly seemed possible Mr Lovibond pointed out that the observations referred to by the author could be equally well explained on the supposition that six colour sensations existed The confusion of colours he had mentioned arose from lack of light Mr Stanley replied to some of the points raised by Captain Abney In proposing a vote of thanks to Mr Stanley, the chairman said it had been shown that light could be resolved into three sensations, but it was not known how this resolution occurred Prof S P Thompson said the gist of Mr Stanley's paper seemed to be that lights of different colours were concentrated at points situated at different depths in the retina, the violet falling on the part nearest the crystalline lens, and the red furthest away Another view of the action was that the different sensations might be due to the vibrations of longer wave length having to travel greater distances along the nerve terminals before they were completely absorbed

Mathematical Society, January 12 —Mr A. B Kempe, F R S , President, in the chair —The President (Prof Elliott, F R S , Vice-President, in the chair) read a paper on the application of Clifford's graphs to ordinary binary quantics (second part) In the first part it was pointed out that by some small modifications and a recognition of the fact that the covariants of $f(x, y)$ are invariants of the two quantics $f(X, Y)$ and $(Xy - Yx)$, the theory of graphs, which had been left in an unfinished state by the late Prof Clifford, furnished a complete method of graphically representing the invariants (and therefore the covariants) of binary quantics The method as modified depends essentially on the fact that any invariant, when multiplied by a suitable number of polar elements U, U′, V, V′, &c , can be expressed as a "pure compound form" (or sum of two or more such forms), the product of a number of "simple forms" Each of the latter has a "mark," viz one of the letters $a, b, c,$ and has also a certain valence, 0, 1, 2, 3, &c and these being given it is fully defined, *e g* , the simple form of mark a and valence 3 is graphically



having three radiating bonds, and is algebraically

$$a_0\,\mathrm{UVW} + a_1\,(\mathrm{U'VW} + \mathrm{UV'W} + \mathrm{UVW'}) + a_2\,(\mathrm{UV'W'} + \mathrm{U'VW'} + \mathrm{U'V'W}) + a_3\,\mathrm{U'V'W'},$$

the pairs of polar elements U, U′; V, V′; and W, W′, corresponding to the three bonds of the graphical representation A pure compound form is graphically represented by a number of simple forms having their bonds connected so that there are no free ends. If in the algebraical expression of a compound form two simple forms both contain the pair of polar elements U, U′, there will be a bond connecting their graphical representations; if the two simple forms both contain two pairs of such elements, viz. U, U′ and V, V′, there will be two bonds connecting their graphical representations and so on ; if they contain no common pair their graphical representations will have bond connecting them, A pair of polar elements will appear in two simple forms only, so that each bond in the graphical representation of a compound form corresponds to a distinct pair of polar elements If the algebraical expression corresponding to a graph be multiplied out, it will be found to consist of two distinct factors, viz :—(1) the product of all the polar elements, and (2) a function of the letters a_0, a_1, a_2 , $b_0, b_1, b_2,$, &c , &c. , corresponding to the marks a, b, &c of the simple forms contained in the compound form represented by the graph, the latter factor being an invariant of the quantics

$$(a_0, a_1, a_2, \ldots a_\alpha)(x, y)^\alpha$$
$$(b_0, b_1, b_2, \ldots b_\beta)(x, y)^\beta$$
$$\&c., \&c$$

where α is the valence of the simple forms of mark a, which are here supposed to be all of the same valence, and similarly in the case of β, γ, &c

In this second part a method of algebraically representing invariants is considered, which is directly derivable from the method of the first part, and was suggested by the graphs, but differs essentially from the earlier method in that it is independent of the use of polar elements. It shows, moreover, that the graphs may be regarded as absolutely equivalent to the invariants they represent, in lieu of being equivalent to those invariants multiplied by a number of polar elements. This second method deals in the first instance with "primary" invariants, *i e* invariants of two or more quantics linear in the coefficients of each If these quantics are

$$(a_0, a_1, a_2, \ldots a_\alpha)(x, y)^\alpha$$
$$(b_0, b_1, b_2, \ldots b_\beta)(x, y)^\beta$$
$$\&c , \&c ,$$

and we take

$$a = a_1 \frac{d}{da_0} + a_2 \frac{d}{da_1} + a_3 \frac{d}{da_2} + \&c \quad \textit{ad infinitum}$$
$$b = b_1 \frac{d}{db_0} + b_2 \frac{d}{db_1} + b_3 \frac{d}{db_2} + \&c \quad \textit{ad infinitum}$$
$$\&c , \&c.$$

we may express any primary invariant by an expression, or the sum of two or more expressions, consisting of the product of differences of the operators a, b, operating upon the product of the corresponding leading terms, a_0, b_0, &c Thus

$$(a - b)^2 a_0 b_0 \equiv a_2 b_0 - 2a_1 b_1 + a_0 b_2$$

is an invariant of the two quantics

$$a_0 x^2 + 2a_1 xy + a_2 y^2,$$
$$b_0 x^2 + 2b_1 xy + b_2 y^2,$$

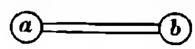
linear in the coefficients of each , and

$$(a - b)^2 (a - c) a_0 b_0 c_0 \equiv a_3 b_0 c_0 - a_2 b_0 c_1 - 2a_2 b_1 c_0 + 2a_1 b_1 c_1 + a_1 b_2 c_0 - a_0 b_2 c_1$$

is a similar invariant of the three quantics

$$a_0 x^3 + 3a_1 x^2 y + 3a_2 xy^2 + a_3 y^3$$
$$b_0 x^2 + 2b_1 xy + b_2 y^2$$
$$c_0 x + c_1 y$$

These two invariants are graphically represented by

 and 

respectively, where the relation between the algebraical and graphical expressions is obvious, viz to every letter p in the algebraical representation there corresponds a nucleus including the mark p, and to every factor $(p - q)$ in the algebraical representation there corresponds a bond connecting the nuclei of marks p and q

We can pass to invariants of higher degrees in the coefficients of the various quantics by substituting like coefficients for unlike Thus, if we make $b_0 = a_0$, $b_1 = a_1$, $b_2 = a_2$, the primary invariant

$$a_2 b_0 - 2a_1 b_1 + a_0 b_2$$

becomes the invariant of degree 2

$$2(a_0 a_2 - a_1^2)$$

of the single quantic

$$a_0 x^2 + 2a_1 xy + a_2 y^2.$$

This invariant will be graphically represented by substituting the mark a for the mark b in the graph representing the corresponding primary invariant

If we proceed to deal in the same way with the invariant,

$$a_3 b_0 c_0 - a_2 b_0 c_1 - 2a_2 b_1 c_0 + 2a_1 b_1 c_1 + a_1 b_2 c_0 - a_0 b_2 c_1,$$

we get, as the invariant represented by substituting for the marks b and c the mark a, the expression of the third degree,

$$a_3 a_0^2 - 3a_2 a_1 a_0 + 2a_1^3.$$

This is not an invariant of a single quantic, but of the three

$$a_0x^3 + 3a_1x^2y + 3a_2xy^2 + a_3y^3$$
$$a_0x^2 + 2a_1xy + a_2y^2$$
$$a_0x + a_1y$$

It bears, however, a definite relation to the first of these three quantics, viz it is a *seminvariant* of that quantic, being in fact the source of its cubic-covariant J The paper points out that all seminvariants are thus invariants of two or more quantics, and can therefore be represented by graphs, the difference between a graph representing an invariant of a quantic and one representing a seminvariant of the same quantic consisting merely in this, that the simple forms, *i e* the small circles or nuclei of the graphs in the former case are all of the same "valence," *i e* have the same number of bonds, while in the latter, though of like marks, they differ in valence The classification of seminvariants, according to the valences of the simple forms composing them, or, in other words, according to the orders of the quantics of the systems of which they are respectively invariants, obviously throws considerable light upon their structure

The paper also deals with the breaking up of graphs into simpler ones, and gives a theorem upon the subject which leads to some interesting results It points out, moreover, how the graphs representing the sources of covariants can be instantaneously derived from those representing the covariants themselves

On the evaluation of a certain surface integral and its application to the expansion of the potential of ellipsoids in series, Dr Hobson

On the vibrations of an elastic circular ring, by Mr A E H Love —The ring is supposed to be of small circular section of radius c, and the elastic central-line a circle of radius a There are four ways of displacing the ring A point on the central-line may move along the radius of the circle which is its primitive form, or perpendicular to the plane of this circle, or along the tangent to this circle, and the circular sections may be displaced by rotation about the central-line The modes of vibration fall into four classes, of which two are physically important —Class I. Flexural vibrations in plane of ring —These were investigated by Hoppe in 1871 (*Crelle*, bd lxxiii) The motion of a point on the elastic central line is compounded of a displacement in and out along the radius and a displacement along the tangent to the circle, so proportioned that the central-line remains unstretched, and the nodes of the former displacement are the antinodes of the latter There must be at least two wave-lengths to the circumference, and the frequency ($p/2\pi$) of the mode in which there are n wave-lengths to the circumference is given by the equation

$$p^2 = \tfrac{1}{4}\,\frac{n^2(n^2-1)^2}{n^2+1}\,\frac{E}{\rho_0}\,\frac{c^2}{a^4}$$

in which E is the Young's modulus, and ρ_0 the density of the material Except for the numerical coefficient this is precisely similar to the formula for the lateral vibrations of a straight bar of the same material and section and of length πa (for which the fundamental tone has the same wave-lengths). The sequence of component tones when n is very great is ultimately identical with that of the tones of a free-free bar of length πa, but the sequence for the low tones is quite different to that for a bar Class II Flexural vibrations perpendicular to the plane of the ring.—It is found to be impossible to make the ring vibrate freely so that each particle of the elastic central-line moves perpendicular to the plane of the ring, unless at the same time the sections turn about the central-line through a certain angle The flexure perpendicular to the plane of the ring is always accompanied by *torsion* As in Class I. there must be at least two wave-lengths to the circumference, and the frequency of the mode in which there are n wave-lengths to the circumference is given by the equation

$$p^2 = \tfrac{1}{4}\,\frac{n^2(n^2-1)^2}{1+\sigma+n^2}\,\frac{E}{\rho_0}\,\frac{c^2}{a^4}$$

where σ is the *Poisson's ratio* for the material and the other constants have the same meaning as before. (For most hard solids σ is about $\frac{1}{4}$.) Since n must be at least 2 the sequence of tones is very nearly the same as in the vibrations of Class I, but the pitch is slightly lower, the ratio of the frequencies for the gravest tones being $\sqrt{\frac{21}{20}}$, which is very little less than a *comma*. For the higher tones, as we should expect, there is no sensible difference These two classes include all that have much physical importance The remaining types can be classified as —Class III Extensional vibrations —The motion may be purely radial or partly radial and partly tangential In the second case there will be an integral number of wave lengths, and when this number is n we have the formula for the frequency

$$p^2 = (1+n^2)\,\frac{E}{\rho_0}\,\frac{1}{a^2}$$

Putting n = zero we find the frequency of the purely radial vibrations The pitch of any mode of extensional vibration of the ring is of the same order of magnitude as the pitch of the corresponding longitudinal vibration of a bar of length equal to half the circumference, the formula for the latter being in fact derived by writing n^2 for $1+n^2$ Class IV Torsional vibrations —The motion consists of an angular displacement of the sections about the elastic central line accompanied by a relatively very small displacement of the points on this line perpendicular to the plane of the ring When there are n wave-lengths to the circumference the frequency is given by the formula

$$p^2 = (1+\sigma+n^2)\,\frac{\mu}{\rho_0}\,a^2,$$

in which μ is the *rigidity* of the material There is one symmetrical mode for which n is zero, and since $2\mu(1+\sigma) = E$, the frequency of this mode is $\frac{1}{2}\sqrt{2}$ of that of the radial vibrations The pitch of the torsional vibrations is comparable with that for a straight rod of length equal to half the circumference, the formula for the latter being in fact derived by writing n^2 in place of $1+\sigma+n^2$ Formulæ equivalent to those given in connection with Classes II and IV have been obtained by Mr Basset (Proc Dec 1891), but he has not interpreted his results

Entomological Society, February 8.—Mr Henry John Elwes, president, in the chair —The President announced that he had nominated Mr F DuCane Godman, F R S, Mr Frederic Merrifield, and Mr George H Verrall as Vice Presidents during the Session 1893–1894.—Mr S Stevens exhibited a specimen of *Chærocampa celerio*, in very fine condition, captured at light, in Hastings, on September 26 last, by Mr Johnson —Mr A J Chitty exhibited specimens of *Gibbium scotias* and *Pentarthrum huttoni*, taken by Mr Rye in a cellar in Shoe Lane He stated that the *Gibbium scotias* lived in a mixture of beer and sawdust in the cellar, and that when this was cleaned out the beetles disappeared The *Pentarthrum huttoni* lived in wood in the cellar.—Mr McLachlan exhibited a large Noctuid moth, which had been placed in his hands by Mr R. H Scott, F R S., of the Meteorological Office. It was stated to have been taken at sea in the South Atlantic, in about lat 28° S., long. 26° W Colonel Swinhoe and the President made some remarks on the species, and on the migration of many species of Lepidoptera.—Mr W F H Blandford exhibited larvæ and pupæ of *Rhynchophorus palmarum*, L, the Gru-gru Worm of the West Indian Islands, which is eaten as a delicacy by the Negroes and by the French Creoles of Martinique. He stated that the existence of post-thoracic stigmata in the larva of a species of Rhynchophorus had been mentioned by Candèze, but denied by Leconte and Horn. They were certainly present in the larva of *R palmarum*, but were very minute —Mr. G T Porritt exhibited two varieties of *Arctia lubricipeda* from York, an olive-banded specimen of *Bombyx quercus* from Huddersfield, and a small melanic specimen of *Melanippe hastata* from Wharncliffe Wood, Yorkshire —Mr H Goss exhibited species of Lepidoptera, Coleoptera, and Neuroptera, sent to him by Major G H Leathem, who had collected them, last June and July, whilst on a shooting expedition in Kashmir territory, Bengal. Some of the specimens were taken by Major Leathem at an elevation of from 10,000 to 11,000 feet, but the majority were stated to have been collected in the Krishnye Valley, which drains the glaciers on the western slopes of the Nun Kun range Mr Elwes remarked that some of the butterflies were of great interest —Mr. G. F Hampson exhibited a curious form of *Parnassius*, taken by Sir Henry Jenkyns, K.C B, on June 29 last, in the Gasternthal, Kandersteg —Mr. J. M Adye exhibited a long series of remarkable varieties of *Boarmia repandata*, taken last July in the New Forest.—Mr C O Waterhouse exhibited a photograph of the middle of the eye of a male *Tabanus*, showing square and other forms of facets, multiplied twenty-five times.—Mr. R. Trimen, F.R.S., communicated a paper entitled "On some new, or imperfectly known, species of South African

Butterflies," and the species described in this paper were exhibited —Mr T D A. Cockerell communicated a paper entitled "Two new species of *Pulvinaria* from Jamaica."—Mr Martin Jacoby communicated a paper entitled "Descriptions of some new genera and new species of Halticidæ"

Linnean Society, February 2 —Prof Stewart, President, in the chair —On behalf of Mr Thomas Scott, the Secretary read a report on the entomostraca from the Gulf of Guinea, collected by Mr John Rattray —Mr H. Bernard gave an account of two new species of *Rhax*.—An important paper by Mr Arthur Lister, on the division of nuclei in the mycetozoa, gave rise to an interesting discussion, in which Dr D H Scott, Prof Howes, and others took part —This was followed by a paper on the structural differentiation of the protozoan body as studied in microscopic sections, by Mr J E Moore The meeting adjourned to February 16

PARIS

Academy of Sciences, February 6 —M de Lacaze-Duthiers in the chair —On the variations in the intensity of terrestrial gravitation, by M d'Abbadie Observations begun in 1837 at Olinda (Brazil), on the variations in the direction of gravitational force also made its constancy doubtful Experiments on falling bodies revealed irregularities similar to those described (last number) by M Mascart The closed barometer employed by the latter may be termed a *brithometer* —On the preparation of carbon under high pressure, by M. Henri Moissan (see article) —On the reproduction of the diamond, by M C Friedel Remarks by M Berthelot (see article) —On the pathogeny of diabetes, part played by the expenditure and the production of glycose in the deviations of the glycemic function, by MM. A Chauveau and Kaufmann The same inferiority of venous with respect to arterial blood, as regards the amount of sugar contained in it, occurs in all the deviations of the glycemic function produced by a lesion of the central nervous system This inferiority is equally pronounced in the hyperglycemia resulting from the extirpation of the pancreas.—On the progress of the art of surveying with the aid of photography, in Europe and America, by M A Lausedat Since 1888 a zone of twenty miles on each side of the Canadian Pacific Railway, in the neighbourhood of the Canadian National Park, has been surveyed with the aid of photography under the direction of Messrs Deville, Drewry, and McArthur, at an average rate of 1040 square km per annum for four men under great climatic disadvantages. The cost of the undertaking amounts to three dollars per square km —Determination of the amount of carbonic oxide which can be contained in confined air, by means of a bird employed as physiological reagent, by M N Gréhant —On the properties of faculæ, reply to a note by Mr. G Hale, by M H Deslandres —The probability of coincidence between solar and terrestrial phenomena, by M G. E Hale —Note on an explicit expression of the algebraic integral of a hyperelliptic system of the most general form, by M F de Salvert —On a generalisation of Bertrand's curves, by M. Alphonse Dumoulin —On the surfaces which admit a system of lines of spherical curvature and which have the same spherical representation for their lines of curvature, by M Blutel —On semicircular interference fringes, by M G Meslin Rectilinear interference fringes are sections of hyperboloids by planes parallel to their axis, the light being propagated in a direction at right angles to that axis. If the light proceeds along the axis, a screen perpendicular to it will cut circular sections, and the fringes will have the form of a circumference of which a greater or smaller arc will be seen accordingly as the two pencils overlap more or less In practice these circular fringes were obtained by separating two of Billet's half lenses and placing them one before the other in front of a very small hole illuminated by sunlight, such that the axis of the pencil passes through the optical centre of the two lenses. Under these conditions two pencils are formed from the same source of light, which may be made to show circular fringes by moving the lenses slightly in a direction perpendicular to their optical axes.—Study of the fluorides of chromium, by M. C. Poulenc.—On a new soldering process for aluminium and various other metals, by M. J. Novel. For aluminium the following solders are recommended: (1) Pure tin, fuses at 250°. (2) Pure tin 1000 gr, lead 50 gr. (280° to 300°) (3) Pure tin 1000 gr.; pure zinc 50 gr (280° to 320°). These solders do not stain or attack aluminium. A nickel soldering bit is preferable. (4) Pure tin 1000 gr.; red copper 10 to 15 gr (350° to 450°) (5) Pure tin 1000 gr, pure nickel 10 to 15 gr (350° to 450°) These give a slightly yellowish tint, but are very durable (6) Pure tin 900 gr., copper 100 gr, bismuth 2 to 3 gr This is specially suitable for soldering aluminium bronze —Action of acetic acid and formic acid upon terebenthine, by MM. Bouchardat and Oliviers —On the mode of elimination of carbonic oxide, by M L de Saint Martin Experiment shows that animals partly intoxicated by carbonic oxide, when placed in conditions under which natural elimination is impossible, destroy slowly but regularly a certain quantity of the poisonous gas, this destruction being the more active the less the intoxication. It is probably converted into carbon dioxide The toxic effect is entirely dependent upon the time during which the organism is exposed to the gas, and a very small quantity can be fatal on prolonged exposure —Influence of pilocarpine and floridzine on the production of sugar in milk, by M Cornevin —On the seat of the colouring matter in the green oyster, by M Joannes Chatin —On pseudo-fertilisation in the *Uredines*, by MM P A Dangeard and Sapin-Trouffly —On the substances formed by the nucleole in *Spirogyra setiformis*, and the directive force which it exerts upon them at the moment of the division of the cellular nucleus, by M Ch Decagny —On a process for measuring the double refraction of crystalline plates, by M Georges Friedel.—A horizontal section of the French Alps, by M W Kilian —On the arrangement of the cretaceous beds in the interior of the Aquitaine basin, and their relations to tertiary formations, by M Emmanuel Fallot.

CONTENTS.

THURSDAY, FEBRUARY 23, 1893

MAN AND EVOLUTION

Evolution and Man's Place in Nature By Henry Calderwood, LL D, F R S E, Professor of Moral Philosophy, University of Edinburgh (London Macmillan and Co, 1893)

THIS work appears to have been written for the purpose of setting forth the author's views as to the twofold nature and origin of man He admits, fully and unreservedly, that both the bodily organism and the lower mental nature of man have alike been developed by a process of evolution from a lower animal form, but he urges with much force, and often with both eloquence and dialectic skill, that the rational and moral nature of man has not been thus developed

The book, however, has many defects, and one cannot but feel that the writer has undertaken a task somewhat beyond his powers Most prominent is its extreme diffuseness and vagueness, the want of systematic treatment, the frequent reiteration of the same ideas under different forms of words, and the misconceptions arising from want of familiarity with many of the subjects discussed We are also annoyed by the frequent reference to problems to be discussed or solved, which are yet only hinted at or talked about later on Thus, in the first chapter, we are told that a "fuller study of human life" is now required, and that the crowning effort of science in the study of Nature must be "the solution of the problem of man's appearance" on earth Yet no attempt is made in the whole volume, either to solve this problem or even to show what progress has been made towards solving it At p 154 we are told that—"We are now ready for consideration of Darwin's argument"—as to the relation of the mental nature of man and the lower animals And on the next page—"The direction to be followed now becomes more obvious"—after which we have pages of general remarks on the intelligence of the dog and the ant Then, at p 162—"The method to be followed is clear we must compare the higher animals with man"—and —"careful comparison of the two orders of life is the only course open for scientific inquiry," and again,—"The difficulties belonging to such a mode of inquiry are many, but no easier method is available" Then, at p 167, we find that Darwin "has at least suggested the essential conditions of our inquiry" After this we have another series of vague general remarks, till at p 171 we find another statement of the mode of inquiry, and we are told that "we must have in full view all that is common to man, as animal, with the higher mammals, making account of close approximation in organic structure" Yet we nowhere find any attempt to apply these principles or methods so laboriously set forth, but are put off with such statements as—"In proof of exercise of intelligence, examples are many and familiar, making it unnecessary to enter upon detailed references" Then we are interrupted by fifteen pages of remarks on instinct among insects, although it has been repeatedly stated that the relation of man to the higher animals was the problem to be discussed; and at p. 193, we are told that—"Now at length, after careful survey of lower levels, we advance towards the height, on which the grand problems of intelligence become visible Study of comparative intelligence now becomes possible" Then follow again page after page of what can only be described as "general remarks" on horses, dogs, monkeys, and other animals We are told, for example—"When the higher animals are compared with the lower, it is clear that a power of intelligence must be attributed to the higher, which cannot be credited to the lower Phenomena of domestication come to our aid here, confirming this generalisation" And a little further on, as a proof that dogs can interpret signs and act upon them, we have the following concrete illustration, among the very few in the book, and therefore we may presume it is considered a valuable one "'Go home' will send one dog back, but the Gaelic equivalent alone will be effective in the case of a dog reared in the Highlands of Scotland, where the Celtic tongue is in common use" And then, as if the intelligent reader might doubt this astounding fact, the author adds, "Observation affords ample testimony for this"

Although the author has evidently read very widely on the subject of evolution, his want of grasp of the subject is continually shown Thus, when discussing the struggle for existence, he seems to think that this is usually considered to be limited to a struggle for food He says —"A general view of the relations of life and environment will guard against interpretation of facts exclusively by reference to struggle for existence consequent on the relations of numbers to food-supply" "Life is too rich in variety to find adequate explanation of its history in the mere balancing of our numbers with food-supplies" "In no life is progress to be explained exclusively by reference to amount of food-supply". "environment must be read much more largely than could be suggested by mere dependence on materials for nutriment" —the above passages all occurring in a single paragraph.

We have to thank the author, however, for the very clear manner in which he admits, and even enforces the application of evolution to man He states this conclusion in several places. Thus, at page 261, we find the following —

"The novelty of the situation lies in this, that man's alliance with all animal life has been established with a clearness and fulness of representation never before possible in the history of the world The long-hidden secrets of nature are disclosed, and, behold! man has his heritage among the beasts of the field The discovery is indeed a large one, the demonstration has been worked out in minute detail till no place is left for doubt"

By far the best portion of the work is that which is its special feature—the discussion of the rational as contrasted with the mere perceptive and intelligent nature of man and of the lower animals A few quotations will explain the author's views, and show him at his best

"The conditions of action are changed when rational self-direction comes into view This change is so great as to amount to a complete contrast with all that has appeared in lower forms of life Passion and appetite have not disappeared: they are present as before, but instead of determining conduct, a new exercise of power has appeared to control them. Life has here a duality within it, which has not been seen at any lower stage.

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Life's history becomes in this way a history of conflict, of which no trace has appeared at any earlier point in natural history The struggle between individuals has not disappeared, but a struggle within the individual life occurs, which has never been visible in the history of any inferior order of life" (p 55)

Another aspect of the rational nature is thus defined :—

"The difference which severs man from the animals lies beyond the craving, and the cunning, and the consuming of what has been captured We trace it in his plans for the day, in his preparation of his weapons, in his survey of the heavens, in his taking of reckonings for direction He deals with the relations of means to ends, he utilises past experience in his reflections over what has happened , he reaches general conclusions" (p 270)

Perhaps the finest passage in the book is at p. 287, tracing the moral element in the thought of all kinds of men and all diversities of race, as shown by the sense of wrong and injustice We can only give here the concluding lines —

"To this appeals the criminal in the heart of our surging crowds, placed under arrest, if he should be condemned on insufficient evidence To this appeals every buyer in the market, defrauded by the thrusting of adulterated goods into his hands And to this does every gentle one make appeal, defrauded in ways still worse, by false expressions of love, from whose falseness recoils a blighted life, bearing through long and weary years witness to the cruel wrong that has been done Where, along the devious paths in which man is found, is justice not honoured, at least by outcry against harsh wrongs?"

There is much in this volume that will attract readers more disposed towards the esthetical and moral than towards the scientific aspects of evolution Agreeing, as the present writer does, with most of the conclusions of the author, he can but regret that they have not been set forth in a manner more likely to attract scientific readers A. R W

POINCARÉ'S "THÉORIE MATHÉMATIQUE DE LA LUMIÈRE."

Théorie Mathématique de la Lumière Par H Poincaré, Membre de l'Institut (Paris: G Carré, 1889 and 1892)

THIS work consists of two volumes, the first of which comprises a course of lectures delivered by the author in 1887–1888, whilst the second contains a further course delivered in 1891–1892

The first volume commences with a discussion of the constitution of the luminiferous ether, in which the latter is regarded as a system of discret molecules in stable equilibrium under the action of molecular forces, and the author finally deduces equations of motion of the same form as those which are furnished by the ordinary theory of isotropic elastic media. He then adopts the hypothesis, originally due to Lord Kelvin, that the velocity of propagation of the longitudinal wave is practically zero The principle of Huygens is next dealt with, and this is followed by a chapter on diffraction. A complete discussion of all the difficulties attending the resolution of waves would carry us too far, but the author does not appear to be acquainted with the masterly investigation of Sir G Stokes, or the formula deduced by him, which gives the effect of an element of a plane wave at a distant point, and which enables the unsatisfactory reasoning on which the principle of Huygens depends to be dispensed with The diffraction of light diverging from a focus is next discussed, and the intensity of light diffracted by a circular aperture or disc is obtained in the particular case in which the point of observation is the projection of the centre of the aperture or disc upon a screen, but no mention is made of Prof. Lommel's able investigation in the general case of an excentric point A few stock problems relating to the diffraction of parallel rays are also discussed, but nothing is said about the resolving power of optical instruments, or the theory of gratings, including Prof Rowland's ingenious invention of concave gratings

Chapter V commences with the theories which have been proposed to explain the photogyric properties of quartz and certain organic substances, and concludes with an account of some of the theories of *ordinary* dispersion This is followed by a long chapter which begins with Fresnel's theory of double refraction, and then proceeds to discuss the theories of Cauchy, Neumann, Sarrau and Bousinesq

In all these theories the ether is regarded as an æolotropic elastic medium, and in considering them the author is to be congratulated on having shown no sympathy with the small minority who regard the writing down of equations as a foolish process, but although during recent years much time has been spent in elaborating such theories, it may be questioned whether the majority of them have contributed any very substantial addition to scientific knowledge The theory of the propagation of waves in an æolotropic elastic medium was rigorously investigated by Green as long ago as 1839, and although a theory of this kind is useful in enabling the mind to form a mental representation of the mechanism which is required to produce double refraction, it is well known that Green's theory, and all others of a similar character, fail to furnish a satisfactory explanation of this phenomenon. The principal defects of such theories are, that although most of them lead to Fresnel's wave surface, or to one which is a very close approximation thereto, they require us to suppose that the vibrations of polarized light are parallel instead of perpendicular to the plane of polarization, and they also fail to give results which explain crystalline reflection and refraction, unless certain additional assumptions of a very questionable character are made Probably it will not be thought an exaggeration to say, that the only theory of elastic media which satisfactorily explains double refraction is the one which is due to the joint labours of Lord Rayleigh, Lord Kelvin, and Mr Glazebrook.

At the commencement of Chapter VII, which deals with reflection, the following statement is made (see p 320).—

"La réflexion vitreuse a donné lieu à trois théories également confirmé par l'expérience, ce sont celle de Fresnel, celle de Neumann et MacCullagh et celle de Cauchy"

The theories of Neumann and MacCullagh depend upon the hypothesis that the *density* of the ether is the same in all media, and that it is the rigidity which

varies, and it is somewhat surprising that M Poincaré does not appear to be aware of the investigations of Lorenz and Lord Rayleigh, who completely exploded this hypothesis twenty years ago by showing that it leads to two polarizing angles. The weak point in the investigations of most French mathematicians on the subject of reflection and refraction arises from the fact that, in consequence of their not having made a careful study of Green's papers and the subsequent developments by Lord Rayleigh and Lord Kelvin, they are unable to deal satisfactorily with the longitudinal or pressural wave. The difficulties arising from the existence of these waves may be got rid of either by assuming, as Green did, that the ratio of the velocity of propagation of the longitudinal wave to that of the transverse wave is very large, or, by adopting Lord Kelvin's hypothesis, that the above ratio is very small, but it cannot be too emphatically stated that the existence of such waves must not be disregarded, and that any attempt to ignore them will inevitably end in failure.

This chapter concludes with a brief account of metallic reflection, in which the author has adopted the equations of motion given by Voigt. The chief difficulty in trying to explain metallic reflection, by the introduction of a viscous term into the equations of motion, is due to the fact that Eisenlohr has shown that for certain metals the pseudo refractive index is a complex quantity whose real part is negative.

Turning now to Volume II, which consists of a further course of lectures delivered in 1891–1892, we find that it commences with the theory of isotropic elastic media in its ordinary form. Next follows a chapter on the electromagnetic theory, in which the author confines himself to the case of an isotropic medium, and has given no account of the investigations of Glazebrook on crystalline reflection and refraction, in which it is shown that the intensities of the reflected and refracted waves satisfy the same equations as those deduced many years previously by MacCullagh from an erroneous theory, but which nevertheless explain the facts in a fairly satisfactory manner. M Poincaré assumes that the vector potential satisfies the solenoidal condition; but although the employment of the vector potential is valuable as a mathematical artifice, its use requires extreme care, inasmuch as it contains an undetermined quantity, and I believe it can be proved that in certain cases the solenoidal condition is not satisfied. In the electromagnetic theory of light this difficulty can always be evaded by eliminating the vector potential from the equations, which is the preferable course to pursue.

In Chapter V, after discussing ordinary reflection and refraction, the author attempts to construct an electromagnetic theory of metallic reflection and refraction by taking into account the conductivity. This theory leads to Cauchy's formulæ, but requires that the real part of the pseudo-refractive index should be positive, whereas Eisenlohr has shown that for certain metals these formulæ cannot be reconciled with experiment unless the real part is negative. In the case of steel this quantity is positive throughout the whole range of the visible spectrum; but as thin films of iron when magnetized, exhibit anomalous dispersion, it is doubtful whether this hypothesis is satisfactory even in the case of steel or iron.

The next four chapters are devoted to the principle of Huygens and to diffraction, and in Chapter X. the author has discussed Von Helmholtz's theory of anomalous dispersion. The advantage of theories of the class to which that of Von Helmholtz belongs is, that they endeavour to account for dispersion and absorption by taking into account the mutual reaction between ether and matter, and show that when one or more of the free periods of the vibrations of the matter coincides with one or more of the free periods of the rays of the spectrum, absorption and anomalous dispersion will be produced. By the aid of this theory the absorption produced by sodium vapour may be accounted for, as well as the anomalous dispersion and selective reflection produced by fuchsine and other aniline dyes. The author has not, however, developed the consequences of this theory as far as might be done.

It is not unnatural that M Poincaré should have given special prominence to the writings of his own countrymen, his treatise would, however, have been much improved had he not confined himself so exclusively to the writings of French mathematicians, but had given a fuller account of the work done by mathematicians of other nationalities. A. B. BASSET

THE MOTHS OF INDIA.

The Fauna of British India, including Ceylon and Burma. Published under the authority of the Secretary of State for India in Council. Edited by W. F. Blanford. "Moths." Vol. I. By G. F. Hampson. (London: Taylor and Francis, 1892.)

MR HAMPSON is already favourably known to entomologists by his work on the "Lepidoptera Heterocera of the Nilgiri District," which forms Part viii of the series of "Illustrations of typical specimens of Lepidoptera Heterocera in the collection of the British Museum." In the work before us he has undertaken a far more important task, nothing less than a descriptive handbook of the moths of India, which, when complete, will prove as useful to Indian entomologists as the well-known work on the butterflies of India by Marshall and De Nicéville.

Hitherto the available information on the moths of India has been scattered over a great variety of books and periodicals, far too numerous and costly to be easily available out of London or Calcutta, and extremely difficult to use satisfactorily, even if accessible. But Mr Hampson has been given the fullest facilities for examining all the principal public and private collections of Indian moths, from that of the British Museum downwards, and has also made free use of the libraries of the British Museum at South Kensington, which now contain the finest series of entomological books in the world, and the result is a work which can hardly fail to give an enormous impetus to the collection and study of Indian moths.

Much attention has been paid to the classification of moths, and the introductory pages are occupied with details of structure, illustrated by woodcuts of parts of the head, antennæ, legs, and neuration. This is followed by a genetic tree of the families of moths, and by a

tabular key based chiefly on neuration and antennæ Mr Hampson admits thirty-four families of Indian moths, of which the first twenty three, including 1158 species, are dealt with in the volume before us The earlier families of moths are, however, much less numerous in species than the later ones, and it must not be supposed that Mr Hampson has dealt with anything like half the Indian species in his first volume, which comprises the series of families usually classed under Sphinges and Bombyces, extending, according to the author's classification, from *Saturniidæ* to *Hypsidæ* The important Bombycide families, *Arctiidæ*, *Agaristidæ*, and *Uraniidæ*, are, however, relegated to the second volume, while several families of more or less doubtful position find a place in vol i, such as the *Cymatophoridæ*, *Thyrididæ*, *Sesiidæ*, and *Tinægeriidæ* We observe that Mr Hampson closes the series of moths with the *Tineidæ*, *Pterophoridæ*, and *Alucitidæ*, and in this adopts the usual classification, though in the main he has struck out an entirely new classification of his own, and the very first innovation which meets the eye is the novelty of commencing the moths with the *Saturniidæ*

We hope that Mr Hampson will take an opportunity of discussing the various systems of classification of moths which have been proposed by Guenée, Herrich-Schaffer, Plötz, and other entomologists, not forgetting the strange system proposed by Zebrawski, in his work on the Lepidoptera of Cracow, in which the butterflies are placed in the middle instead of the beginning of the series of Lepidoptera. Such a discussion would be un suitable in the present work, but if published elsewhere might be very useful

Long descriptions of genera and species in a work of this character would have been out of place, and we are glad to find that they have been avoided Each family or subfamily is succinctly characterised, and usually illustrated by a figure of the larva. This is followed by a tabular key to the genera, and then by a notice of the genera and species The notice of each genus consists of synonymy, type, range, and a brief indication of the principal characters. That of the species includes synonymy, description, including both sexes, and transformations when necessary, range and expanse An excellent woodcut is usually given of one representative of each genus, showing the wings and body on one side, and the neuration on the other, extra figures of antennæ and legs being sometimes added

No book, however useful or carefully compiled, can be free from errors, but these cannot be detected at a glance, and the only technical mistake of importance which we have noticed in turning over Mr Hampson's work is that the broad-bordered Australian *Macroglossum kingii*, Macl, is included among the synonyms of the narrow-bordered *Cephonodes hylas*, Linn

Much, no doubt, remains to be said about Mr. Hampson's classification, his use of generic names, and his placing together insects regarded as distinct by other authors as synonyms. But these are all points admitting of great difference of opinion, and we do not propose to discuss them further in the present notice.

We should add that various new families, besides many new genera and species, are described by Mr. Hampson for the first time. W. F. K.

OUR BOOK SHELF

The Year-Book of Science (for 1892) Edited by Prof T G Bonney, D Sc, LL.D, F R S (London Cassell and Co, 1893)

ALL interested in scientific progress will welcome the appearance of the second volume of this useful year-book The staff of contributors includes such names as Dr Ramsay, Prof. Seeley, Mr Botting Hemsley, &c, and the accuracy of the summaries of the year's developments may therefore be thoroughly relied upon The plan of the volume follows closely on the lines of its predecessor, but it has been extended so as to include geographical and anthropological matters, and zoology has received more complete treatment If one may judge of the activity in different departments of science by the space required for the account of their progress, electricity and organic chemistry would appear to take the lead As in the last volume, no attempt has been made to present a complete catalogue of papers The object has been simply to select the memoirs of exceptional interest; and so far as we have been able to judge, the selections have been judicious An excellent index of subjects, and one of authors, complete what will no doubt be found a very useful volume

Treatise on Thermodynamics By Peter Alexander, M.A Pp xii, 203 (Longmans, Green, and Co, 1892)

THIS is in many respects a singular work Whole pages, we may almost say whole sheets, are devoted to the multiplication of elaborate proofs of intrinsically simple theorems for which a few lines would be ample allowance, while some of the real difficulties of the subject are but lightly touched on The other special characteristics, so far as we have seen, are three in number First, and most prominent, the extraordinary proportion of formulæ to text, which gives the whole the look of a treatise on Partial Differential Coefficients rather than on a branch of Physics Second, the fearful and wonderful collection of names for special cycles, *e g* *Isothermentropicycle*, *Isobarymegacycle*, *Isenergentropicycle*, &c Finally, the expressions of doubt or hesitancy with which many steps, universally recognised as valid, are introduced. In the first and second of these characteristics the author far transcends the results of the licence willingly allowed to pioneers like Clausius and Rankine But these have been (at least in great part) long since discarded, and can never be reintroduced. The third characteristic is, to say the least, not precisely one to be desiderated in a text-book, where we naturally expect to find some slight trace of "Sir Oracle"

Mediæval Lore an Epitome of the Science, Geography, Animal and Plant Folk-Lore and Myth of the Middle Ages Being Classified Gleanings from the Encyclopædia of Bartholomew Anglicus on the Properties of Things Edited by Robert Steele (London Elliot Stock, 1893)

THE original work of which parts are translated in the present volume, may be said to have a place of its own in the history of European literature It was written in the thirteenth century, and the Latin text was soon widely appreciated, while in the course of the fourteenth century it was translated into French, Spanish, Dutch, and English The book is full of interest, for it presents a summary of all that was known in the Middle Ages about man and the world The change which has been gradually effected by the use of modern scientific methods is, of course, incalculable; but some readers will probably be surprised to find to how large an extent Bartholomew mingles the results of shrewd and accurate observation with quaint fancies and unverified judgments The present volume consists of selections from the edition of Berthelet, 1535; and the good style of the translator adds greatly to the charm of the author's

philosophy and science Mr. Steele has done his work with much tact and care, and an interesting preface is contributed by Mr. William Morris

Astronomy for Every day Readers By B J Hopkins, F.R.A S. (London George Philip and Son, 1893)

THIS is a little book which aims at explaining in "as accurate and interesting a manner as possible such of the phenomena of the heavens as should be known to every intelligent person" It consists of six chapters dealing respectively with day and night, the phases of the moon, the tides, the seasons, eclipses, meteors, shooting stars, and comets Descriptive astronomy is not touched upon, but there is an introductory chapter giving a general survey of the solar system and its dimensions The book has been very carefully written, and the scientific explanations are much relieved by interesting references to the history of the subject The author has succeeded in giving very clear and concise accounts of the every-day phenomena with which the book specially deals, and it seems well adapted to awaken a desire for more in the class of readers to whom he more particularly appeals A biography of the author—who is described as "the working-man scientist"—is also included

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications*]

Blind Animals in Caves

IN an article in the current number of the *Contemporary Review* Mr Herbert Spencer discusses the "familiar instance" of blind animals in caves as bearing upon the hypothesis of the transmission of acquired characters Mr Spencer is not satisfied with the explanation of the blindness of these cave animals offered by Weismann, who endeavours to account for them by two conditions recognised as operating in regard to other cases by Darwin, viz cessation of selection and parsimony of growth ("Origin of Species," sixth edition, p 118), of which the former author has treated under the name Panmyxia. Mr. Spencer shows that the saving of ponderable material in the suppression of an eye is but a small economy he loses sight of the fact, however, that possibly, or even probably, the saving to the organism in the reduction of an eye to a rudimentary state is not to be measured by mere bulk, but by the non-expenditure of special materials and special activities which are concerned in the production of an organ so peculiar and elaborate as is the vertebrate eye

That, however, to which I wish here to draw the attention of Mr Spencer and his readers is this —Mr Spencer appears to think that if he disposes of Weismann's explanation of the blindness of cave-animals according to "Panmyxia"—there remains only the explanation by "transmission of acquired characters" in the field He appears not to be acquainted with the explanation which I have offered of the blindness of cave-animals It is closely similar to that given by Darwin of the occurrence of wingless insects on oceanic islands. My explanation consists in an application to the case in hand of Darwin's principle of "natural selection." I published it some years ago in my article "Zoology" in the "Encycl Britannica," reprinted in 1890 in a volume of essays, bearing the title "The Advancement of Science." My suggestion was (and is) as follows, and I should like to see what Mr. Spencer has to say to it:—"This instance (that of the blind cave animals) can," I wrote in the article above-named, "be fully explained by natural selection acting on congenital fortuitous variations. Many animals are thus born with distorted or defective eyes whose parents have not had their eyes submitted to any peculiar conditions. Supposing a number of some species of Arthropod or Fish to be swept into a cavern or to be carried from less to greater depths in the sea, those individuals with perfect eyes would follow the glimmer of light and eventually escape to the outer air or the shallower depths, leaving behind those with imperfect eyes to breed in the dark place A natural selection would thus be effected In every succeeding generation (bred in the dark place) this would be the case, and even those with weak but still seeing eyes would in the course of time escape, until only a pure race of eyeless or blind animals would be left in the cavern or deep sea."

My own position in regard to the hypothesis of the transmission of acquired characters remains what it was ten years ago, viz that in the absence of observed instances of this transmission and in the presence of repeated observation that particular acquired characters are *not* transmitted, I do not consider it legitimate to *assume* a transmission of acquired characters as the explanation of any given case, such, for instance, as that of the blind cave animals I am confirmed in this attitude by the fact that a little consideration has enabled me and others to explain satisfactorily, by reference to no hypothetical causes, but to the admitted and demonstrable facts of "congenital variation" and "natural selection," instances brought forward as "only to be explained on the assumption of the truth of Lamarck's hypothesis"

On the other hand, I have always considered that there is not sufficient ground for asserting that a transmission of acquired characters *can not* take place The important question is still as it was five years ago, "*Does* it take place?"

Oxford, February 14. E RAY LANKESTER.

Glacier Action.

I HAVE read with great interest and pleasure the short review in your paper of last week by Prof Bonney, giving a summary of the results of a survey of the French freshwater lakes, and indicating as the most probable conclusion that they cannot be accounted for on the theory of the late Sir A Ramsay, by the digging out power of glaciers

Living as I do in a highly glaciated country, and in a country also full of lakes, both fresh and salt, I have never believed in that theory Lakes seem to me to be due to the same causes which have produced the glens and hollows in which they lie, and these causes cannot be identified with glacier action alone The theory of Ramsay attributes to glacier action powers and effects which have never been proved to belong to them Glaciers do not dig out They rub down—abrade—and scoop, when they are moving down inclined planes at angles more or less steep. But when they reach level ground they do not dig, they rest upon the level surfaces, and when pressed from behind they flow over it But I have never seen any proof that they can act like a ploughshare, or rather like one of the new digging machines

In so far as all existing glens may have been formerly occupied by glaciers, their depths must have been increased by glacier action, on the supposition that they were tilted, or upraised at some angle required for this form of true glacier action On this supposition, indeed, lake basins may be said to be partly due to glaciers But then this supposition involves and depends upon the assumption that earth movements have made the lake basins what they now are—hollows in a comparative level

Like all other general theories in the history of geology, the "glacial theory" seems to me to have been ridden to the death, and I have been long waiting for some signs of that reaction or correction which is still much needed. I hold that in this country there is not only no evidence of "ice sheets" overriding all the hills, but the strongest evidence against such sheets Our glens had true glaciers in abundance, no doubt, and they have left their tool-marks very distinctly But those marks are quite inconsistent with one universal ice-cap or ice sheet over all the land ARGYLL.

Inveraray, February 16

Dr. Joule's Thermometers

EVERY one will, I am sure, be glad to know that Dr Joule's thermometers are under investigation by Prof. Schuster

It is unfortunate that Joule does not give the actual readings of the freezing point, but if the comparison quoted by Rowland was made in either 1879 or 1890 it may be that he referred to the reading of November, 1879, when the total rise of the zero point was 12·92 scale divisions In that case the original reading in April, 1844, would be 9 70, at any rate this number cannot be very far from the truth

The temporary changes of zero point alluded to by Prof Schuster certainly complicate the matter, but from the numbers given it would appear that since 1879 or 1880 there has been a

further secular rise of from 0 38 to 0 89 of a scale division Nothing is said in Joule's paper about the temperatures at which the thermometers had been kept before the readings of the freezing point were taken, but as the later observations—and most of the earlier ones—were made in the winter months, it may perhaps be assumed that the temperatures were nearer 7° than 30°, and that the actual reading on the scale last winter should be taken as nearer 23 51 than 23 00 If this is so the total rise of the zero point last winter would be nearer 13 81 than 13 30

Prof. Schuster states that "with properly annealed thermometers the secular changes are much smaller than the temporary ones," and that is no doubt true for observations extending over a limited time and with such comparatively large variations of temperature as from 7° to 30° It may be pointed out, however, that the secular rise since 1879 or 1880 is probably greater than the maximum temporary change recorded by Prof Schuster, and of course the total secular rise is enormously greater

It may be true that the secular changes of a thermometer gradually vanish, but it must, I think, be conceded, that in the case of Dr Joule's thermometer it will be a long time before absolute constancy is attained There can be no doubt that even now, nearly forty nine years after the first reading was taken, the zero point is still rising, and it does not appear to me to be very improbable that during the next fifty years there may be a further rise of two scale divisions, the amount calculated from the purely empirical formula which I have suggested

SYDNEY YOUNG

University College, Bristol, February 20

Foraminifer or Sponge?

UNDER the above heading in last week's NATURE Dr Hanitsch briefly draws our attention to Mr A Goes' report on the deep sea organisms procured by Prof Agassiz in the American tropical Pacific, which he describes as Arenaceous Foraminifera, with the name *Neusina Agassizi*

As it was from me that Dr Hanitsch received the specimens he describes, which I had after a personal conversation on the matter sent him, for his opinion as to their relation to true sponges, I venture to send some further observations on these interesting forms

Dr Hanitsch is, I believe, quite right in referring Mr Goes' Neusina to Prof. Haeckel's *Stannophyllum zonarium*, as described in his report on the *Challenger* deep sea Keratosa But while admitting my admiration of Prof Haeckel's wonderful production on the *Challenger* specimens, I do not agree with him as to their being true Keratose sponges

My conclusion is based upon the examination of nearly the whole *Challenger* collection, and in not one species could I find the slightest trace of any of the flagellated chambers characteristic of sponges.

Prof Haeckel accounts for the absence of this important feature through the bad preservation of the specimens Yet he describes the most delicate parts of a commensal Hydroid in full, and was able to observe amœboidal cells, and the granulated sarcode bodies peculiar to all bottom living Foraminifera.

If, however, the forms described by Prof Haeckel prove after all to be true Keratose sponges, the present state of our knowledge does not justify their separation from such recognised genera of Foraminifera, as Masonella, and Syringammina of the late Dr. G Brady, Technitella, Haliphysema, and Marsipella of Canon Norman, or *Hyperammina palmiformis*, described by myself from the Faröe Channel, all which forms have the power of forming siliceous and chitinous skeletons.

Without going into further detail here it will be readily understood that I quite agree with Mr Goes in placing these organisms among the Foraminifera, although it would have been better had he given us a clearer and more detailed description of his Neusina.

I had hoped to have published my personal observations on these most interesting organisms, but circumstances have prevented me doing so up to the present.

I for one would be glad if Dr. Hanitsch would give his opinion as to their supposed sponge structure, which he has not done in his previous letter F. G PEARCEY,

Late of the *Challenger* Expedition and Commission

Owens College Museum, Manchester.

Colonial Meteorology

ON p 363 of your last number your reviewer of the "Year-book of the Imperial Institute," after remarking that "climate certainly deserves better treatment," continues —

"We do not think space would be wasted in giving the mean monthly temperatures and rainfall for the average year and for two extreme years, at a few representative stations in the larger colonies This information cannot indeed be found in any existing books, but must be worked out from original records, which exist abundantly, and are rarely made available to practical workers "

I am afraid that the reviewer does not always read NATURE, for you, sir, have on several occasions noticed my efforts in this direction, efforts which have gone on uninterruptedly for twenty years. As, now that you have taken the matter up, it is not improbable that some of the funds lavished on the Imperial Institute may be devoted to the subject, and my small organisation be swamped or superseded, I hope that you will, in justice to the directors of the various Colonial observatories who have helped me for so many years, and as some consolation for the entire ignorement of our organisation by your reviewer, allow me to give its history in the fewest words possible

In 1873 I determined to try to publish monthly a table giving the principal climatic data for each synchronous month at widely spread stations over the entire British Empire The leading idea was identity, so as to ensure comparability I therefore prepared some blank forms and sent them with a circular letter to about twenty of our leading Colonial meteorologists Every one without exception promised to help, and it says much for colonial climate to add that during the subsequent twenty years not more than five or six of my original correspondents have passed away

During the period occupied in the transit of my request and of the replies thereto, I wrote a series of short articles pointing out the leading features, and as far as practicable the mean values, for the various stations, so that when we began publishing the monthly values, the departures from the mean could be recognised. These articles and the tables themselves from 1874 to 1881 appeared in *The Colonies* (subsequently *The Colonies and India*) When in 1882 that paper passed into other hands, the proprietors declined to publish the tables, and I began to insert them in the *Meteorological Magazine*, where they have appeared regularly month by month for the subsequent thirteen years At the close of each year an extra table is given with a summary of the results for the year, and NATURE has often done me the honour of quoting portions of these summaries

I enclose copy of our last table, and though I know that to reproduce it would be to make a somewhat large demand upon your space, I feel that the work (wholly unpaid, be it remembered) of my Colonial friends during these past twenty years, claims some consideration and some recognition You will see by the signatures that the authorities are the highest attainable.

G J. SYMONS.

62, Camden Square, N W , February 17

Ozone.

WITH reference to a paragraph in NATURE, p 373, on observations of ozone in the atmosphere, and the paucity of observers and records, I may be allowed to state that I have collected sets in the North Atlantic and Pacific Oceans and Mediterranean These have been taken by officers of the Royal Navy and mercantile marine at sea, and some of the records have been tabulated, and may be communicated to some society in due course. Moffatt's papers, made by Negretti and Zambra, have been used throughout, so the observations are all uniform and comparable. W. G BLACK.

Edinburgh, February 19

LION-TIGER AND TIGER-LION HYBRIDS

THE Council of the Royal Zoological Society of Ireland entertain some hope that it will be possible to produce in their Gardens examples of hybrids or cross-breeds between the two largest species of cat, namely, the lion and tiger

That such hybrids have been produced is a matter of historical record, and as the writer is particularly inter-

ested in the success of the experiment now in progress in the Dublin Gardens, where over one hundred lion cubs have been successfully reared, he thinks it desirable to record all the details which he has been able to collect on the subject

So far as can be ascertained the only lion-tiger cubs, as they have been called, which were ever produced belonged to several distinct litters by different parents, perhaps, but in the same menagerie—that of F Atkins, of Windsor

The father of the first litter of these cubs was a lion bred in Atkins's menagerie, the head-quarters of which were at Windsor. The mother was an imported tigress From Griffith's account ("Animal Kingdom," vol ii p 448, 1827) it would seem that the lion and tigress were about two years together, in the same cage, before any issue appeared The first litter, consisting of three cubs, was born at Windsor on October 17, 1824—being the result of a particular intercourse which lasted for ten or twelve days in the beginning of the previous July The cubs were shortly afterwards exhibited to his Majesty, who, according to the showman's own handbill—a copy of which has been lent to me by Dr William Frazer—christened them lion-tigers The lion died six weeks afterwards, and the cubs, as related by Griffith, were fostered by several bitches and a goat, and it was expected would attain to maturity, but although there is no clear intimation as to the exact date when this was written, the figures of the cubs accompanying the account are said to represent them at the age of only about three months It is stated by one writer, however, that they did not attain to maturity ("English Cyclopædia Nat Hist," vol ii p 763, art "Felidæ," 1854)

The next litter was born at Edinburgh on December 31, 1827, according to Atkins's showbill and Sir William Jardine's works[1] There were two cubs, and it would seem that they were exhibited together with, and therefore probably reared by, the mother, in the same den, but whether she were the same tigress as the mother of the previous litter is not clear

They were seen by Sir William Jardine in September, 1828, and his figures may have been taken from them, but it has some resemblance in details, though not in general pose, to the figures published by Griffith of the 1824 litter It would seem that Sir William was under the impression that it was these very cubs which were subsequently exhibited together with their parents in the same cage in the autumn of 1829 But there is a difficulty in accepting this conclusion, because the stuffed specimens of these two cubs still exist—one in the British Museum (Natural History) and the other in the Science and Art Museum, Edinburgh. I have recently had opportunities of examining both, and I should be inclined to think that the cubs were not *more* than about nine or ten months old when they died So that either the cubs seen in 1829 were born subsequently to December 31, 1827, or the stuffed cubs just referred to must have been born previous to that date. That the cub in the British Museum was presented by J Atkins, of Windsor, is attested by Dr Gray's "Old List," page 40, which, through the courtesy of Dr Gunther, I have been able to consult.

That the specimen in Edinburgh was one of those born in 1827, and figured by Sir William Jardine, is, indeed, stated in the "English Cyclopædia," which adds that the cubs of that litter died young. Hence, it seems most probable that the cubs seen in the autumn of 1829 belonged to a subsequent litter, as has been suggested above. Further, Mr J G. Robertson, formerly of Kilkenny, has informed me that he saw a lion, tigress, and their three hybrid cubs in one cage in Kilkenny, where they were brought by a showman about the year 1832. They were the sole stock of the show.

[1] "The Menageries, Quadrupeds," Sir William Jardine (2nd edition), vol i, pp. 191, 192. 1830.

Accordingly, it seems that besides the definitely attested births of the years 1824 and 1827, there were also, probably, some others One of the accounts states that there is no great difficulty in promoting the union of the two species

Besides the cub already referred to as having been presented to the British Museum by J Atkins, I have also been shown by Dr Gunther unmounted skins of two reputed hybrid lion-tiger cubs, which are said in Dr Gray's list to have been purchased from a dealer named Mathur, in 1842 They cannot, I think, have survived more than two or three days after birth, and their markings are too indistinct to justify any special description, particularly as their parentage is not more definitely attested But it is of some importance to place on record here what is said as to the markings of the cubs first referred to The specimens in the British and the Edinburgh Museums are both somewhat faded In Gray's list the former is thus described "Hybrid cub between lion and tigress, yellow, back slightly waved, limbs and tail banded with black"

Sir William Jardine merely says the general colour was not so bright as that of the tiger, and the transverse bands were more obscure

Griffith describes the cubs he figured as follows —

"Our mules, in common with ordinary lions, were born without any traces of a mane, or of a tuft at the end of the tail Their fur in general was rather woolly, the external ear was pendant towards the extremity, the nails were constantly out, and not cased in the sheath, and in these particulars they agreed with the common cubs of lions Their colour was dirty yellow or blanket colour, but from the nose over the head, along the back and upper side of the tail the colour was much darker, and on these parts the transverse stripes were stronger, and the forehead was covered with obscure spots, slighter indications of which also appeared on other parts of the body The shape of the head, as appears by the figures, is assimilated to that of the father's (the lion); the superfineness of the body on the other hand is like that of the tigress" (p. 449)

Prof R H Traquair, F R S, keeper of the natural history division of the Edinburgh Museum, has kindly had a photograph taken of the specimen above referred to prepared for me, and the transverse markings are distinctly visible in this picture

I am tempted to conclude this record with an extract from Atkins's somewhat quaintly-expressed handbill, which does not bear any date, but probably belonged to the year 1828 The greater part of the bill consists of a long poetical description of the family with "a tigress their dam, and a lion their sire," and of the numerous distinguished persons who had paid them a visit The following prose portion will probably be sufficient to extract from what is possibly one of few still existing copies of the handbill

"ATKIN'S IMMENSE MENAGERIE

"Wonderful Phenomenon in Nature

"*The singular, and hitherto deemed impossible, occurrence of Lion and Tigress in one den*

"Cohabiting and producing young, again took place in this menagerie, on the 31st of December, 1827, at the City of Edinburgh, when the royal tigress brought forth two fine cubs!! And they are now to be seen in the same den with their sire and dam The first litter of these extraordinary animals were presented to our most gracious Sovereign, when he was pleased to express considerable gratification, and to call them lion-tigers, than which a more appropriate name could not have been given. The great interest the lion and tigress have excited is unprecedented, they are a source of irresistible attraction, especially as it is the only instance of the kind

ever known of animals so directly opposite in their dispositions forming an attachment of such singular nature Their beautiful and interesting progeny are most admirable productions of nature The group is truly pleasing and astonishing, and must be witnessed to form an adequate idea of them The remarkable instances of subdued temper and association of animals to permit the keeper to enter their den, and to introduce their performance to the spectators, is the greatest phenomenon in natural history"

V BALL

OBSERVATIONS OF ATMOSPHERIC ELECTRICITY IN AMERICA[1]

THE meteorological official of the United States known as "The Chief Signal Officer" has sanctioned the publication of this voluminous report of 320 quarto pages, embodying the result of a widespread photographic record and direct reading of atmospheric electrometers carried out under the auspices of the United States Government during the years 1884 to 1888, with the immediately utilitarian object of ascertaining how far it was possible to use electrical indication in weather prediction As Mr Mendenhall says, "No studies or investigations which did not bear upon this question were [considered] proper or allowable"

Although thus limited in scope the actual observations made and here recorded can hardly fail to be of service to future investigators into this obscure subject

The report begins with a historical introduction, in which it is admitted that electricity was first purposely drawn from the clouds in France by Buffon and D'Alibard about a month before Franklin tried his already projected experiment, and that de Saussure was one of the first to obtain fairly quantitative results and to detect a diurnal period

Volta "hit upon the capital device of a burning match" to replace the previous feeble collecting devices such as a bullet and wire shot up into the air But nothing really exact and continuous was done "until Sir W Thomson attacked the problem." He introduced the quadrant electrometer and the water-dropper, which have been the universal recording instruments ever since

In fact "the work of Palmieri on Mount Vesuvius constitutes perhaps the only extensive series of observations in which instruments founded on the original design of Sir W. Thomson have not been used"

In the States the first energetic and influential mover in the direction of a serious record appears to have been Prof Cleveland Abbé, who got himself authorised in 1880 by the Chief Signal officer to consult with Prof Rowland on the subject, and afterwards with Prof Trowbridge, and to make arrangements for a series of effective observations Under the auspices of these gentlemen a staff of observers were trained and suitable instruments obtained, tested, and improved Various collectors were tested, and in 1883 a photographic registration apparatus of M Mascart was put into operation. In 1884 Mr Mendenhall "was appointed to assume the direction of the work as chief of the physical laboratory and instrument division of the office in Washington" Stations were established in Washington, Baltimore, Boston, New Haven, Ithaca, and Ohio

Much work was done in connection with electrometers by McAdie and McRae, but this is incorporated in the article "Electrometer" of the "Ency Britt."

The instrument ultimately adopted was a quadrant electrometer of the Mascart pattern with special improvements, and was constructed by the Société Génevoise A picture of it is given.

[1] "Report of Studies of Atmospheric Electricity" By T C Mendenhall Extract from Memoirs of the National Academy of Sciences, 1889. (Washington.)

The method of connecting the quadrants to the two equal halves of a water battery, so that they might always be at equal opposite potentials, and of attaching the needle to the collector, was after many trials adopted, partly because higher insulation was thus possible, partly in order to get a straight line law Deviation from this, due to what is called the "electric directing couple," is not overlooked, but by a stiff suspension and small range it is minimised

An interesting chapter is that on "collectors" The water-dropper was mostly used, but its freezing is apt to interrupt the record "Sergeant Morrill experimented on a special flame collector," supplied with gas at constant pressure and arranged so that wind could not extinguish it, and "before the termination of the work obtained very satisfactory results" But in order to secure uniformity between different stations he also designed a mechanical collector—a clockwork machine with revolving arm and intermittent contacts, which is virtually a gigantic replenisher, utilising the atmospheric potential as an inductor, and thereby feeding the electrometer up to the same potential. It seems to be as quick in response as a water dropper (an important point, as some of the fluctuations of potential are very rapid), but "as it was only completed towards the end of the period of observation nothing very definite can be said of its performance" An illustration of the ingenious device is given in detail

Observations

Preliminary records are given showing the curves got at a roof station and a balcony station, also at different observatories in the same town Some also from the top of the Washington Monument, which naturally show far greater potential and changes than the instrument in the Signal Office

There are plotted a number of zigzags obtained from the different stations about the States, and very complicated and entangled the record is None of the stations show any agreement, and, particularly at Ithaca, the electrometers seem usually to have been in a wildly excited state

But during an Aurora on May 20, 1888, they were singularly quiet, and the remark is made "It will be observed that the indications of the electrometer were positive during the day and night, and that no unusual fluctuations occurred."

The atmospheric potential is usually positive, and it has been often thought that a change to negative signalised bad weather Certainly this does frequently happen, sufficiently often to make it worth while specially to examine this point; and several curve charts are given to show that "negative electricity in clear weather was observed at most if not all of the Signal Service Stations on numerous occasions during the progress of the work In many cases precipitation occurred at points 10 to 100 miles distant, but in others clear weather prevailed over almost the entire country A number of instances of negative potential during clear weather occurred at Ithaca, where careful attention was given to the matter of special observation by Mr. Schultze"

Effect of Dust, Haze, Fog

"The effect of dust, haze, smoke, &c, in producing negative potential has been noticed by more than one observer [Query whether the negative potential can have ever produced or permitted the haze —O. J L.] Several instances of the action of clouds of dust were noted by Sergeant Morrill at Boston On March 7, 1888, in the afternoon the potential was observed to fall rapidly from − 90 to − 270 upon the rising of an especially heavy cloud of dust, and similar phenomena were observed on April 7." "A fall of potential could be certainly predicted when a dust cloud was seen rising. On other days when high winds and dust clouds prevailed negative potential

was observed A figure is given of an observation at Terre Haute, Ind, on a day when a fog formed after sunset, and the potential then rapidly fell from + 1000 to − 200 volts" "The same phenomenon was frequently observed during the autumn when the formation of a haze or fog just as the sun was setting was a common occurrence"

The observer at Terre Haute (Sergeant McRae) wisely made special observations as to the possible effect of locomotives on a railway a quarter of a mile distant, but, so far as the recods show, the passage of a train, when not happening to coincide with a fog formation, did not seem to disturb the curves

Clouds and Wind

"The direct action of a cloud or group of clouds in producing a fall of potential was often observed" For instance the following at Boston — "In the morning of January 3, 1888, the potential had been steadily positive At 11 30 it was + 32 volts, from which it fell steadily at the approach toward the zenith of a small cumulus cloud, reaching − 21 volts As the cloud passed away the potential rose to + 6, again falling to − 31 as a large mass of cumulus clouds approached Later the sky became overcast, and the potential became steadily negative

"On June 7, at 5 30 p m, the potential fell from + 43 to − 173, and then rose slowly to its former value The rise and fall occupied fifteen minutes, and coincided with the appearance over the buildings to the west of a fleecy cirro-stratus cloud and its disappearance over the institute building in which the electrometer was located

"Again, on June 9 the potential was positive all day up to 5 p.m At that hour it fell from + 73 to − 113, then rising to + 52 The sky was nearly free from clouds, and the fluctuation coincided with the approach and departure of a cirro-stratus cloud, passing about 15° from the zenith The inductive action of the cloud was plainly suggested in all of these cases"

High wind also usually causes a drop of potential

Averages

Some charts are then given of average monthly potentials, showing nearly always positive average values, highest in the winter, lowest in summer

Some smoothed diurnal curves are also given, and "seem to indicate the existence of two principal maxima of potential in the day, and also in a general way that one of these occurs not many hours before noon and the other toward the latter part of the day"

Thunderstorms

Special attention was paid to the observations before, during, and after the occurrence of thunderstorms, but the needle then dashes wildly to either side, and sparks often begin to pass And the remark is made —"Aside from the general characteristics (rapidity and range of fluctuation) these potential curves seem to have little in common The examination of a few cases only might lead to interesting conclusions, which would almost certainly be overthrown by the study of a greater number. Sometimes the potential falls rather steadily until the violent movements begin, but sometimes it rises just as long and steadily. In many cases the fluctuations start from a high positive, while in many others the reverse is the case The storm is usually accompanied by precipitation; sometimes this begins before the needle starts on its series of swings from side to side, and sometimes these movements precede precipitation. The steady rise of potential for some hours immediately following a thunderstorm may mean that clear and fair weather is to be expected, but Fig. 71 is good evidence that it may also be interpreted to mean that another thunderstorm is just at hand."

"Although these records are somewhat unsatisfactory as far as throwing any light upon the nature of thunderstorms, it must not be forgotten that with a single exception [two stations at Washington] none of these storms have influenced more than one station The complete investigation of a storm would demand a large number of observing stations relatively near to each other, by means of which a full history of the potential changes about and in all parts of the storm could be obtained

"Such an examination might result in bringing order and system out of what seems at present little less than confusion"

Then follow many specimens of the actual photographic record at Baltimore on days when lightning occurred, and finally a mass of tables embodying abstracts of results at the different stations, and also some taken at Kew and Greenwich in England, though at both of these institutions the scale used appears to be arbitrary

General Conclusions

Among the conclusions the following may be noted "Instruments similar in every respect, separated by a distance of a hundred meters may give very dissimilar indications" (Not merely, it is explained, as regards *absolute* values only, which may be expected to disagree, but as regards fluctuations also) "Observers were instructed to study the appearance of negative electricity before and after and during precipitations, and at one time the hope was indulged in by the writer, as well as by several of the observers, that this phenomenon might afford great assistance in the prediction of local storms, rains, snows, &c, which offer so much difficulty in forecasting by present methods.

"Further observation and investigation, however, did not justify this expectation, serving rather to increase the meteorological conditions under which negative potential might be looked for, and to diminish the definition of relationship between it and precipitation That negative electricity is tolerably certain to be observed in connection with precipitation in a majority of cases is doubtless true, but it does not appear in such a way as to be of any value in forecasting"

Near the end of the historical introduction we learn with regret that the observations thus tabulated and discussed are now no longer going on

"In August, 1888, all observations were discontinued It was thought that a sufficient number had been accumulated to decide the question of their use in weather forecasting, and in fact their study up to that date gave little encouragement in that direction" "Many questions of great scientific interest had to be set aside for those likely to be of immediate practical value"

The amount of material thus rapidly accumulated, centralised, and well discussed, is typical of what can be done under efficient Government authorisation and by the head of a National Laboratory The carrying on of the research for immediate utilitarian ends, and stopping it as soon as it was seen that the results aimed at were not forthcoming, is perhaps also typical

It is to be hoped that some day the question will be reopened, and a fresh series of results obtained So far as I (who am by no means a meteorologist) can judge, I should surmise that a number of fairly concentrated stations over a large plain would be desirable, and also that the vertical gradient of potential should be attempted by a series of collectors at different altitudes on a tall mast, or possibly up a hill-side

Further, the general aspect of the curves seems to me to suggest that the instruments were almost too sensitive and not sufficiently dead-beat They should be quick in indication and at the same time thoroughly damped, so that the record shall contain as little as possible of any effect due to instrumental inertia Some very light

quartz-fibre instrument might be devised, and perhaps it might contain its own recording apparatus in a compact form, so as to make registration a much easier and less cumbrous business than it has been hitherto.

When so much is unknown it is a mistake to begin by observing with too great intricacy of detail. The salient features should be first obtained, and then attention directed to the minutiæ, but one of the first things to do is to arrange that every swing in the curve shall mean a swing of atmospheric potential, and not a mere excursion of a heavy needle

I hope that the energy, skill, and judgment of the various observers in the States, and of Mr Mendenhall, the author of this valuable report, may be utilised through the resources of the U S Government by the inauguration of a fresh series of observations under somewhat different conditions, and without the hamper of any immediately specified practical object OLIVER J LODGE

THE PRESERVATION OF THE NATIVE BIRDS OF NEW ZEALAND

IN our issue of September 16 last year (vol xlvi p 502) we printed an excellent memorandum drawn up by Lord Onslow, late Governor of New Zealand, relating to a proposal for the preservation of the native birds of that colony by setting apart two islands for this purpose, namely, Little Barrier or Hauturn Island in the north, and Resolution Island in the south As regards the first of these islands, we have lately received a copy of the report by Mr Henry Wright (addressed to the Hon John Ballance, Premier of New Zealand) upon the subject According to Mr Wright, Hauturn Island, in the Gulf of Hauraki, which is almost circular in shape, and contains an area of from 9000 to 10,000 acres, rising in the middle to an elevation of about 2000 feet, is very well adapted for the purpose required Writing with a thorough knowledge of all the north island, Mr Wright is able to say that there is no other part of it where the native birds are to be found in anything like such profusion and variety He gives a list of forty species to be met with within its limits, and mentions as particular varieties the stitch-bird or kotihe (*Pogonornis cincta*) and the large dark kiwi (*Apteryx bulleri*) as both found there There are slight difficulties in the way of the project, such as the presence of about a dozen Maoris now living on the island, and of a claimant for the timber, which, in the shape of kauri pine (*Dammara australis*), is present in large quantities There are no Weka Rails (*Ocydromus*) in the island to destroy the birds' eggs, and there are no bees, which, for some reasons, are considered to be highly inimical to the native birds in New Zealand The wild pigs, formerly numerous, have been killed out, and the mutton-bird (*Œstrelata gouldi*), the young of which were formerly eaten by the pigs, will consequently be able to breed again undisturbed Cats unfortunately are very numerous, but Mr. Wright proposes to offer at once a reward for their destruction, which is, of course, of great importance.

Mr Wright's report seems quite convincing as to the suitability of Hauturn Island for the object in view, but we regret to hear that some difficulties have arisen in the Parliament of New Zealand as to the appropriation of the funds required for the purpose.

Lord Onslow, however, is not disposed to let the matter drop, and will, we are sure, be strongly supported by Lord Glasgow, the present Governor of New Zealand, in carrying the matter to a successful issue. The Council of the Zoological Society of London, whose attention has been called to the subject, have passed in its favour the following resolutions, which were communicated to a general meeting of that body on the 16th inst

(1) The council of the Society have learnt with great satisfaction the steps that were proposed to be taken by the Earl of Onslow, when Governor of New Zealand, and by the Houses of General Assembly for the preservation of the native birds of New Zealand, by reserving certain small islands suitable for the purpose, and by affording the birds special protection on these islands

(2) The council much regret to hear that difficulties have been encountered in carrying out this plan as regards one of these islands (Little Barrier Island), and trust that the Government of New Zealand may be induced to take the necessary steps to overcome these difficulties and to carry out this excellent scheme in its entirety

(3) The council venture to suggest that besides the native birds to be protected in these reserves shelter should also be afforded to the remarkable Saurian, the Tuatera Lizard (*Sphenodon punctatus*), which is at present restricted to some small islands on the north coast of New Zealand, in the Bay of Plenty

These resolutions have been communicated to the present Governor of New Zealand, and will, we trust, be of some assistance to him in inducing his Ministers to carry this excellent scheme into execution

THE EARTHQUAKES IN ZANTE.

THE following is a list of the shocks of earthquake at Zante, compiled from telegrams published in the *Times* and *Standard* —January 31, at daybreak, the most destructive earthquake, of which, however, some warning must have been given, if we may judge from the comparatively small loss of life Other slighter shocks followed during the day February 1, 2 a m, another severe shock, felt also in Cephalonia. February 2, two more violent shocks, one of which caused some fresh damage. February 3, further shocks, but less frequent and violent February 5, another violent shock. February 6, continued shocks of slight intensity, followed by three more severe ones in the afternoon and evening. February 7, another violent shock in the morning, resulting in but little additional damage February 8, some slight shocks. February 10, some slight shocks in different districts February 11, 1 a.m, a somewhat severe shock, followed by a succession of shocks between 8 and 9 p m February 12, further shocks in the early morning, soon after midnight, and again at intervals during the day February 13 or 14, renewed slight shocks, accompanied by loud subterranean rumblings The Athens correspondent of the *Times*, telegraphing on February 20, says "The shocks of earthquake continue at Zante, with varying degrees of violence No serious damage is reported, but those who are compelled to live in the half-ruined or insecure houses are exposed to frequent alarms." It is estimated that the total loss of property due to the shocks may exceed £600,000.

According to a telegram in the *Times* for February 6, the tide in Venice on the evening of February 1 "ebbed so low as to leave several of the canals without water The gondola traffic was interrupted at different points, and many of those craft were stranded. This phenomenon corresponded with the earthquakes at Zante and Cephalonia." A simple calculation will show, however, that this can hardly have been due to the principal shock. The straight line joining Zante and Venice passes almost directly up the Adriatic, and its length is roughly 720 miles. Taking the time between daybreak on January 31 and the evening of Feb 1 at 36 hours, this would give for the sea-wave an average velocity of 20 miles an hour, corresponding to an average depth of about 30 feet, which is considerably less than the actual amount, the mean depth of the Adriatic being 110 fathoms.

Earthquakes are frequent in Zante, and sometimes very severe. One of the most destructive shocks, which occurred on October 30, 1840, is described by Ansted in

his work on the Ionian Islands (pp 415-419) chiefly from the report of the Lord High Commissioner, Sir Howard Douglas. The prison was in this case also unroofed, and hardly a house in the town of Zante escaped some injury All of the villages on, or bordering on, the plain suffered more or less, especially Sculikado, which was reduced to a heap of ruins The total amount of damage done was estimated at not less than £300,000 The great earthquake was followed by a large number of others, some very severe, ninety-five being counted up to November 4 Ansted notes (pp 368, 369) the curious fact that each of the Ionian Islands seems for the most part to have its own earthquakes, independently of the others About the year 1818, he says, all the sensible shocks in Cephalonia and Zante were tabulated, the record extending over two and a quarter years "During this time thirty distinct and well-marked shocks were recorded in Cephalonia, but in no case did the shocks in Zante, although nearly contemporaneous, absolutely coincide with them In most cases an interval of some days, and almost always more than twenty-four hours, seems to have elapsed between the times of the disturbances in the two, although they are so near that in these days [1863] of long range, a cannon-shot fired from the one might reach to the other"

NOTES

THE French Academy of Sciences has opened a subscription in support of the movement for the publication of the writings of Jean Servais Stas and the erection of a monument in his memory.

A MEETING of delegates of the Academies of Science at Berlin, Gottingen, Leipzig, Munich, and Vienna was held on January 29, under the presidency of Prof Ribbeck The object of the meeting was to prepare the way for a sort of federal union of the various German scientific societies, so that they may be able to act together about important matters of common interest A hope was expressed that a great international confederation of scientific societies might ultimately be formed

ANNOUNCEMENT has been made of the death, on February 2, 1893, at Hendaye, in the Department of the Basses Pyrénées, in his sixty-eighth year, of M Victor Aimé Léon Olphe Galliard, author, among other works, of "Contributions à la Faune Ornithologique de l'Europe Occidentale," in forty livraisons (of which the last was published in 1892) giving an elaborate description of the birds not merely of Western but of almost the whole of Europe, to say nothing of allied species belonging to other countries. M Olphe Galliard (whose name few writers, even Frenchmen, spell correctly) was remarkable among his countrymen for his knowledge of other languages than his own, and his recognition of the works of foreign ornithologists stands out in great contrast with that accorded to them by most continental authors. He translated into French several valuable papers written in Swedish and other tongues as little known, thus bringing them before readers to whom they would have been otherwise inaccessible, while he still further showed his appreciation of foreign naturalists by introducing into his principal work portraits of Johann Friedrich Naumann and William Macgillivray as the representative ornithologists of Germany and Great Britain. The earliest performance by which M Olphe-Galliard will be remembered was his description in the *Annales* of the National Society of Lyons for 1852 of the interesting Algerian bird which he called *Erithacus Moussieri*, after a French army-surgeon of that name who had recognised it as a new species in 1846. In the following year specimens of it were procured by the late Mr. Louis Fraser, and placed in the British Museum, but they met no kind reception there then, or even later, for the species finds itself in the *Catalogue of Birds* (vii. p 20) far removed from what all naturalists who have observed it in life declare to be its nearest relations—the Stonechats or the Redstarts—and shot into the rubbish-hole placarded *Timeliidæ*, where no one would ever think of looking for it. M Olphe Galliard's latest publication consisted of letters addressed to him by the somewhat eccentric Christian Ludwig Brehm, which appeared in the *Ornithologisches Jahrbuch* for 1892

A MEETING of conchologists is to be held at 67, Chancery Lane, on Monday, February 27, at 8 p m, for the purpose of founding a "Malacological Society of London"

THE Geologists' Association has arranged for a visit of the members to the British Museum (Natural History), Cromwell Road, on March 18, when Mr W Carruthers will give a demonstration on "Gymnosperms from the Devonian to the present time" There will be an excursion to Norwich, Cromer, and Lowestoft at Easter

SOME admirable suggestions for the guidance of teachers of evening classes in wood working under the direction of County Councils have been prepared by the Examination Board and Committee of the City and Guilds of London Institute The suggestions relate to drawing lessons, object lessons, and bench work lessons

THE type of weather during the past week has undergone but little change from that of the preceding week Anticyclonic areas lay over Scandinavia and Spain, and low pressure systems continued to skirt our north and west coasts The general conditions, however, were much quieter, although a deep depression reached the west of Ireland on Sunday, causing gales on our western coasts. On Tuesday a large and important disturbance arrived over the south-west of England from off the Atlantic, and the wind circulation around its central area was complete The difference of barometric pressure was, however, by no means large in different parts of the kingdom, and consequently there was not much wind The barometer fell as low as 28 7 inches over the centre of the cyclonic area, and later during the day the disturbance continued its passage across England, and was accompanied by heavy rain Temperature continued high for the season, the daily maxima ranging generally from 45° to 55°, while on Sunday, the 19th inst, the thermometer rose to 60° in the inland parts of England. In London it reached 59°, which was a higher reading than had been recorded so early in the year since 1878 The sky was exceptionally brilliant in the east and south-east on that day, but on the whole the air has been very damp throughout the week, and rainfall has been of almost daily occurrence For the week ended the 18th inst the rainfall exceeded the mean in all districts, except in the east of England. In the west of Scotland and the south-west of England the excess was considerable Bright sunshine only exceeded the normal amount in Ireland and the north and east of Scotland

THE Pilot Chart of the North Atlantic Ocean for February, 1893, shows that the weather in the North Atlantic during January was not abnormally severe, and that the eastern part of the ocean was unusually free from storms A map is given illustrating the great size and severity of the hurricane of December 22 last, which had moved rapidly from Hatteras in an east north-east direction. At the time selected for illustration, when the centre lay in longitude 36° west, the storm area covered the entire Atlantic from Labrador and Nova Scotia to Madeira, Portugal, and Ireland Some very low barometer readings were recorded, the lowest being 27 75 inches. There was a large amount of ice during January along the coast of

America, as far south as Hatteras; in Chesapeake Bay it was reported to be thicker than for twenty-five years.

THE official report of the International Meteorological Conference at Munich from August 26 to September 2, 1891, has now been issued. It contains protocols of the various meetings, with appendices and supplements.

THESSALY was supposed to have got rid of the plague of field mice, but it appears that the congratulations offered to her were somewhat premature. The Athens correspondent of the *Times* telegraphs that swarms of these troublesome creatures are beginning to reappear both in Thessaly and in the neighbouring district of Phthiotis. "It was hoped," he says, "that the severe cold and heavy rains of the last few months had exterminated them, but they seem to have taken refuge in the mountains, and are now returning in large numbers to the plains. The Prefect of Phthiotis has applied to the Government for instructions as to the best means of dealing with this destructive pest."

ACCORDING to a correspondent of the *Scotsman*, writing from Borthwickbrae, Selkirkshire, the mice pest in Scotland has greatly diminished, if it has not entirely disappeared, during the last two months. "The great abundance of owls," he says, "coupled with the very severe weather, has no doubt given them a check." During the severe storm of last month the owls, unfortunately, suffered also. The keeper at Alemoor Loch counted over thirty of the short-eared or heather owl, and eight kestrel hawks—some lying dead, others able to fly a few yards only, while several sat until lifted in the hands. The short-eared owls did not go to the woods to roost, which were close to the loch, but were in the willows and reeds along the edge of the loch.

SIR EDWARD BIRKBECK has accepted the presidency of the British Sea-Anglers' Society, which was founded recently at a meeting held in London. It is proposed that the Society shall have branches in all parts of the United Kingdom, and the members hope that they may be able not only to secure for themselves certain advantages in connection with their favourite sport, but to be of some public service. The chairman of the preliminary meeting, Mr. C. H. Cook, touched on the question of legislation for the protection of sea fish. "I hope," he said, "that the anglers will take up the cause of immature sea-fish. Already a movement, to which we may give a strong impetus, is rolling forward in this direction, but it is checked by the trawlers' interests. The harm done by these men is almost incalculable. I have seen their nets within a stone's throw of the shore, in less than three fathoms of water, where they scoop up and destroy the infant fish by the million. It may be that the evidence tendered by trustworthy members of the Sea-Anglers' Society may be the means of putting an end to inshore trawling. I hope it will. It often happens that the information given to the Fishery Boards is wilfully misleading, owing to it being given by fishermen, who fear they will lose their living."

THE Council of the Cremation Society of England, in its Report for 1892, expresses much satisfaction with the progress made by the cause which the Society represents. It seems that within the year no fewer than 104 bodies were cremated, "including a large proportion of individuals well known in society by their connection with art, science, or literature, or by a distinguished position of some other kind, ten having been members of the medical profession."

MR. A. H. S. LUCAS, who has edited the *Victorian Naturalist* admirably since it was started nearly nine years ago, has tendered his resignation in consequence of his election to the head-mastership of Newington College, Sydney. The Field Naturalists' Club, of Victoria, to which the magazine belongs, has expressed its cordial thanks to Mr. Lucas for his services. Mr. F. G. A. Barnard, who has been both secretary and librarian of the club, will act for the present as Mr. Lucas's successor.

A MOST interesting and suggestive paper on "pottery glazes: their classification and decorative value in ceramic design" was read by Mr. W. P. Rix at the meeting of the Society of Arts on February 7. It is printed in the current number of the Society's Journal. Mr. Rix tries to show that the relative merit of various glazes is based upon certain optical principles, which have only been partially examined by men of science, and that these principles, underlying the pleasurable sensations to the eye, really govern that which we are pleased to call good taste and excellence, so far as glazes are concerned, and are not mere matters of opinion. The reading of the paper was followed by a lively discussion, in the course of which Mr. Binns quoted a saying attributed to Mr. Gladstone, that a fine piece of glaze "feels like the touch of a baby's hand." Mr. Binns had often been struck with the aptness of the illustration. There was a peculiar soft texture in a fine piece of glaze that only a connoisseur could appreciate.

THE *Times* of Tuesday gives an account of a process by which anthracite coal bricks are now being manufactured. The bricks are made of grains of anthracite dust, which are forced to cohere by means of a special cementing compound and by great pressure. The coal dust is mixed with the binding material in the proportion of 96 per cent. of the former to 4 per cent. of the latter. The compound is fed into a mixer, where it meets a jet of steam, a stiff paste being formed, which is delivered successively into a series of moulds under a pressure of 25 cwt. As the mould plate revolves, the charge in each mould is brought between two rams, which exert a pressure of two tons per square inch on each side of the charge, forming a very dense and homogeneous coal brick. The brick, still in the mould, passes on to the delivery ram, by which it is pushed out on to a table, and is removed for the market. These coal bricks are said to make an excellent fuel and to possess a very high efficiency for steam-raising purposes. The *Times* thinks that with such a fuel at the disposal of the public there is room to hope for a reduction in the pollution of the atmosphere of towns, as well as a reduction in the coal bills of steamship companies and of steam users generally. It adds that the invention is being worked by the Coal Brick Syndicate, of 2, Trafalgar-buildings, Northumberland Avenue, London.

IT seems that serious depredations have been committed among the recently-discovered Phœnician tombs at Gebel Imtarfa, in Malta. The *Mediterranean Naturalist* says that the manner in which not only these tombs, but many others, have been rifled of their contents by irresponsible curiosity hunters, and the state in which many of the ancient ruins of the islands now are constitute a disgrace to European archæological science. More has been done to obliterate and destroy vestiges of Malta's ancient history during the last two centuries than was effected in the preceding two thousand years. Orders have been issued from head-quarters, Valletta, to the effect that the District Commanding Royal Engineer is to report immediately any discoveries of ancient tombs, burial places, or pottery that may occur in course of excavations for works, or come to light in any way; and that such objects are to be carefully preserved until they have been inspected by an officer of the Civil Government, and left untouched *in situ* until this inspection has been made.

A DISCUSSION on Mr. E. G. Carey's paper—to which we lately referred—on the bridges of the Manchester Ship Canal is

reported in the new instalment of the Transactions of the Institution of Engineers and Shipbuilders in Scotland. Mr Carey, in the course of his reply to the various speakers, alluded to the question as to the value of annealing steel. He said that, so far as his experience went, annealing steel certainly removed all stress. At the Forth Bridge they were very curious about this subject. They had a single strip of steel, which they strained up to some 30 times, to about 25 tons on the square inch. After every straining, it was annealed. That went on for days and weeks, and the steel seemed to be literally the same as when they started. The experiment grew wearisome, and ultimately, when the strain was run up inadvertently to about 30 tons per square inch, and the specimen finally broke, it was almost a relief, but it proved that the annealing of steel removed all strain, and that, although injured, if annealed, it seemed to recover its former properties.

A VALUABLE synonymic and bibliographical catalogue of the New Zealand land and freshwater Mollusca, by H. Suter, was communicated to the Linnean Society of New South Wales at its meeting on December 28. In 1880 Prof. Hutton, in his "Manual of the New Zealand Mollusca," enumerated 125 species of land, fresh, and brackish water molluscs. Since then zoology has made such rapid strides that this fauna is raised in Mr Suter's catalogue to a total of 178 species, divided by him into 45 genera. The land mollusca embrace 142 species, of which 15 are operculate; the fluviatile shells are reckoned at 32, 12 being bivalves and 7 operculate univalves. This large addition of one-third to the list of twelve years ago is not the greatest advantage the present catalogue has over its predecessor; numerous species are now removed which, by the negligence of collectors or the errors of European authors, were formerly included among the shells of New Zealand. The attention bestowed during the last decade upon the anatomy of the New Zealand snails has furnished data for a more natural classification, while the increase of colonial libraries has facilitated the quotation of fuller references than were previously available.

MR J. M. STAHL, Illinois, has much to say in the *American Agriculturist* about the virtues of wood ashes. Speaking of them as a medicine for farm animals, he says he has found them of great value. He has raised swine rather extensively for more than twenty years without cholera or swine plague, and has not lost one per cent. of his hogs from disease. He keeps wood ashes, and charcoal mixed with salt, constantly before his swine in a large covered box with holes two-by-six inches near the bottom. The hogs will work the mixture out through these holes as fast as they want it. He selects ashes rich in charcoal, and mixes three parts of ashes to one of salt. There is no danger of the swine eating too much of this mixture, or of pure salt, if it is kept constantly before them, and they are provided with water. The beneficial effects of the mixture are quite marked, especially when the hogs are fattened on fresh maize. A little wood ashes, given to horses, is also, he maintains, very beneficial. In thirty-seven years' experience upon the farm he has lost but one horse, and this was overheated in the horse-power of a threshing-machine during his absence, and the only "condition powder" he has ever used has been clean wood ashes. The ashes may be given by putting an even teaspoonful on the oats twice a week, but he prefers to keep the ashes and salt mixture constantly before the horses, and has made for it a little compartment in one corner of the feed box. His experience is that the best condition powder is a mixture of three parts wood ashes to one of salt; and that when it is given regularly, and reasonable care and intelligence are used in handling the horse, no other medicines are necessary. Mr. Stahl has also great faith in the efficacy of wood ashes as a fertiliser.

A VALUABLE paper on the industrial resources of the Caucasus, by an Austrian official, Herr G. Sedlaczek, is summarised in the Board of Trade Journal for February. Dealing with the silk industry, the author says that the Russian Government has spent more money for the furtherance of this department of trade than for any other industrial purpose in Caucasia, and that the results are in no way commensurate with the trouble and outlay. Although the country possesses innumerable mulberry trees, in some parts forming veritable forests, and excellently suited for feeding silkworms, although the climatic conditions are favourable, and the inhabitants have from time immemorial been familiar with the working up of the raw material, the most untiring efforts of the Government have proved little else than a struggle to preserve the mere existence of the silk culture and industry. The estimated production of silk in Transcaucasia at the present day is 36,000 pouds, although in 1855 it was 30,000 pouds. The average value of the produce is said to be about 6,000,000 roubles. Considerable advance has been made in reeling, spinning, and twisting; new foreign machinery is everywhere at work, and all that is wanting is a good raw material, the production of which is, however, being constantly prevented, on the one hand by disease in the worms, and on the other by the indolence of the producers. The Russian demand for silk is far from covered by native production, silk being annually imported to the value of about 12½ millions of roubles, while the exports amount only to about 3,000,000 roubles in value. In spite of protective duties the imports are increasing while the exports are decreasing.

MANY marine animals (radiolaria, ctenophora, &c.) rise and sink slowly in the water, having some means, apparently, of changing their specific gravity. This has been recently studied by Herr Verworn (*Pflüger's Archiv*), in the case of *Thalassicolla nucleata*, a radiolarian about the size of a pea. It has a central capsule with nucleus, a coarse endoplasm, a vacuole-layer, a gelatinous layer, and ray-like processes. As a rule, these animals float at the surface. They sink on seizing food heavier than themselves, also when strongly stimulated by shaking, or by chemical agents. It was found that the central capsule and the gelatinous layer are both heavier than sea water, while the vacuole layer is lighter. On being stimulated, the pseudopodia (or processes) were drawn into the vacuole-layer, and the protoplasm also retired from this, the walls of the vacuoles flattening from without inwards, till at length very little of them was left. Then the animal began to sink. At the bottom the vacuoles were soon regenerated, and the animal rose again. Thus it appears that the vacuole layer is the hydrostatic apparatus of these organisms, the vacuole liquid being that part of the cell which is lighter than sea water, and keeps the cell at the surface. The same probably holds good with other pelagic animals. That the vacuole liquid is lighter than the sea-water from which it comes is no difficulty, since it is known that living protoplasm is impermeable for many salts.

A VOLUMETRIC method for determining the amount of chromium in a specimen of steel has become a great metallurgical desideratum since the good qualities conferred upon steel by its addition have become generally known. Such a method is described by G. Giorgis, of the University of Rome, in the *Atti* of the *Accademia dei Lincei*. It is founded upon the formation of potassium chromate and hydrated manganese sesquioxide on adding a solution of potassium permanganate to a solution of sesquioxide of chromium in potassium hydrate. Ten grammes of the steel are dissolved in a mixture of sulphuric and nitric acids (3 to 1), the solution is made up to 1 litre with distilled water, and 250 c.c. are made just alkaline with sodium hydrate, and treated with hot permanganate of potash till the solution assumes a red colour. After cooling the whole is

poured into a flask of 500 c c capacity, filling up with water. 400 c.c. are filtered through a dry filter, acidified with sulphuric acid, reduced by SO_2, and concentrated to 200 or 100 c c, according to the quantity of chromium probably present Donath's method may then be employed, consisting in the addition of the chromium salt prepared as above described, to a measured quantity of a standard permanganate solution, and watching for the golden yellow colour assumed by the mixture when the permanganate is all dissolved, *i e* when all the chromium exists in the form of a chromate, from which the amount of chromium is easily calculated It is said that this process is extremely accurate, and requires only a small fraction of the time required by gravimetric methods

THE subject of dew appears to be still involved in some controversy. An experimental contribution to it has been recently made by Herr Wollny (*Forschungen*, &c), who used plants in glazed pots with earth of varying moisture, some of these being allowed to radiate freely on favourable nights, while others were screened The following is a brief outline of Herr Wollny's views .—Dew depends partly on evaporation from the ground, partly on transpiration. It is at present doubtful whether precipitates from the air share in it or not A cloudy sky weakens the cooling process without stopping it wholly With copious radiation, the temperature minimum is at the surface of the plant-covering (of the ground), and here the aqueous vapour rising from the warm ground is partly precipitated With increase of the ground-heat downward there is increase of the water brought up by the plants, which is given up as vapour and condensed The more moisture there is in the ground, the more water is evaporated from the ground and the plants Dew formation is usually favoured by the larger number of stomata on the under surface of leaves than on the upper On a given surface of ground the dew is more plentiful the stronger the plant organs above ground, and the closer the plant growth The temperature of still air increases from the surface to a certain limit (at about 5 feet over grass it was sometimes 4° or 5° C. warmer than on the ground) In experiments with blotting paper, cotton wool, feathers, and asbestos, the first was much moistened, while the others showed dew in drops Bodies of organic origin attract more moisture than those of mineral (a case of hygroscopic absorption). For vegetation, the author considers the benefit of dew but trifling Of the whole annual precipitation at Munich dew only gave 3 23 per cent.

WITH the present year the weekly *Botanische Zeitung* enters on the fifty-first year of its existence, and Graf zu Solms Laubach gives with the first number of the year an interesting sketch of its history, uninterrupted for half a century, even during the stormy period of 1847–1849 The inception of the undertaking was due to the suggestion of a botanist still living, Dr Carl Müller, of Halle The first number of the *Botanische Zeitung* appeared on January 9, 1843, under the editorship of Von Mohl and Schlechtendal. The editorial chair has been occupied since then by some of the most distinguished German botanists, De Bary, Hallier, Kraus, Jost, and the present editors, Solms-Laubach and Wortmann

DR. VINES, the Professor of Botany in the University of Oxford, has for some time past had in preparation a "Student's Text book of Botany," which will be more comprehensive than his edition of Prantl's well-known "Elementary Text-book." It is to be fully illustrated, and is expected to be ready early in the autumn of this year. It will be published by Messrs. Swan Sonnenschein and Co.

MESSRS GAUTHIER-VILLARS ET FILS, Paris, continue to issue the useful series of small volumes called "Encyclopédie Scientifique des Aide-Mémoire." The following volumes have lately been added: "Corderie," by M Alheilig, "Formation des Gîtes Métallifères," by L. de Launay, "Le Grisou," by M. Le Chatelier, "Moteurs à Vapeur," by M Dudebout; "Détente Variable de la Vapeur," by A Madamet, "Canons, Torpilles, et Cuirasses," by A. Croneau, "Textiles Végétaux," by H. Lecomte, "Essais d'Or et d'Argent," by H Gautier, "État Actuel de la Marine de Guerre," by L. E Bertin, "Industrie des Cuirs et des Peaux," by Ferdinand Jean.

THE "Annuaire," for 1893, of the Royal Observatory of Belgium, by F Folie, has been published This is the sixtieth year of issue

THE Department of Science and Art has issued the volume for 1893 containing its calendar, history, and general summary of regulations

IN the course of an elaborate investigation recently published in the *Zeitschrift fur Hygiene*, December 9, 1892 ("Die Aetiologie des infectiosen fieberhaften Icterus" (Weil'sche Krankheit), Jaeger draws attention to the dangers which may arise from bathing in polluted water Already in 1888 Pfuhl (*Deutsche militar-arztl Zeitschrift*, 1888, Heft 9 and 10) attributed an outbreak of typhoid fever, accompanied by jaundice, which occurred amongst the garrison stationed at Altona to bathing in the Elbe, which at the time was described as more than usually polluted. Hueber and Globig came to similar conclusions with regard to outbreaks of the above "Weil'sche Krankheit," which appeared at Ulm on the Danube and Lehe respectively Jaeger has made a special study of the cases which arose amongst the soldiers at Ulm, and has endeavoured to trace, if possible, the infection to its source It was found that the military bathing place was situated below the point where the Danube is joined by the highly-polluted river Blau. This stream is described as being practically an open sewer, and even before it reaches Ulm is stated to be grossly contaminated in its flow through the small village of Soflingen It was further ascertained that in this village for many years a mysterious disease had been rife amongst the ducks and geese, whilst fowls were also occasionally attacked, and that moreover it was a common custom to throw the dead carcases of these animals into the Blau as the readiest means of getting rid of them A careful examination of some of the birds which had succumbed to this disease revealed the constant presence of a micro-organism, which Jaeger asserts was identical with that found repeatedly and isolated in the cases of icterus investigated by him at Ulm It is further stated that by mixing some of the highly-polluted Blau water at Soflingen with sterile broth, and inoculating it into white mice, they were killed in sixteen hours, and that the organism, which was found abundantly present in various organs of the body, was in every respect identical with that previously isolated in the cases of icterus at Ulm, and from the carcases of the birds at Söflingen. Taking these various results into consideration Jaeger is of opinion that they afford very strong evidence of the virus of this disease having been introduced into the highly contaminated stream at Soflingen, and conveyed thence to the military bathing-place, which, as already mentioned, is situated below the junction of the Blau with the Danube In consequence of the appearances in cultivations to which this organism gives rise, the author has suggested for its name *Bacillus proteus fluorescens*, and claims in it to have discovered the exciting cause of the so-called "Weil'sche Krankheit," the etiology of which is attracting much attention on the continent.

NOTES from the Marine Biological Station, Plymouth :— Heavy gales have prevailed for many weeks, confining operations to the inshore waters. The week's captures include numbers of the Archiannelid *Dinophilus taeniatus*, of the Polychaeta *Marphysa*

sanguinea and *Sagalion boa*, and of the Nudibranch *Ancula cristata* In addition to the forms mentioned last week, the townettings have contained the Siphonophore *Muggiæa atlantica*, the Anthomedusa *Margellium* (*Lizzia*) *octopunctatum*, and several ephyræ of *Aurelia*, together with numbers of Teleostean ova, Prosobranch and Opisthobranch veligers, larval Lamellibranchs and *Cyphonautes*-larvæ The Polychæte *Cirratulus cirratus* and Gastropod *Littorina littoralis* are also breeding

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. Walter Neall; two Red and Yellow Macaws (*Ara chloroptera*) from South America, presented by Mr Henry Goschen; a Herring Gull (*Larus argentatus*) European, presented by Mr W R Galbraith, a Bar-breasted Finch (*Munia nisoria*) from Java, presented by Mr Sydney D Birch, two Whooper Swans (*Cygnus musicus*) European, purchased, a Vulpine Phalanger (*Phalangista vulpina*), three Barbary Mice (*Mus barbarus*) born in the Gardens

OUR ASTRONOMICAL COLUMN

COMET BROOKS (NOVEMBER 19, 1892).—The following ephemeris for Comet Brooks is taken from *Astronomische Nachrichten*, No 3142.—

1893	R A. (app) h m s	Decl (app) ° ′
Feb. 23	0 31 49	+24 18 2
24	33 0	23 59 8
25	34 9	23 42·1
26	35 17	23 25 0
27	36 24	23 8 5
28	37 30	22 52 4
March 1	0 38 34	22 36 8

COMET HOLMES (1892 III).—Several communications with respect to the late appearances of this comet are inserted in the Comet Notes of *Astronomy and Astrophysics* for February, among which will be found one by Prof E Barnard Observing with a 12-inch on the night of January 16, at 8h 10m, he found that an estimation of the comet's diameter gave 30″, while a setting of the wires indicated 29″ 4 While under observation "*the comet seemed to be perceptibly brightening*," and further measurements at 9h 45m gave a diameter of 32″ 4 At this time he says "The nucleus had developed clearly, and was very noticeable as a small, ill-defined star" With the 36 inch, which he was able to use later, he made the following measures, which we reproduce here, as they are quite unique in showing the increase in diameter of a comet due evidently to some external impact —

Standard Pacific time h m	Diameter ″
10 29	43 4
10 30	44 9
10 31	43 6
10 42	47 8
10 43	47 9
10 45	46 0
11 13	47 3
11 15	46 1

In concluding his remarks he says · "This is certainly the most remarkable comet I have ever seen, taking everything into consideration"

The following is the ephemeris for this week:—

Greenwich, Midnight

1893.	R A (app) h m. s.	Decl (app) ° ′ ″
Feb 23	2 19 4·4	+34 31 7
24	20 44·6	33 36
25	22 25 5	36 9
26	24 6 4	38 42
27	25 48 0	41 18
28	27 29 6	43 54
March 1	29 11 9	46 34
2	2 30 54 3	34 49 13

SOLAR OBSERVATIONS AT ROME.—In the *Memorie Degli Spettroscopisti Italiani* for January, Prof Tacchini communicates the observations made at the Royal College with respect to the various phenomena observed at the solar surface during the third trimestre of 1892. Dealing first with the prominences the total number for each of the months are respectively for north latitudes, 182, 129, 120, total 431, and for south latitudes 141, 167, 185, the total number here amounting to 493 The balance here is in favour of the southern hemisphere for greater frequency, but a curious fact may here be remarked, and that is that the maxima for the north and south latitudes occur in the months of July and September respectively, each exceeding considerably the number of prominences recorded for the same month in the opposite hemisphere.

The greatest frequencies occurred in latitudes (+60° +70°) and (−50° −60°) The groups of spots seem to have predominated slightly in the southern latitudes, the record showing 49 against 41, at the equator as many as 13 for zone (0° +10°) were seen, the zone (0° −10°) showing only 4, the relative frequency occurred here in the same zones in both hemispheres (±10° ±20°)

With reference to eruptions, the month of July contains the only records, six for the northern, and three for the southern hemisphere, four of these taking place in zone (+10° +20°)

Prof Tacchini also has a note on the great prominence of November 16 last, in which he describes in detail the numerous observations which he was fortunate to procure. Although one can gather a good idea of the rapidity of the ascent from the table, the figures which accompany it show in a striking manner the great changes of shape that was such a conspicuous feature in its ascent. At 9h 0m on the 16th the height was only 131″ 8, but at 1h it had reached 319″ 2, and at 1h 35m, 534″ 3, thus being its maximum height It is interesting to notice the numbers showing the increase of altitude in *one* minute of time.

For instance, at 11h. 55m the increase of altitude per minute was 0″ 56, at 1h 4m it was 6″ 75, decreasing from this value to 4″ 34 at 1h 27m At 1h 32m the velocity of ascent was increased, the value amounting to 9″ 72, but at 1h 34m the increase of altitude reached its maximum, 20″ 80, showing the ascent per minute.

THE STAR CATALOGUE OF THE "ASTRONOMISCHE GESSELSCHAFT"—The Harvard College Observatory has now completed the task of cataloguing the zone of stars undertaken in connection with the great catalogue of the *Astronomische Gesselschaft* The stars included number 8627, and lie between 49° 50′ and 55° 10′ north declination, and the positions are reduced to the epoch 1875. Most of the observations were made by Prof Rogers during the years 1870–1884, and the reductions have throughout been in his charge. The publication appears simultaneously as vol xv part ii of the *Annals of the Harvard Observatory*, and as one of the volumes of the *Gesselschaft* All concerned are to be congratulated on the completion of the zone, which involved over twenty-six thousand observations and an immense amount of calculation

NOVA AURIGÆ.—Mr Fowler draws attention to the fact that the nova is still as bright as ninth magnitude, and therefore easily visible in comparatively small telescopes. Its spectrum seems to consist of the two bright nebula lines near wave lengths 5006 and 4956 The latter is only slightly fainter than that at 5006.

PARALLAX OF β CYGNI.—Mr Harold Jacoby, whose work on the reduction of the Rutherford photographic measures of the stars about β Cygni we have previously referred to, suggests in *Astronomical Journal*, No. 287, that the discrepancies in the results can be explained on the hypothesis of a parallax of β Cygni amounting nearly to a whole second of arc To investigate this he has chosen five pairs of comparison stars, from which he has computed the parallax from each pair separately by "using the difference of the distances of the two comparison stars from β as the quantity from whose variation the parallax should appear;" in this way he has obtained the weighted mean for the parallax to be + 0″·97, a value which, if endorsed by further observations will show us that of all stars β Cygni is one of our nearest neighbours.

GEOGRAPHICAL NOTES

MR. G. B. GRUNDY, of Brasenose College, the student in geography appointed jointly by the University of Oxford and the Royal Geographical Society, has made a careful survey of the battlefield and site of the town of Platæa and of Leuctra,

in Greece. He is now engaged in preparing a comprehensive memoir on the subject which may be expected to throw new light on some questions of historical geography

MR MACKINDER, in his fifth lecture for the Royal Geographical Society's education scheme, spoke of the chief lines of communication between Asia and Europe and the ways by which successive bands or hordes of Asiatic invaders forced a passage into the heart of Europe The routes across Asia Minor from the Gate of Cilicia to the northern waters, and the thoroughfare through the Balkan peninsula now traversed by the international railway, were shown to have guided the movements of peoples and the formation or dissolution of nations from the dawn of European history on to the present day.

THE United States appears to have entered the field as an aggrandising power, taking up territory beyond the limits of the continent of North America. The annexation of Hawaii seems likely to be effected without remonstrance, and a footing has also been obtained in San Domingo, the eastern part of the island of Haiti

MR A. VAUGHAN WILLIAMS has been exploring the region round the mouth of the Sabi River in south-east Africa He has ascended the stream for thirty miles to the limit of tidal influence

THE orthography of African place names is a perpetual source of confusion It appears that in place of Zimbabwe or Zimbabye we ought, in order to render the sound of the word used by the people surrounding the ruins, to write "Zimbabghi" The familiar name Mashonaland is in itself a corruption of the native name, but is always pronounced Mashunaland, a pronunciation to which the spelling ought to conform.

RAILWAYS seem likely at last to become established in China The line from Teintsin to Taku has now been extended to the River Lan, a total distance of 130 miles, and is being rapidly pushed northward, a considerable section being already opened for passenger traffic.

CAPTAIN BOWER'S JOURNEY IN TIBET

AT an extra meeting of the Royal Geographical Society, on Monday night, Captain H Bower described his recent journey with Dr Thorold across Tibet from west to east They set out from Leh on June 14, 1891, and were fortunate enough to get well into Tibet before meeting any natives. Travelling due east they crossed a pass of 18,400 feet, on the other side of which lay the Horpa Cho, the highest lake yet met with in Tibet, and probably the highest in the world, its altitude being 17,930 feet Along the route eastward many other lakes were passed, all salt and without outlet, the want of fresh water being sometimes severely felt, a kettleful of hailstones was a welcome catch on one occasion The travellers used ponies and donkeys for carrying their loads, as yaks do not eat grain, and grass was often not met with for many days' journey At length, after travelling east and south-east for about 700 miles, they were stopped within 200 miles of Lhasa by the Tibetans, who paid no attention to Chinese passports, and after much parleying insisted on a complete change of route The party had to retrace their steps for several days' march, turn northward, and then make their way east at a safer distance from the capital It was now the month of October and the crossing of passes over 18,000 feet, with temperatures of 15° or more below zero, in strong wind was extremely trying About the end of November, for the first time for four months, the tents were pitched at a less altitude than 15,000 feet, and soon afterwards Chiamdo was reached Here great difficulty was experienced with the lamas, who insisted that no European should enter the town; but by the intervention of the Chinese Amban, whose power was really but slight, the party was allowed to proceed, passing round the outside of the town. From Chiamdo to Batang the way was easy, and no difficulties were experienced thereafter At Ta-Chen-Lu they entered China and reached Shanghai on March 29, 1892 Throughout Central Tibet the authorities disclaimed the sovereignty of China, maintaining that only the grand lama had jurisdiction in that region. Many of the lamas met with were educated and intelligent men, but not inclined to give information. Much difficulty was experienced in getting the names of lakes and mountains, no two Tibetans giving the same answer. The fanaticism and distrust of the people created constant difficulties, but Captain Bower, under the pretext of being a Buddhist with a peculiar ritual, succeeded in making observations for position openly as part of a religious service, previous attempts to do so by stealth having failed.

THE CHEMISTRY OF OSMIUM.

AN important addition to our knowledge of the chemical nature of this interesting element is contributed by Prof Moraht and Dr Wischin, of Munich, to the current number of the *Zeitschrift fur Anorganische Chemie* Two years have scarcely elapsed since the position of osmium in the periodic system was finally decided by the painstaking re-determination of its atomic weight by Prof Seubert Previous determinations of the atomic weight of osmium had been made with material which Seubert subsequently showed to be impure, and in consequence the erroneous value, 198 6, had been ascribed to it Indeed previous to the year 1878 the order of precedence as regards atomic weight of the four metals of the platinum group —gold 196 2, iridium 196 7, platinum 196 7, and osmium 198 6 —was entirely at variance with the order demanded by their chemical and physical properties, and a standing contradiction of the periodic law of Newlands and Mendeleef In that year, however, Seubert attacked the case of iridium, and as the result of a series of determinations, made with the laborious care which has characterised all his work, the atomic weight of this metal, when obtained in a pure state, was shown to be 192 5, a number very different to that previously assigned to it, and which was afterwards remarkably confirmed, even to the decimal place, by an independent investigation by Joly Three years later Seubert made his celebrated re-determination of the atomic weight of platinum, which resulted in the number 194 3 being finally derived for the true atomic weight of the perfectly pure metal This value was likewise subsequently confirmed by Halberstadt In the year 1887 the position of gold was decided by simultaneous independent re-determinations of its atomic weight by Thorpe and Laurie in this country and Kruss in Germany, the two values being practically identical, 196 7 Lastly, in 1891, Seubert completed his work by re-determining the atomic weight of osmium with a specimen of the metal of practically perfect purity, with the result that the old number, 198 6, was found to be entirely erroneous, due to considerable quantities of impurities being present in the samples previously employed, and that the real value of this constant was 190 3, thus removing osmium from its former situation at the end of the series and placing it in its proper position at the head of it

The order of precedence of the metals of the platinum group is therefore as follows —Osmium 190 3, iridium 192 5, platinum 194 3, and gold 196 7. This order is in full accordance with the relative chemical and physical properties of these metals, and the last outstanding exception to the periodic generalisation has disappeared

Although the properties of pure metallic osmium, and particularly its atomic weight, are now known with certainty, the nature of its compounds is yet very little understood Moreover, it is evident from the result of the investigation of Prof. Seubert that previous workers have been dealing with an impure metal of atomic weight, 198 6. It was therefore desirable that not only should the chemistry of this element be extended to compounds hitherto uninvestigated, but that the composition and properties of the compounds already known should be subjected to a re-examination

Prof Moraht and Dr Wischin have therefore taken up the study of the compounds of osmium with oxygen, sulphur, and the halogens, employing material of a very high degree of purity, and the results of their investigation are both novel and interesting.

Work with osmium compounds is endowed with peculiar personal danger to the chemist, owing to the great facility exhibited under the most various conditions for the formation of the tetroxide OsO_4, a substance which boils at 100° C, and is very volatile at the ordinary temperature, and which attacks the skin, the lungs, and particularly the eyes with most serious consequences.

The material started with was a comparatively pure sample of the best known salt containing osmium, potassium osmate, $K_2OsO_4.2H_2O$. This salt was further purified by distillation

with nitric acid or aqua regia and absorption of the liberated tetroxide vapours in a solution of caustic potash The dark brown solution of potassium perosmate thus formed was largely diluted with water, and reduced to osmate by the addition of alcohol. After the expiration of about twenty-four hours almost the whole of the osmium had separated in the form of beautiful little crimson octahedrons of the salt $K_2OsO_4\ 2H_2O$, which, after washing with dilute alcohol, proved to be quite free from impurity, showing no trace of iridium

Previous observers have noticed that an aqueous solution of *potassium osmate*, K_2OsO_4, is most remarkably affected by sun light, a rapid decomposition being brought about with deposition of a black precipitate to which the composition $OsO_2\ 2H_2O$ has been ascribed The specimens experimented with, however, undoubtedly contained iridium, and it was therefore of interest to investigate the action of sunlight upon solutions of the pure salt just described When the crimson octahedrons of pure $K_2OsO_4\ 2H_2O$ were dissolved in cold water, and the clear red dish violet-coloured solution was exposed to direct sunshine, no evidence of change was apparent for several days, but the moment the vessel containing the solution was immersed in a bath of boiling water, while in bright sunshine, decomposition commenced, and a black precipitate rapidly accumulated, until after the expiration of two or three hours the whole of the osmium present was deposited As there is a marked tendency for the production of the noxious fumes of osmium tetroxide during this decomposition of the hot osmate solution by the waves of light it is best to take the precaution of reducing their amount to a minimum by the addition of a little alcohol, which acts as a strong reducing agent under these circumstances, and by passing a stream of hydrogen through the solution during the whole operation The precipitate is usually so finely divided that considerable difficulty is experienced in separating it from the solution The filtration succeeds best when the filter is previously moistened with dilute acetic acid, when a clear colourless filtrate is usually at once obtained The precipitate cannot be dried in a warm air bath, as it is largely converted thereby into the volatile osmium tetroxide It may safely, however, be dried over phosphoric anhydride in the vacuum of an air pump.

The accurate analysis of an insoluble substance of the nature of this precipitate, and containing a metal such as osmium, which so readily oxidises to the volatile tetroxide, is a task of exceptional difficulty The usual method of reduction to metal in a stream of hydrogen is insufficient, for more or less of the tetroxide is always formed during the process, necessitating the use of an absorption apparatus containing a solution of caustic potash, placed in front of the tube containing calcium chloride to absorb the water formed The difficulty is, then, how to estimate the small quantity of osmium thus dissolved in the large excess of alkali It was eventually found that the weak electric current from three Daniell's cells precipitates the whole of the osmium from such a solution, contained in a nickel dish which forms the negative electrode, in the form of pure *osmium dioxide*, OsO_2, which may conveniently be dried *in vacuo* over phosphoric anhydride and weighed as such.

By this mode of analysis the interesting fact was eventually elicited, that the black insoluble substance formed by the action of light upon a hot solution of potassium osmate is not, as was previously supposed, a hydrate of osmium dioxide of the composition $OsO_2\ 2H_2O$, but is no other than free *osmic acid* itself, the hydrate of osmium trioxide, $OsO_3\ H_2O$ or H_2OsO_4 Osmic acid is thus formed by the direct action of water, under the influence of sunlight and slight rise of temperature, upon the potassium salt This remarkable change is expressed by the simple equation.

$$K_2OsO_4 + 2H_2O = H_2OsO_4 + 2KOH$$

The liquid, as soon as the change commences, is observed to exhibit a strong alkaline reaction, becoming, as indicated in the equation, a solution of caustic potash It is singular that the presence of alcohol and the passage of a current of hydrogen during the reaction do not cause any reduction, serving only to hinder the further oxidation to the state of tetroxide Indeed, if the crimson octahedral crystals of potassium osmate are covered in sunshine with warm alcohol and a current of hydrogen is allowed to bubble through the liquid, no trace of blackening is observed upon the faces of the crystals. The moment water is added, however, decomposition is immediately brought about.

Osmic acid, H_2OsO_4, is a soot-black powder, which fumes strongly in moist air, owing to its rapid conversion into the volatile osmium tetroxide, OsO_4, but which is quite permanent at the ordinary temperature when preserved under water containing alcohol It dissolves readily in nitric acid with formation of the hydrate of osmium tetroxide, the so-called per-osmic acid Cold hydrochloric acid attacks it but very slightly Upon warming, however, it is entirely soluble, forming an olive-green liquid, which will be subsequently considered, with liberation of a small quantity of chlorine Sulphuric acid does not attack it Osmic acid reacts in a most energetic and interesting manner with sulphuretted hydrogen gas Even in the dry state at the ordinary temperature the reaction proceeds with considerable violence If the experiment is conducted in a piece of combustion tubing, upon which a bulb has been blown for the reception of the osmic acid, the moment that the gas enters the tube the whole of the black powder immediately becomes incandescent, and drops of water and a large quantity of free sulphur are deposited in the portion of the tube not heated by the reacting substances The residual product of the reaction is a brown powder, which has been found to be a hydrated oxysulphide of osmium of the composition $2OsSO\ H_2O$

The reaction occurs in accordance with the equation—

$$2H_2OsO_4 + 4H_2S = 2OsSO\ H_2O + 5H_2O + 2S$$

This *oxysulphide of osmium* is soluble in acids with decomposition, even sulphuric acid decomposing it with evolution of sulphuretted hydrogen It possesses acid properties, for it liberates carbon dioxide from carbonate of soda and sulphuretted hydrogen when fused with sulphide of potassium It would, moreover, appear to contain SH groups, for it yields mercaptan upon treatment with soda and ethyl iodide, the osmium being reduced to the dioxide OsO_2. Its probable constitution is therefore represented by the graphic formula —

$$\begin{array}{l} \mathrm{Os}\begin{cases}\diagup \mathrm{SH} \\ = \mathrm{O} \\ \diagdown \mathrm{O}\end{cases} \\ \mathrm{Os}\begin{cases}\diagup \mathrm{O} \\ = \mathrm{O} \\ \diagdown \mathrm{SH}\end{cases} \end{array}$$

When this oxysulphide is warmed in dry sulphuretted hydrogen another violent reaction occurs, the whole mass again becomes incandescent, and the whole of the oxygen is eliminated in the form of water The product of this second reaction with sulphuretted hydrogen is pure *osmium disulphide* OsS_2.

$$Os_2O_3(SH)_2 + 2H_2S = 2OsS_2 + 3H_2O$$

Of the *halogen* compounds of osmium only the chlorides have been at all investigated, chiefly by Claus, whose observations may be summarised in a few words

When finely-powdered metallic osmium is heated in a stream of dry chlorine sublimates are formed The first chlorine compound formed is chromous green in colour, but is only produced to a very slight extent There is next deposited a dense black sublimate, and finally a smaller quantity of a sublimate of the colour of red lead None of these three chlorine compounds are crystalline. Claus subsequently stated that the lowest chloride $OsCl_2$ is a bluish-black solid when isolated, and forms a dark bluish-violet solution, the sesquichloride Os_2Cl_6 is reddish-brown in the solid state, and gives with water a rose-red coloured solution, and the dichloride $OsCl_4$ is the compound which exhibits the colour of red lead, and yields a lemon-yellow solution

These observations of Claus are completely confirmed by the experiments of Prof Moraht and Dr Wischin, who, however, have extended them, and have been able to isolate other and higher chlorides of osmium

They commenced by warming a large quantity of the free osmic acid above described for two days upon a water-bath with concentrated hydrochloric acid, the flask in which the reaction was conducted being connected with an upright condenser A little alcohol was added in order to prevent the formation of osmium tetroxide The osmic acid eventually entirely dissolved with formation of the dark olive green coloured solution previously incidentally mentioned, a little chlorine being evolved at the commencement of the operation It was found impossible to evaporate the solution upon the water bath without decomposition, but evaporation *in vacuo* over sulphuric acid and solid caustic potash, the latter to absorb the hydrochloric acid, succeeded admirably. The solid left after complete evaporation consisted of well formed crystals which assumed the habit of six-sided pyramids. These crystals were dark olive-green in colour when moist, but when the last traces of superfluous water were removed, exhibited a bright vermilion colour. They were readily

soluble in water and alcohol, the solutions being coloured dark green, and the salt may be recrystallised from these solvents Upon analysis they were found to consist of the chloride Os_2Cl_7 crystallised with seven molecules of water

This chloride of osmium, $Os_2Cl_7 7H_2O$, would appear to be a molecular compound of the *trichloride*, $OsCl_3$, and the *tetrachloride*, $OsCl_4$ For when potassium chloride solution is added to the solution of the crystals in alcohol, a precipitate of brilliant red octahedrons and cubes of potassium osmichloride, K_2OsCl_6, is obtained, showing the presence of *osmium tetrachloride*, $OsCl_4$ Moreover, when the precipitate is separated by filtration, and the filtrate concentrated by evaporation *in vacuo*, dark green crystals of the *trichloride*, $OsCl_3$, are deposited containing three molecules of water of crystallisation

During the reduction of these crystals of the trichloride in a current of hydrogen for the purposes of analysis, a small quantity of a white sublimate was obtained, which probably consisted of the *octo-chloride*, $OsCl_8$, corresponding to the tetroxide OsO_4

Bromine does not react with osmium with anything like the energy of chlorine The free elements do not appear to combine at all, even at moderately high temperatures. Only a small quantity of a sublimate of a dark brown colour is obtained by passing bromine vapour over osmic acid This sublimate dissolves to a brown solution in water, which, however, rapidly decomposes with deposition of a black precipitate

When osmic acid, H_2OsO_4, is treated with hydrobromic acid in the manner just described in the case of hydrochloric acid a similar reaction occurs with formation of a clear reddish-brown solution which yields, upon evaporation *in vacuo* over sulphuric acid and solid caustic potash, small crystals of a molecular compound of the *tribromide*, $OsBr_3$, and the *hexabromide*, $OsBr_6$, together with six molecules of water of crystallisation. These crystals of $Os_2Br_9 6H_2O$ are dark reddish-brown in colour and exhibit a beautiful metallic lustre They are quite stable when preserved in a dry atmosphere, but rapidly deliquesce in moist air

Iodine appears to possess even less affinity for osmium than bromine When, however, osmic acid is treated with hydriodic acid a deep greenish-brown solution is obtained which deposits *in vacuo* dark violet rhombohedrons, exhibiting a brilliant metallic lustre, consisting of the anhydrous *tetra-iodide of osmium*, OsI_4 This iodide, the only one containing osmium yet prepared, is permanent in a dry atmosphere at the ordinary temperature, but rapidly deliquesces like the bromide when exposed to moist air

In relative stability the chloride bromide and iodide of osmium above described exhibit a gradation such as would be expected from the relations between the halogen elements themselves The iodide is readily dissociated by slightly raising the temperature, and upon the addition of water is decomposed with the deposition of a black precipitate containing the metal A similar decomposition occurs, although much more slowly, in case of the bromide. The chloride, however, is well-nigh permanent under these conditions, only exhibiting traces of decomposition after the lapse of a considerable time

A E TUTTON

REDUCTION OF TIDAL OBSERVATIONS[1]

THE tidal oscillation of the ocean may be represented as the sum of a number of simple harmonic waves which go through their periods approximately once, twice, thrice, four times in a mean solar day. But these simple harmonic waves may be regarded as being rigorously diurnal, semi-diurnal, ter-diurnal, and so forth, if the length of the day referred to be adapted to suit the particular wave under consideration The idea of a series of special scales of time is thus introduced, each time-scale being appropriate to a special tide For example, the mean interval between successive culminations of the moon is 24h. 50m., and this interval may be described as the mean lunar day. Now there is a series of tides, bearing the initials M_1, M_2, M_3, M_4, &c, which go through their periods rigorously once, twice, thrice, four times, &c., in a mean lunar day. The solar tides, S, proceed according to mean solar time, but, besides mean lunar and mean solar times, there are other special time scales appropriate to the other tides

The process of reduction consists of the determination of the mean height of the water at each of twenty-four special hours, and subsequent harmonic analysis. The means are taken over such periods of time that the influence of all the tides governed by other special times is eliminated.

The process by which the special hourly heights have hitherto been obtained is the entry of the heights observed at the mean solar hours in a schedule so arranged that each entry falls into a column appropriate to the nearest special hour Schedules of this kind were prepared by Mr Roberts for the Indian Government [1] The successive rearrangements for each sort of special time were made by recopying the whole of the observations time after time into a series of appropriate schedules The mere clerical labour of this work is enormous, and great care is required to avoid mistakes.

All this copying might be avoided if the observed heights were written on movable pieces But a year of observation gives 8760 hourly heights, and the orderly sorting and resorting of nearly 9000 pieces of paper or tablets might prove more laborious and more treacherous than recopying the figures.

The marshalling of movable pieces might, however, be reduced to manageable limits if all the twenty-four observations pertaining to a single mean solar day were moved together, for the movable pieces would be at once reduced to 365, and each piece might be of a size convenient to handle

The realization of this plan affords the subject of this paper, and it appears that not only is all desirable accuracy attainable, but that the other requisite of such a scheme is satisfied, namely, that the whole computing apparatus shall serve any number of times and for any number of places.

The first idea which naturally occurred was to have narrow sliding tablets which should be thrown into their places by a number of templates It is unnecessary to recount all the trials and failures, but it will suffice to say that the slides and templates would require the precision of a mathematical instrument if they are to work satisfactorily, and that the manufacture would be so expensive as to make the price of the instrument prohibitive

The idea of making the tablets or strips to slide into their places was accordingly abandoned, and the strips are made with short pins on their under sides, so that they can be stuck on to a drawing board in any desired position. The templates, which were also troublesome to make, are replaced by large sheets of paper with numbered marks on them to show how the strips are to be set The guide sheet is laid on a drawing board, and the pins on the strips pierce the paper and fix them in their proper positions

The strip belonging to each mean solar day is divided by black lines into 24 equal spaces, intended for the entry of the hourly heights of water The strip is nine inches long by ¼ inch wide, and the divisions (⅜ by ¼) are of convenient size for the entries There was much difficulty in discovering a good material, but after various trials artificial ivory, or xylonite, was found to serve the purpose Xylonite is white, will take writing with Indian ink or pencil, and can easily be cleaned with a damp cloth It is just as easy to write with liquid Indian ink as with ordinary ink, which must not be used, because it stains the surface

The observations are to be treated in groups of two and a half lunations or 74 days A set of strips, therefore, consists of 74, numbered from 0 to 73 in small figures on their flat ends

If a set be pinned horizontally on a drawing board in vertical column, we have a form consisting of rows for each mean solar day, and columns for each hour The observed heights of the water are then written on the strips.

When the twenty-four columns are summed and divided by the number of entries we obtain the mean solar hourly mean heights The harmonic analysis of these means gives the mean solar tides But for evaluating the other tides the strips must be rearranged, and to this point we turn our attention

Let us consider a special case, that of mean lunar time. A mean lunar hour is about 1h 2m m.s time, hence the 12h. of each m s day must lie within 31m. m.s. time of a mean lunar

[1] "On an Apparatus for facilitating the Reduction of Tidal Observations." By G H Darwin, F R S, Plumian Professor and Fellow of Trinity College, Cambridge. A paper read before the Royal Society on December 15, 1892

[1] An edition of these computation forms was reprinted by aid of a grant from the Royal Society and is sold by the Cambridge Scientific Instrument Company, but only about a dozen copies now remain.

hour. The following sample gives the incidence to the nearest lunar hour of the first few days in a year:—

Mean solar time d	h		Mean lunar time d	h
0	12	=	0	12
1	12	=	1	11
2	12	=	2	10
3	12	=	3	9
4	12	=	4	8
5	12	=	5	8
6	12	=	6	7
7	12	=	7	6
&c			&c	

The successive 12h of m s time will march retrogressively through all the twenty four hours of m lunar time

Now, if starting from strip 0, we push strip 1 one division to the left, strip 2 two divisions to the left, and so on, the entries on the strips will be arranged in columns of approximately lunar time.

The rule for this arrangement is given by marks on a sheet of paper 18 in broad; these marks consist of parallel numbered steps or zigzags showing where the ends of each strip are to be placed so as to bring the hourly values into their proper places.

At the end of a lunation mean solar time has gained a whole day over mean lunar time, and the 12h solar again agrees with the 12h lunar. On the guide sheet the zigzag which takes its origin at the left end of strip 0 has descended diagonally from right to left until it has reached the left margin of the paper, and a new zigzag has begun on the right margin

When the strips are pinned out following the zigzags on the sheet marked M, the entries are arranged in 48 columns but the number of entries in each column is different The 48 incomplete columns may be regarded as 24 complete ones, appertaining to the 24 hours

Harmonic analysis of the 24 means of the complete columns gives the required tidal constants It must be remarked, however, that as the incidence of the entries is not exact in lunar time, investigation is made in the paper of the corrections arising out of this inexactness

The explanation of the guide sheet for lunar time will serve, *mutatis mutandis*, for all the others

The zigzags have to be placed so as to bring the columns into exact alignment, and printers' types provide all the accuracy requisite

To guard against the risk of the computer accidentally using the wrong sheet, the sheets are printed on coloured paper, the sequence of colours being that of the rainbow The sheets for days 0 to 73 are all red, those for days 74 to 74 + 73, or 147, are all yellow, those for days 148 to 148 + 73, or 221, are green, those for days 222 to 222 + 73, or 295, are blue, and those for days 296 to 296 + 73, or 369, are violet

Thus, when the observations for the first 74 days of the year are written on the strips all the sheets will be red, the strips will then be cleaned, and the observations for the second 74 days written in, when all the guide sheets will be yellow, and so on.

The paper also gives another considerable abridgement of the process of harmonic analysis, which is independent of the method of arrangement just sketched

In the Indian computation forms the mean solar hourly heights have been found for the whole year, and the observations have been rearranged for the evaluation of certain other tides governed by a time scale which differs but little from the mean solar scale. It is now proposed to break the mean solar heights into sets of 30 days, and to analyse them, and next to harmonically analyse the 12 sets of harmonic constituents for annual and semi annual inequalities By this plan the harmonic constants for 11 different tides are obtained by one set of additions. In fact, we now get the annual, semi annual, and solar elliptic tides, which formerly demanded much troublesome extra computation A great saving is secured by this alone, and the results are in close agreement with those derived from the old method.

An abridged method of evaluating the tides of long period MSf, Mf, Mm, is also given The method is less accurate than that followed hitherto, but it appears to give fairly good results, and reduces the work to very small dimensions

The advantages of the method proposed in the present paper may be best realized by a comparison of the amount of work entailed in the reduction of a year's tides as it has hitherto been carried out by the Indian Survey at Poona, and what it will be under the new method

It has been usual in the Indian reductions to use three digits in expressing the height of water, and there have been fifteen series, or even more It follows from a simple multiplication that the computer has had to write 394,000 figures in reducing a year of observation This does not include the evaluation of the annual and semi annual tides, so that we may say that there have been about 400,000 figures to write

It is now proposed to express the heights by two digits, and they only have to be written once, and the number of figures to write is 17,500, accordingly the writing of 382,000 figures is saved

In the old method the computer had to add together all the digits written, say, 394,000 additions of digit to digit

It is now proposed to use twenty four hourly values in three series, viz S, M, and MS, and twelve two hourly values in eight others, and the number of additions comes to 123,000 Thus 270,000 additions are saved

We may say that formerly there were about 800,000 operations (writing and addition), and that in the present method there will be about 140,000 This estimate does not include a saving of several thousands of operations in obtaining the tides of long period It may therefore be claimed that the work formerly bestowed on one year of observation will now reduce at least five years, and that the results are equally trustworthy

The manufacture of the computing strips of xylonite is rather expensive, but as it formerly cost in England rather more than £20 to reduce a year of observation, the cost of the apparatus will be covered by the saving in the reduction of a single year, and it will serve for any length of time

The apparatus, together with computation forms, will be on sale with the Cambridge Scientific Instrument Company at a price of about £8

It is proper to mention that Dr Borgen has devised and used a method for attaining the same end as that aimed at in this paper He has prepared sheets of tracing paper with diagonal lines on them, so arranged that when any sheet is laid on the copy of the observations written in daily rows and hourly columns, the numbers to be summed are found written between a pair of lines This plan is inexpensive and has considerable advantages, but the chance of error is no doubt increased by the fact that the lines of addition are diagonal, and because figures seen through tracing-paper are comparatively faint

THE HARVARD COLLEGE OBSERVATORY

THE forty seventh annual report of the director of the astronomical observatory of Harvard College, for the year ending October 31, 1892, by Prof E C Pickering, has been issued. We reprint the following passages —

The number of photographs taken with the eight inch Draper telescope is 2777 The number taken in Peru with the Bache telescope is nearly two thousand, of which 601 have been received in Cambridge The examination of these plates has as usual led to the discovery of a large number of interesting objects. Ten variable stars, U Delphini, S Pegasi, T Aquarii, R Crateris, R Carinæ, S Canis Minoris, S Carinæ, R Ophiuchi, X Ophiuchi, and Espin's variable star in Auriga in addition to the thirty seven previously announced have the hydrogen lines bright in their spectra. Seven new variable stars have been discovered this year by means of this property The number of stars of the fifth type has been increased by eight, making the total number now known of these objects forty five The hydrogen line F was shown to be bright in the spectra of six stars in addition to those already known Photographs have been obtained of the spectra of eight planetary nebulæ showing bright lines The spectrum of the nebula surrounding thirty Doradus is unlike that of other gaseous nebulæ The star A G C 20,937 has a somewhat similar spectrum Five stars have been shown to have spectra of the fourth type All of these peculiarities have been detected by Mrs Fleming except in the cases of one of the known variables, one of the planetary nebulæ, and two of the stars of the fourth type, which were found by Mr A E Douglass, in Peru, before the plates were sent to Cambridge

The amount of valuable material accumulated with these instruments is continually increasing, and has proved useful in many cases in studying the history of newly discovered objects.

The brightness for several years past of stars suspected of variability has been furnished to various astronomers. Plates have been sent to the Lick and Amherst Observatories and to the Smithsonian Institution for special investigations From one of them a new variable star in Aries was discovered by Prof Schaeberle It is hoped that this use of our plates may increase in the future A large number of photographs were taken of the new star in Auriga An examination of the older photographs showed that the region containing it had been photographed eighteen times from November 3, 1885, to November 2, 1891, and that it was then apparently fainter than the thirteenth magnitude It appeared upon five plates taken between December 16, 1891, and January 31, 1892 After its discovery it was photographed on sixty five chart plates and thirty six spectrum plates, until April 6, when it became too faint to be visible in the encroaching twilight All of these plates have been carefully studied and measured Twenty one charts and fifteen spectrum plates of this object have been taken since its reappearance in September, 1892 On these last plates, the spectrum is shown to resemble that of a planetary nebula

Many photographs of the lunar eclipse of November 15, 1891, were taken both at Cambridge and at the Boyden observing station near Arequipa, Peru The examination of these photographs for the detection of a possible lunar satellite led only to a negative result

The number of photographs taken with the 11 inch Draper telescope is 996 They include 372 spectra of β Aurigæ to determine the law of periodic doubling of the lines 244 of these images show the lines double so that the separation can be measured In like manner 208 spectra of ζ Ursæ Majoris have been photographed, and in 49 of them the lines are separated widely enough to be measured A similar study has been made of the new star in Auriga, of β Lyræ, of 11 Monocerotis, and of some other stars having peculiar spectra Photographic charts have also been obtained of numerous variable stars, stars having large proper motion, clusters and stars having peculiar spectra to determine their parallax if it is perceptible

Boyden Department

In establishing the fund that bears his name, Mr Boyden desired to secure an astronomical station where the effects due to the atmosphere would be greatly diminished This has now been successfully accomplished in the Harvard Station at Arequipa, Peru, where the effect of the air is no longer as heretofore the principal obstacle to progress in astronomy Instead of this the limit is now the size and excellence of our instruments A great advance would probably be made in our knowledge of the planets, and perhaps of the fixed stars, if a telescope of the largest size could be mounted under such favourable conditions.

This station has continued in charge of Prof. W. H Pickering The instruments chiefly employed have been the 13-inch telescope, the 8 inch Bache telescope, and a photographic camera having an aperture of $2\frac{1}{2}$ inches The first of these instruments has been largely devoted to visual work, for which unusual advantages are afforded by the transparency and steadiness of the air at this station Many interesting results have been derived from the observations made of the moon and various planets The observations of the moon relate to Plato and other regions, which have been carefully examined, and also to the systems of bright streaks visible at full moon The markings of Mercury have been studied, and this investigation appears to confirm Schiaparelli's view that the rotation of Mercury on its axis occupies the same time as its revolution in its orbit Although this planet appears to have no atmosphere, the markings upon it are very faint compared with those upon the moon Venus was micrometrically studied near its inferior conjunction with regard to its diameter, polar compression, and the refractive effect of its atmosphere. No permanent markings could be detected An extensive series of observations was made upon Mars The relative positions of 92 points upon its surface were determined by the micrometer. More than forty minute black points were discovered, provisionally designated as lakes The polar compression of the planet was measured, and appeared to be greater than that indicated by theory, which may be due to an excess of cloud in the equatorial regions The presence of the dark and narrow streaks called canals by Schiaparelli has been confirmed and various measurements of them have been made The clouds projecting beyond the limb, and terminator, discovered at the Lick Observatory, have been studied, and their height has been found to be at least twenty miles The relative colours of different portions of the planet have been minutely observed Two large dark blue areas have been detected, and other portions have been noticed to be subject to gradual changes of colour

Many new double stars were found in a survey of the heavens south of 30°, between 12h. and 18h The August occultation of Jupiter was observed both visually and photographically, as was also the new star in Auriga and Swift's comet, the photographs of which showed detail not noticeable in the visual observations.

With the camera, having the aperture $2\frac{1}{2}$ inches, very satisfactory photographs have been obtained of the Magellanic clouds, showing their composition to be partly of stars and partly of nebulous matter, also the spiral structure of the larger of the two clouds

Meteorological observations are regularly carried on Stations have been established at Mollendo, 100 feet above sea level, at La Joya, the elevation of which is 4,150 feet, at the observing station, 8,060 feet high, at the Chachani Ravine 16,650 feet high, where numerous miscellaneous observations have been made Notwithstanding the great height of the last named station, it can be reached by a mule path, and a hut has been erected where the observers can pass the night A survey of the Arequipa valley and neighbouring mountains has been made, depending on two separate base lines The heights of the mountains have been measured, and in some cases the result has been checked by a mercurial barometer.

The Bruce Photographic Telescope

This instrument, which if successful will be in many respects the most powerful in the world, is now rapidly approaching completion The eight surfaces of its objective have been ground and polished so that it could be tested on a star The results were satisfactory, although, of course, no definite opinion can be formed until the final corrections are applied The focal length proved to be that desired within half of one per cent Plans have been made and the foundations laid for a one story brick building with a sliding roof, in which it will be erected during its trial in Cambridge After this it is proposed to send it to the Arequipa station in Peru

Photographs have been taken with the transit photometer on 192 evenings, and when clear, throughout the entire night With this instrument images are obtained of all stars brighter than the sixth magnitude which cross the meridian during the night The value of this work was illustrated when the new star in Auriga was discovered in February, 1892 It then appeared that this object had been photographed on twelve nights since December 10, 1891, while no trace of it was visible on thirteen plates covering this region and taken before December 2, 1891 The only knowledge that exists of its changes of light during the six weeks in which it remained undiscovered is furnished by these photographs and those taken with the 8-inch telescopes It was also photographed with the transit photometer on twelve nights after its discovery Of the forty thousand standard stars of the tenth magnitude about eight thousand have been selected by Miss E F Leland during the past year, making eleven thousand in all

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—In the Chemical Department Prof. Odling is lecturing on the glucoses, Mr Fisher on inorganic chemistry, Dr. Watts on organic chemistry, and Mr. Veley on physical chemistry. There are about sixty students working in the laboratories, and a few of the senior men are engaged in research.

Among the apparatus belonging to the late Duke of Marlborough, presented by the Duchess, are three large spectroscopes by Hilger, one having five prisms, another being a direct vision spectroscope 5 feet 6 inches in length, two balances by Deleuil, a mercury pump by Alvergniat, Dumas' vapour density apparatus, Thomson's electrometer gramme machine, large Rhumkorf coil and a quantity of valuable glass apparatus. There are besides a number of specimens of compounds of rare earths

The Regius Professor of Medicine has placed his pathological

laboratory under the direction of the lecturer in Pharmacology Dr Ritchie of Edinburgh is carrying out in it some researches in Bacteriology The Chemical Club started last term by some of the senior men continues to hold meetings weekly for the discussion of recent chemical investigations. Mr. Ingham of Merton is secretary The meetings are well attended and useful.

Mr R T Günther, B A, Demy of Magdalen College, has been elected to the Naples Biological Scholarship for the ensuing year.

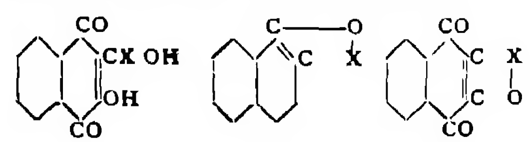
CAMBRIDGE.—Mr H Bury, Fellow of Trinity College, has been appointed by the Board for Biology and Geology to the use of a table at the Naples Zoological Station for March and April, 1893.

The Boards for Biology and Geology, and for Physics and Chemistry, have reported in favour of extending to Part I of the Natural Sciences Tripos the plan already adopted for Part II., namely, the substitution of distinct papers in each scientific subject, instead of papers each of which contains questions in all the subjects They propose that the change come into operation in 1894.

SOCIETIES AND ACADEMIES

LONDON

Chemical Society, January 19 —Prof A Crum Brown, President, in the chair —The following papers were read — Glucinum, Part I The preparation of glucina from beryl, by J Gibson The methods at present in use for preparing pure glucina from beryl are tedious and difficult to apply on the large scale, as the mineral, which contains but a small quantity of glucinum, has to be reduced to a very fine powder before being treated by the reagents usually employed for the decomposition of refractory silicates The author has worked out a process which greatly facilitates the preparation of glucina. If the coarsely ground beryl is heated in an iron vessel with six parts of ammonium hydrogen fluoride, complete decomposition occurs below a red heat The product contains the aluminium and most of the iron as insoluble fluoride and oxide respectively, together with glucinum fluoride, which dissolves on extraction with water In order to remove the last traces of iron from crude glucina, advantage is taken of the fact that the precipitation of a lead or mercuric salt by ammonium sulphide effects by mass action the complete separation of small quantities of iron which may be present in the solution —The determination of the thermal expansion of liquids, by T E. Thorpe The author describes various improvements in the ordinary dilatometrical method of determining the thermal expansion of liquids Amongst these the most important is the application of a device frequently employed in the construction of standard thermometers, and consisting in enlarging the bore of the dilatometer stem at some point On such an instrument the positions of the 0° and 100° points may be determined irrespectively of its range, and the thermometer, and the column of liquid in the dilatometer stem may be totally immersed in a bath of moderate size, thus doing away with corrections for the emergent columns of the two instruments. The methods of constructing, calibrating, and using the dilatometers are described, together with the baths employed in heating them —The determination of the thermal expansion and specific volume of certain paraffins and paraffin derivatives, by T E Thorpe and L M Jones The authors give the data relating to a number of hydrocarbons, alcohols, ketones, and other derivatives of the paraffins. The results show a fairly satisfactory agreement, in most cases, with the values calculated by Lossen's formula, but all the observed specific volumes, with the exception of that of propionic anhydride, differ considerably from those calculated by means of Kopp's values.—The hydrocarbons derived from dipentene dihydrochloride, by W A. Tilden and S Williamson The dihydrochloride, $C_{10}H_{16}2HCl$ melting at 50°, prepared by the action of moist hydrogen chloride on optically active turpentine, is known to be identical with that obtained from the active citrenes (limonenes) or from inactive "dipentene." On heating it with aniline, an oil is obtained which has hitherto been supposed to consist essentially of dipentene, on oxidising it, however, a certain proportion of aromatic acids is obtained. These acids are not formed on oxidising the active limonenes or pure dipentene with nitric acid; their formation in the previous case is, however, satisfactorily explained by the authors, who find that the dipentene obtained from the dihydrochloride contains large proportions of cymene, terpinene, terpinolene, and a small quantity of a saturated paraffinoid hydrocarbon boiling at about 155° —Sulphonic derivatives of camphor, by F S. Kipping and W J Pope The authors have succeeded in preparing camphorsulphonic acid, $C_{10}H_{15}O\ SO_3H$, a compound hitherto unknown, by the direct action of anhydrosulphuric acid or chlorosulphonic acid on camphor The acid is purified by the conversion of its sodium salt into camphorsulphonic chloride, $C_{10}H_{15}O\ SO_2Cl$, the latter substance is apparently obtained in optically different modifications which are separated only with considerable difficulty The sulphonic chloride is readily hydrolysed on boiling with water, yielding the sulphonic acid from which a series of well-defined salts has been obtained The action of anhydrosulphuric acid on bromocamphor results in the formation of bromocamphorsulphonic acid, this on suitable treatment yields a sulphonic chloride, $C_{10}H_{14}BrO\ SO_2Cl$, which crystallises in magnificent colourless octahedra, melting at 136-137° A bromocamphorsulphonic chloride of similar composition has been previously described by Marsh and Cousins as a "black, semi-crystalline tar," a repetition of their work shows this to be merely an impure form of the substance now described. The corresponding chlorocamphorsulphonic chloride described by Marsh and Cousins as a "microcrystalline, black solid," crystallises in massive colourless octahedra when pure, it melts at 123-124°, and has a specific rotatory power $[\alpha]_D = +110°$ The authors describe a number of salts and derivatives of these sulphonic acids —The preparation of dinitro-α naphthylamine $[NH_2\ NO_2\ NO_2 = 1\ 2\ 4]$ from its acetyl and valeryl derivatives, by R Meldola and M O Forster Meldola's process of preparing dinitro α naphthylamine from α acetnaphthalide having been questioned, the authors have re investigated the method and confirm it in all respects, they give full working details of the process, and show that the same product is obtained by the nitration and subsequent hydrolysis of valeronaphthalide —Thionyl bromide, by J Hartog and W E Sims. Thionyl bromide is obtained as a heavy, crimson liquid by the action of sodium bromide on thionyl chloride, its colour is possibly due to impurity At 150° the bromide decomposes, yielding bromine and sulphur bromides —Desulphurisation of the substituted thioureas, by A E Dixon. The monosubstituted thioureas are all de ulphurised on boiling with an alkaline solution of a lead salt, the same is true of disubstituted thioureas containing benzenoid groups, but not if such groups be absent. The tri- and probably also the tetra substituted thioureas are not de sulphurised under similar conditions A number of new thioureas are described.—Salts of active and inactive glyceric acid the influence of metals on the specific rotatory power of active acids, by P F Frankland and J. R Appleyard. The authors have prepared and analysed a number of salts both of inactive and dextro-glyceric acid; the solubilities and specific rotatory powers are also given Certain remarkable numerical relations apparently exist between the rotations of many of the salts, these should have considerable bearing on the vexed question of multiple rotation, and will be discussed after they have been submitted to a more detailed investigation.—Dibromo-β lapachone, by S C Hooker and A D Gray. Monobromo-β lapachone cannot be converted into dibromo-β-lapachone by the action of bromine alone; the formation of the latter derivative in the preparation of monobromo-β-lapachone from lapachol, is due to the production and subsequent decomposition of an additive compound of monobromo-derivative and hydrogen bromide —The conversion of para- into ortho-quinone derivatives, by S C Hooker. Both in the lapachol and other groups, compounds derived from a naphthaquinone, of the type represented by formula I, are far more readily converted, by the action of acids, into anhydrides derived from β-naphthaquinone (II) than into anhydrides of the α quinone type (III)

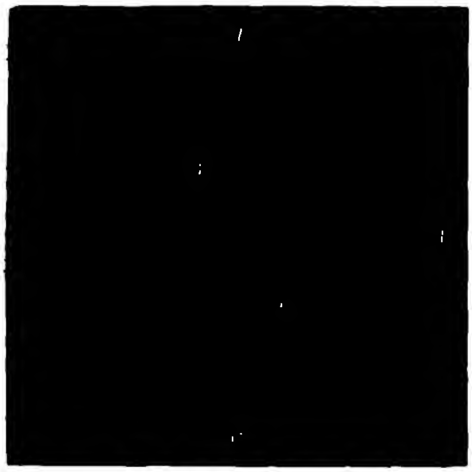


I. II III.

—The nitro-derivatives of phenolphthalein, by J. A Hall The author has prepared dinitro and tetranitro-phenolphthalein,

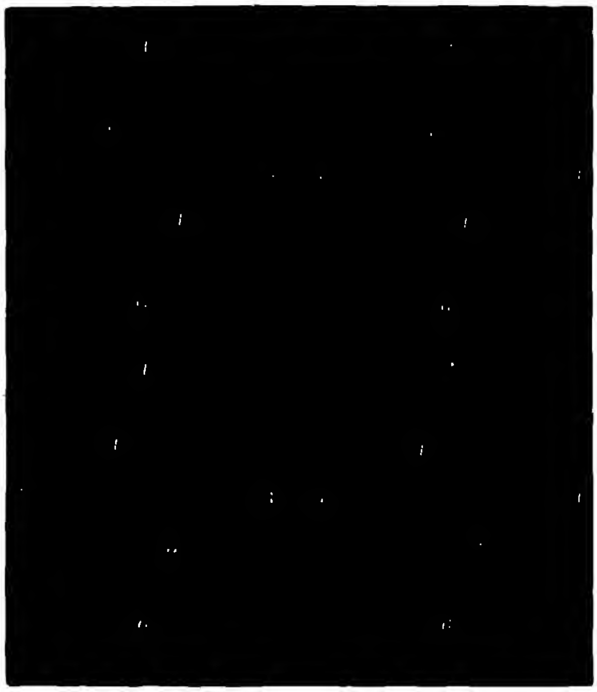
and describes their properties.—A method for the preparation of acetylene, by M. W. Travers. Calcium carbide may be prepared by heating a mixture of sodium, gas carbon, and calcium chloride for half an hour at bright redness in an iron bottle. The carbide thus obtained yields acetylene on treatment with water. 240 c.c., half the theoretical quantity, of acetylene is obtained for every gram of sodium used in the preparation of the carbide.

Mathematical Society, February 9.—Mr. A. B. Kempe, F.R.S., President, in the chair.—The following communications were made:—The Harmonics of a Ring, by Mr. W. D. Niven, F.R.S. This paper treats of the potential functions of an anchor ring, and explains how problems to which those functions are applicable may be solved for two coaxal rings. The proposition on which the method depends establishes that the ring harmonics of any degree may be derived from their predecessors of lower degree by simple differentiations with regard to the radius of the dipolar circle of the ring and the distance of a fixed point from the plane of this circle. Ultimately the harmonics depend upon the potential at any point due to a distribution on the circle either uniform or varying as a circular function of the arc. Now the potential due to such distribution on a circle B may readily be expressed in terms of the harmonics pertaining to a coaxal circle A, and hence any harmonic pertaining to B, and therefore any series of such harmonics, may be expressed in a series pertaining to A. In the latter form they are suitable for the application of surface conditions at any ring whose dipolar circle is A. The application worked out in the paper is the problem of the influence of two electrically charged coaxal rings upon one another. It is also shown how the same problem may be solved for a ring and sphere, symmetrically situated as regards the axis.—The group of thirty cubes composed by six differently coloured squares, by Major MacMahon, R.A., F.R.S. Selecting any one of the thirty cubes at pleasure it is possible to select eight of the remaining twenty-nine which in reference to the cube selected have a very peculiar and interesting

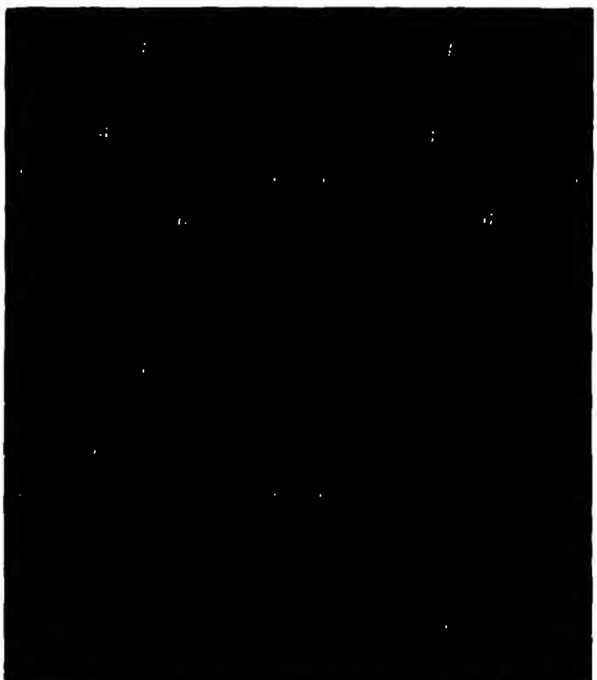


Selected Cube (transformed) diagonal 16 vertica

property. It is possible to form the eight cubes into a single cube in such wise that contiguous faces of the cubes are similarly coloured, and also so that the resulting cube has the appearance of the *selected* cube in regard to the colouring of its faces. To each cube of the thirty belong in this way eight other cubes, the selection of the eight cubes being unique. For the examination of this property the selected cube is transformed into an octahedron by joining the middle point of each face to the middle points of the adjacent faces; a regular octahedron with six differently coloured summits is thus obtained. Each triangular face is determined by three differently coloured summits, and exactly eight other octahedra are obtained by circular substitutions performed on the three colours which determine a face. In regard to the eight faces there are eight clock-wise and eight counter clock-wise substitutions, but only eight different octahedra can be obtained. These give the eight cubes associated with the selected cube. The eight cubes having been determined, the problem of forming them admits of just two solutions. One solution is—



Lower Four Cubes



Upper Four Cubes.

The other solution is obtained by interchanging clock-wise and counter clock-wise rotations of octahedral faces. Other interesting properties of these cubes are examined in the paper.

Geological Society, January 25.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—On inclusions of tertiary granite in the Gabbro of the Cuilin Hills, Skye; and on the products resulting from the partial fusion of the acid by the basic rock, by Prof. J. W. Judd, F.R.S.—Anthracite and bituminous coal beds; an attempt to throw some light upon the manner in which anthracite was formed; or contributions towards the controversy regarding the formation of anthracite, by W. S. Gresley.

February 8.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—Notes on some coast-sections at the Lizard. By Howard Fox and J. J. H. Teall, F.R.S. In the first part of the paper the authors describe a small portion of the west coast near Ogo Dour, where hornblende-schist and serpentine are exposed. As a result of the detailed mapping of the sloping face of the cliff, coupled with a microscopic examination of the rocks, they have arrived at the conclusion that the serpentine is part and parcel of the foliated series to which the hornblende schists belong, and that the apparent evidences of intrusion of serpentine into schist in that district are consequences of the folding and faulting to which the rocks have been subjected since the banding was produced. The interlamination of serpentine and schist is described, and also the effects of folding and faulting. Basic dykes, cutting both serpentine and schists, are clearly represented in the portion of the coast which has been mapped, and these locally pass into hornblende-schists, which can, however, be clearly distinguished from the schists of the country. The origin of the foliation in the dykes is discussed. The second part of the paper deals with a small portion of the coast east of the Lion Rock, Kynance. Here a small portion of the "granulitic series" is seen in juxta position with serpentine. The phenomena appear to indicate that the granulitic complex was intruded into the serpentine; but they may possibly be due to the fact that the two sets of rocks have been folded together while the granulitic complex was in a plastic condition, or to the intrusion of the serpentine into the complex while the latter was plastic.—On a radiolarian chert from Mullion Island, by Howard Fox and J. J. H. Teall. The main mass of Mullion Island is composed of a fine-grained "greenstone," which shows a peculiar globular or ellipsoidal structure, due to the presence of numerous curvilinear joints. Flat surfaces of this rock, such as are exposed in many places at the base of the cliff, remind one somewhat of the appearance of a lava of the "pahoehoe" type. The stratified rocks, which form only a very small portion of the island, consist of cherts, shales, and limestone. They occur as thin strips or sheets, and sometimes as detached lenticles within the igneous mass. The chert occurs in bands varying from a quarter of an inch to several inches in thickness, and is of radiolarian origin. The radiolaria are often clearly recognisable on the weathered surfaces of some of the beads, and the reticulated nature of the test may be observed by simply placing a portion of the weathered surface under the microscope. The authors describe the relations between the sedimentary and igneous rocks, and suggest that the peculiar phenomena may be due either to the injection of igneous material between the layers of the stratified series near the surface of the sea-bed while deposition was going on, or possibly to the flow of a submarine lava. The form of the radiolaria observed in the deposit, and also their mode of preservation, are described in an appendix by Dr. G. J. Hinde.—The reading of these papers was followed by a discussion, in which the President, Rev. Edwin Hill, Prof. Bonney, Dr. Hicks, Dr. Hind, and the authors took part.—Note on a radiolarian rock from Fanny Bay, Port Darwin, Australia, by G. J. Hinde. A specimen brought from Fanny Bay by Captain Moore, of H.M.S. *Penguin*, is of a dull white or yellowish tint, in places stained red. It has an earthy aspect, and is somewhat harder than chalk, but gives no action with hydrochloric acid. Microscopic sections show a fairly transparent groundmass, apparently amorphous silica, containing granules and subangular fragments up to ·075 millim. in diameter, some of which appear to be quartz. Besides this, the rock contains numerous radiolaria, and it is really a radiolarian earth intermediate in character between the Barbados earth and such cherts as those of the Ordovician strata of Southern Scotland. The details of the extent of the deposit and its relationship to other rocks of the area are not yet obtainable, though it is possible that a considerable thickness of rock mentioned by Mr. Tenison Woods as occurring in this area may also be of radiolarian origin. The author describes a species of *Cenellipsis*, two of *Astrophacus*, one of *Lithocyclia* (new), one of *Amphibrachium*, three of *Spongodiscus* (one new), four of *Spongolena* (all new), two of *Dictyomitra* (both new), one of *Lithocampe* (new), and two of *Stichocapsa* (both new). From these it is not practicable at present to determine the geological horizon of the rock; with one exception, all the genera represented occur from Palæozoic times to the present.—Notes on the geology of the district west of Caermarthen. Compiled from the notes of the late T. Roberts (communicated by Prof. T. McKenny Hughes, F.R.S.). To the east of the district around Haverfordwest, formerly described by the author and another, an anticlinal is found extending towards Caermarthen. The lowest beds discovered in this anticline are the *Tetragraptus*-beds of Arenig age, which have not hitherto been detected south of the St. David's area. They have yielded eight forms of graptolite, which have been determined by Prof. Lapworth. The higher beds correspond with those previously noticed in the district to the west; they are, in ascending order:—(1) Beds with "tuning-fork" *Didymograpti*, (2) Llandeilo limestone, (3) *Dicranograptus*-shales, (4) Robeston Wathen and Sholeshook limestones. Details of the geographical distribution of these and of their lithological and palæontological characters are given in the paper. After the reading of this paper Dr. Hicks said he felt sure he was expressing the feelings of the Fellows in referring to the serious loss which the Society had suffered by the death of Mr. T. Roberts, who certainly was one of the most promising palæontologists in this country. The important researches which he carried on, in conjunction with Mr. Marr, had made is now comparatively easy to understand some intricate and extensive districts in Pembrokeshire and Caermarthenshire, which previously were little more than blanks on the geological map.

February 17.—Anniversary Meeting.—The medals and funds were awarded as follows:—The Wollaston medal to Prof. N. S. Maskelyne, F.R.S.; Murchison medal to the Rev. O. Fisher; Lyell medal to Mr. E. T. Newton; and the Bigsby medal to Prof. W. J. Sollas, F.R.S.; the balance of the proceeds of the Wollaston fund to Mr. J. G. Goodchild; that of the Murchison fund to Mr. G. J. Williams; and that of the Lyell fund to Miss C. A. Raisin and Mr. A. N. Leeds. The following is the list of officers and council elected at the meeting:—President: W. H. Hudleston, F.R.S. Vice-Presidents: Sir A. Geikie, F.R.S., G. J. Hinde, Prof. J. W. Judd, F.R.S., H. Woodward, F.R.S. Secretaries: J. E. Marr, F.R.S., J. J. H. Teall, F.R.S. Foreign Secretary: J. W. Hulke, F.R.S. Treasurer: Prof. T. Wiltshire. Prof. J. F. Blake, Prof. T. G. Bonney, F.R.S., R. Etheridge, F.R.S., Sir A. Geikie, F.R.S., Prof. A. H. Green, F.R.S., Alfred Harker, H. Hicks, F.R.S., G. J. Hinde, T. V. Holmes, W. H. Hudleston, F.R.S., J. W. Hulke, F.R.S., Prof. J. W. Judd, F.R.S., R. Lydekker, Lieut.-General C. A. McMahon, J. E. Marr, F.R.S., H. W. Monckton, Clement Reid, F. Rutley, J. J. H. Teall, F.R.S., Prof. T. Wiltshire, Rev. H. H. Winwood, H. Woodward, F.R.S., H. B. Woodward. The presidential address dealt with some recent work of the Geological Society, the subjects ranging over a period of six or seven years. These embraced Pleistocene geology, theories in connection with Glaciation, Tertiary, Cretaceous, Jurassic, and Permo-Triassic geology. It further mentions that the number of papers on Pleistocene geology has been very considerable, and many of them relate to the south east and the south of England; those relating to Central England and South Wales were fewer in number, whilst the north had furnished but few papers. The great memoir on the Westleton Beds had provided much material for consideration; that portion relating to the Southern Drift being especially interesting. Reference was made to a paper on Pleistocene succession in the Trent basin as forming a fitting introduction to the fascinating problems connected with the North Wales border on the one side and with Flamborough Head on the other. From Scotland notice was taken of some supplementary remarks on the paralled roads of Glen Roy. Speculation as to the evidence of a palæozoic ice age, the date and duration of the Pleistocene glacial period, and a notice on misconceptions regarding the evidence of former glacial periods were also discussed. The Tertiary Geology of the London and Hampshire basins was considered, more especially in relation to the Upper Eocene, or Bartons, and their probable equivalents in West Surrey. Under this heading, also, comes the Geology of Barbados, since the oceanic deposits in that island were held to be of late Tertiary age. These interesting discoveries were reviewed

at some length, and the results compared with tables in the recently issued "*Challenger* Reports" In Upper Cretaceous Geology the phosphatic deposits at Ciply and Taplow were noticed, and also the important correlations of the basement-beds in Norfolk, Lincolnshire, and East Yorkshire The Lower Cretaceous beds at Specton next passed under review, more especially in connection with their somewhat difficult palæontology and possible equivalents in Eastern Europe It then went on to state that our knowledge of the Upper Jurassics of the East of England had of late years received considerable additions and important correlations between our Upper Jurassics generally, and their equivalent on the Jura had been effected, that the inferior Oolite and the Lias boundary had come in for their share of attention, whilst a determined attempt had been made to refer a portion of the red rocks of South Devon to the Permian

PARIS

Academy of Sciences, February 13 —M de Lacaze-Duthiers in the chair.—On an invariant number in the theory of algebraic surfaces, by M Emile Picard —Study of the Cañon Diablo meteorite, by M Henri Moissan The composition of the meteorite is very variable from point to point In the fragments examined the percentage of iron varied from 91 09 to 95 06, and that of nickel from 1 08 to 7 05 Diamonds were also found, both transparent and black, and a brown form of carbon of feeble density The largest diamond measured 0 7 mm by 0 3 mm It had a yellow tint and a rough surface, and was transparent to light —On the meteoric iron of Cañon Diablo, by M C Friedel A small quantity of a silver-white fragile compound occurring in the meteorite in the form of plates disseminated through the nickeliferous iron and accompanied by schreibersite, was isolated, and its composition found to correspond to the probable formula Fe_6S The mixtures of ordinary carbon, graphite, and diamond were found chiefly associated with nodules of yellow troilite —On the presence of graphite, carbonado, and microscopic diamonds in the blue earth of the Cape, by M Henri Moissan. After repeated and lengthy treatment with boiling sulphuric and hydrofluoric acids, 250 gr of blue earth left a residue weighing only 0 094 mgr. In this residue brilliant hexagonal crystals of graphite were found, giving rise, when treated with potassium chlorate, to a graphitic oxide of a colour passing from green to yellow Another species of graphite was also isolated which, when treated with H_2SO_4 at 200° C, swelled up considerably and dissolved Its artificial preparation will be described in a subsequent paper The portions of the residue unaffected by potassium chlorate and heavier than methylene iodide (density 3 4) comprised an amber-coloured mass, black diamonds, microscopic true diamonds, and small transparent crystals in form of elongated prisms, which did not burn in oxygen and were not fluorescent in violet light The first, which contains a large proportion of iron, and the last, which contains silica, can be destroyed by treatment with fused potassium bisulphate and then with hydrofluoric and sulphuric acids The blue earth, which was taken from the Old de Beers Mine, thus contained all the carbon compounds found in the iron matrix employed for their artificial production —The clasmatocytes, the fixed cellules of the connective tissue, and the pus globules, by M L Ranvier In an inflamed tissue the clasmatocytes and leucocytes are the only ones which give rise to purulent globules, the latter being, in fact, mortified lymphatic cellules —Glycosic expenditure attendant upon nutritive movement in hyperglycemia and hypoglycemia brought about experimentally, consequences bearing upon the immediate cause of diabetes and other deviations of glycemic function, by MM A Chauveau and Kaufmann —Observations of Holmes's comet made with the *equatorial coudé* (0 32 m) of the Lyon Observatory, by M G Le Cadet —On an explicit form of the addition formulæ of the most general hyperelliptic functions, by M. F de Salvert —On the laws of reciprocity and the sub-groups of the arithmetical group, by M. X. Stouff —Experiments on overflowed weirs, by M H Bazin.—On the fringes of caustics, by M J Macé de Lépinay —On a phenomenon of apparent reflection at the surface of the clouds, by M. C. Maltézos —On the electric figures produced at the surface of crystallised bodies, by M Paul Jannetaz If the face of a crystal be covered with matter consisting of light and small grains, such as lycopodium seed or talc powder, and an electric discharge passed into the face through a point outside it, certain figures are formed, many of which were investigated by Wiedemann and Senarmont Very regular ellipses were obtained by M. Jannetaz by passing a series of discharges from an electrostatic machine or an induction coil The orientation of the major axes of the ellipses was observed for a large number of minerals. In most cases this axis was perpendicular to the direction of maximum conductivity for heat. In the case of a well defined single cleavage, such as that of mica, talc, a block of wood, the cut edge of a book, or a schistose rock, the major axis was perpendicular to the plane of cleavage. The point need not touch the plate Figures were obtained on a plate of gypsum strewn with lycopodium powder, and charged from beneath. Positive and negative sparks show the same effect —Action of temperature on the rotatory power of liquids, by M Albert Colson —Density of nitrogen dioxide, by M A Leduc —Considerations on the genesis of the diamond, by M J Werth —On the chlorine derivatives of the propylamines, the benzylamines, aniline and paratoluidine, by M A Berg.—On dipropylcyanamide and dipropylcarbodiimide, by M F Chancel —Survival after section of the two vagi nerves, by M C Vanlair.—On the internal pericycle, by M Léon Flot —On a modification to be applied to the construction of bottles designed to collect specimens of deep waters, by M J Thoulet The compressibility of water is such that one litre, collected at a depth of 8000 m below sea-level, would expand by 35 cc when the bottle was opened at the surface Such bottles may therefore be constructed of thin sheet copper or other metal allowing an expansion of thirty-five parts in 10,000 —Lines of structure in the Winnebago County meteorite and some others, by Mr H A Newton —On a meteorite observed at Newhaven (Connecticut), by Mr H A Newton

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THURSDAY, MARCH 2, 1893

MODERN OPTICS AND THE MICROSCOPE

The Microscope its Construction and Management Including Technique, Photomicrography, and the past and future of the Microscope By Dr Henri van Heurck, &c. English edition re-edited and augmented by the author from the fourth French edition, and translated by Wynne E Baxter, F R M S, F G S (London Crosby Lockwood and Son, 1893)

THIS is a handsome, even a luxurious, book It is beautifully printed on highly-finished paper, and with a margin ample enough to satisfy the most exacting connoisseur The illustrations are clearly produced, the binding is admirable, and after a careful comparison with the last French edition, we do not hesitate to say that the translation is as felicitous as it is accurate

Its author has aimed apparently at an elementary treatise on the microscope, which is nevertheless intended to cover almost the entire field involved in its history, production, and use The difficulties of such a task are not a few To be elementary and thoroughly popular up to a limit, very sharply defined, and then to lead on those who choose to follow into the deeper aspects of this many-sided subject, is at once practical and natural The optics of the modern microscope are the possession of the specialist. Abbe himself has failed to make them accessible to and understanded by any but those educationally equipped Hence the constant misunderstanding of the fundamental principles of the Diffraction Theory and its related applications so frequently manifest even where the subject is supposed to be more or less familiar

As might have been readily supposed, the author of this treatise has given evidence of skill in the presentation of the main points of elementary optics, it is, however, clearness and conciseness, not originality, that is to be noticed. The illustrations are those familiar to English text-books for the last quarter of a century, and the diffraction theory has in no way been simplified to the reader of an elementary treatise by that most efficient of all elementary modes of imparting ideas on more or less abstruse subjects, viz carefully devised and well-explained diagrams

Considering the object of this treatise, viz the impartation of knowledge to those not mathematically prepared to follow it in that direction, by giving a concise, clear, and comprehensive view of the meaning and application of the diffraction theory of microscopic vision, the transition from the first to the second chapter will be so abrupt and unlinked as to leave the elementary reader practically in the dark. The chapter on "The Theory of Microscopic Vision" is unexceptional so far as it goes. It cannot be other, it is Prof Abbe's, but, in a treatise claiming to maintain its elementary character more completely than any other similar work which covers so wide a range this is surely not enough.

The diffraction theory of vision is introduced to the tyro with no explanation of what diffraction is, and with no illustration of its action until he is plunged *in medias res* in Abbe's application of it to the profoundly important and inestimably valuable theory itself The "elementary" character of this is at least questionable Beyond this that most important factor in the diffraction theory in its practical application, Numerical Aperture, is wholly without explanation, save such as arises from its technical introduction and employment, but there are few points on which it is more important that an elementary student should be more clearly instructed, and there are few that lend themselves more to efficient diagrammatic presentation In the same relation it may be noted that the very essential formula $n \sin u$—expressing the general relation discovered by Abbe between the pencil of light admitted into the front of the objective, and that emerging from the back lens of the same, which is such that the ratio of the semi-diameter of the emergent pencil to the focal length of the objective could be expressed by the sine of half the angle of aperture (u) multiplied by the refractive index of the medium (n) in front of the objective or $n \sin u$—but this is a German mathematical formula, and its English equivalent is $\mu \sin \phi$, and although the German form of symbol is employed in England, and thoroughly understood by mathematicians, those who are entering for the first time upon a study of this difficult subject, and therefore unaccustomed to the mathematical formulæ employed, might readily fall into confusion, seeing that the "elementary" source of their information leaves them without a hint on the subject

Another serious defect, as we believe, in this "elementary" presentation of the diffraction theory of microscopic vision is the absence of an easy explanation of the *photometrical* equivalent of different apertures. Certainly it is not of the essence of the problem, but it is just one of those points which in a very marked and instructive manner illustrate the meaning and value of numerical aperture as such, and for elementary exposition this must be of importance Thus, if two circles be taken to represent the backs of two objectives of the same power but of different apertures, and the radius of one be twice that of the other, then each radius will represent the angle $n \sin u$ But because the areas of these circles are to each other in the proportion of the squares of their radii, it follows that if each radius be designated by $n \sin u$, the area of the lesser circle will be to the area of the greater circle as the square of the radius of the former is to the square of the radius of the latter Hence the area of the greater circle will be four times as great as that of the lesser, which teaches that since the numerical aperture of one objective is twice as great as that of another its illuminating power will be *four times* as great—a most important incidental and explanatory *raison d'être* for great N A.

In this connection we notice what is certainly not easily explicable as an exposition of the details of Abbe's great theory. On page 56 of "The Microscope" Dr Van Heurck almost incidentally states the very important fact that "Prof. Abbe has satisfactorily established the fact that a certain relation must exist between magnification and angular (?) aperture." This is undoubtedly one of the most important demonstrations of the theory Great numerical apertures have proved of untold value to the competent student of minute details, by opening up structures that mere amplification must have left for ever impenetrable. But that does not annul the import-

ance of small apertures Low amplifications are as useful in their own department as high ones, and to put great apertures to lower magnifying powers than such magnifying power warrants is to sin against the elementary principles of the Abbe theory of vision And on the other hand, wide apertures can never be utilised unless there is a concurrent and suitable linear amplification of the image which is competent to exhibit to the eye the smallest dimensions which are by optical law within the reach of such apertures

Thus it follows that great amplification will be useless with small apertures If the power be deficient the aperture will not avail, if the aperture be wanting nothing is gained by high power The law is, "Employ the full aperture suitable to the power used" In Abbe's words, "A proper economy of aperture is of equal importance with economy of power." [1]

Taking these facts, then, which are apparently recognised by Dr Van Heurck, it is very remarkable to find on page 49, in a discussion of the "screw threads" or gauges employed by the makers of microscopes, that the general value of the English gauge is admitted, but it is added, "The English thread is not, however, all that we have to say on this matter In America the *American thread* is also employed, which is considerably greater, and admits the use of lenses with a much larger diameter, *and thus offers certain advantages* In the first place, the larger the lens the easier it is to make, and consequently the real curvatures approach closer to the calculated curvatures, then the larger the lens the more luminous rays it admits, and this in photography is not to be despised"

To our judgment this statement is a contradiction of the admission made on page 49, quoted above

The enlargement of the screw for the purpose of putting in larger back lenses to objective combinations was first mooted in America in 1879,[2] when "Mr Bullock urged the desirability of adopting a uniform objective screw of larger size than the Society screw now in use (1879), as being essential to the efficacy of *low power lenses of high angle*"

This "American gauge" was subsequently introduced and known as the "Butterfield gauge of screw for objectives." [3]

Now, we must remember the date of the introduction of this large gauge for objectives, and its relation to the introduction of the apochromatic system of lenses We must further remember that the purpose of its adoption was to permit the introduction of larger back lenses than the Society gauge would suffer into an objective combination This meant giving relatively great apertures to lower powers But this, carried beyond a certain limit, violated a fundamental law of Abbe's theory[4] Now it is said that these larger lenses are easier to make (!) and approach more nearly to the calculated curves. But in truth objectives with wide apertures which are low powers, and must therefore have large backs, are most difficult lenses to produce It was, in fact, to escape the difficulty of giving lower powers larger angles that opticians of the first rank always designated their objectives as of lower magnifying power than they really were They in fact made a $\frac{2}{3}$rds a $\frac{1}{2}$, a $\frac{1}{2}$ a $\frac{4}{10}$ths; a $\frac{4}{10}$ths a $\frac{1}{4}$, a $\frac{1}{4}$ a $\frac{1}{5}$, and so on

Since Butterfield's gauge was introduced, long before the days of apochromatism, that is when our ignorance allowed us to over-aperture our low magnifying powers, it was tolerable, because it was evidence of experimental effort to improve the capacity of our lenses But to day *with* the society screw we are easily provided with a series beginning with a 1 inch objective of 3, and a $\frac{1}{2}$ inch objective of 65 N A., and we may venture to think that these are the highest ratios of aperture to power that will be accomplished for many a day, and therefore the highest ratios allowable by the Abbe theory of vision, which we now know, at least in this point, to be an enunciation of the established laws of optics

Moreover, *these* lenses are really difficult to make, with their back lenses easily placed within the diameter of the Society screw A high ratio of aperture to power always involves great expense in production, and therefore we find that the *low-priced* oil immersions of this immediate time are $\frac{1}{12}$ths and $\frac{1}{8}$ths, not objectives of low magnifying power, and for this reason only

Since then the Society screw is sufficient for more than double the apertures shown by Abbe to be in suitable ratio to the lower powers, we find it more than difficult to account for the teaching in a treatise intended to be essentially elementary, that the Butterfield screw gauge for objectives provides conditions which "offer certain advantages," when the supreme object of this part of the book is to enunciate fully the nature and qualities of oil immersion achromatic, and especially apochromatic, object glasses, by which we can get larger apertures with the society screw than in the old days of Butterfield's gauge could be got by the use of abnormal backs to objectives We find also that "penetrating power" is referred to in passing as one of the properties of object glasses (p 56), but since the diffraction theory of microscopic vision is associated with a special interpretation of what this means, and since it is to Prof Abbe that we are indebted for placing this hitherto obscure matter on a sound, scientific basis, it somewhat disappoints the reader to find no allusion whatever to the valuable work done on this subject, nor any elementary endeavour to explain the great truth that the actual depth of vision must always be the exact sum of the accommodation depth of the eye and the focal depth of the objective But there are few matters of more practical importance or that lend themselves more to simple exposition

In a treatise purporting to be essentially for the beginner we confess to disappointment concerning the instructions as to the "choice of a microscope" What is needed is that the tyro should know the *essentials* of the instrument, the points in it that are of indispensable importance, and a clear account of the manner in which these may—by the uninitiated—be seen to be of inferior or acceptable workmanship The reader is not even informed that in so important a matter as the *fine adjustment* there is a different value to be attached to several entirely different methods by which this function of the microscope is performed The bar and lever movement, essentially the best in principle and practice, is only referred to as existing, in the index, which is thus

1 J R M S., ser ii vol ii p 304
2 *American Naturalist* vol xiii. p. 60.
3 J R M S, ser ii vol i. p. 301
4 *Ibid*, vol ii p 304

made to serve as a kind of glossary, and even more remarkable is the fact that the patent lever fine adjustment of Swift and Son, the only fine adjustment which, in our judgment, makes the "Jackson Model" microscope (which Dr Van Heurck evidently affects) at all a practicable instrument, is treated in the same way So indeed is Campbell's differential screw, and the highest commendation is given to the form adopted in the author's own model No doubt in its present form it is relieved of many defects incident to the form of fine adjustment to which it belongs, but it must be remembered that we are told that each of the divisions of the milled head of this fine adjustment corresponds to the $\frac{1}{1000}$th of a millimetre Yet the screw which gives this fine result has to lift the whole "body" of the instrument In the lever fine adjustments only a nose-piece is lifted, having an inconsiderable weight, and producing in practice no friction, and to this the objective is attached, it certainly appears but reasonable, as it has proved in practice to workers who have employed the several methods for continuous years, that the "wear and tear" upon so fine a screw to which such heavy work is given does not contribute to permanent steadiness, or in constant work, to continued accuracy

In fact, after careful study of the microscope specialised in this treatise, it is difficult to discover anything really new or distinctive in it save the bringing of the fine adjustment pinion of the sub-stage above the level of the principal stage The value of this may be variously assessed, but it has the plain disadvantage of preventing the complete rotation of the principal stage, and it may be doubted if it has any advantage which will compensate for this

There is little, if anything, to enable the reader to distinguish as to the practical value of one form of stand as compared with another, and yet there can be no greater divergence in form than that between the Continental stand on the one hand with its dead weight to produce steadiness, and the two English models known as the Ross and Jackson models respectively on the other What distinguishes them, in what either of them has superiority over the other, and wherein in any of them what is essential to a first-rate working microscope, is nowhere discussed

It is true that the models of many makers are presented and beautifully printed, but many of these are not printed in these pages as revealing essential differences important for the reader to observe, but they are placed amongst others simply as the productions, with slight variations, of the same instruments by different makers We cannot but believe that if some plain directions had been given as to the essentials of a good microscope, and the principal models passed in review showing their conformity or otherwise to these requirements, the "elementary" object of the book would have been more fully accomplished, and the tyro more fully aided in the "choice of a microscope"

Dr Van Heurck has shown his practical knowledge of the microscope as a manipulator in many ways, in this book, but perhaps this is nowhere more fully seen than in his full appreciation of the *condenser* as an indispensable instrument in bringing out the finest optical possibilities of the most perfectly constructed object glasses His book may be said to be alone amongst continental treatises on the microscope in this respect It has been by very tardy steps that the continental makers, or the continental microscopists, have learned to appreciate the immense importance of a condenser in causing optical combinations to give their highest results It is but recently that so leading a firm as Zeiss has yielded on this point and produced condensers The first was chromatic, and, as a consequence, proportionately unsatisfactory Then came the most useful achromatic form of Abbe But we are glad to observe that Van Heurck recognises that the *apochromatic* immersion condenser of Powell "is the most perfect condenser which exists at present" (p 85) It is inevitable that with apochromatic objectives it should be We cannot possibly see how the splendid objectives on apochromatic principles can give their finest results unless they are illuminated by an apparatus which is not only as perfect in workmanship, but of as great a numerical aperture, and with as complete corrections as the objective which is collecting the light and forming the image of the object the condenser is illuminating

And for this reason, while we admit fully that the plate of photo-micrographs produced in this and other volumes by the very exceptional skill of Dr Van Heurck with the most remarkable object glass which the manipulative skill of man has yet produced, viz the 2 5 mm with N A 1 63, is a monument to his manipulative ability, we still contend that he worked under difficulties of no small importance The only condenser provided for this lens by the great firm which produce it, is one which of necessity has a flint front, but is as wholly uncorrected as the glasses used by Hooke or Bonanni!

Now if it be important to use an apochromatic condenser at all, how much more important to use it on such a lens, with such an aperture and such exquisitely refined corrections This objective has never yet had its best power revealed, because its illumination has been always a counteraction of its own refinements

We are surprised that in manipulation the tyro is recommended in this treatise to focus *down* upon the object first, of course with great care, and then to find the actual focal point by withdrawing the tube by either coarse or fine adjustment A far more elegant and safe method is certainly adopted, and we doubt the preference expressed for daylight as the best constant source of illumination It is uncertain and always variable and more refractory than the edge of a good lamp-flame, unless we need a monochromatic ray from a sunbeam

At the close of the book there is a communication which had appeared before in the Journ Roy Micro Soc, from Dr S Czapski, which gives a suggestion for the possible enlargement of the practical N A. of homogeneous object-glasses, which makes an advance to 2 0 possible without the employment of the dense flint and highly refractive media needed by the lens spoken of above In fact it is plain that true monochromatic light may increase a N A of 1 40 to 1 75

There is a chapter on photomicrography which has the value that is inevitable, coming as it does from one of the most practised and efficient workers, still it can hardly be expected to be exhaustive, and every practical photomicrographer has, and adopts as most perfect, his

own methods, and as none will ever become photomicrographers who have not some ingenuity and enthusiasm, it is only needful that they be set to work, and they will undoubtedly find *their own* "best methods"

This treatise is too general to expect from it more than useful and suggestive hints on the subject of the preparation and mounting of objects, and the same may be said as to the history of the microscope, which is nevertheless given in an interesting and useful manner The book will undoubtedly attract many readers, and it will afford help to many who are seeking it, but we respectfully doubt whether it will enable the elementary reader to fully follow the diffraction theory of microscopic vision, so as to be able to understand its application to the wide range of subjects supposed to be dealt with from that point of view by this sumptuous treatise

W H DALLINGER

A UNIVERSITY EXTENSION MANUAL

The Earth's History an Introduction to Modern Geology By R D Roberts, M A (Camb), D Sc (Lond) With Coloured Maps and Illustrations (London John Murray, 1893)

THIS is not a large book, and a slightly less ambitious title might have been more appropriate Certainly it is an introduction to the study of modern geology rather than a history of the earth, for the latter is regarded from a limited point of view But from the page preceding the frontispiece it appears that the volume is one of a series of "University Extension Manuals" It partakes, therefore, of the advantages and disadvantages of this method of disseminating knowledge

The topics treated by Dr Roberts are the progress of geological thought the beginnings of the earth's history the modifications of its surface due to forces destructive and reproductive. the movements of its crust, including the action of volcanoes. Finally he deals with the formation of rock masses, and attempts to give—though of necessity this subject is very imperfectly treated—some idea of the evolution of the British Islands.

The materials employed by the author are not generally novel, for one text-book must draw from much the same storehouse as another, but Dr Roberts has a lucid and pleasant method of statement, gained no doubt by his experience in the lecture room One point, however, though it relates to a well-worn subject, will be fresh to most readers In speaking of the submergence of the so-called Temple of Serapis at Puzzuoli, Dr Roberts cites a passage from the Acts of Peter and Paul, an apocryphal booklet, to which attention was drawn a few months since by Mr Thomson (*Geol Mag*, 1892, p 282) This states that Pontioli (Puteoli, now Puzzuoli) was submerged as a punishment for the martyrdom of Dioscurus "They all see that city Pontioli sunk into the sea-shore about one fathom, and there it is unto this day for a remembrance under the sea." On which passage Dr Roberts observes that when the Acts was written, "Puzzuoli was under water, and had been so for so long a time that the memory of the actual events had been lost and replaced by the tradition recorded in the Acts." At first sight this, as he says, seems in favour of the submergence having occurred "between the third and fifth centuries, and probably earlier than the fourth"

This passage certainly makes it probable that the submergence began at a rather early time, but it is no easy matter to fix the date of any passage in these Acts Parts of the book are believed to be as old as the second century, while others are not earlier than the fifth century The book, also, was not of Western but of Eastern origin Had the book been written in Italy then, notwithstanding its other absurdities, some weight might be attached to a topographical reference, but these, as it was compiled at a distance, and by obviously ignorant people, seriously impair its credit It is also needful to show that this story forms part of the later recensions and is not merely founded on some vague tradition of change of level in the neighbourhood. In any case, Dr Roberts seems to go a little too far in saying "this would allow about ten centuries, during which the marble columns were under water exposed to the action of the living molluscs" Hardly so, this tradition at most would not take us beyond the first submergence, that indicated by the brackish water deposit at the base of the pillars Over this came an irregular mass of volcanic ash, which was covered by a calcareous tufa, in places full four feet thick The former, of course, may have accumulated in a few hours, but the latter must indicate a considerable time The temple, also, must have been in complete ruin before the showers of ashes fell—which also would require time So that Dr. Roberts perhaps would have done better to have adhered to the more cautious statement in Mr Thomson's letter, and not claimed quite so long a period for the maximum submergence

Within the limits, which the necessities of the case impose, the book is well conceived and well executed though we cannot help doubting the wisdom of encouraging, by manuals necessarily partial and incomplete, students to imagine that they have really mastered a subject, at any rate, it should be frankly admitted that this, however useful and interesting, is not education

OUR BOOK SHELF

The Health Officer's Pocket-Book By E F Willoughby, M D, D P H (London Crosby Lockwood and Son, 1893)

THIS is a work the object of which is to provide a portable and well-bound book of reference, to which the health officer may turn at any moment for most of the facts, formulæ, and data required in his daily practice, and while one cannot give unqualified assent to Dr Willoughby's contention that such a book is indispensable, one is prepared to acknowledge that it may prove to be useful It is not easy, however, to conceive the conditions under which a health officer is called upon to take action or to give advice, at a moment's notice, upon points so remote from the routine practice of his duties that he will ever find it necessary to carry about, for consultation, a pocket-book of abstruse sanitary facts and formulæ and legal enactments If such a work is indispensable, the author would have done well to restrict its bulkiness somewhat, and more especially since he could have achieved this by the omission of a great deal of matter which is, on the face of it, foreign to the purpose of the book. To instance such.—The parts which nitrogenous and non-nitrogenous food stuffs play in the animal economy; the origin and nature of cyclones, a quantity

of discursive material upon vital statistics, and a host of elementary hygienic facts with which every sanitarian is conversant,—are none of them points it can ever be necessary for the health officer to carry about with him for hasty reference.

The most useful sections, and those which most justify the *motif* of the book, are the following:—Those which deal with mathematical problems, and set forth useful algebraical and trigonometrical formulæ, together with a few logarithm tables; that upon demography and vital statistics; and the serviceable abstract of sanitary law, in which corresponding or similar sections of the Public Health Act, 1875, and the Public Health (London) Act, 1891, are considered side by side.

There is very little in the book which is not correct and up to date, save that which refers to the subject of water analysis. This contains many errors, and, since the utility of its introduction is very questionable, it is regrettable that it mars the all-round accuracy of the work. In this section Dr. Willoughby gives several results of his own analyses, and those who are familiar with the subject will find their experiences much at variance with the writer's.

In what he calls a typical sample of *rain-water* he found 0.63 grains per gallon of nitrates as HNO_3, and 0.114 and 0.172 parts per million of "ammonia" and "albuminoid ammonia" respectively; in *river-water* at Latchford he found no nitrates, not even a fraction of a part per million, and the "ammonia" and "albuminoid-ammonia" were 0.08 and 0.16 (parts per million) respectively. Loch Katrine water is, moreover, credited (and Wanklyn is quoted as the authority) with 0.008 parts per million of "albuminoid-ammonia," and with 0.004 of "ammonia," and the former is said to correspond to 0.0056 grains per gallon!

While unquestionably the work contains some material which will make it useful to the health-officer, the health student will find much in it which he may peruse with advantage.

Engler's Botanische Jahrbucher fur Systematik, Pflanzengeschichte und Pflanzengeographie. (Leipzig: W. Engelmann.)

SINCE Dr. A. Engler's appointment to the post of Director of the Berlin Botanical Garden and Museum, this periodical has become the organ of the very active staff of botanists of that establishment; and the comparatively recent German colonial policy has revived the interest in systematic and economic botany, to which it is devoted chiefly. Vols. xv. and xvi. are being published concurrently. This publication is partly devoted to original work and partly to a review of contemporary botanical literature. The fifteenth volume is largely taken up by contributions to the flora of tropical Africa, in the form of an elaboration by various botanists of the extensive collections made by numerous German travellers. Quite a host of new species are described, but, truth to say, nothing very remarkable in new generic types. *Hybophrynium* is a new genus of Scitamineæ, near *Trachyphrynium*, with which it was generically associated by Bentham and Hooker; and the Aroideæ, elaborated by Engler himself, include two or three new genera. *Pseudohydrosme* is characterised by a large, almost truncate spathe and a spadix without any terminal naked continuation.

Dr. J. Urban, who has been for some years engaged in collecting materials for a general flora of the West Indies, contributes "Additamenta ad Cognitionem Floræ Indiæ Occidentalis," a critical work, both from a botanical and a literary standpoint. No new genera are described.

One of the most interesting articles in the sixteenth volume is by Dr. O. Warburg, on the mountain plants of Kaiser Wilhelm's-Land, New Guinea. The collection of plants dealt with consisted of only fifty-three species, whereof thirty-two were supposed to be endemic, though the material of a few was insufficient for description. Two new genera are described, namely, *Hellwigia pulchra*, a pretty scitamineous plant, and *Zoellenia*, a singular boragineous plant, described as having ten nutlets in the place of the usual four! Among the new species are five rhododendrons, and the most noteworthy feature of the collection was the absence of essentially Australian types.

Another paper of general interest is Dr. Kränzlin's "Beitrage zu einer Monographie der Gattung Habenaria," excluding *Platanthera*, united with *Habenaria* by some botanists, 347 species are described; and they are spread over nearly the whole area inhabited by orchids.

Dr. Carl Bolle's "Botanische Ruckblicke auf die Inseln Lanzarote und Fuertaventura" is a pleasantly written essay on the indigenous and cultivated plants of these islands. The "Jahrbucher" contain many other valuable articles. W. B. H.

Descriptive Geometry Models for the use of Students in Schools and Colleges. Designed by T. Jones, M.I.M.E. (Moss Side, Manchester.)

THE models are six in number. They are intended to show a line (1) by its projections, (2) by its traces; the inclination of an oblique plane (3) to the vertical plane, (4) to the horizontal plane; and to determine the angle (5) between two intersecting lines (6) between two planes. They are accompanied by hints for fixing and studying the models, and with a useful list of problems suggested as exercises for students. The clearness of the explanations, the simplicity of the constructive apparatus, and the compactness of the arrangements (all being contained in a handy cardboard box) commend Mr. Jones's work to students of solid geometry.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Lion-Tiger Hybrids.

I HAVE read Dr. Ball's account of this subject in the issue of NATURE for February 23, 1893, and beg leave to call attention to the fact that the University of Cambridge possesses the skeleton and the stuffed skin of an *adult* hybrid between a lion and a tigress. I am able to supply the following information (which I have verified so far as it was possible) with regard to this specimen from a contemporary MS., entitled "Notice of the Lion-tiger which died in Cambridge, March 1833," by J. B. Melson, then an Undergraduate at Trinity College. This MS. no doubt contains the substance of a paper by Mr. Melson, which was communicated by Dr. Haviland to the Cambridge Philosophical Society, May 6, 1833. The paper was unfortunately not printed in the Transactions of the Society.

The Cambridge specimen, like those mentioned by Dr. Ball, was procured from the menagerie of Mr. Atkins. It was about six years old, and for some time previous to its death had been affected with paralysis of its hind quarters, arising probably from a distortion of the lower thoracic region of the vertebral column [which is still a marked feature of the actual skeleton]. Although inferior in size to either of its parents, the animal appeared to have attained its full dimensions. The shape of the head resembled that of the father (the lion), whilst the form of the body was more similar to that of the tigress. The body was faintly striped, while the prevailing shade was "of a dingy lion colour." The animal had neither a mane nor a tuft at the end of its tail.

The specimen was a female, and Mr. Melson states that "all the individuals of this hybrid race have as yet been females." The orifice of the vagina was smaller than in the tigress; and

the uterus was "merely rudimentary and nothing more than a membranous tube terminating in the two fallopian tubes" The ovaries were normal in appearance, though very much smaller than those of the full-grown lioness or tigress

The extreme length of the skull, from the end of the occipital crest to the end of the præmaxillæ, of the specimen now in the Cambridge Museum, is 290 mm, the distance between the foramen magnum and the end of the præmaxillæ is 235 mm, and the extreme zygomatic breadth is 190 mm The ascending process of the maxilla ends at a point 3 mm in front of the posterior end of the nasal bones, and has a somewhat rounded termination In these characters the skull of the hybrid resembles that of the lion much more closely than that of the tiger S F Harmer

University Museum of Zoology, Cambridge, February 27

Travelling of Roots

The mode in which roots travel in pursuit of food (moisture) is often remarkable Innumerable instances have been published But I think the inclosed is one of the most striking which I have come across The specimen kindly sent to the Kew Museum by the vicar of Petersham is most extraordinary The roots seem to have behaved more like the mycelium of a fungus than an ordinary axial structure

W T Thiselton Dyer

Royal Gardens, Kew, Feb 24

Memorandum by the Rev. W H Oxley, Vicar of Petersham, dated February 16, 1893

Roots of a Wistaria from the dining-room of Eden House, Ham, just demolished

The root entered the room by a very small chink in the side of the window, near the ceiling, and on removing the paper, which had not been disturbed for many years, from the walls (of the room about 14ft square) the whole of the plaster beneath the paper was found covered with a fine network of roots spreading all round the room The specimen is about one third of the whole roots and the stem where it entered the room There was not the faintest appearance of anything of the sort on the surface of the wall paper to give rise to the suspicion of these roots being there, and the room was continually inhabited, with fires, &c

The Flight of Birds

With reference to an extract from *Science* on the flight of birds, which appeared in your "Notes" of February 16, I agree with the writer of that extract that the rapidity with which the generality of birds travel is often considerably over estimated.

Some few months ago, whilst crossing, by G W R. express, the moors of Bridgewater Level in Somerset, a couple of turtle doves rose at a distance of about eighty yards from the train, and flew for a considerable distance in a line nearly parallel with the rails

I observed them with much interest, for I wished to have some comparison of their power of flight with that of some "homing" pigeons in my possession, and perceived that they were being slowly overtaken. They must have flown fairly parallel with the line of rails for at least 500 yards, and finally bore away northward We must have been travelling at about forty miles an hour at the time, so that their speed would have been a little less than that I was the more surprised at this as I had had "homing" pigeons, trained by myself, which, on a clear, calm day, had flown from the Quantock Hills to Taunton (a distance of seven miles) in less than eight minutes—a quite superior rate of flight, which, however, I do not think they would continue for a long distance The Columbacei generally may be considered good flyers; the turtle, however, I believe from observation to be somewhat below the average standard of excellence. It certainly cannot be compared with the Passenger Pigeon of America, which has frequently been killed in the neighbourhood of New York with Carolina rice still undigested in its crop—having probably accomplished a journey of between 300 and 400 miles in about six hours, giving the high record of sixty miles an hour for six hours in succession My own impression is that there is a great difference in the speeds of various orders and tribes of birds. I have repeatedly observed the fieldfare, which is a fairly strong flyer, overtaken by trains of which I have been an occupant, and which could not have been travelling more than forty miles an hour On the other hand, I have witnessed the pursuit of a wood-pigeon or cushat by a hawk, in which both birds exhibited powers of flight which might seem incredible to persons unobservant of nature. In this instance I should have estimated the speed of the pigeon, which was straining every muscle to reach the shelter of a belt of timber, to be about sixty miles an hour, whilst that of the hawk, which flew with little effort, could not I think have been less than eighty, during the brief period that they were within my sight I should be glad to hear from any of your correspondents their opinion as to the rapidity of flight in the Raptores (British) Herbert Withington

Taunton, February 22

The Niagara Spray Clouds

I do not remember having seen anywhere a reference to the fact that the spray clouds of Niagara exhibit an ice bow in clear frosty weather

I had an opportunity last week of seeing a very fine complete bow, the inner one, the outer being absent

There was no trace of the mock suns or of the bands of white light usually present, though I have seen ice bows without the latter, I have never seen one before without any trace of mock suns, these are generally accounted for by supposing the presence of hexagonal ice prisms I would suggest the inference that the ice crystals in the Niagara spray clouds are not prisms but rhombs Chas A Carus-Wilson

McGill University, Montreal, February 6

British New Guinea

In Nature (vol xlvii p 345) Mr H O Forbes has a lenient review of Mr J P Thomson's "British New Guinea," in which he reproduces a figure of four natives In the original they are called "native mountaineers" (p 95) As a matter of fact only the two central men are mountaineers, the two outermost being coast natives who acted as decoys to induce the timid highlanders to submit to being photographed Mr Thomson has a reprehensible habit of inserting figures which, while they illustrate the contiguous text, really belong to a different part of British New Guinea than that there dealt with I fancy Mr Forbes has been deceived in this respect, for the last figure which appears in the review is entitled by Mr Thomson "Native Ornaments" (p 120), and, though occurring in his description of the Fly River district, represent, if I am not mistaken, Papuan Gulf natives, most probably Motu Motuans Alfred C Haddon

I quite agree with Prof Haddon's remarks above, which you have been good enough to submit to me, with regard to the mountaineers of the interior of New Guinea They enter into details which, in an already over long review, I had no space for There is no doubt about the right hand figure (p 346) being *not* a mountaineer I was less confident about the man on the left hand The *two central figures* recall to me perfectly the people of Uburukara, of whom I took photographs in 1886, the plates of which were ruined during my disastrous march down the Goldie, and it was they who specially attracted my attention With regard to the "Fly River" natives, I have never had the fortune to see any of them, but I certainly took the central figure to be one, while remarking to myself the likeness of the right hand man to a Motuan—to men with whom he could be matched in any village indeed between the Gulf and Kerepunu.

104, Philbeach Gardens, S W Henry O Forbes

Some Lake Basins in France

I regret that, through some inadvertence on my part, the name of the author of the "Atlas des Lacs Français," mentioned in my letter (p 341) is wrongly printed. It should be Delebecque. In a letter received from M. Delebecque, he informs me that "the direction of the arrow on the map of Lake Léman is not exactly N, but N. 7° W." He informs me also that the curious funnel shaped hole at the northern end of the Lake of Annecy, which I suggest may be a submerged swallow hole, is the site of a spring This fact, however, need not be fatal to my suggestion, because the changes in level might convert what was once a swallow-hole into a spring. At present water at one time flows up from the dolinas of the Julian Alps, at another it drains off down them T. G Bonney.

ON ELECTRIC SPARK PHOTOGRAPHS, OR, PHOTOGRAPHY OF FLYING BULLETS, &c., BY THE LIGHT OF THE ELECTRIC SPARK[1]

I

WHEN I was honoured by the invitation to deliver this lecture I felt some doubt as to my ability to find a subject which should be suitable, for there is a prevailing idea that in addressing the operative classes, it is necessary to speak only of some practical subject which bears immediately upon the most important industry of the place in which the lecture is being delivered, but it seems to me that this is a polite suggestion that the audience are unable to be interested by any subject except that particular one which occupies them daily. Now though I am a comparative stranger in Scotland I have heard quite enough, and I know quite enough, of the superiority of the education of you, who have the good fortune to live in this the most beautiful half of Great Britain, to be aware that, as is the case with all highly-educated men, you are able to take a keen and genuine interest in many subjects, and that I had better choose one to which I have specially devoted myself, if I do not wish to expose myself to the risk of being corrected. I will ask you therefore in imagination to leave your daily occupation and come with me into the physical laboratory, where, by the exercise of the art of the experimentalist, problems which might seem to be impossible are continually being solved. I wish as an experimentalist to present to you an example of experimental enquiry.

Let us suppose that for some reason we wish to examine carefully and accurately some moving object travelling, if you will, at so great a speed that, observed in the ordinary way, it appears as a mere blur, or perhaps at a speed so tremendous that it cannot be seen at all. In such a case, in order to get a clear view of the moving body we may either look through an aperture which is only opened for a moment as the body passes by, or we may suddenly illuminate the object by a flash of light when it is in a position in which it may be seen. If in either of these cases the hole is open, or the illumination lasts so short a time that the object has no time to move appreciably while it is in this way brought into view, we get what may in ordinary language be called an instantaneous impression and the object appears clear, sharp, and at rest. In the same way if we wish, with the object of obtaining a permanent record, to photograph a moving body we must either allow the eye of the camera to see through a hole for a moment, *i.e.* we must use a rapid shutter, and many such are well known, or we must, keeping the photographic plate exposed and the object in the dark, make a flash of light at the right time. As before, if the shutter is open or the flash lasts so short a time that the object cannot move appreciably in the time, then, if any impression is left at all it will be sharp, clear, and the same as if the body were at rest. The first method, that of the shutter, I do not intend to speak about to-night, but as, owing to the kindness of Mr F. J. Smith, I have with me the most beautiful example that I have seen of what can be done by this method, I thought perhaps I should do well to show it. Mr Smith was in an express train near Taunton, travelling at forty miles an hour, and when another express was coming up in the opposite direction at sixty miles an hour, *i.e.* approaching him at one hundred miles an hour, he aimed his camera at it and let a shutter of his own construction open and shut so quickly that the approaching train was photographed sharply. There is a special interest about this photograph; it shows one of the now extinct broad-gauge engines on the road. However, this is an example of the method which we shall not consider this evening.[2]

[1] Lecture delivered at the Edinburgh meeting of the British Association by C. V. Boys, F.R.S.

[2] I have heard that a cannon-ball has been photographed by means of a rapid shutter, but I have no direct information on the subject.

For our purpose we require what is called instantaneous illumination,—a flash of light. It is of course obvious that it depends entirely upon the speed of the object and the sharpness required, whether any particular flash is instantaneous enough. No flash is absolutely instantaneous, though some may last a very short time.

For instance, a flash of burning magnesium powder lasts so short a time that it may be used for the purpose of portraiture, and while it lasts even the eye itself has no time to change. The lower part of the second slide (FIG. A) is a photograph of the eye of Mr

FIG. A

Lower part — Upper part

Colebrook after he had been some minutes in a dark room, taken by the magnesium flash; the upper part is the same eye taken in daylight. The pupil is seen fully dilated and the eyelid has not had time to come down, and so we might reasonably say that the flash was instantaneous; it was for the purpose practically instantaneous. Yet when I make this large clock-face four feet across revolve at so moderate a speed that the periphery is only travelling at forty miles an hour and illuminate it by a magnesium flash you see no figures or marks at all, only a blur. Thus the magnesium flash, which for one purpose is practically instantaneous, is, tested in this simple way, found to last a long time. Let me now, following Lord Rayleigh, contrast the effect of the magnesium flash with that of a powerful electric spark. At each spark the clock-face appears brilliantly illuminated and absolutely at rest and clear, and if it were not that I could at once illuminate it by ordinary light it would be difficult to believe that it was still in motion.

The electric spark has been often used to produce a flash by means of which phenomena have been observed which we ordinarily cannot see. For instance, Mr Worthington has in this way seen and drawn the exact form of the splash produced by a falling drop of liquid.

Mr Chichester Bell, Lord Rayleigh, Mr F. J. Smith, and others have used the illumination produced by an electric spark to photograph phenomena which they were investigating. I am able to show one of Lord Rayleigh's, a breaking soap bubble, in which the retreating edge, travelling something like thirty miles an hour, is seen with all the accuracy and sharpness that is possible with a stationary object. Mr F. J. Smith has extended the use of sparks for the purpose of physiological enquiry, taking a row of photographs on a moving plate at intervals that can be arranged to suit the subject, and is thus putting in the hands of the much-abused experimental physiologist a very powerful weapon of research. I had hoped to show one of these series of an untechnical character, to wit, a series taken of a cat held by its four legs in an inverted position and allowed to drop. The cat, as every one is aware, seems to do that which is known to be dynamically impossible, namely, on being dropped upside down to turn round after being let go and to come down the right way up. The process can be followed by means of one of Mr Smith's multiple spark photographs. However, his cats do not seem to like the experiments, and he has in consequence had so much trouble with them that his results,

while they are of interest, are not, up to the present, suitable for exhibition

Let me now return to single spark photographs We have seen that the magnesium flash, which for the purpose of portraiture is practically instantaneous, yet fails to appear so when so moderate a speed as forty miles an hour (and indeed a far lower speed) is used for the purpose of examining it Is anything of the kind true in the case of the electric spark? Will the spark, by which we saw the clock-face absolutely sharp, after all fail to give a sharp view when tested by a much higher speed? I have taken such a spark and attempted (though I knew what the result would be) to photograph by its light the bullet of a magazine rifle passing by at the rate of about 2100 feet a second, or, what is the same thing, at about 1400 miles an

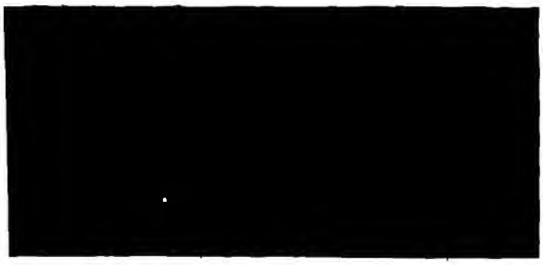


FIG 1

hour, the result (Fig 1) shows not a clear sharp bullet but a blur, the spark lasted so long a time that this bullet was actually able to travel half an inch or so while the illumination lasted Thus we see, that if we wish to examine bullets, &c., in their flight, any electric spark will not necessarily do. We shall have to get a spark which while it gives enough light to act on the plate yet lasts so short a time that even a rifle bullet cannot move an appreciable distance during the time that it is in existence.

A knowledge of electrical principles enables one to modify the electrical apparatus employed to make this spark in such a manner that its duration may be greatly reduced without, at the same time, a very great sacrifice of light, but while this may be done it is important to be able to observe how long the spark actually lasts, when made by apparatus altered little by little in the proper manner The desired information is at once given by the revolving mirror For instance, every one is aware how, by a turn of the wrist, one may reflect a beam of sunlight from a piece of looking-glass so as to travel up the street at a most tremendous velocity, but suppose that, instead of being moved by a mere turn of the wrist, the mirror is made to rotate on an axle by mechanical means at an enormous speed, then, just as the rotation is more rapid, so will the beam of light travel at a higher speed In the particular case that I am going now to bring before your notice, a small mirror of hardened steel was made by Mr Colebrook, the mechanical assistant in the physical laboratory at South Kensington, mounted so beautifully that it would run at the enormous speed of 1000 turns a second (not 1000 a minute) without giving any trouble The light from the spark was focussed by the mirror upon a photographic plate. Now if the light were really instantaneous, the image would be as clear and sharp as if the mirror were at rest, if, on the other hand, it lasted long enough for the image to be carried an appreciable distance, then the photograph would show a band of light drawn out to this distance The mirror is now placed on the front of the platform, and a beam of electric light is focussed by it upon the screen, from which it is distant about 20 feet Now that I turn the mirror slowly, you see the spot of light drawn out into a band reaching across the screen, and this is described over and over again as the mirror revolves Let us suppose that the mirror is revolving once a second, then it is easy to show that the spot of light is travelling at about 250 feet a second It is not difficult therefore to see that if the mirror is revolving 1000 times as fast, the spot of light will traverse the screen 1000 times as fast also, *i e*, about 250,000 feet a second, or 160,000 miles an hour—a speed which is 200 times as great as that of a Martini-Henry bullet, while such a bullet only travels 14 times as fast as an express train. You will see, then, that it is not difficult to observe how long a spark lasts when its image can be whirled along at such a speed as this. I have now started the electro-motor, and the mirror is turning more and more rapidly Now it gives a musical note of the same pitch as that given by the tuning-fork I am bowing; it is therefore turning 512 times a second It is now giving a higher note, *i e* it is turning faster and faster, until at last it gives the octave, at which time it is turning 1028 turns a second The band of light on the screen is produced by a spot now travelling at a still higher speed than that which I have just mentioned I had hoped to have shown with this apparatus the actual experiment of drawing out the apparently instantaneous flash of an electric spark into a band of light, but I found that while it was easy to show the experiment in a small room, the amount of light was not sufficient to be seen in a great room like this I must therefore be content to show one or two of the photographs which were taken lately in the physical laboratory at South Kensington by two of the students, Mr Edser and Mr Stansfield, whom I now take the opportunity of thanking. The next slide shows the drawn-out band of a particular spark made between magnesium terminals by the discharge of a condenser of $2\frac{1}{2}$ square feet of window-glass, the spark being $\frac{1}{8}$ inch long Below the drawn-out band I have drawn a scale of millionths of a second. If the spark had been instantaneous it would have appeared as a fine vertical line This line, however, has been drawn sideways to an extent depending on the duration of the spark. The spark, except at the ends, is extinct in rather less than one-millionth of a second, but the ends remain alight like two stars, being drawn out in consequence into two lines, which have lasted, as measured by the scale, as long as six or seven millionths of a second Such a light is, therefore, seen to last when tested with this very powerful instrument so long that it seems absurd to call it instantaneous. It lasts too long for the purpose of bullet photography. In order to get sparks of shorter duration it is necessary to abolish the metal magnesium, in spite of the brilliant photographic effect of the two ends of the spark between knobs of this material, it is well to avoid all easily volatile metals, such as brass, because of the zinc that it contains, and instead to employ beads of copper or of platinum In the second place, the duration of the spark proper, which in the last case was nearly a millionth of a second, can be reduced by (1) reducing the size of the condenser, but one must not go too far, as the light is reduced also, (2) by replacing any wire through which the discharge may have taken place by broad bands of copper as short as possible, this has the further advantage of increasing the light, and (3) the light may be increased without much change being made in the duration by making a second gap in the discharge circuit, the spark in which, however, must be hidden from the plate. Fig. 2 shows the trail of the best spark for the purpose of bullet

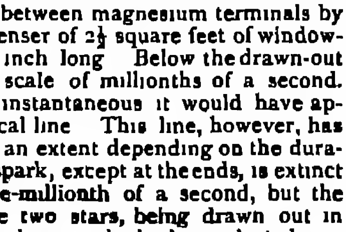


FIG. 2

photography that I have obtained up to the present In this case the surface of the condenser is one square foot, and the discharge is taken through bands of copper about two inches broad, and not more than about four inches long apiece Extra good contact is made between these copper bands and the tin-foil surface by long radiating tongues of copper-foil soldered to the end of the copper bands The knobs are platinum, but this seems no better than copper The whole of the light is extinct in less than one millionth of a second, while the first blaze, which is practically the whole spark, the tail being in comparison of no consequence, does not last so long as a ten-millionth of a second, in other words, it lasts so short a time that it bears the same relation to one second that one second bears to four months, or again, a magazine rifle bullet, travelling at the enormous speed that is now attained by the use of this weapon, cannot go more than one four-hundredth of an inch in this time Other sparks of still less duration were examined, but this was chosen for the purpose of photographing bullets [1]

Now, having obtained a suitable flash of light, I must next show how a spark may be used for the purpose of photographing a bullet in its passage This was first done by Prof E Mach,[2] of Prague, whose method is illustrated by the diagram Fig 3 The squares on the

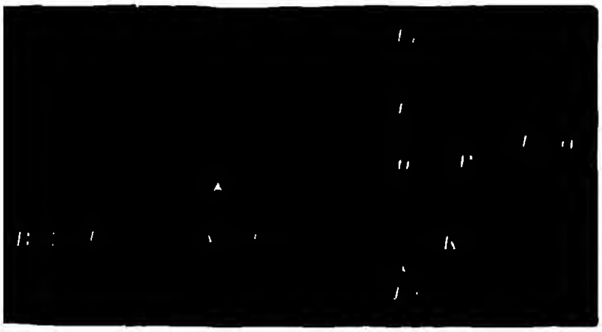


FIG 3.

right-hand side represent certain electrical apparatus by means of which a Leyden jar (J) is charged with electricity to such an extent that, while it is unable to make two sparks at B and A, it is nevertheless able to, and at once will, make a spark at B when the second gap at A is closed by a bullet or other conductor The dotted lines represent wires through which the discharge then takes place. The spark at B, magnified by the lens *l* in front of it, then fills the field lens L with light, so that the camera K focussed upon the spark gap A will then receive an image of the bullet as it passes, and thus a photograph is secured. I am able to show two of these which Prof Mach has kindly forwarded to me, and what I wish to point out is that in each of these photographs—and this is perhaps the most interesting feature which any of these exhibit—there are seen, besides the bullet and the wires which the bullet strikes in its journey, certain curious shades, one in advance of the bullet and one from the tail, while a trail is left behind very like that seen in the wake of a screw steamer In fact, the whole atmospheric phenomenon accompanying the bullet is not unlike that seen on the surface of water surrounding and behind a steamship These were seen for the first time, and their visibility by this method was, I believe, predicted by Prof. Mach before he made his first experiment

The part that I have played in this matter is after all very subordinate I have attempted to simplify the means, and the results which may be obtained by the modified method which I have devised, are, I believe, in some respects—I don't say in all—clearer and more instructive than those obtained by the more elaborate device of Prof Mach

Fig 4 is a diagram of the apparatus that I have used. C is a plate of window-glass with a square foot of tin-foil on either side This condenser is charged until its potential is not sufficient to make a spark at each of the gaps E and E′, though it would, if either of these were made to conduct, immediately cause a spark to form at the other *c* is a Leyden jar of very small capacity connected with C by wire, as shown by the continuous lines, and by string wetted with a solution of chloride of calcium, as shown by the dotted line So long as the gap at B is open this little condenser, which is kept at the same potential as the large condenser by means of the wire and wet string, is similarly unable to make sparks both at B and E′, but it could, if B were closed, at once discharge at E′ Now suppose the bullet to join the wires at B, a minute spark is made at B and at E′ by the discharge of *c*, immediately C, finding one of its gaps E′ in a conducting state, discharges at E, making a brilliant spark, which casts a shadow of the bullet, &c., upon the photographic plate P Though this is simple enough, the ends that are gained by this contrivance are not so obvious In the first place the discharge circuit of C, via E and E′ is made of very short broad bands of copper, a form which favours both the brilliancy and the shortness of duration of the sparks; further, the double gap, of which E′ may be the longer, causes the intensity of the light of either spark to be greater than it would be if the other one did not exist—in a particular case the light of the shorter was increased six or eightfold—at the same time the duration is not greatly affected For this reason the spark at E may be made very short, so that the shadow is almost as sharp as if the light came from a point. The spark formed at B, which is due to the discharge of *c* only, is very feeble, so that it is unable to act on the plate, whereas, had the discharge of C been carried round by B, the light at this point would hopelessly have spoilt the plate, and at the same time the light at E would have been feebler and would have lasted longer.

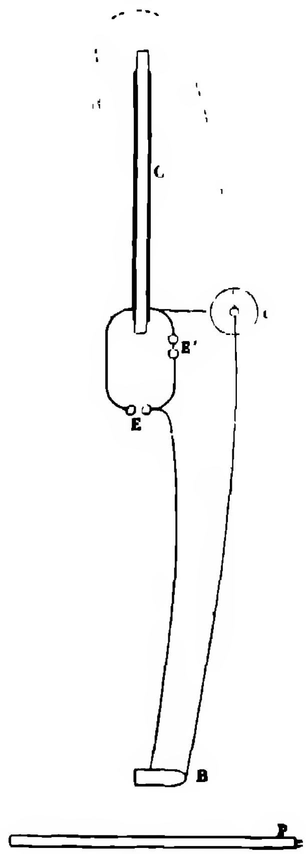


FIG. 4

[1] These sparks were made to go off at the time that the mirror was facing towards the photographic plate by the employment of the same device as that described below in connection with Fig 4 On the axis of the mirror an insulated tail of aluminium was secured, so as nearly to bridge a gap in the discharge circuit of an auxiliary jar of small capacity, there being a gap common to both circuits. A self-induction coil was used instead of the wet string, as being for this purpose preferable. The length of time that the spark lasted was thus measured without taking the electricity round by the mirror, which would have been quite sufficient to modify the duration of the discharge, and it was easier than making and adjusting a second reflecting mirror, which would have answered the same purpose.

[2] See NATURE, vol. xli. p. 250.

The wet string, while it is for the purpose of keeping the condenser c charged a perfect conductor, is nevertheless, when this discharges at E' and B, practically a perfect insulator, if it were replaced by wire then C would also wholly or partially discharge itself by B and E'. Finally, in avoiding all lenses one is free from the considerable absorption of the more refrangible rays which sparks provide in great abundance, and which are largely absorbed by glass. On the other hand the photograph is a mere shadow, but this is no drawback, for the bullet itself is on either system a mere silhouette, whereas the atmospheric phenomena are more sharply defined, and their character is more clearly indicated without lenses than is possible when they are employed.

Fig. 5 is a photograph of the apparatus set up in one of the passages in the Royal College of Science, in which the experiments were made. It is apparently of the rudest possible construction. The rifle seen on the left of the figure is of course made to rest freely on six points,[1] in order that its position every time it is fired may be the same. The bullet then traverses precisely the same course, so that wires placed in the line between holes in two cards made by one shot will be hit by the next. The two wires which the bullet joins as it passes by are set up in the box seen in the middle of the figure with the lid propped up so as to show the interior. The photographic plate is on the left-hand side and the spark when made is just within the rectangular prolongation on the right-hand side. Paper tubes with paper ends are placed on each side of the box to allow the bullet to enter and leave, and yet not permit any daylight to fall directly on the plate. All is black inside, and so the small amount of light which does enter the box through these holes is not diffused in any harmful manner. The large box at the back is a case 5 ft long, filled with bran which stops the bullets gently without marking them. The little condenser is just below the rectangular prolongation of the photographic box, the large condenser is the vertical square sheet seen just to the right. The electrical machine used to charge the condensers is seen on the table. It is a very beautiful 12-plate Wimshurst machine made by Mr Wimshurst and presented to the Physical Laboratory. This machine not only works with certainty but is so regular in its working that no electrometric apparatus is necessary. All that has to be done is to count the number of turns of the handle which are required to produce the sparks at E and E' when the gap at B is not joined, and to count the number which are sufficient to produce a spark at E when the gap at B is suddenly closed. Then if the rifle is fired after any number of turns between these, but by preference nearer the larger than the smaller number, the potential will be right, the spark E, inside the box, and the spark E', which is in sight outside the box, will be let off, and if a plate is exposed a photograph will be taken. If by chance the E' spark is not seen then there is no occasion to waste the plate, another bullet may be fired after resetting the wires and the result will be as good as if one shot had not failed. When all is in order a failure of this kind is very rare. I also arranged a tube in the side of the box with a pocket telescope fixed in it and focussed on the wires. If a piece of white card or paper is placed in the line of vision and so as to be illuminated by a spark let off as above described but preferably much nearer the card, the bullet will be seen by any one looking through the telescope. I took this down, however, at once, as the photograph showed more than could ever be seen by the eye. The box seen just to the right of the rifle with a coil of wire upon it is the one in which the revolving mirror was fixed, and in which the trails of sparks made near the door at the end of the passage were photographed. The apparatus for photographing

FIG. 5.

[1] Six independent points of support are required for a geometrical clamp. In this case a V support near the muzzle supplied two, a V support near the breech two more points, the rifle was pressed forward until a projection under the muzzle rested against the front V, thus allowing freedom of recoil, but otherwise preventing all uncertainty of position except that due to rotation in the V's which is made impossible by the sixth point, that is, the lower end of the stock resting sideways against a leather covered wooden bracket fastened to the same table to which the V's were attached.

the bullets was put together and set up by Mr Barton, a student, whose very skilful help in the matter and afterwards during the experiments I found of very great value

FIG 6

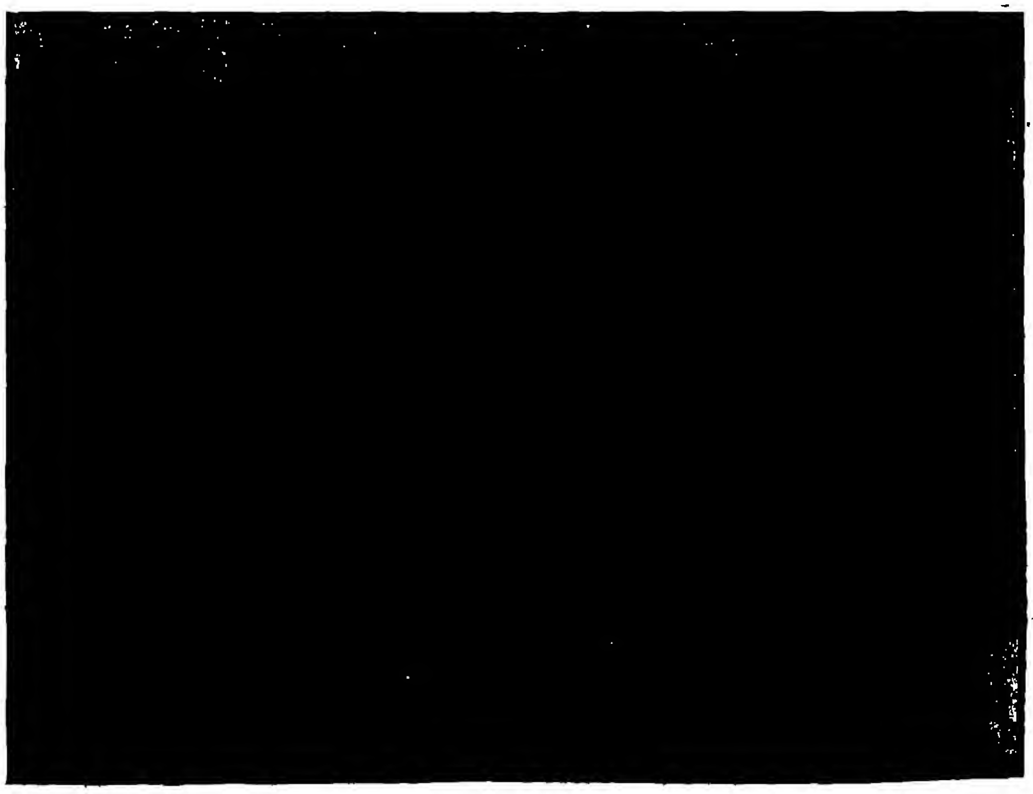


FIG. 7.

The first photograph which I am able to show was taken at Christmas, before the apparatus just described was put together It was taken to see if the idea would practically succeed, merely using for the purpose bits of wire and other things to be found in any laboratory, which were set up in a dark room in less than an hour. The first shot was successful, but the sharpness of the photograph is not what it might be, owing to the fact that I used, for the sake of the brilliant light, a spark taken between magnesium terminals However, the bullet is clearly enough defined, as are the wires which it has just struck This is a photograph of a pistol bullet travelling only 750 feet a second You will notice that unlike that taken by Prof Mach, which represented a shot going at a much higher speed, this photograph shows no atmospheric phenomena surrounding the bullet I would only add, in connection with this photograph, that by some accident the wad remained attached to the bullet in this case forming the enlarged tail I do not know if this often happens, it must, if it does, seriously disturb the flight of the projectile, and introduce an anomaly that might not easily be accounted for

The next photograph, Fig 6, shows a bullet which has just left a Martini-Henry rifle. This is taken with the apparatus in its latest form, and the bullet appears perfectly sharp. There is no sign of any movement whatever in so far as the bullet itself is concerned.

But now that we are dealing with a higher speed, namely, 1295 feet a second, there is evidence of the movement of the bullet in the form of a wave of compressed air in front and of other waves at the side of and behind the bullet. I shall explain this in a moment, but I would rather first show another photograph, Fig. 7, of a bullet travelling at a still higher speed, a magazine rifle bullet travelling about 2000 feet a second, in which these air waves are still more conspicuous, and in which a glance is sufficient to make it evident that the waves are much more inclined to the vertical than in the previous case.

Now as it may not be evident why these waves of air are formed, why their inclination varies with the speed, or why existing they are visible at all, a short explanation may not be out of place, more especially as they form the most interesting feature in the remaining photographs that I have to exhibit, which cannot, as a matter of fact, be properly interpreted without frequent reference to them.

I would first ask you to examine some still water into which a needle held vertically is allowed to dip. If you move the needle very slowly not a ripple is formed on the surface of the water, but as the needle is moved more quickly at first a speed is reached at which feeble waves appear, and then as the speed increases a swallow-tail pattern appears, the angle between the two tails become less as the velocity gets higher. Now in the case of water-waves the velocity with which they travel depends on the distance between one and the next, and for a reason into which I must not now enter either very long or very short waves travel more quickly than waves of moderate dimensions. If they are about two-thirds of an inch long they travel most slowly—about 9 inches a second. Now so long as the needle is travelling less quickly than this no disturbance is made, but when this speed is exceeded the swallow-tail appears. Suppose, for example, the velocity of the needle to be double the minimum wave velocity for water, *i.e.* let the needle move at 18 inches a second, and let it at any moment have arrived at the point *p*, Fig. 8. Then any disturbance, started

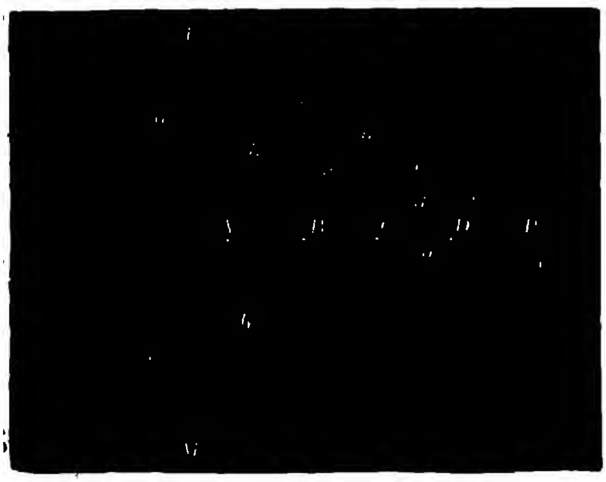


FIG. 8

when it was at the point A, must have travelled as far as the circle *aaa* in which A*a* is half A*p*, similarly for any number of points BC, &c., between A and *p* any disturbance must have travelled as far as the corresponding circles *bb*, *cc*, &c., the result is that along a pair of lines, *p*L, *p*M, touching all the circles that could be drawn in this way, a wave will be found, and it is clear that as the velocity of the point is made greater the successive radii A*a* B*b*, &c., will become in proportion to A*p* less, the circles will be smaller, and the angle between L*p* and M*p* will become less, while when the velocity is made less the reverse happens, until at last A*a* B*b*, &c. = A*p* B*p*, &c., and then when they exceed these quantities no lines L*p* M*p* can be drawn touching all these circles, there is no wave surface which the disturbances from all the successive points can conspire to produce, and the consequence is there is still water.

Now consider the case of a bullet moving through the air. Here again we are dealing with a case in which a wave cannot travel at less than a certain speed which is obviously the velocity of sound (1100 feet a second under ordinary circumstances), but, as in the case of surface waves on water, higher speeds are possible when the wave is one of very great intensity. The conditions in the two cases are therefore very nearly parallel, if the bullet is travelling at less than the minimum speed no waves should be formed—the pistol bullet at 750 feet a second did not show any—if the bullet is travelling at higher speeds than 1100 feet a second waves should be formed which should include a sharper angle as the speed is made to increase. This was found to be so in the case of the Martini-Henry and the magazine rifle bullet.

The curved form of the wave near the apex is due to the fact that when it is very intense, when the compression is very great, the velocity of travel is greater and, immediately in front of the bullet, the air is compressed to so great an exent that the wave at this part can travel at the speed of the bullet itself.

The reason why the waves should be visible at all is not difficult to follow. Consider a shell of compressed air though which rays of light from a point are made to traverse. These rays travel in straight lines, except where they meet a medium of different density, and the denser this is and the more nearly they meet this at a grazing incidence the more they will be bent towards the perpendicular. In comparison with water or glass a layer of compressed air has very little refractive power, and so rays which strike the shell anywhere except at the extreme edge are practically uninfluenced in their course and strike the plate practically in the same place that they would do if the shell of compressed air had not been

FIG. 9.

traversed. But those rays *ab*, *ab*, Fig. 9, which strike the shell of air almost tangentially are bent inwards slightly at *b* and again at *c*, having traversed what is equivalent to a wide angle prism, and strike the plate at *e*, leaving the place *d*, where they would have gone had they not been refracted, dark, moreover at *e* they meet other rays which have been hardly at all refracted since they have passed actually into the shell and out again, and therefore *e* is doubly illuminated. The consequence is that a wave or shell of

compressed air gives rise to an image on the plate, in which there is a dark line and a light line within it. Similarly a wave of rarefaction must produce a light line with a dark one within it.[1] An examination of the photograph Fig. 7 will make it evident that not only is the head wave a wave of compression, but the wave, which starts from the end of a kind of vena contracta behind the bullet, is also a wave of compression. It is a curious fact which requires explanation that the head and tail waves are not parallel to one another, and they do not show any sign that they would become parallel if they were continued indefinitely. This can only be due to either the tail of the bullet travelling considerably faster than the head, or to the actual velocity of propagation of the tail wave being less than that of the head wave. The effect observed is true and is not optical, being neither due to the refractive effect of the outer shell disturbing rays which are tangential to the inner shell, nor to an effect of perspective, for though the projection of a cone from a point upon a plane is only seen of the proper angle, when the perpendicular, dropped from the point upon the plane, passes through the vertex of the cone, yet when, as in the case of Fig. 11, where it passes within both cones, and more within the outer one than the inner one, the effect is to make the projections of both of a greater obtuseness, and of the outer one to a greater extent than the inner one, nevertheless an examination of the amount of this effect of perspective made by Mr. Barton showed that the distortion was not sufficient to be noticeable, as the difference in the acuteness of the cones certainly is.

(*To be continued.*)

[1] It may be worth while to point out that the dark and light lines are, and ought to be, parallel to one another as soon as they are so far away from the shadow of the bullet as to be practically straight lines. For if the thickness of the shell is divided up into a series of elements the ray passing through any one of these will meet with a refractive medium, which is less effective as the diameter of the part of the shell considered is greater, while the refractive angles of the elementary prisms become inclined more so as to compensate for the diminished density.

NOTES

ADMISSION to the Croonian Lecture, which Prof. Virchow, as we have already announced, is to deliver before the Royal Society at 4.30 p.m. on the 16th inst., will be by ticket, which may be obtained from the assistant secretary by introduction of a Fellow of the Society.

THERE will be widespread regret at the announcement which we now make that the distinguished geologist, Prof. K. A. Lossen, of Berlin, died there on the 24th ult. He had been ailing for some time, and suffered severely before he entered into his rest. In spite of the deafness which necessarily restricted his intercourse with men of science, he had formed a wide circle of friends who learned to appreciate the simplicity, candour, and geniality of his character, while at the same time they came to respect and admire more and more his wide range of knowledge, and that marvellous and apparently intuitive perception of the true characters of rocks which made him probably the best field-petrographer in Germany.

WE have received news of the death of Cav. Giuseppe Antonio Pasquale, for many years professor of botany in the University of Naples, and director of the botanic garden. Prof. Pasquale was the author of numerous articles on botany and cognate subjects. His earliest works of which we have cognisance were on the flora of Capri (1840), and the flora of Vesuvius (1842). In 1869 he published a more complete "Flora Vesuviana, confronte con quella dell' isola di Capri." He appears to have been appointed to the post of director of the Naples Botanic Garden in 1866, and the following year he published a catalogue of the plants cultivated there, together with a brief history of the garden.

THE German Government has established a biological Institute on the island of Heligoland, and has appointed Dr. Kuckuck its botanical director.

PROF. SCHWEINFURTH landed at Port Said on January 7, for an expedition into Upper Egypt which is intended to extend over several months. Dr. D. Riva, who accompanied Schweinfurth on his last journey, has undertaken an expedition to Eastern Africa in the vicinity of the river Giuba.

THE moss herbarium of Dr. Rehmann and the Hepaticæ-herbarium of Dr. Gottsche have passed into the possession of the Botanical Museum of Berlin; the Botanical Museum of the University of Vienna has acquired the moss herbarium of Hoppe; and the Botanical Institute of the German University at Prague the greater part of the valuable library of Prof. Willkomm.

THE Reale Istituto Veneto di Scienze, lettere ed arti proposes the following prize subjects:—(1) A lithological, mineralogical, and chemical investigation of the rocky, sandy, earthy, and saline materials brought down under various conditions by one of the chief rivers of Venetia from the Alpine valleys, and deposited at various distances from the base of the Alps to the sea (prize, 3000 lire, date December 31, 1893). (2) A compendium of the history of mathematics, with a mathematical chrestomathy containing extracts from mathematical works of antiquity, the middle ages, the renaissance, and recent times down to Gauss (indicating in each case the reason for introducing the extracts), (prize and date the same). Papers may be written in Italian, Latin, French, German, or English, and are to be sent in to the secretary with motto and sealed packet.

SIR ANDREW BARCLAY WALKER, who died on Monday, did much to promote intellectual life in Liverpool. The University College of that city has good reason to remember him as one of its most generous benefactors. He assumed the entire pecuniary responsibility for the erection of the Walker engineering laboratories, which cost about £20,000.

MR. O. M. EDWARDS, who was appointed to investigate the various conditions which have to be taken into account in connection with the proposal for the establishment of a Welsh University, has completed his inquiries and forwarded his report to the Vice President of the Committee of Council on Education. A writer in the *University Correspondent* says the report is practically a pamphlet of about eighteen octavo pages, containing a short account of the origin and progress of the educational movement in Wales, and intended to supplement the information already possessed by the Department of Education on this head. It contains a succinct epitome of the various schemes proposed—the Shrewsbury Charter, the proposals of Dr. Roberts and Prof. Evans; gives the state of efficiency of Lampeter and the three Welsh colleges; contrasts them with those at Leeds and Manchester; and points out how far, more or less, the Welsh institutions are prepared and adapted, in point of staff, students, accommodation, and appliances, to receive similar powers.

THE Municipal Council of Paris has been giving names to some new streets, and changing those by which various old streets have hitherto been known. The names selected for use are for the most part those of illustrious Frenchmen, and it is significant that among them are some well known men of science. The Rue du Battoir, for instance, is henceforth to be called the Rue Quatrefages, in memory of the famous anthropologist; and the Rue Claude-Vellefaux becomes the Rue Charles-Robin, in memory of the great physician. A new street is called after

Ernest Renan. This is only one of many indications of the respect in which science is held in France. We shall probably have to wait some time before it is decided by the municipal authorities of London that streets shall be known by the names, say, of Darwin and Joule.

THE atmospheric disturbance referred to in our last issue as crossing this country on Tuesday, February 21, reached the English Channel on the following day; afterwards its progress eastwards was unusually slow, and north-west winds belonging to the rear of the disturbance were experienced. Frost occurred during the night of the 22nd in many parts, and towards the close of last week the daily maxima fell below 40°, except in the extreme west and south-west, while in the midland counties frost continued throughout the day, and hail and snow occurred in many places. After a temporary improvement in the south and south-east districts on Saturday, a deep depression reached our south-west coasts from the Atlantic, causing strong gales on Sunday, and very severe snowstorms in Scotland, with heavy rain in other parts of the country, the fall exceeding an inch and a quarter on the north-east coast. By Sunday evening the disturbance had reached the north-east of England, where the barometer had fallen to 28.6 inches; this depression was preceded by severe frost in Scotland, the minimum temperature recorded at Nairn being as low as 11°. On Monday a north-westerly gale was blowing in Scotland, accompanied by snow, and on the same day a new depression arrived over the south west of England, accompanied with further heavy rainfall in the southern half of the kingdom, and strong winds and gales in the English Channel; frost also occurred in many parts. After these gales had subsided, the weather still remained in a very disturbed and unsettled condition. The *Weekly Weather Report* issued on February 25 showed that the temperature for that week was generally 1° to 2° below the mean in Great Britain, and 3° to 4° below in Ireland; also that the rainfall was much in excess of the average in the southern and eastern parts of England.

THE Report of the Meteorological Council for the year ending March 31, 1892, just presented to Parliament, reviews the work of the office under four heads: (1) *Ocean Meteorology*. The charts for the Red Sea were in an advanced state, and the extraction of data for the current charts of the Atlantic, Pacific, and Indian Oceans, and of data referring to the southern ocean, was being actively carried on. In this branch of the work the supply of instruments to ships is supplemented by the supplies to remote stations, when favourable opportunities occur. (2) *Weather Telegraphy and Forecasts*: An important station has been established at the North Foreland, and the work generally in this branch continues to increase; both the Daily and Weekly Weather Reports have been extended and improved. Weather forecasts are prepared three times daily; the total percentage of success of the 8h. 30m. p.m. forecasts which appear in the morning newspapers was 80, being 2 lower than in 1890-91. The results were best in England south, and worst in Scotland west. The percentage of success of the forecasts issued during haymaking was 89 per cent. Although these forecasts are issued solely for the benefit of farmers, the Agricultural Department does not at present aid in their dissemination. (3) *Land Meteorology of the British Isles*. Under this head are included all observatories, anemograph stations, and volunteer stations, necessary for the study of the periodic variations of the meteorological elements, and of climatology. Among the publications we may specially mention the "Harmonic Analysis of the Hourly Observations at British Observatories," which is probably the first systematic publication of the description that has hitherto been brought out by any of the established meteorological institutions. (4) *Miscellaneous*. This head gives an account of the various researches now in hand, among which are included investigations relating to rainfall, sunshine, fog, &c. It also contains particulars relating to the work done in cataloguing books and pamphlets, and also a classified summary of expenditure. A special note contains an account of the anemometer comparisons carried out by Mr. W. H. Dines, with the aid of a grant from the Council.

THE Meteorological Council have just issued a summary of the *Weekly Weather Report*, 1892, containing, among much other information of importance to agricultural and hygienic meteorology, an appendix showing the rainfall and mean temperature for the 27 years 1866 to 1892, for each of the 12 districts into which the United Kingdom is divided for the purpose of weather forecasts. The values show that the average rainfall for the whole of the British Islands is 34.9 inches; in the wheat-producing districts the average fall for the year is 28.2 inches, while for the grazing, &c., districts it is 41.6 inches. The wettest district is the west of Scotland, where the average annual rainfall is 45.5 inches, and the driest is the east of England, where the average amount is 25.8 inches. The values for the year 1892 varied considerably in different localities; the wettest district during the year was the north of Scotland, where the fall was 5.6 inches in excess of the average, while in the south west of England the deficiency was 12.5 inches. As regards temperature, the average for the whole area for the 27 years (omitting the Channel Islands) was 48°.4, and the mean difference of temperature between the wheat-producing and grazing districts scarcely amounted to a degree. The average value for the whole area during 1892 was 1°.6 below the mean for the 27 years; there was a deficiency in every district during that year, the greatest amount being 2°.3 in the east of Scotland, and the least, 0°.9 in the south of England; in fact, it was the coldest year experienced since 1879.

AN electrical actinometer was used by Messrs. Elster and Geitel, of Wolfenbüttel, in their measurements of the sun's ultraviolet radiation. The instrument, as described in *Wiedemann's Annalen*, was based upon the action of ultraviolet light in accelerating the dissipation of an electric charge from a cathode of amalgamated zinc. By exposing a plate of the metal to the light from a stream of sparks from an induction coil at various distances, and determining the dissipation of a negative charge imparted to it, this was proved to be a linear function of the light intensity. In its portable form the instrument consists of a cylinder which can be directed towards the sun, and into which a charged sphere of amalgamated zinc is introduced by means of an insulating handle. The fall of potential during a few seconds' exposure is determined by means of an Exner electroscope. Messrs. Elster and Geitel have made observations for each month in the year, and found the ultraviolet radiation to exhibit an inverse relation to atmospheric electricity. Comparisons were also made of the results at various heights above the sea-level, the stations being the summit of the Sonnblick (3100 m.), Kolm-Saigurn, in the adjoining valley (1600 m.), and Wolfenbüttel (80 m.). It was found that 40 per cent. of perpendicular ultraviolet rays from space reached the level of Sonnblick, 23 per cent. of these were absorbed before reaching the next station, and only 47 per cent. of the remainder arrived at the level of Wolfenbüttel.

TEN years ago there was some correspondence in NATURE on the subject of snow rollers. The phenomenon does not seem to occur very often, so that some interest attaches to a communication in *Science* (February 3), describing an instance noted last year at Milledgeville, Ohio. Mr. W. S. Ford says that on the morning of January 30, 1892, the clean level fields surrounding that town were covered with balls of snow, varying in size from three to five inches long and from one to two inches wide,

Wheat-fields and meadows abounded with these balls, and suggested, at first sight, that a troop of school-boys had been having a battle with the snow Two fields, of thirty acres each, that came under Mr Ford's observation (one a new sown wheat-field and the other a meadow) were literally covered with these "snow rollers," there being at least 500 on the acre Road sides and lots contained a few, and he noticed them on house-tops and straw ricks On close investigation, he found the balls to be uniformly light and fragile, so that to lift one and preserve its form was impossible Some were oblong, some almost spherical, while others resembled a tea-cup or small bowl There were no tracks behind them, or, if these had been made, the falling snow had obliterated them The accompanying weather conditions were as follows —The ground had been covered with snow for three weeks A crust had formed on the top, thick and firm enough in places to bear up a person This thawed a little during the afternoon of the 29th The ensuing night was warm, the mercury registering 40° F By ten o'clock a brisk wind was blowing, which increased in velocity, and soon the snow began to fall in large, moist flakes. The morning showed that about a half-inch had fallen on the crust, and on this lay the balls The phenomenon was reported from several places in the vicinity, chiefly in the Fayette County, and from Clinton County, which adjoins it on the west, but nowhere did the rollers extend uninterruptedly over any great area

IN November last, according to a writer in the Journal of the Straits Branch of the Royal Asiatic Society, there was in Singapore one of the largest specimens of the Mias or Orang Utan ever captured, it was a male, and probably of the species known as *Simia satyrus*, Linn, or the Mias Pappan of the Dyaks The animal was captured in Borneo, and bought by a native dealer in Singapore, who eventually sold him to a German ship's captain, by whom he has been, it is believed, taken to Germany As far as the writer could judge, his height must have been close on 4 feet 5 inches The cage in which he was confined was 4 feet 2 inches or thereabouts in height, and he could easily touch the top of it with his head without standing erect His face was immensely broad, the cheeks being flattened out sideways into a sort of disc The hair was long (about 4 inches) and thick and of a bright red colour, and he had a distinct short pointed beard The eyes were dark brown

A WRITER who signs himself "Tutuila" contributes to the current number of the Journal of the Polynesian Society some interesting notes on the races known as the Tokelaus, or Line Islanders, called by themselves the Kai-n Abara, which means "people of our land" The Kai n-Abara inhabit all the islands of the Gilbert Group, Nanumea, and Nanumanga in the Ellice Group, and Banapa or Ocean Island. They are apparently of the Micronesian type, but although they have long straight hair, and are more of a copper colour than brown, they are not pure Micronesian They are intelligent, can reason inductively, are brave, having a very respectable share of courage, and are extremely pugnacious, both sexes fighting like fiends on the least provocation In every township there is a large house called "maneabau," in which the members of each family of "aomata" or "gentry" have a certain space allotted to them. All the social government is carried on in this house, and everything of a public nature is discussed in it Decision is given by general vote, the majority carrying their point. The older and wealthier landowners have most influence where there are no nobles, but do not seem to have more votes than any one else. A woman can vote and speak as well as a man, and in general the women decide the question, unless it is one of war against another island

MR A J. CHITTY records in the new number of the *Entomologist's Monthly Magazine* that in the neighbourhood of Forres, Morayshire, where he spent six weeks last autumn, he found that Coleoptera were very abundant He captured specimens of a good many species new to the district, and one or two which had not, he believes, been recorded before from Scotland.

A LIST of the Batrachia in the Indian Museum, by W L Sclater, has been issued by the trustees of the institution The arrangement and nomenclature are formed on Mr Boulenger's work in the British Museum catalogues, and the Reptiles and Batrachia in the "Fauna of British India" series.

AN interesting paper on the were-wolf in Latin literature, by Kirby W Smith, is printed in the new number of the Johns Hopkins University Circulars The were-wolf is a person who, either from a gift inborn or from the proper use of certain magic arts of which he has learned the secret, can change himself into a wolf of unusual size and ferocity, or, furthermore, the transformation may be unavoidable, owing to the curse or charm of some outside power, and not to be got rid of until a fixed period has elapsed or various conditions, more or less difficult, have been complied with Such enchantments are common in the folk-lore of all nations, but, on Roman ground, they do not appear in connection with the were-wolf story Mr Smith mentions the were-wolf story told by Petronius, who describes how the companion of the freedman Niceros took off his clothes, and, becoming a wolf, began to howl and took to the woods Niceros tried to pick up the clothes, but found they had all turned to stone The wolf was wounded in the neck with a spear, and afterwards Niceros found his comrade in bed, while his neck was being dressed by a doctor Here the transformation is attributed to a power born in the person, and Mr Smith thinks that this may be the nearest approach to the original form of the superstition, because "among savages, these modern types of early humanity, just such stories are more or less common" The other class of Roman were wolf stories—those in which the change is effected by means of a charm—simply form one of a large number of different transformations, the theory and methods of all being practically the same

WE have received the first part of the new *Contributions from the Botanical Laboratory of the University of Pennsylvania* It contains papers by Dr J T Rothrock on a monstrous specimen of *Rudbeckia hirta*, and on a nascent variety of *Brunella vulgaris*, by Dr J M Macfarlane, contributions to the history of *Dionæa muscipula*, by Mr J W Harshberger on an abnormal development of the inflorescence of Dionæa, by Mr. H Trimble on Mangrove tannin, by Dr W P. Wilson on *Epigæa repens*, and on the movements of the leaves of *Melilotus alba*

THE paper by Dr Macfarlane on Dionæa is of great interest and confirms the statement previously made by him that, to produce closure of the leaf, two distinct stimuli are required, which may be communicated to the same hair, or to different hairs on the same half, or to hairs on opposite halves of the leaf He regards the leaf, previous to secretion, as in a state of tetanic contraction, resulting from a series of stimuli, which may either be partially or entirely mechanical, thermal, luminous, chemical, or electric. The so-called "hairs" are not true hairs, but emergences, and their structure is described in detail Each consists of three distinct regions, the joint, the base, and the shaft. While previous observations, such as those of Darwin and Prof Burdon Sanderson, have been made on plants of Dionæa under abnormal conditions of cultivation, Macfarlane's are especially valuable as having been made on the plant in its native condition, and this is also the case with those of Mr Bashford Dean, contributed to the Transactions of the New York Academy of

Sciences. Mr Dean states that there is a marked difference in the irritability of different leaves, that the leaves usually fail in capturing the larger and more active insects, that even small insects constantly escape, and that the leaf repeatedly closes on inorganic and vegetable objects

MR W SAVILLE KENT'S book on "The Great Barrier Reef of Australia" will be ready for publication before the end of the present month It will include a series of photographic views of coral reefs of various construction from several selected localities, with similar and also coloured illustrations and descriptions of the living corolla, coral polyps, and other marine organisms commonly associated on the reefs. Mean while, Messrs W H Allen and Co, who are to publish the book, have issued enlarged and very beautiful copies of some of the principal illustrations These are intended for the use of museums, colleges, and natural history societies, and will certainly be highly appreciated wherever they may happen to be introduced

A TRANSLATION of Prof Weismann's "Das Keimplasma," recently reviewed in NATURE, has been issued in "The Contemporary Science Series" (Walter Scott) The translators are Prof W N Parker and Harriet Ronnfeldt, who have done their work carefully In the preface Prof Parker explains that in the case of special technical terms which have no recognised English equivalents he has added the German words in brackets the first time they are used He has had the great advantage of being able to consult Prof Weismann personally with regard to many of the more difficult passages

THE County Council of Northumberland has issued a valuable pamphlet, by Dr W Somerville, giving an account of experiments made last season throughout Northumberland with a view of gaining practical information regarding some points connected with the economic manuring of the turnip crop

MESSRS METHUEN AND CO have added to their "University Extension Series" a volume on "The Mechanics of Daily Life," by V. P Sells. The author makes no attempt at the mathematical treatment generally adopted, but seeks rather to use the subject "as a means of scientific training, and as an illustration of the method of examining nature by reasoning and experiment"

MESSRS CASSELL AND CO are publishing in monthly parts a new issue of Dr Robert Brown's "Our Earth and its Story," with many coloured plates, maps, and upwards of 700 illustrations.

TWO important papers upon the ready preparation of large quantities of the more refractory metals by means of the electric furnace are contributed by M Moissan to the current number of the *Comptes Rendus* The "electric furnace" is simply a small furnace constructed of lime, so arranged that it can be intensely heated by a very powerful electric arc A quantity of magnesia, which M Moissan finds to be perfectly stable even at this high temperature, is first placed in the cavity of the furnace, and upon this the crucible of retort-carbon containing a mixture of powdered carbon and the metallic oxide to be reduced When the metal is volatile a current of hydrogen is passed through the furnace, and the vaporised metal is condensed in a comparatively cool receiver. In this manner M Moissan has succeeded in rapidly preparing considerable quantities of the metals of the alkaline earths, calcium, strontium, and barium If the metal is not sensibly volatile it is left in the crucible after the reduction in the form of an ingot The rare metal uranium, and the metals manganese and chromium belong to this category, and their preparation forms the subject of M Moissan's two communications.

METALLIC uranium was prepared with great difficulty, and only in small quantities by Peligot, by reducing the oxide with an alkali metal. At ordinarily procurable temperatures the various oxides of uranium are practically irreducible by carbon This no longer obtains, however, at the extremely high temperature of a very powerful electric arc The nitrate of uranium is first calcined in a porcelain crucible, whereby a reddish-coloured mixture of the sesquioxide and of the green oxide U_8O_4 is obtained This mixed oxide is then well ground with a very slight excess of powdered carbon, and the whole lightly packed in the crucible of retort-carbon, which is afterwards placed in position in the lime furnace Upon submitting the mixture in the crucible to the action of the arc produced by a current of 450 ampères, the reduction is completely effected in a few minutes The ingot of uranium thus produced exhibits a brilliant fracture and great hardness. It possesses the peculiar property of sending forth a shower of incandescent sparks when struck against a piece of porcelain, or when fragments of it are shaken about in a glass flask, reminding one of the combustion of particles of freshly reduced iron when allowed to fall through the air The yield of the metal is very considerable, thus in one experiment of twelve minutes' duration an ingot weighing over two hundred grams was produced The metal is not quite free from carbon, the amount of the latter depending upon the excess used M Moissan is now engaged in perfecting a ready mode of refining it

IN order to prepare metallic manganese the protoxide is mixed with carbon as in the case of uranium, and the mixture submitted to the arc produced by a current of 300 ampères The reduction is completely effected in five or six minutes, an ingot of 120 grams being readily obtained The comparatively weaker arc derived from a current of only 100 ampères gives the same yield in 10–15 minutes Any large excess of carbon is to be avoided as carbides of manganese are then produced If an excess of the oxide is employed the metallic manganese obtained is almost pure, and may be preserved unchanged in open vessels The carbides, however, are rapidly attacked by the moisture of the atmosphere, and if thrown into water evolve a gaseous mixture of hydrogen and various hydrocarbons Chromium has always been found hitherto to be much more difficult to reduce than manganese, but complete reduction occurs in 8–10 minutes in the electric furnace, employing a mixture of the sesquioxide and carbon and a current of 350 ampères, the yield being an ingot of 100 grams A current of only 30 ampères, however, is sufficient to produce ten grams of the metal in half an hour's time Moreover, it is possible to refine the somewhat impure (from carbide) metal by a simple repetition of the process in presence of a fresh quantity of the sesquioxide The pure chromium thus obtained is completely transformed into the volatile chloride when heated in a stream of chlorine. The reduction in the electric arc succeeds equally well with crude chrome iron ore, an alloy of iron and chromium being obtained from which the chromium may very readily be converted into chromate by projecting it into fused nitrate of potash or soda and subsequent extraction with water.

NOTES from the Marine Biological Station, Plymouth — During the past week ephyræ of *Aurelia* have become quite plentiful in the Sound The Anthomedusæ have been represented by numbers of the charming *Rathkea octopunctata* of Haeckel, and the Leptomedusæ (which are still scarce) by isolated examples of several species, including the *Thaumantias octona* of Forbes Ctenophore ova and several larval and young Ctenophores have been noticed The proportion of Polychæte larvæ and of Cirrhipede *Nauplii* remains fairly constant, while there has been an appreciable increase in the numbers of Brachyurous Zoææ. The Hydroid *Sertularia argentea* and Actinian *Cereus pedunculatus* (= *Sagartia bellis*) are now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythrus*, ♂) from East Africa, presented by Mr R Hughes, a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr W Yeoman, two Herring Gulls (*Larus argentatus*) British, presented by Mr J S Williams, an Ariel Toucan (*Ramphastos ariel*) from Brazil, presented by Mr Ellis Edwards, a Great Eagle Owl (*Bubo maximus*) European, presented by Commander E G Rason, R N, two Spengler's Terrapins (*Nicoria spengleri*) from Okinawa Shima, Loo Choo Islands, presented by Mr P Aug Holst, two Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, presented by Capt Worster, a Spiny tailed Mastigure (*Uromastix acanthinurus*) from Algeria, presented by Miss Rigley, a Cuming's Octodon (*Octodon cumingi*) from Chili, deposited, an Eland (*Oreas canna*, ♂), born in the Gardens

OUR ASTRONOMICAL COLUMN

COMET BROOKS (NOVEMBER 19, 1892) —The following ephemeris has been computed by Ristenpart (*Astronomischen Nachrichten*, 3154) from five normal places of this comet, using the elements—

T = 1893, January 6 529304 M T Berlin

$$\left.\begin{array}{rl} \omega = & 85\ 12\ 51''0 \\ \Omega = & 185\ 36\ 29\ 0 \\ \iota = & 143\ 51\ 45\ 9 \end{array}\right\}\ 1890\ 0$$

$$\log q = 0\ 0774148$$

12h Berlin M T

1893	R A (app) h m s	Decl (app) ° ′	Log r	Log Δ	Br
Mar 2	0 39 35	+22 18 6			
3	40 37	22 4 1			
4	41 37	21 50 1			
5	42 37	21 36 5	0 1738	0 3379	0 54
6	43 36	21 23 3			
7	44 34	21 10 5			
8	45 31	20 58 1			
9	0 46 27	20 46·1	0 1842	0 3563	0 47

The unit of brightness occurred on November 21 5, 1892

COMET HOLMES (1892, III) —M Schulhof, in *Astronomischen Nachrichten*, No 3153, continues the ephemeris for Comet Holmes, from which we make the following extract —

12h Paris Mean Time

1893	R A (app.) h m s	Decl (app) ° ′ ″
March 2	2 30 59 8	+34 49 0
3	32 42 7	51 41
4	34 26 0	54 24
5	36 9 6	57 7
6	37 53 5	34 59 52
7	39 37 7	35 2 37
8	41 22 2	5 24
9	43 7 1	35 8 11

NOVA AURIGÆ —Last week we mentioned that Mr Fowler's observation of this nova consisted of two bright nebula lines situated near wave-lengths 5006 and 4956, the former being only slightly brighter than the latter In *Astronomischen Nachrichten*, No 3153, Mr Huggins, in a note dated February 11, writes with respect to his observations on February 7, 8, and 10, using a 4 inch Rowland grating (14,438 lines to the inch) and the second order, that the band was "resolved into a long group of lines extending through about 15 tenth-metres The lines appeared more or less bright upon a faintly luminous background which could be traced a little beyond the lines at both ends of the group. Two lines, the brightest in the group and about equally bright, formed the termination of the group towards the blue, and a line nearly as bright as these was seen about the middle of the group The group is therefore brighter at the blue end, but it does not possess any of the features of a fluting. No contrast in the spectroscope could well be more striking than that which this extended group of lines forms with the narrow and defined principal line in the nebula of Orion"

HYDROGEN LINE Hβ IN THE SPECTRUM OF NOVA AURIGÆ —Owing to the curious appearance of the Hβ line in the spectrum of Nova Aurigæ, this line first appearing double and then afterwards quadruple, various explanations have been put forward to account for this peculiarity From the hypothesis of two bodies, which did not agree with the facts observed, that of three or more bodies was suggested, until at last it was supposed that six bodies in all were in question This supposition seemed most improbable, and since then the matter has been allowed to lie dormant With reference to the behaviour of this line in the spectrum of vacuum tubes, Herr Victor Schumann (*Astronomy and Astrophysics* for February) has made some very interesting experiments, taking great care to use the hydrogen in as dry and pure a state as possible We will here only refer to the most important part of the paper, leaving the reader to refer to the article itself for the apparatus, &c, employed The photographic plates employed were made by himself according to the "silveroxydammonmethode" of Dr Eder, of Vienna Working with pressures from 1 to 100 mm of mercury, the results obtained at those of 65, 80, and 100 gave the following results --At 65 mm Hβ and Hγ were most prominent, and in the negatives they were well defined, "although the sharpness of their edges is injuriously affected by broad, hazy fringes of considerable intensity, which shade off into the background from both sides of the line" Under a pressure of 80 mm Hβ lost most of its definition, and close to it on each side were observed two fine thin lines, the fringe also being present but a little wider than before Hγ, although increased in breadth, has lost its definition With a pressure of 100 mm, "the more refrangible component of the pair of lines just mentioned as belonging to Hβ, has disappeared, and in its place has appeared Hβ itself, broad, but very weak, near by on the lower side one observes a thin line twice" With reference to the fringe of Hβ he says, it has now "spread itself out more towards the blue than the red, thus displacing the middle of it towards the blue" Hγ remains a very weak line These observations showed that of all the hydrogen lines Hγ was the only one that showed reversal as well as displacement, and he concludes with the remark that "if it be asked whether the phenomena of reversal as observed in my hydrogen spectra furnish in themselves an explanation of the reversal of the lines in the spectra of Nova Aurigæ, the answer must be decidedly in the negative"

COINCIDENCE OF SOLAR AND TERRESTRIAL PHENOMENA —Since Prof G E Hale commenced his solar researches at the Kenwood Observatory, much has been added by him to our knowledge of the physics of the sun Faculæ, for instance, which were supposed to be scattered only here and there on the solar surface, are now found, by means of the fine spectroheliograph, to occupy largely both hemispheres, and sometimes to extend in almost unbroken belts across the disc This fact has led him to consider the question of the probability of chance coincidence between terrestrial magnetism and spots and faculæ (*Astronomy and Astrophysics*, for February), his attention being especially brought in this direction through a paper communicated to the Paris Academy of Sciences by M Marchaud M Marchaud, in summing up his results after an examination of both solar and magnetic observations, says, with reference to the curve of magnetic intensity, that "each of these maxima sensibly coincides with the passage of a group of spots or a group of faculæ at its shortest distance from the centre of the disc" From an examination of 142 photographs of the sun, obtained between January 25 and December 3, 1892, at the Kenwood Observatory, Prof Hale finds that no less than 132 show "one or more groups of faculæ on the central meridian, *i e* at their shortest distances from the centre of the solar disc" The chances, therefore, that at any given time one or more groups may be located at the central meridian, he finds as 0 93. This value, as he remarks, will be reduced for periods of decreased solar activity, but "coincidences noted in epochs like the present can hardly be regarded as of great importance"

"ASTRONOMICAL JOURNAL" PRIZES —In addition to the prizes already offered, and to which we have previously referred (NATURE, vol xlvii., Astronomical Column, p 282), two extra ones, subject to the same conditions, are now to be presented The first is to be given to "the observer making, by Argelander's method, the best series of determinations of maxima and minima of variable stars during the two years ending 1895, March 31" The sum in this case is two hundred dollars It is stated that "a principal basis for the award is to be the extent to which the de-

terminations will contribute to our better knowledge of the periodic variables by furnishing the largest number of maxima or minima of the largest number of stars, having especial regard to stars whose characteristics are at present not very well known" The award of four hundred dollars will be given for the "most thorough discussion of the rotation of the earth, with reference to the recently discovered variations of latitude" The manuscript (which will be returned to the author) is to be transmitted to some one of the judges not later than March 31, 1895

For the award of these prizes the judges are Messrs., Asaph Hall, Seth C Chandler, and Lewis Boss

GEOGRAPHICAL NOTES

The Liverpool Geographical Society has issued its first annual report, which, although not showing a very cordial reception of the new society by the public, is not without some promise of future growth The Earl of Derby is President, there are twenty-two Vice-Presidents, a substantial Council, and a staff of honorary officials Staff Commander E C Dubois Phillips has been appointed Secretary The second year of the society was inaugurated by a lecture on the Discovery of the Alps, by Mr D W Freshfield, President of the Alpine Club, and one of the Secretaries of the Royal Geographical Society Other lectures have been arranged for, and it is to be hoped that the membership of the society will rapidly increase

The tenth German Geographentag is announced to meet in Stuttgart on April 5, 6, and 7 The programme includes (1) The special geography of Wurtemberg and the researches on the lake of Constance, (2) Recent geographical investigations with special reference to desert phenomena, (3) Cartography, (4) Economic or applied geography, and (5) School geography An exhibition will be held at the same time, mainly of objects illustrative of the geography of Wurtemberg

Prof Penck has a long paper in the March number of the *Geographical Journal*, describing in detail his scheme for a map of the world on the scale of 1 1,000,000 The importance of having maps of every country on one scale has long been recognised by working geographers, but, with the exception of the little atlas on gnomonic projection by the late R A Proctor, we do not know of any effort having been made to place such maps before the public The minute scale of the work referred to reduced its value to a minimum Prof Penck's scheme is one of great magnitude He would allocate the production of the map to the Governments or public bodies of each country On this principle, 769 sheets would be required to represent the land surface of the globe, each sheet containing 5° square between the equator and 60°, and between 60° and the poles 5° of latitude and 10° degrees of longitude The British Empire would be responsible for 222 sheets, Russia for 192, United States for 65, France 55, Scandinavia 54, China 45 Five countries would have from 20 to 30 sheets each, six more would have over 10, and ten countries would require a smaller number, Belgium, Switzerland, and Greece having only one each One advantage of the proposed scale is that it corresponds within the limits of the shrinkage of paper with the 16 miles to an inch Survey of India maps (1 1013760) and with the 25 versts to an inch Russian maps (1 1050000)

MONGOLIA AND CENTRAL TIBET.

At the meeting of the Royal Geographical Society on Monday Mr. W Woodville Rockhill gave an interesting account of a journey in Mongolia and Central Tibet Leaving Peking on December 1, 1891, Mr Rockhill travelled to the frontier town of Kalgan, then, entering Mongolia, he passed through the pasture-lands of the Ch'ahar Mongols After a few days spent at Kuei hua Ch'eng, the traveller continued westward, and crossing the Yellow River on the ice at Ho-k'on, he crossed the Ordos Mongols country, and afterwards Alashan. Again entering China proper the route led through Ning hsia, Lanchou, and Hsi-ning, the westernmost town in China, on the high road to Tibet. On March 14 Mr Rockhill left for Tibet by an unexplored route, passing south of the Koko nor and along the foot of the mountains to the south side of the Ts'ai dam, making several excursions on the way, one of special importance from the Mongol village of Shang to Tosu Nor to determine by astronomical observations the position of this sheet of water discovered by him in 1889. Mr Rockhill's party consisted originally of five Chinese, but one had to be invalided home a few days after leaving Kumbum, and two others deserted him at Shang He was able to hire at this place an old Chinese trader, and with these three men, assisted for a while by a Mongol and then by a Tibetan guide, he travelled till he reached China again in October, 1892 On May 27 the final start for Tibet was made from the Naichi gol in western Ts'aidam, and a general south-westerly direction was followed until July 7, when a point some 30 miles from the north-west corner of the great central Tibetan lake, called Tengri nor by the Mongols, was reached Between the Naichi gol and the Ts'aidam the party had to endure great hardships, the great altitude ranging from 14,000 to 17,000 feet above sea level, terrible daily snow and hail-storms, fierce winds and frequent absence of fuel, and towards the end starvation The route, moreover, led them through vast salt marshes, bogs, and across numerous rivers, in which quicksands were frequently found The geographical results of this portion of the journey were important (1) The determination of the limits of the basin of the Murus (the great Yang-Tzŭ Kiang of China) and the discovery of the sources of the main branch of this river in the snow covered flanks of the great central Tibetan range of mountains known as the Dangla (2) The discovery of the eastern limit of the lake covered Central Asian plateau which becomes some 600 miles west of the route Mr Rockhill followed the Pamir, but is in the section he crossed of it called Nahtsang, and sometimes, though apparently erroneously, Chang T'ang or "Northern Steppe"

Game was scarce in the great part of this region, and so wild that it could not be approached

On July 2 the last provisions were eaten, and from that date to the 7th the party subsisted solely on tea On the latter day a small encampment of Tibetans was reached, and a little food purchased The next day a valley was entered dotted over with tents, it was the pasture lands of the Namru Tibetans and Lh'asa governed territory The headman refused to give the party food unless Mr Rockhill agreed to await the arrival of the head chief, who would decide as to whether he should be allowed to proceed southward, or be sent back to the north

After six days' discussion with the chief and several officials from Lh'asa a compromise was effected, and Mr Rockhill, with an escort of ten Tibetan soldiers, started eastward to reach the frontier post of Nagchuká, on the high-road to Lh'asa from the Koko nor

On July 27 Mr Rockhill crossed the Dangch'u and found himself on the territory of Jyadé, or "The Chinese Province," which is governed by native chiefs appointed by the Chinese Minister, resident at Lh'asa (or Lh'asa Amban) This important province was separated from Lh'asa by the Chinese in the seventeenth century, in view of the enmity existing between its people, who profess the Bonbo religion, a form of the devil worship or shamanism, though now mixed up with lamaism to such an extent, that it is hardly distinguishable from it, and the followers of the yellow and red sects of Buddhism living on Lh'asa soil

Passing to the south of the city of Ch'amdo, to which town Mr Rockhill, like his predecessor, Captain Bower, was refused admittance, the high road to China was reached at Pungdé (two stages south of Ch'amdo), and from this point to China a Chinese escort was given the traveller, and he was able to enjoy (!) all the luxuries of Chinese travel Stopping at Draya, at Gartok, Bat'ang and Lit'ang, Ta-chien-lu, in Ssŭ ch'uan, was reached on October 2 Here, on the eastern border of Tibet the journey was practically ended, for, though several thousand miles still separated Mr Rockhill from the seaboard, they could be travelled in comfort and rapidity. Leaving Ta-chien-lu on October 5, he was in Shangai on the 29th, exactly eleven months from the time he had left it. "In that time I had travelled about 8000 miles, surveyed 3417, and during the geographically important part of the journey crossed sixty-nine passes, all of them rising over 14,000 feet above sea-level, and not a few reached 18,000 I had taken series of sextant observations at a hundred points along the road, determined one hundred and forty six altitudes by the boiling point of water, taken three hundred photographs, and made important ethno-

logical and botanical collections For two months we had lived at an altitude of over 15,000 feet, soaked by the rains and blinded by the snow and hail, with little or nothing to eat, and nothing to drink but tea, and yet not one of us had a moment's illness from the day we left till we reached our homes again"

GASES IN LIVING PLANTS[1]

PLANTS are permeated by the same gases that make up the atmosphere surrounding them oxygen, carbon dioxide and nitrogen Nitrogen in the form of a gas is neither used nor generated by any part of plants, unless we except the tubercles of certain roots, and so it occurs in about the same per centage inside the plant as outside of it On the other hand, both oxygen and carbon dioxide enter into combination with, and are liberated from, the plant tissues in varying amounts at different times The percentage of these two gases in the cavities of the plant vary through a considerable range In a series of determinations made by Lawes, Gilbert, and Pugh, in England, the oxygen ranged from 3 to 10 per cent, and the carbon dioxide from 14 to 21 per cent in plants which had been for some time in the dark, while plants which had been standing in sunlight reversed these figures, and gave 24 to 27 per cent of oxygen and 3 to 6 per cent of carbon dioxide The two gases, therefore, bear a somewhat reciprocal relation, their sum usually being about 25 to 30 per cent of the total gas in the plant

The variations in the relative amount of oxygen and carbon dioxide are due to two independent processes incident to the life of plants One of these processes is assimilation, by which all green cells of plants in the presence of sunlight, or its equivalent, such as a strong electric light, absorb carbon dioxide and liberate oxygen This process goes on with great rapidity in healthy cells, but is entirely checked upon the withdrawal of light, or when it reaches a certain low intensity. Of course it never takes place in roots, flowers, the central portion of large stems, or other parts which are not green, nor in any fungi or other plants not possessed of green colouring matter

The other great cause of disturbance in the relation of oxygen and carbon dioxide in the plant is the process of respiration

Respiration in plants is essentially the same as in animals, and consists in a fixation of oxygen and the liberation of carbon dioxide It takes place in every living cell, whatever the kind of plant, whatever the part of the plant, and whatever the conditions of active existence The rate of respiration varies with the temperature, the age of the cell, and the nature of the chemical transformations In normal respiration the amount of oxygen absorbed is approximately the same as the amount of carbon dioxide evolved There are, however, certain modified forms of respiration in which this does not hold true

If living plants be placed in a vacuum, or in an atmosphere deprived of oxygen, it is found that they can still carry on life processes for some time, accompanied with an evolution of carbon dioxide The oxygen necessary for this process is obtained from the breaking up of compounds in the cells, and it is therefore called intramolecular breathing

The germination of seeds, which contain a large amount of oil, is somewhat the opposite of this last process In order to convert the fat into a more directly serviceable food material for the plant, a large amount of oxygen enters into the new combination, for which there is no equivalent amount of gas liberated It consequently comes about that oily seeds in germinating absorb a far larger amount of oxygen than they liberate of carbon dioxide This is known as vincular breathing

Another variation from normal respiration is known as insolar breathing, and which, with still some other modifications, I need not stop to explain To this brief statement of plant respiration must be added that much yet remains to be discovered regarding the details of the processes

Assimilation and respiration are the two great causes which disturb the relative volume of the two variable gases in plants

We shall now turn to the movement of the same two gases, oxygen and carbon dioxide There has never been a disposition as in the case of many other plant phenomena, to explain the movement of gases upon any other than purely physical principles. We have therefore to do simply with the question of the aids and hindrances to the establishment of an equilibrium between the gases inside and outside the plant, irrespective of whether the cells are alive or dead

It has already been stated that the relative amounts of oxygen and carbon dioxide inside the plant are usually very different, and that within a few hours the relation of the two may be completely reversed To this may be added that the pressure of the gases inside the plant is sometimes more, sometimes less than that of the atmosphere outside the plant, almost never the same Hales observed in his early work that a mercury gauge connected with the inside of the trunk of a tree showed an internal pressure when the hot rays of the sun warmed the trunk This was largely due, undoubtedly, to an expansion of the gases in the trunk, by the heat Such an excess of pressure in water plants is very common, although due to other causes It may readily be shown by breaking stems under water, when bubbles of gas will be liberated, as undoubtedly many have noticed in gathering water lilies, or other water plants

On the other hand, the pressure of the gas inside the plant may be less than on the outside This has long been recognised, but was best demonstrated by Von Hohnel in 1879, to whom it occurred to cut off stems under mercury In doing so the mercury rose to a considerable height in the vessels of the stem, and as mercury is without capillarity, this can only be ascribed to the greater pressure of the outside air, or in other words, to a partial vacuum in the plant

An observation was made by Hales, which we may use to illustrate how such a negative pressure, as it has been called, can be brought about He cut off a branch, fastened an empty tube to the cut end, and plunged the other end of the tube into a liquid He found that as evaporation of moisture from the leaves took place, the liquid was drawn up into the empty tube This phenomenon can now be explained more satisfactorily than could be done at that early day By evaporation the liquid water inside the plant escapes in the form of vapour, and the space it occupied is filled by the gases, thus rarifying them This rarifaction may go on in uninjured plants until the internal pressure is greatly reduced But in the experiment, the pressure is equalised by the rise of the liquid in the tube A later modification of Hales' experiment is to use a forked branch, place the cut end in water to give a continuous supply of moisture for transpiration, and attach the empty tube to one of the side forks of the stem, cut away for that purpose

It is self-evident that such condensation and rarifaction of the gases in the plant could not take place if the cell walls were readily permeable to gases Thus it comes about that one of the most important topics in connection with the movement of gases in the plant, is the permeability of tissue walls of various kinds, and especially those constituting the surface covering of plants

I shall not attempt to conduct you through the tangle of supposition and fact, errors in experiments, correct and incorrect conclusions, and the general confusion which has come from the labours of physicists, chemists and botanists for the last twenty-five years, during which the subject has received particular attention The results of the later work have been to cast grave doubts upon the correctness, or at least the interpretation of some of the experiments most relied upon heretofore Nevertheless many points still lie open for verification, and untouched parts of the subject await investigation

In the earlier days it was found that the leaves and young stems of plants have their epidermis more or less well supplied with minute openings, called stomata, or breathing pores, which communicate with small air cavities inside, which in turn branch out among the cells into a network of minute passages rarifying throughout the plant. This intricate network of intercellular passages affords an air communication throughout the whole plant, and connects directly with the outside atmosphere through the stomata Subsequent to the discovery of stomata, it was ascertained, that in stems more than one year old, the stomata are replaced by another kind of opening, known as lenticels, which in some form are doubtless to be found in the bark of shrubs and trees of whatever age

Gases stream into and out of the plant through the stomata and simpler lenticels, according to the law governing the movement of gases through minute openings in thin plates. The rate of movement is accordingly proportional to the square roots of the density of the mixing gases Such a movement of gases is known as effusion

The movement by which gases pass from one part of the

[1] Reprinted from the *American Naturalist* for February

plant to another, through the intercellular spaces, are governed by other laws It was at first thought that the rate of movement would correspond to that in capillary tubes, according to the well known law of Poiseuille, that it is proportional to the fourth power of the diameter, divided by the length of the tube But upon testing the matter two years ago, Wiesner found that owing to the extreme minuteness of the intercellular spaces, and their zigzagged and branched condition, this law does not hold, neither does the movement prove to be proportional to the density of the gases The discovery of the law of the rate of movement of gases in intercellular spaces, that is, the transpiration of gases, is, therefore, yet to be discovered, together with other interesting facts pertaining to the subject Poiseuille's law does, however, hold good for the movement of gases in the woody ducts, but here it is of limited application, for these do not connect with one another, with the intercellular spaces, or with the exterior of the plant

The walls of most cells, ducts, and surface covering of plants, except as already mentioned, are imperforate, that is without any openings that can be demonstrated by the microscope If gases pass through them, it must be in accordance with some law of diffusion, or osmosis Many experiments in this line have been tried, and the results have been of the most diverse character It is impossible to give a fair idea of the subject in the time at my disposal, and it must suffice to mention a few bare facts

The most astonishing and important results were obtained by Wiesner, in experiments conducted at Vienna, two years since It would be a most natural interpretation, it seems to me, to think that the gases are forced from one cell to another, through the cell walls by differences in pressure. Wiesner found, however, that it is impossible to force gases through cell walls of any kind whatever, by any pressure they will stand, acting for any length of time For instance, a bit of grape skin held up a column of mercury, 70 centimetres high, for seventy five days, and a piece of cherry skin withstood a pressure of 3 atmospheres for twenty four hours Similar experiments were tried with cuticularised, suberised, liquefied and simple cellulose tissues from many sources, and with uniformly the same results, whether the tissues were moist or dry, alive or dead.

But in the same set of experiments it was found that if gases cannot be forced through cell walls, they will readily pass through by simple osmotic diffusion All cells permit the passage of gases by diffusion when moist, dependent upon the coefficient of absorption and the density of the gas Cuticular and corky formations also permit the passage of gases when dry Thus we see that gases may be forced through the stomata, or breathing pores, by varying pressure, but can only pass through the epidermis and bark of plants by diffusion We therefore arrive at the conclusion that the gases inside and outside of the plant are brought to an equilibrium by direct interchange through the stomata and intercellular spaces, aided by the comparatively slow process of diffusion through the whole surface of the plant, both above and below ground

J C ARTHUR

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD —The Curators of the Hope Collections will proceed to the election of a Hope Professor in Trinity Term 1893 Candidates for the Professorship, of which the emoluments are £480 per annum, are required to send in their applications, together with such evidence of their qualifications as they may wish to submit to the Curators, on or before May 1, 1893, to the Registrar of the University, Clarendon Buildings, Oxford The duties of the Hope Professor are, to give public lectures and private instruction on zoology with special reference to the Articulata, to arrange and superintend the Hope collection of annulose animals, and to reside in the University for the term of eight months in every academical year between October 1 and July 15.

Physiological Department.—It is satisfactory to note that the number of students in this department is greater than in any previous corresponding term The increase is due not only to the larger number of candidates for the M.B. degree, but also to a larger number of candidates for honours in Physiology in the Honour School of Natural Science The course of study during the term has comprised lectures on the general subjects of the Honour School by the Waynflete Professor on the physiology of nutrition, by Dr J S Haldane, and on the nervous System, by Dr E Starling Mr Leonard Hill has undertaken the course of lectures on elementary physiology Practical instruction has been carried on under the superintendence of Dr Haldane and Mr M S Pembrey

SCIENTIFIC SERIALS

Bulletin of the New York Mathematical Society, Vol ii No 4 (New York, 1893) —The contents of this number are an abstract of a paper (read before the Society, June 4, 1892) by Prof W Woolsey Johnson, entitled "On Peters's Formula for Probable Error" (pp 57 61) A clear abstract of Engel and Sophus Lie's Theorie der Transformationsgruppen, by C H Chapman (pp 61-71), and a similar account of U Dini's work on the theory of functions of a real variable, by J Harkness (pp 71-76) Notes and new publications complete the number.

Bulletin de l'Académie Royale de Belgique No 12.—An unpublished corollary of Kepler's laws, by F Folie A deduction of Dewar's empirical formula for the ratios of the mean velocities of the planets from Kepler's third law —On the common cause of surface tension and evaporation of liquids (preliminary note) by G Van der Mensbrugghe The author endeavoured to show in 1886 that the particles of a liquid are at distances apart which increase as we approach the surface, and that therefore the tension is greatest at the surface Following up this view, he regards surface tension as the elastic force due to tangential displacement of surface particles, and evaporation as produced by molecular displacement beyond a certain limit in a direction normal to the surface He predicts that a liquid of high surface tension will be able to evaporate across another liquid which has a lower density and surface tension, and does not mix with the former —On a new optical illusion, by M J Delbœuf —On the reduction of invariant functions in the system of geometric variables, by Jacques Deruyts —Construction of a complex system of straight lines of the second order and the second class, by François Deruyts.—Contribution to the study of diastase, by Jules Vuylsteke —Pupine, a new animal substance, by A B Griffiths —Two experimental verifications relative to refraction in crystals, by J Verschaffelt. Billet has calculated that if refraction takes place on a cleavage face of a crystal of Iceland spar, the angle of refraction for the extraordinary ray corresponding to normal incidence is 6°12', and that the ray is normal with an incidence of 9° 49' M Verschaffelt has determined these angles experimentally, and found them to be 6° 9' and 9° 45' respectively, thus showing a close agreement with the theoretical values —On the bacterian fermentation of sardines, by M A B Griffiths.—On prejudices in astronomy, by M F Folie —On the constitution of matter and modern physics, by P de Heen

Ann dell' Ufficio Cent Meteor e Geodinamico, ser secund, part iii vol xi 1889 Roma, 1892 —Fumo di Vulcano veduto dall' Osservatorio di Palermo durante l'eruzione del 1889, by A Ricco.—From the obervatory terrace (72m above sea level) the summits of some of the Lipari islands are visible, but that of Vulcano (140km distant) is not so Any smoke or vapour that exceeds 300m in height can, however, be seen The author was not successful in either photographing or measuring the dimensions of the smoke cloud, which were, however, estimated by comparison with the size of Alicuri, which had been carefully determined. At the commencement of the observations (January 6, 1889) the smoke column reached a height 10½km and had the form of the pine tree Several drawings are given, and the form assumed in some cases is very curious. The paper terminates with some thermodynamical calculations, which are very interesting, but unfortunately based on false premises. The author supposes that the eruption was caused by the access of the sea-water. He supposes this to be at sea level, and calculating the pressure at this point, concludes the vapour was produced from water heated to 196° C. only. He seems to be unacquainted with the solution of H_2O in the fluid volcanic glass, the vesiculation and escape of vapour from it, involving so many data with which the physicist has not yet supplied us, as to make any calculations of such a nature of a highly romantic rather than of practical use.

Mem Soc. degli Spettroscopisti Ital vol xxi 1892 —La Grandissima Macchia Solare del Febbrajo 1892, by A Ricco — This memoir is a description of an enormous sun spot which developed from some small ones that had been noticed during three rotations before January 17 On February 5, they made their grand entry on the solar face on the east side, and by the 7th could be seen by the eye aided only by a smoked glass The whole spot was composed of a very large one surrounded by smaller ones, and composed of great tongues of flame extending in towards the nucleus, sometimes arranged in a spiral manner It attained its maximum on February 11, when the whole patch measured, in earth diameters, as follows Total length, 20, total breadth, 8, the more compact extended 8 in each direction After this the breaking up of the spot proceeded at a rapid rate, and by rotation the spot passed out of sight on the 18th On the next rotation the diminution was much more marked The author gives six observations of latitude, eight drawings, and several spectroscopic observations on the flames

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 23 —"On the Mimetic Forms of certain Butterflies of the Genus *Hypolimnas*" By Colonel C Swinhoe, M A Communicated by Prof E Ray Lankester, F R S

The object of this investigation is to study the changes undergone by the species of a small group of butterflies as they are traced from one locality to another, and to ascertain the bearing of these facts upon the theory of mimicry

We find the representatives of the Indian *Hypolimnas bolina* in a long list of localities in Malaya, Polynesia, and Africa the local representatives differ from each other and from the Indian form, but they agree in possessing in one or both sexes a more or less superficial resemblance to some conspicuous species belonging to a specially defended group and inhabiting the same locality, the same is true of the three forms of the female of *Hypolimnas misippus*

The facts afford the most convincing evidence of the truth of the theory of mimicry enunciated by H W Bates.

The study of these numerous but closely-related forms belonging to the genus *Hypolimnas* also throws light upon such interesting questions as —

(1) The special liability of the female to become mimetic

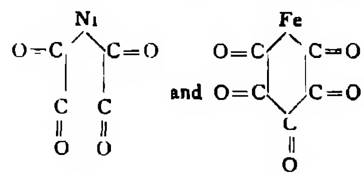
(2) The ancestral form from which the various mimetic varieties have been derived

(3) The mimetic resemblance to different species in the same locality

(4) The divergent conditions under which mimicry appears in closely related species

(5) The relation between selection and variation in the production of mimetic resemblance

Physical Society, February 10.—Annual general meeting —Mr Walter Baily, Vice-President, in the chair.—The reports of the Council and Treasurer were read and approved, copies of the balance-sheet being distributed to members From the former it appears that the society now numbers 371 ordinary members and 12 honorary members, and during the past year the society has lost six members by death, viz. the Rev T Pelham Dale, Dr J T. Hurst, B Loewy, C. E Walduck, G M Whipple, and P W Willans Obituary notices accompany the report —The treasurer's statement shows the financial condition of the society to be satisfactory A cordial vote of thanks to the Committee of Council on Education for the use of the rooms and apparatus of the Royal College of Science was proposed by Mr Shelford Bidwell, seconded by Mr Blakesley, and carried unanimously. A similar vote was accorded to the auditors, Mr H M. Elder and Mr A P Trotter, on the motion of Dr Gladstone, seconded by Prof S P Thompson. Prof. Ramsay proposed a vote of thanks to the officers of the society for their services during the past year; this was seconded by Prof. Fuller, and carried. Prof. Perry responded The following gentlemen were declared duly elected to form the new council —President: Prof A W. Rücker, F.R S. Vice-Presidents: Walter Baily, Major-General E. R. Festing, F R.S; Prof J Perry, F R S, Prof S P. Thompson, F.R.S. Secretaries H. M. Elder, 50, City Road, E.C., and T. H. Blakesley, 3, Eliot Hill, Lewisham, S E. Treasurer: Dr. E. Atkinson, Portesbery Hill, Camberley, Surrey Demonstrator C Vernon Boys, F R S, Physical Laboratory, South Kensington Other members of Council Shelford Bidwell, F R S, W E Sumpner, Prof G Fuller, J Swinburne, Prof J V Jones, Rev F J Smith, Prof G M Minchin, L Fletcher, F R S, Prof O Henrici, F R S, James Wimshurst —In response to invitations for suggestions regarding the working of the society, Prof S P Thompson said all must appreciate the efforts of the late Council, and particularly of the honorary secretaries, in making the society better known But he could not help thinking that there were many persons amongst teachers of physics and scientific amateurs whose active sympathies it was desirable to engage, who were not yet associated with the society Perhaps the time of meeting was not convenient for all, but he thought much might be done by freely circulating particulars of what was going on at the meetings The daily papers merely announced the meetings, but said nothing as to the place of meeting or the papers to be read In his opinion the society did not take the position in the scientific world to which it was entitled, and he wished to inspire members with a determination to bring its claims prominently forward —Mr Blakesley pointed out that almost all the scientific and technical papers gave full announcements of the meetings and of the papers to be read —Mr W F Stanley said Friday afternoon was not convenient for scientific men engaged in trade —The meeting was then resolved into an ordinary science meeting —Dr J H Gladstone, F.R S, read a paper on some recent determinations of molecular refraction and dispersion The paper relates to the new metallic carbonyls, the metals indium and gallium, sulphur, and to liquefied oxygen, nitrous oxide, and ethylene The carbonyls were found to be extremely refractive and enormously dispersive For iron pentacarbonyl, $Fe(CO)_5$, the molecular refraction for the line α of hydrogen was found to be about 68 5, and the molecular dispersion between γ and α of hydrogen 6 6 For nickel tetra-carbonyl, $Ni(CO)_4$, the corresponding numbers are 57 7 and 5 93 In discussing the results it was pointed out that if the molecular refraction of CO be taken as 8 4, the value expected in organic substances, then the atomic dispersions of nickel and iron come out greatly in excess of the known values as determined from solutions of their salts The author considers the most probable explanation of the excessive refractions and dispersions of the carbonyls is to be sought in the peculiar arrangement of the CO, and on optical as well as chemical grounds accepts the ring formulæ indicated by Mr Mond in his lecture at the Royal Institution, viz. —



On this supposition the molecular refraction of CO comes out 11 9 from the nickel compound and 11 3 from the iron ore, whilst the molecular dispersion (γ—α) is about 1 3 in each case For indium and gallium the atomic refractions calculated from latest data are 13 7 and 11 6 respectively Sulphur has been examined in the states of solid, liquid, and gas, and also in simple chemical combination and in solution, all the resulting numbers for its atomic refraction being remarkably concordant For the line C this is about 16 The dispersions in all the different states are also in close agreement Numbers relating to carbon and chlorine are also given The specific refractions of oxygen, nitrous oxygen, and ethylene in the liquid states had been recently determined by Profs Liveing and Dewar For liquid oxygen the refraction equivalent (3 182) differs little from that deduced from gaseous oxygen at ordinary temperatures (3 0316), and also corresponds fairly closely to the 3 0 obtained by Landolt from organic compounds. Liquid nitrous oxide gave 11 418 and 11 840 as the molecular refractions for the red ray of lithium and the line G respectively. In discussing these numbers it was pointed out that nitrogen in nitrous oxide was not in the same condition as nitrogen in ammonia. The latest determinations with liquid ethylene gave the molecular refraction for the line A as 17 41, the theoretical value being 17 40, thus showing very close agreement.—Mr E C C Baly made a communication on separation and striation of rarefied gases under the influence of the electric discharge

Chemical Society, February 3.—Dr W H Perkin, Vice President, in the chair The following papers were read —The connection between the atomic weight of the contained metals and the magnitude of the angles of crystals of isomorphous series, by A E Tutton The author has made a detailed goniometrical investigation of twenty two salts belonging to the $R_2M(SO_4)_2,6H_2O$ series of double sulphates containing as the alkali metal R potassium, rubidium or cæsium, and as the dyad metal M magnesium, zinc, iron, manganese, nickel, cobalt, copper, or cadmium On classifying the salts into three groups according to the alkali metals which they contain, it is found that the geometrical and other properties of the salts containing rubidium as the monad metal, lie between those of the corresponding potassium and cæsium salts Thus the cæsium salts show the greatest power of crystallising, those of potassium the least, whilst the salt containing rubidium occupy an intermediate position in this respect Similar behaviour is observed with regard to the crystalline habits of the various salts, each of the three groups is characterised by the possession of a distinctive habit The crystalline habit of the salts containing potassium is widely different from that of the salts containing cæsium, the specific characteristic habit of the rubidium salts is of an intermediate nature There is a difference of some two degrees or so between the axial angles (β) of the potassium and cæsium salt crystals containing the same dyad metal, the magnitude of the angle β in the corresponding rubidium salt is approximately the mean of these two The differences between the axial angles are hence approximately proportional to the differences between the atomic weights of the contained alkali metals if the dyad metal remain the same The magnitudes of all the angles between the faces of the crystals of the salts of this series containing rubidium as the alkali metal lie between, though not ordinarily midway between, the magnitudes of the corresponding angles upon the crystals of the potassium and cæsium salts containing the same dyad metal The alkali metals exert a preponderating influence upon the geometrical form of the crystals, the magnitudes of the angles being altered on displacing one alkali metal R by the next higher or lower to an extent attaining a maximum, in certain angles, of more than a degree, whilst the displacement of the dyad metal M by any other of the same group is unattended by any material change in the angular magnitudes —The preparation of phosphoric oxide free from the lower oxide, by W A Shenstone and C. R Beck Phosphoric oxide may be freed from the lower oxides by distilling it over platinum sponge in presence of excess of oxygen —Contributions to our knowledge of the aconite alkaloids Part IV, on isaconitine (napelline), by W R Dunstan and E F Harrison The authors have examined the alkaloid isaconitine $C_{33}H_{45}NO_{12}$, which occurs together with its isomeride aconitine in the roots of *Aconitum napellus* It is present to as great an extent as aconitine, and is obtained in the pure state as a colourless, friable, varnish-like mass Its alcoholic solution is feebly dextrorotatory The salts somewhat resemble the corresponding aconitine salts in physical properties On attempting to prepare an aurichloride, aurochlorisaconitine, $C_{33}H_{44}(AuCl_2)NO_{12}$, results Isaconitine is gradually hydrolysed by mineral acids or water yielding the same products as does aconitine, viz. aconine and benzoic acid

$$C_{33}H_{45}NO_{12} + H_2O = C_{26}H_{41}NO_{11} + C_7H_6O_2.$$

Whilst aconitine is a most violent poison, even in excessively minute doses, relatively large quantities of isaconitine must be administered to small animals in order to produce a toxic effect, which effect is the result of a physiological action in the main distinct from that of aconitine. It seems doubtful whether isaconitine would prove toxic to man, except when given in very large doses —Contributions to our knowledge of the aconite alkaloids · Part V, the composition of some commercial specimens of aconitine, by W R Dunstan and F. H Carr The great differences in toxic power exhibited by different samples of aconitine have led the authors to examine sixteen specimens of "aconitine from *A. napellus*." Most of the samples were amorphous; these contained little or no aconitine, but were chiefly composed of aconine, isaconitine, and homoisaconitine, all of which appear to be very slightly, if at all, toxic. Of the crystalline specimens examined, only two were pure, most of them being contaminated with more or less amorphous alkaloid. Hence it is not surprising that great differences have been observed in the mode of action and toxic power of commercial "aconitine."—Synthesis of oxazoles from benzoin and nitriles, by F R Japp and T S Murray The authors find that nitriles and benzoin interact with elimination of water when a mixture of the two compounds is dissolved in concentrated sulphuric acid, an oxazole being formed in which the hydrocarbon radicle attached to the cyanogen of the nitrile occupies the *meso* position Thus acetonitrile yields in this manner $\alpha\beta$ diphenyl μ-methyloxazole

$$\begin{array}{l} Ph\ CH\ OH \\ \quad\ | \\ Ph\ CO \end{array} + NC\ Me = \begin{array}{l} Ph\ C.O \\ \quad\ \| \\ Ph\ C\ N \end{array}\!\!\!\begin{array}{c}\diagdown \\ \diagup\!\!\diagup\end{array}\!\! C\ Me + H_2O$$

A number of instances of this reaction are cited. The above oxazole, when treated with ammonia, is converted into the corresponding imidazole identical with Japp and Wynne's methyldiphenylglyoxaline —The action of nitrosyl chloride and of nitric peroxide on some members of the olefine series, by W A Tilden and J J Sudborough Ethylene dichloride alone results from the interaction of ethylene and nitrosyl chloride Propylene and butylene yield with nitrosyl chloride a mixture of dichloride and nitrosochloride, whilst trimethylene (amylene) is almost entirely converted into nitrosochloride —Piperazine, by W Majert and A Schmidt The authors correct certain erroneous statements regarding the physical and chemical characters of piperazine They have prepared the following series of hydrates of piperazine, the hexhydrate, which crystallises from dilute aqueous solutions, being the most readily formed —

$C_4H_{10}N_2$,	H_2O	m p	75°
,,	$2H_2O$	,, ,,	56°
,,	$3H_2O$	,, ,,	39-40°
,,	$4H_2O$	,, ,,	42 43°
,,	$5H_2O$	,, ,,	45°
,,	$6H_2O$	,, ,,	48°

Linnean Society, February 16 —Prof Stewart, President, in the chair —Mr Clement Reid exhibited and gave an account of some seeds of *Paradoxocarpus carinatus*, an extinct Pliocene and Pleistocene plant from the Cromer fossil bed Mr Reid also exhibited and described some examples of *Potamogeton headonensis*, a new type of pond weed from the Oligocene strata of Hordle Cliff in Hampshire His remarks, which were listened to with great interest, were elucidated with the aid of diagrams, and were criticised by Mr W Carruthers and others.—Mr J E Harting exhibited some dried plants of a so-called Greek tea (*Sideritis theezans*, Boissier), which during a recent visit to Thessaly he had found to be extensively used there, as an infusion in lieu of tea He also exhibited some photographs of Thessalian scenery, showing the geological and botanical character of the country bordering the great plain of Larissa.—Dr Otto Stapf pointed out on the map the scene of Bornmueller's recent botanical explorations in Persia, and gave some account of the flora of that region as far as has at present been ascertained —On behalf of Mr C B Plowright, a paper, communicated by the President, was read on the life history of the Æcidium on *Paris quadrifolia*.—On behalf of Mr. J C Willis, who was unfortunately prevented by illness from attending, a paper was read entitled "Contributions to the natural history of the flower" This paper, the first of a series, dealt with the fertilisation by insects of plants belonging to the genera *Claytonia*, *Phacelia*, and *Monarda* —Some observations on British worms, by the Rev. H Friend, were read on his behalf by the Secretary

Royal Meteorological Society, February 15 —Dr. C Theodore Williams, President, in the chair —The following papers were read —Report on the phenological observations for 1892, by Mr E Mawley The Royal Meteorological Society has for a number of years past collected observations on natural periodical phenomena, such as the date of the flowering of plants, the arrival, song, and nesting of birds, the first appearance of insects, &c. These observations were supervised and discussed by the Rev. T A. Preston until 1888, since which time they have been under the direction of Mr. E Mawley The year 1892 was on the whole very cold and backward The frequent frosts and dry weather during the first five months greatly retarded vegetation, and consequently all the early wild flowers were very late in coming into blossom. Bush fruits and strawberries were, as a rule, good and fairly plentiful Plums and pears were almost everywhere a failure, and apples were considerably under the average The wheat crop was a very light one, owing in part to the attacks of blight brought

on in many places by the frost in June Oats, beans, and peas were much under the average, while barley was the chief crop of the year Potatoes, turnips, and mangolds were above the average During August butterflies were very numerous, the clouded yellow butterfly being exceptionally abundant —Relation between the duration of sunshine, the amount of cloud, and the height of the barometer, by Mr W Ellis This is a discussion of the observations made at the Royal Observatory, Greenwich, during the fifteen years 1877-91, from which it appears that in the months from February to October there is, on the whole, a distinct probability of increased sunshine and correspondingly less cloud with increase of barometer reading The winter in all conditions of the barometer is uniformly dull Mr Ellis says that it is evident that high barometer in summer presages increased sunshine, that the effect is less pronounced in early spring and late autumn, and that it becomes slightly reversed in winter —Winter temperatures on mountain summits, by Mr W Piffe Brown In this paper the author gives the lowest winter temperature on the summit of Y Glyder fach, four miles E N E from Snowdon, and 3262 feet above sea level, as recorded by a minimum thermometer during the last twenty five years The lowest temperature registered was 9° during the winter 1891-2

Zoological Society, February 14 —Osbert Salvin, F R S, Vice President, in the chair —The secretary read a report on the additions that had been made to the Society's menagerie during the month of January 1893 —Prof G B Howes exhibited and made remarks on an abnormal sternum of a Marmoset (*Hapale iacchus*) in which the mesosternal elements of the opposite sides were distinct, and alternately disposed, and discussed its probable bearings upon the sternum of the Anthropomorpha, particularly as represented by the orang —Prof T Jeffrey Parker, F R S, read a paper on the cranial osteology, classification, and phylogeny of the *Dinornithidæ* The author gave a detailed description of the skull in various genera and species of Moa, founded upon the examination of more than 120 specimens A detailed comparison with the skulls of the other Ratitæ followed, as well as an extensive series of measurements —The bearing of the facts ascertained upon the classification of the family was discussed The author recognised five genera of *Dinornithidæ*, arranged in three subfamilies as follows Subfamily DINORNITHINÆ, genus *Dinornis*, subfamily ANOMALOPTERYGINÆ, genera *Pachyornis*, *Mesopteryx*, and *Anomalopteryx*, subfamily EMEINÆ, genus *Emeus* The phylogeny of the group was then discussed *Mesopteryx* was considered to be the most generalised form, while *Dinornis* and *Emeus* were both highly specialised, but in different directions Of the other Ratitæ, *Apteryx* came nearest to the Moas in the structure of its skull, and strong affinities were shown to the New Zealand genera by *Dromæus* and *Casuarius* *Struthio* and *Rhea*, on the other hand, showed no special affinities, so far as the skull is concerned, either to the Australasian forms or to one another —Mr R. Lydekker read a paper on the presence of a distinct coracoidal element in adult sloths, and made remarks on its homology It was shown that in two skeletons of sloths in the British Museum the shoulder-girdle exhibited a distinct coracoidal element This element, like the coracoid process of the human scapula, was correlated with the precoracoid of the lower vertebrates, and the question was then discussed as to the name by which it should properly be called —A communication was read from Dr G Radde, containing an account of the present range of the European bison in the Caucasus

OXFORD

Junior Scientific Club, Feb 17 —In the Morphological Laboratory —The President in the chair —Mr. A L. Still gave an exhibit of a variety of a common pheasant, which was shot near Croydon This proved to be an extremely light coloured young cock —Mr H. Balfour gave an exhibit of some modern Klepsydras, such as are now used in guard rooms in many parts of Northern India and Burmah He also showed some water clocks from Burmah, one of which was of interest as having come from the Imperial Palace of Mandalay, where it was the public standard of time.—Dr Leonard Hill read an account of his researches on the gas evolved from muscles.—Mr H V. Reade read a paper on consciousness, and the unconscious, citing several cases of dual personality, and showing that memory could be explained by purely physiological reasoning

EDINBURGH

Royal Society, February 6 —Sir Arthur Mitchell, K C B, Vice president, in the chair —Mr John Aitken read a paper on the particles in fogs and clouds In a paper read some time since on the water particles in clouds, Mr Aitken came to the conclusion that there was a relation between the density of the clouds and the number of water particles present In May last year he made further observations, and got results opposite to the former Instead of the density being nearly proportional to the number of water particles present, it was much short of proportionality, and the particles were small in size Mr Aitken points out that the size of the particles of water changes with the age of the clouds, and concludes that his first observations were made upon old clouds, while the latter series were made upon newly formed clouds He also considered the question of the persistence of fog-particles There are two kinds of fog In one the particles tend to persist, in the other they do not That is, in one case, change of size of the particles takes place rapidly, in the other it does not In town fogs it is not so much the number of dust particles that is of importance as their composition If town dust were composed of particles having an affinity for water the fogs would have shorter duration —Sir Douglas Maclagan described and explained an apparatus designed by Mr J Buchanan Young, Public Health Laboratory, Edinburgh University, for counting bacterial colonies in roll cultures —A note, by Prof Anglin, on properties of the parabola, was read —Mr A J Herbertson read a preliminary note on the hygrometry of the atmosphere at Ben Nevis He finds that the observations already made agree well with the formula $y = ax + bw + c$, where y is the difference between the readings of the dry and wet bulbs, x is the temperature of the dry bulb, w is the weight of moisture per litre, and a b c are constants

DUBLIN

Royal Dublin Society, January 18 —Prof W J Sollas, F R S, in the chair —Dr J Joly, F R S, read a paper on the cause of the bright colours of Alpine flowers The conditions of insect life upon the higher Alps are referred to in this paper as bearing upon the question Observations made by the author show that many thousands of bees and butterflies frequently perish in the cold of night time on Swiss glaciers and firns The author advocates the view that the scarcity of fertilising agents promotes a struggle for existence in the form of a rivalry to attract the attention of the fewer fertilisers by vivid colouring —Prof G A J Cole read a paper on *Hemitrypa hibernica*, M'Coy —A paper was read on a suggestion as to a possible source of the energy required for the life of bacilli, and as to the cause of their small size, by Dr G Johnstone Stoney, F R S, Vice President —Prof W J Sollas, F R S, read a paper on the law of Gladstone as an optical probe

February 22 —Prof W J Sollas, F R S, in the chair —Mr Thomas Preston read a lecture note on the principle of work, showing that since the virtual work of a force is equal to the movement of an equal force at right angles to it, the principle of virtual work follows immediately as a corollary to the theorem of movements —Prof D J Cunningham, F R S, communicated a paper by Prof A M Paterson on the human sacrum —Prof A C Haddon communicated a paper by Miss Florence Buchanan on *Eunice phylocorallia*, n sp, commensal with *Lophohelia prolifera*

PARIS

Academy of Sciences, February 20 —M de Lacaze-Duthiers in the chair —Description of an instrument to show the small variations in the intensity of gravitation, by M Bouquet de la Grye The instrument, which has been set up in a cellar of the Dépôt de la Marine, consists of an iron tank containing hydrogen confined over mercury, with three tubes leading out through the bottom Two of these tubes are bent upwards to about 40 cm above the ground. One of them is used for filling the tank with mercury, the other for letting in the hydrogen, which is accomplished by letting mercury run out through the third pipe at the bottom The second pipe ends in a horizontal tube made of glass, through the walls of which the fluctuations of the column of mercury sustained by the elastic force of the hydrogen can be observed By means of an alcohol thermometer immersed in the mercury on the top of the tank, changes of temperature of one-thousandth of a degree are indicated by a move-

ment of 1 mm The column oscillates with each change of temperature and each variation of gravitation, but is not affected by changes of pressure, since the tube is kept closed at the top. Under these circumstances, the instrument in question is capable of indicating the change of gravitational force due to the change in the position of the moon by a displacement of 0 46 mm The apparatus is difficult to set up, and will require some improvement before it can give trustworthy results —Observation on the conditions which appear to have obtained during the formation of meteorites, by M Daubrée The heterogeneous structure of meteorites, the innumerable iron granules disseminated through the stony matrix, so different from the well-defined and voluminous crystals obtained by the fusion of the constituent minerals in the laboratory, and M Stanislas Meunier's success in imitating meteorites by means of gaseous reactions, lead to the conclusion that they have not been produced by fusion, but by a sudden precipitation of different gases into the solid state —On the preparation of uranium at a high temperature Rapid preparation of chromium and manganese at a high temperature, by M Henri Moissan (see Notes) —On stereochemistry, by M C. Friedel —On the benzoates and metanitro benzoates of diazoamidobenzene and paradiazoamidotoluene, by MM A Haller and A Guyot —High atmospheric pressures observed at Irkutsk from January 12 to 16, 1893, by M Alexis de Tillo During four days the barometer remained above 800 mm, and on January 14 the highest value known up to the present, 807 5 mm, was reached, the temperature being − 46° 3 C —M Callandreau was elected Member in the place of the late Admiral Mouchez, and M Kekulé Correspondent in the place of the late M Stas —Summary of solar observations made at the royal observatory of the Roman College during the last quarter of 1892, by M P Tacchini — On the terms of the second order resulting from the combination of aberration and refraction, by M Folie —On the essential singularities of differential equations of a higher order, by M Paul Painlevé,—Remarks on the preceding communication, by M E Picard —On uniform integrals of linear equations, by M Helge von Koch —Generalisation of Lagrange's series, by M E Amigues —On the part played by the steam jacket in multiple expansion engines, by M A Witz.—A direct reading stereo-collimator, by M de Place —Hysteresis and dielectric viscosity of mica for rapid oscillations, by M. P Janet. A comparison of differences of potential and resulting charges during rapid oscillations, determined by means of the apparatus described last year, reveals a lagging of the charge behind the potential, both increasing and decreasing, and a curve plotted with the values obtained for a mica condenser suggests some analogy with Ewing's curves of magnetic hysteresis —Optical field, absolute, and relative field of view of the human eye, by M C J A Leroy —On the achromatism of semicircular interference fringes, by M G. Meslin —A new system of atomic weights, partly founded upon the direct determination of molecular weights, by M A Leduc.—Decomposition of the alkaline aluminates by carbonic acid, by M A Ditte — On mixtures of ether and water, by M. L Marchis —On the heat of formation of arragonite, by M H Le Chatelier — On the crystalline forms of chromium and iridium, by M W Prinz —Ammoniacal fermentation of earth, by MM A Muntz and H Coudon —On the composition of the salts employed as condiment by the people about the Oubangui, by MM J Dybowski and Demoussy —Oxyhæmatine, reduced hæmatine, and hæmochromogen, by MM H Bertin-Sans and J Moitessier —On the histological alterations of the cerebral cortex in certain mental diseases, by M R Colella —On the structure and growth of the calcareous shell of the barnacle (*B tintinnabulum*), by M Gruvel —On the causes of the green colour of oysters, by M S Jourdain —Geological remarks on the diamond-bearing meteoric irons, by M Stanislas Meunier.

Amsterdam

Royal Academy of Sciences, January 28 —Prof van de Sande Bakhuysen in the chair —Mr. Kapteyn dealt with the distribution of stars in space It has been long known that the mean proper motion in the galaxy is smaller than elsewhere A thorough investigation of the proper motion of *all* the stars of the Draper catalogue observed by Bradley in both co-ordinates (2357 stars) shows, that this fact is due to an excess of insensible or very small proper motion in the milky way. Those exceeding 0″ 055 show no aggregation towards that zone As far as the evidence goes, it further proves, by means of the angle subtended by the solar motion in space, that stars with equal proper motion *in* and *out* of the galaxy have nearly equal distances These two facts taken together prove that Struve's theory of the arrangement of the stars in space must be abandoned In order to find what arrangement must be substituted Mr. Kapteyn has considered the stars of the first and second spectral type separately, and arrives at the conclusion that the latter are very strongly condensed about a centre not far from our system, approximately in the direction of 6h R A and +42° of decl, whilst the stars of the first type are more nearly evenly distributed in the proximity of our sun Notwithstanding this difference in arrangement Mr Kapteyn thinks that probability points to the conclusion that the two types belong to one and the same system — (1) Because the centre of condensation of the second type stars coincides very nearly with the apparent centre of the milky way (which seems to consist mainly of first type stars) (2) Because the stars with *insensible* proper motion of *both* types are strongly condensed towards the plane of the milky way (3) Because groups of stars, which undoubtedly form stellar systems (*e g* Hyades) contain stars of both types —Mr van Bemmelen, in pursuing his inquiry on colloidal hydrates, spoke at the meetings of November 26, 1892, and of January 28, 1893, on the constitution and composition of the hydrogels of S_iO_2 and of CuO, as these result from his determinations of their tension of vapour (at 15°), changing in a continuous way with their tenure of water —Mr Kamerlingh Onnes showed the isodynamics of a new physical laboratory at Groningen, mapped under Prof Haga's direction with the localvariometer by Mr Wind, proving the excellent constancy of the magnetic field A new theory of the localvariometer points to another ratio of distances of the deflecting magnet-pairs than that given by Kohlrausch as preferable —Mr Schoute treated of "the uniform representation of a cubic surface on a plane" Indication of the number of points common to two curves on F^3, the plane representations of which are given Application as to the position of the twenty-seven lines with respect to one another

CONTENTS.

THURSDAY, MARCH 9, 1893

THEORY OF THE SUN

Théorie du Soleil By A Brester, Jz , Docteur ès Sciences (Amsterdam Johannes Muller, 1892)

DR BRESTER'S preliminary account of his new theory of the sun has already been noticed in our columns (NATURE, vol xxxix. p 492) The present volume is a communication to the Amsterdam Academy of Sciences, and gives a complete statement of the principles and their application to the various solar phenomena The author is careful to point out that he has not contributed a single fact of observation himself, but is content to rely on the work of others Nevertheless, he is evidently a most careful student, and if his theory cannot be accepted, some of its points are well worth the attention of solar physicists

Starting with the sun as a mass of incandescent vapours, it does not seem unreasonable to regard, with Dr Brester, the conditions of such a mass of vapour from a purely chemical point of view At certain temperatures combinations of some substances will become possible, heat will be developed, and various phenomena may be produced Dr Lohse[1] has already suggested that this kind of action might be the cause of the outburst of a new star,

Dr Brester appears to unreservedly accept Mr Lockyer's view, that many of the substances with which we are familiar in our laboratories are dissociated into their finer constituents at solar temperatures

In accordance with the generally accepted notion, he also assumes the sun to be gaseous, and regards the photosphere as a shell of partially condensed matter He rejects, however, the idea that the sun is in an almost constant state of agitation. Indeed, the unique point of his theory is that the sun is always in a state of perfect tranquillity, and that the so-called "eruptions" do not really indicate the actual displacement of matter, but simply the translation of the luminous condition He boldly declares (p 4) that "the solar eruptions do not exist," and looks to the known facts of chemistry to explain the multitudinous phenomena with which students of solar physics have to deal

What Dr Brester calls "New Astrochemical Principles" are stated as follows —

Principle I—All incandescent celestial bodies are tranquil in themselves, and their quiet interiors are such that the molecules of different densities, arranged by gravitation in concentric spheres, never lose their stratification

Principle II—The continued cooling of stars generally produces in their exterior layers an intermittent transformation of chemical energy in the form of heat, and thus produces periodical eruptions of heat

Let us see how, with these premises, Dr Brester treats some of the problems of solar physics.

The Formation of Spots—According to the new theory, spots are openings in the photosphere produced by the heat developed in the chemical combination of dissociated molecules, part of the photosphere being evaporated when such an "eruption of heat" occurs On this supposition the spot has the same temperature as the photosphere itself, the condition of things being somewhat similar to that of small pools of water in a mass of ice Dr Brester shows how this view gives an explanation of the proper motions and other phenomena of spots, but we must needs refer those interested to the book itself for full details

The Stratification of the Sun's Atmosphere—All solar physicists agree that in the solar atmosphere there is a stratification of some sort, but there are different views as to the exact nature of it The old idea was that each vapour extended from the photosphere upwards, reaching to a height depending upon its density This view had its birth in the observations showing that all the bright lines of the chromosphere appear to reach the photosphere, but Mr Lockyer showed,[1] that as we have not to deal with a cross section in the observations, the same result would be obtained if the vapours were arranged in true shells Mr. Lockyer follows up this important fact with the suggestion that the various layers are really concentric shells arranged according to their heat-resisting power, any particular substance finding its level where the temperature is just below that of dissociation for the vapour in question Dr Brester, however, goes back to the old view that the layers are arranged in the order of their specific gravities, but modifies it by supposing, with Mr Lockyer, the vapours to lie in shells Further, accepting the dissociation hypothesis, he regards some of these layers as finer constituents of what the chemists call elements

Dr Brester imagines that Mr Lockyer's view demands that the most dissociated, and therefore the lightest molecules, should be found in the layers nearest to the photosphere, while the least dissociated, and therefore the heavier molecules, should appear in the outer layers This, however, is not the case, according to our author, the lighter vapours, such as the hypothetical *helium* and hydrogen being furthest removed from the photosphere, while the heavier, such as iron, appear only in the lower levels The whole subject has been very fully discussed by Mr Lockyer in his "Chemistry of the Sun," and space does not here permit all the arguments to be restated It may be mentioned, however, that, as Mr Lockyer points out (p 172), there is no evidence that the various metals are arranged according to densities, the case of magnesium and sodium is instanced, the heavier metal always showing the longer lines.

In a foot-note on p 17 Dr Brester states that the various elements need not always appear exactly in the order of their specific weights, "Car la hauteur où seront encore visibles les molecules d'une matière quelconque ne dépendra pas uniquement de leur poids mais de leur nombre aussi" It is by this bare statement that he attempts to explain the great height to which the H and K lines of calcium have been shown by recent photographs to extend, and presumably also such cases as that of magnesium and sodium, which has already been referred to. It is unnecessary to say more on this point, as Dr. Brester practically renounces this point of his theory

[1] *Berlin Akad. Monatsb.*, 1877, p 826

[1] "Chemistry of the Sun," p 305

The problem of the stratification of the sun's atmosphere does not, therefore, appear to have been advanced by his discussion of the various observations

Dr Brester's view of the solar surroundings leads him to suppose that the concentric layers which he postulates are ellipsoidal, so that the photosphere cuts different shells in different latitudes The fact that there is an equatorial extension of some sort is abundantly demonstrated by eclipse photographs In the application of this view to the explanation of some of the phenomena presented by the sun Dr Brester displays considerable ingenuity, and we may refer to some of them, as they suggest points which may have to be taken into consideration in other theories

The Solar Rotation—It is a matter of common knowledge that the equatorial regions of the sun, as indicated by the spots, rotate more rapidly than the regions in higher latitudes On Mr Lockyer's hypothesis, which supposes sun-spots to be produced by the fall of condensed materials from the cooler regions of the atmosphere, this is explained by the fact that such atmosphere is highest at the equator, and the spot-forming matter thus having a greater forward velocity previous to its descent, will have a greater angular velocity on reaching the photosphere Dr Brester's view is a modification of this Taking for granted that the solar layers are ellipsoidal, and that the photosphere is an independent partially condensed shell, he points out (p 44) that when the matter of any particular layer condenses to form a part of the photosphere, the increase of density will cause it to descend towards lower layers, and as it will retain its initial velocity, the angular velocity in its new position will be increased In this way he explains the law of solar rotation, but on account of the absence of knowledge of the densities of the vapours near the photosphere, the question cannot be treated mathematically On Dr Brester's view this law applies only to the photosphere itself, the ellipsoidal layers all having the same angular velocity

This he further applies to the reconciliation of the spectroscopic determinations of the velocity which have been made by Dunér and Crew Dunér's observations practically confirm the law derived from the observations of spots, while those of Prof Crew show no change of velocity with change of latitude Dr Brester points out that most of the lines observed by Crew have been seen bright in the chromosphere, while those observed by Dunér have not been so recorded. Hence he concludes that the lines observed by Dunér are produced by the absorption of vapours actually lying in the interstices of the photosphere—and therefore indicating the same velocity—while those observed by Crew show only the uniform angular velocities of the ellipsoidal shells

Changes in the Spectra of Sun-spots—Dr Brester's theory also gives an explanation of differences in the spectra of sun-spots at different parts of the spot-period Observations have shown that at maximum the lines which are most widened in spot-spectra are chiefly lines of unknown substances, while at minimum they are chiefly lines of iron and other known substances When it is remembered that there is a progression in latitude with the advance of the spot-period, Dr Brester's view can readily be understood; the photosphere in each latitude will have a different composition, and hence change of latitude will be accompanied by change of spectrum It is only fair to say that the exact nature of this change has not yet been fully investigated, and hence the explanation offered cannot strictly be put to the test Broadly speaking, however, it is evident from what has already been said, that if Dr Brester's view be correct, there must be a layer of unknown vapours cutting the photosphere about latitude 15° (the latitude of spots near maximum), and layers of the vapour of iron, or some of its constituents cutting the photosphere about latitudes 5° and 30° (the latitudes of spots at minimum) Before the view can be properly tested, it is clear that we must have further knowledge as to whether the iron lines widened in spots of high latitude at the beginning of a sun-spot period are identical with those widened in spots near the equator towards the end of the period, and, so far as we know, information on this point is wanting

The Periodicity of Solar Phenomena—Dr Brester first of all dismisses the suggestion of planetary disturbances as the phenomena usually seen are too irregular to be consistent with orbital motion, and other views are also found wanting. He then shows how the second of the astrochemical principles already referred to appears to him to give the necessary explanation As in our notice of his first essay, we may say that the main idea is that during eleven years the integrated effects of the various chemical combinations which have taken place are such as to very nearly restore the conditions which had existed at the commencement of the period Slight differences would be produced each time, so that after a long interval wide differences might be expected

Many other problems are discussed, and Dr Brester has satisfied himself that his theory is competent to explain them all Want of space, however, will not permit further reference

The volume will be a valuable one, if only for the fact that it brings together a great mass of work which has been done in connection with the sun—over 300 authors being quoted—and although we are not prepared to accept his theory in all its points, it is fair to say that some of his arguments are extremely suggestive, and may help in time to unravel some of the mysteries of our central luminary

In subsequent communications Dr. Brester will extend his theory to the phenomena presented by variable stars, comets, and other celestial bodies A F

ELEMENTARY BIOLOGY

A Course of Practical Elementary Biology By John Bidgood, B Sc, F.L.S. (London Longmans, Green, and Co., 1893)

THIS book deals with certain of the types of animals and plants which are included in other elementary works on the same subject The forms selected are yeast, protococcus, bacteria, mucor, penicillium, chara, fern, flowering plant, amœba, vorticella, paramœcium, hydra, mussel, crayfish, and frog. The author states that "the subjects dealt with cover most elementary biological courses, but apparently do not exactly fit any." The work has, therefore, at any rate, the merit of not having been written merely from the point of view of any particular examination syllabus. A certain amount of originality

is also seen in the attempt to combine a more general treatment of the subject with practical directions

General instructions with regard to the microscope, microtome, and reagents, are given in the introduction, these, however, do not indicate a very wide personal acquaintance with the ordinary laboratory requirements, and the methods of preparation, &c, are mainly copied from Lloyd Morgan's "Animal Biology" and Howes's "Atlas of Practical Elementary Biology" The student is referred to a number of well-known text-books for further information, but it is curious that no mention is made of certain excellent elementary works treating more especially of the types described

The part dealing with plants, which occupies rather more than half the book, is on the whole more satisfactory and contains fewer mistakes than that relating to animals Most of the woodcuts in the former are taken from well-known sources, and a number of original figures are given of *Aspidium* and of *Lamium album*, which latter is selected as a type of the Phanerogams, the author has evidently worked out the structure of these forms with some care In the zoological part many of Lloyd Morgan's diagrams have been utilised, and figures are also taken from various other text-books, such as Milnes Marshall's "Frog," Wiedersheim's "Comparative Anatomy," and Quain's "Anatomy" Most of those from the last-named work, with the corresponding descriptions, naturally do not refer to the frog at all, but this fact is not stated Some of the drawings of invertebrates made by the author are very fair, though they do not indicate much originality, one or two others, such as that of an undischarged nematocyst of hydra, on p 221, are bad The sources from which borrowed figures are taken is not mentioned in all cases, although the contrary is stated in the preface

The author shows very little power of selecting his facts, or of drawing conclusions from them in such a way as to clearly illustrate the general principles of the subject Many of the details, moreover, are incorrect, and errors of the most serious character occur It will be sufficient to refer to a few of these in order to indicate the author's looseness of expression and want of acquaintance of parts of the subject with which he deals

The remarks on the structure and functions of the nucleus, and on the pulsating vacuole in protococcus (pp 46 and 47) are, to say the least, misleading This organism may, it is said, "be looked upon as a closed bag with a double wall—the outer of cellulose, and the inner of protoplasm" (p 50), and the movements of its cilia "probably" drive it through the water (p 48) The investment of the "spermocarp" of chara is called a "pericarp," and the pro-embryo a "prothallium" (pp 88 and 89) The description of karyokinesis (p 108) does not show much knowledge of recent observations On p 90, line 10 from top, the word "sexual" has by an oversight been printed as "several" The oosphere is confused with the fertilized ovum on p 133, although the term oosperm is correctly used on previous and subsequent pages. The description of the part played by the nucleus in the processes of reproduction and conjugation in vorticella on pp 211 and 212 is somewhat incomprehensible. One gathers on pp. 220 and 221 that it is comparatively easy to distinguish the nerve cells in hydra in preparations simply traced up in water and stained with methyl-blue, and in optical sections of the entire animal prepared with osmic acid We may mention that it has recently been shown by Albert Lang that the bud in hydra is *not* "a product of both ectoderm and endoderm" as stated on p 223 The Metazoa are said to be *all* "characterized by the possession of a digestive cavity (*enteron*)" (p 224) On p 234 we read that the "kidneys (nephridia)" of the mussel are "sacculated organs whose walls carry a mass of tubules," and one gathers that the small irregular opening leading from the kidneys into the "ureter" is quite easy to recognise Fig 194A, representing the brain of the frog, is taken from the old figure by Ecker, in which the "olfactory lobes" are separated by a cleft, and the primary fore-brain is said to be the same thing as the thalamencephalon (p 333) We do not see the object of introducing a description of the complicated human auditory apparatus in the chapter on the frog The account of the processes of maturation, fertilization, and segmentation of the ovum of the frog is extremely incomplete and inaccurate, and one might even infer from one sentence on p 331 that the nucleus was quiescent during the division of the egg! We are told that the ectodermic invaginations which give rise to the "nares" become "continuous with the mesenteron" (p. 335) The description of the development of the lungs (p 334), together with the figure copied from Wiedersheim, refer to the mammal, and not to the frog In the account of the development of the body-cavity (p 335), it is said that the latter, "extended upwards through the lateral mesoblastic plates, nearly meets in the middle line beneath the notochord, and so pinches the alimentary canal with its glands into the body cavity", and on page 333 it is stated that the notochord "pierces the mesoblast and divides it into right and left halves" The numbering of the *five* aortic arches given in Fig 225, and that of the *three* mentioned in the text is incorrect (p 336) We learn that metamorphosis begins soon after the development of the gills (p 336) The account of the development of the urinogenital ducts on p 338 is quite incorrect as applied to the frog In Chapter XVIII one gathers that the processes of digestion in all the Cœlomata are quite similar to those which occur in the higher forms, which are then briefly described

Even if we accept the author's dictum that "he will know a good deal of botany who knows Chara and Lamium thoroughly," and give him full credit for having worked up some parts of the subject practically, we must remind him that a wider knowledge than this implies is advisable before attempting to write a book on general biology After reading the preface and introduction, one is led to expect that the high ideal set up by the author as regards actual personal observation would at any rate have led him to examine carefully and accurately all the types described, it is very disappointing to find that this has not been the case In conclusion we venture to repeat Darwin's advice as quoted on p 200 of this book "Give full play to your imagination, but rigidly check it by testing each notion experimentally"

W N. P

VAN'T HOFF'S "STEREOCHEMISTRY"

Stéréochimie Nouvelle Edition de "Dix Années dans l'Histoire d'une Théorie" Par J-H van't Hoff Rédigée par W Meyerhoffer (Paris Georges Carré, 1892)

THE second edition of this work was very fully reviewed in these columns in 1887 (vol xxxvii p 121), and we will therefore content ourselves with noticing briefly the new matter contained in the present edition

We must, however, premise that the stereochemistry of the carbon compounds is based on the assumption that the four monad atoms or groups satisfying the four affinities of a carbon atom are situated at the solid angles of a tetrahedron, the centre of which is occupied by the carbon atom itself, and on the allied conception of the "asymmetric" carbon atom—"asymmetry" arising when the four attached atoms or groups are dissimilar, in which case two enantiomorphic arrangements are possible for any given set of four such atoms or groups (see the notice already referred to) In the first French edition, which bore the title "La Chimie dans l'Espace," the author discussed the greatly increased possibilities of isomerism to which this new theory led Since then chemists have used the theory as a guide in the search for cases of isomerism, and numerous new isomeric compounds have been discovered, the existence of which could not have been predicted as long as the old constitutional formulæ written in one plane were employed The history of this branch of organic chemistry has, during the past seven or eight years, been one continuous triumph for the theory One of the most striking proofs of the value of these stereochemical views is to be found in Emil Fischer's well-known researches on the sugar group In the group of the glucoses of the aldehyde-alcohol type, for example, the presence of four asymmetric carbon atoms has to be assumed, and the theory predicts the existence of no fewer than sixteen isomerides with a normal carbon chain, as compared with the one form admissible under the older view Several of the predicted forms have been prepared, and the relative distribution of the positive and negative asymmetric carbon atoms within the molecule has been determined by E Fischer This and other work confirmatory of the theory, is described and discussed in the present volume

The theory of the asymmetric carbon atom owes its origin to the difficulty of otherwise explaining the optical rotatory power of various organic compounds Quite recently, P A Guye has suggested that the numerical value of this optical rotatory power is dependent upon the relative masses of the substituting atoms or groups attached to the asymmetric carbon atom, and that if two of the four different substituting radicles are of equal mass the rotatory power will cease He was unable to verify this view in all strictness, since, in the cases of this kind which he studied, such as that of methyl-ethyl-aldehyde $(C_2H_5)(CH_3)CH(COH)$, in which $C_2H_5 = COH = 29$, there was optical activity The probable explanation is, that, as suggested by Guye, not only the masses of the groups, but also the interatomic distances, of which the atomic volume is a measure, come into play here However, by varying the weight of a given group attached to an asymmetric carbon atom—thus, by substituting successively different homologous radicles—it was found possible to produce a concomitant variation in the rotatory power of the compound, to make it increase or decrease at will, and even to change its sign This variation is shown in ascending the series of the esters of tartaric acid and its di-acetyl and di-benzoyl derivatives. But whereas the weight of the alkyl-group in the esters determines the amount of the rotatory power, no such influence can be perceived in the case of the metallic salts of tartaric acid, all of which display in solution the same rotatory power, irrespective of the atomic weight of the metal The clue to this anomaly is furnished by the electrolytic dissociation theory of Arrhenius, according to which the dissolved salts are present in the form of their dissociated ions, so that, in the case of the dissolved metallic tartrates, it is the ion $CO_2(CH\,OH)_2CO_2$ which is alone responsible for the rotation Arrhenius's theory thus receives striking confirmation from an unexpected quarter

The subject of compounds containing closed chains is fully discussed in the present edition, and the "cis" and "trans" isomerism discovered by von Baeyer is described

The relative position of the substituting groups in the stereo-isomerides is also discussed

The concluding chapter deals with the stereochemistry of nitrogen—a question which had not emerged when the previous edition was published Some of the information given under this heading is rather meagre, but doubtless the omissions are intentional and they are largely compensated for by a very complete bibliography of the subject

The work is in every sense authoritative, and we cordially recommend it to all interested in the most recent developments of organic chemistry F R J

OUR BOOK SHELF

Die Fossile Flora der Hottinger Breccie By R von Wettstein. With 7 plates (Vienna · Imperial Printing Office, 1892)

THE Hottinger Breccia is a formation about 50 feet thick in the neighbourhood of Innsbruck, and situated about 1200 metres above sea-level The upper part consists of about 35 feet of coarse conglomerate, with fossils chiefly confined to a bed some 3 feet thick, while the remainder is occupied by alternating beds a foot or two in thickness of white or reddish sandstones and breccias, which are for the most part very fossiliferous It has been well known to collectors of fossil plants for upwards of thirty years, and though at first regarded as of tertiary age, is now uniformly recognised as quarternary, possibly inter-glacial, or more probably post-glacial The lower part is characterised by the occurrence of many herbaceous plants, such as the violet, strawberry, coltsfoot, Prunella, &c, which are replaced above to some extent by *Cornus sanguinea*, *Rhamnus Frangula*, an alder, willow, &c, indicating, perhaps, a change in the forest growth without necessarily implying any considerable interval of time. The flora is almost wholly of existing species, and in the main does not differ essentially from that which might be found in a similar situation at the present day; but six of the species no longer flourish at such an altitude, and a few others, like the box, are absent in Northern Tyrol,

while there are also indications in the relative sizes of the leaves of others that the climate was milder. Perhaps the Alps were less elevated and the sea nearer at the time, but interest is given to the problem by the undoubted presence of *Rhododendron ponticum*, which at present only flourishes in a much warmer climate far to the east, but, from its discovery in other localities, was evidently thoroughly indigenous in the Alps. The author regards the flora as a relic of the "steppe-flora" which then spread over the greater part of Europe, and of which numerous traces still exist, especially in Switzerland and Lower Austria, where plants of Oriental facies, such as the yew, box, holly, Ephedra, Sumach, hornbeam, feather grass, maidenhair, &c, are its lingering remains.

The work is carefully prepared, doubtful determinations, except in the case of the Arbutus and a new buckthorn allied to *Rhamnus latifolia* of the Canaries, are eschewed, and the photographic illustrations, pencilled over by the artist, are extremely satisfactory. J. S. G.

Observational Astronomy. By Arthur Mee, F.R.A.S. (Cardiff: Daniel Owen and Co., 1893.)

THIS small book should serve the purpose for which it is issued, the object being to provide the beginner with an inexpensive treatise to enable him to become familiar with and interested in the practice of observational astronomy. For this reason the author limits himself to the purely descriptive side of astronomy, dealing with the sun, planets, comets, and meteors, giving numerous references where necessary. Short chapters are given on eclipses, transits, occultations, and "the sidereal firmament," the latter treating of double and coloured stars &c. The chapter on the telescope contains many practical hints, besides numerous woodcuts, while that devoted to the moon is very pleasant reading, and gives a good account of the more general features. The illustrations, as will be gathered from the above, are very numerous, many of them being from the pen of the author himself. With respect to these, we must add that the one given on p. 72 of the Orion nebula does not remind us of the most beautiful object in the heavens, while on p. 66 Donati's comet is depicted minus the two long streamers which made this object so striking. The book concludes with a short obituary of the Rev. T. W. Webb and an appendix containing brief contributions from Denning on comets and meteors, Gore on variable and temporary stars, Seabroke on double star measurement, and a few others.

W. J. L.

Mechanics and Hydrostatics for Beginners. By S. L. Loney, M.A. (Cambridge University Press, 1893.)

THIS is the latest addition to the series of elementary text-books recently launched by Mr. Loney. The same high standard of excellence is maintained, and the author must again be congratulated on his efforts to place in the hands of a beginner a book which will give him correct ideas of the laws and principles which are included in a study of mechanics.

It consists of three parts, statics, dynamics, and hydrostatics, each part containing the usual chapters. If the reader should fail to understand the chapter on the laws of motion, he must attribute it either to his want of ability or the nature of the subject, for we fail to see how the author could improve his remarks on this part of the subject. We are glad to observe that the words "rate of change" find their way into the statement of the second law, for its definiteness is increased thereby. More than the usual care appears to have been devoted to the selection of suitable examples, some of them are exceptionally good, and thus add to the usefulness of the book. Occasionally the trigonometrical ratios are used, but their definitions will be found in the appendix; we are afraid, however, that the suggestion that their values for certain angles should be committed to memory is not a wise one. G. A. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Glacier Theory of Alpine Lakes.

THE letter of the Duke of Argyll against the theory of the formation of alpine lakes by glacial action shows such an amount of misconception of the theory itself, and so completely ignores the great weight of evidence in its favour, that a few words on the other side seem desirable.

The Duke says that glaciers "do not dig out," do not "act like a ploughshare," but, when moving down a slight incline do "scoop," as well as rub down and abrade. No observer of glaciers has ever stated, so far as I know, that they do "dig out," and it is equally erroneous to say that they "scoop," for that implies that it is the end of the glacier that acts. But the end is its weakest point, where it is melting above and below, and where consequently it can do practically nothing. The whole action of a glacier is a grinding action, and its grinding power is greatest where it is thickest, and where, consequently, it presses on the rocks with the greatest weight. The result of this grinding is seen in the muddy stream issuing from all existing glaciers, while the well known "till" is the product of the rock grinding mill of ancient glaciers and ice sheets.

Notwithstanding the Duke's disbelief in ice sheets I venture to think that their former existence has been demonstrated both in Scotland and Ireland, but leaving this point, I wish to make a few remarks on the extreme inadequacy of the earth-movement theory to account for the facts. In the first place it is certain that no alpine lake can possibly have a long life, geologically speaking. In the course of a few thousands of years, certainly in less than a hundred thousand, all alpine lakes would be filled up by the sediment brought into them. It follows that all the existing lakes must have been formed about the same period, and that, geologically, a very recent one, and corresponding approximately with that of the well known glacial epoch. But if these lakes were all formed by earth movements, either just before the glacial epoch came on, or during its continuance, or afterwards we have to explain the remarkable fact that such movements only occurred within the limits of glaciation, never beyond those limits. In Wales, Cumberland, and Scotland, in the Alps, in Scandinavia, in Finland, in the northern United States and Canada, in Mongolia and Thibet, in Tasmania and New Zealand, we have thousands of rock basin lakes, amid palpable signs of glaciation. But the moment we pass beyond the glaciated districts, mountain lakes abruptly cease. There are hardly any in Spain, none in the Great Atlas, none in Sardinia or southern Italy, except in the volcanic areas and away from the mountains, none in any of the West Indian islands with their fine mountain-ranges, none in the peninsula of India or in Brazil. And there is exactly the same distribution of fiords. We have them in Norway, in West Scotland, in Alaska, in South-West America, and in New Zealand, all characterised by deeper water within than at their outlets, and all in glaciated countries, but nowhere else in the world.

Now it is simply impossible to believe that at a very recent period there should have been earth movements of such a character as to produce lakes, but always in glaciated districts and never beyond them, unless the movements were a result of the glaciation. This has not, I believe, been yet suggested, but, in view of the modern theory that any considerable loading of the surface produces subsidence, it is at least a possible explanation. But there are some important facts that seem more in favour of the grinding out of the lake-basins by the enormous weight of ice accumulated over their sites during the height of the ice-age. Looking at a geological map of the Alps it will be seen that most of the lakes are more or less bordered by tertiary or secondary rocks. Lakes Annecy and Bourget are in miocene

and eocene; the lake of Geneva on the north side is miocene or jurassic, the lake of Neuchatel, miocene, lakes Thun and Brienz, eocene or jurassic, lake Lucerne, eocene and miocene, lakes Zug and Zurich in miocene, lake Constance miocene, lake Maggiore is mostly in gneiss, but it is very suggestive that it is here comparatively shallow, but becomes suddenly deeper and reaches its maximum depth in its lower portion where it is bordered on the east by the jurassic beds, lake Como also has its greatest depth in triassic rocks, the upper portion, where gneiss prevails, deepening gradually southward as in a submerged valley Equally suggestive is the fact that in the eastern Alps of Tyrol and Carinthia, where gneiss, porphyry, and the older stratified rocks prevail, and where glaciers are not now so extensive, there are hardly any lakes, except on the northern borders, where a considerable number occur in eocene, cretaceous, jurassic, or triassic formations

These various facts as to the distribution of alpine lakes—their almost total absence in all parts of the world outside of glaciated districts, and within glaciated districts their prevalence in the newer and more easily denuded rocks—are what have to be explained by the advocates of the theory of earth movements, and this, so far as I am aware, they have never attempted to do Equally important, and equally difficult to explain on the earth-movement theory, is the fact that alpine lakes are almost always situated just at those spots where, by means of converging valleys, the glaciers would become heaped up and attain their maximum thickness, or where there is good evidence that they have been very thick, and it is the grinding power of this enormous weight of ice, acting differentially as regards the softer and harder rocks, that has worn out hollows in pre-existing valleys now occupied by lakes In almost every case, too, it will be seen that there is a constriction or narrowing of the valley towards or beyond the lower end of the lake, which, by preventing the free escape of the ice, has increased its thickness and grinding power

In the presence of such important series of facts as those here referred to, mere opinions, or even small and detailed cases of difficulty, can have no weight, but there is yet another consideration, which most geologists will admit is antagonistic to the earth movement theory The whole tendency of geological observation is in favour of the usually very slow rate of earth-movements, while it is equally in favour of the comparatively rapid action of denudation by running water But in order that earth-movement could form a lake, it would be necessary that the rate of elevation or depression should be so great that the river could not keep pace with it by cutting down its channel, and, considering that all the rivers in question are rapid mountain streams carrying great quantities of sediment, this will be admitted to be a very improbable supposition But when we add to this the still greater improbability that such rapid earth movements have occurred in scores and hundreds of cases, all at about the same time, geologically speaking, and all just in those spots where it can be shown that during the glacial period ice must have accumulated, and where the rocks were of such a character as to admit of being ground away, and yet further, that no similar earth movements producing similar results have recently occurred in any part of the globe beyond the limits of glaciation, the whole assumption becomes so hugely improbable as to render the theory of lake-formation by ice-grinding easy in comparison

Sir Charles Lyell considered that the gravest objection to the glacial erosion theory was the entire absence of lakes where they ought apparently to exist, and he instanced the valley of Aosta and the Dora Baltea, the glacier of which produced the enormous moraines of Ivrea The valley of the Rhone above Martigny may be adduced as another example of the absence of lakes where they might be expected. But this kind of difficulty will apply to many other valleys, and can only be answered by general considerations In both these cases the valleys are comparatively broad and open, and have a rather rapid descent. It is probable, therefore, that the ancient glacier in both was of a nearly uniform thickness, so that its wearing action on the floor of the valley would be tolerably uniform To produce a lake we require essentially a differential action. There must be much more rapid degradation in one part than in another, due either to greater ice-accumulation or to softer rocks in one part than in another In both the valleys referred to there is much uniformity in the rock-formations throughout, and even if some lakes or chains of lakes had been formed, the enormous amount of debris still brought down may well have filled up and altogether obliterated them The absence of lakes in certain valleys cannot be considered an argument of any value until it is ascertained by borings that none have been formed and filled up again It must also be shown that the whole conditions are such as to produce that amount of differential grinding down, without which no lake can be expected to have been formed

It certainly seems to me that all the facts, all the probabilities, all the converging lines of evidence, are in favour of the glacial theory, to which the only serious objection is the assumption that glaciers cannot move uphill But that they can do so, and have done so, is now admitted by most students of glacier motion Mr Jamieson, and other Scotch geologists, have proved that glaciers, over 2000 feet thick, have travelled up lateral valleys, and up the slopes of many hills and mountains and when we consider that the Rhone glacier was 5000 feet thick just above the lake of Geneva, and more than 2000 feet thick where it abutted against the Jura, we can have no difficulty in admitting that it might have travelled up the very gentle slope of the lake bottom, which appears to be less than 100 feet in a mile in its steepest parts ALFRED R WALLACE

Waves as a Motive Power

HAVING frequently observed the swimming motions of the fishes in our Aquarium—and occasionally of porpoises in the open sea—I have tried to make use for propelling boats of the same principle of locomotion, as exemplified particularly in the tail fin

I fixed a fin (blade) of elastic material like a helm to the end of a canoe, moving that fin laterally to and fro, the same went forwards I have since learned that this "motor" was used already twenty five to thirty years ago by Ciotti, a Sicilian, it is of course only an exact version of the method of sculling with one oar, familiar to all boatmen Whilst trying my canoe and models of boats I soon became convinced that a boat ought to move forward if elastic fins are fixed to it, directed backwards, in such a manner that their flat sides are pressed against the surrounding water, when the boat rolls and pitches The elastic fins, whilst overcoming the resistance of the water, curve like the fins of a fish, driving the water backwards and consequently pushing the boat forwards

The canoe was provided with two horizontal fins at the stern and two vertical ones at the keel, total surface 0 2 square metres, speed against rather sharp wind and waves estimated at 25 metres per minute I was unable to take exact measurements, as the canoe was accidentally sunk before the experiment was complete

I then provided another boat, three metres long, at each of the two pointed ends with a horizontal fin (later on two), and at the keel with two vertical fins, these were all made of steel sheet, 1 – 0 8 mm thick, subsequently replaced with aluminium bronze The boat covered, against a gentle sea and wind, the distance of 900 metres in 25 minutes. Putting the fins obliquely the boat turned towards the right or left, directing one group of the fins forward, and another of equal surface backward, their action was paralysed, and in similar manner it was easy to make the boat turn round on the spot or to move backward.

The changing of the surface of the fins (0 3 to 0 6 square metres) caused very little difference in the speed produced. The same movements of the boat take place if the rocking is caused artificially

I undertook a series of trials, in which I wish to acknowledge with thanks the kind assistance of Mr. Nelson Foley. The first result was that the *rolling* yields so little power, (very little energy being sufficient to prevent rolling,) that the vertical fins as a source of power may be nearly neglected in the calculations

As to *pitching*, the power resulting from the action of the waves against gravity is proportioned to (weight of boat with crew) × (number of undulations) × (height of waves) But only a small portion of the energy developed in moving the boat up and down acts upon the fins (surface of boat in water-line three square metres, surface of fins 0·3 to 0 6 square metres), and of this remaining available force a considerable portion is lost by the low efficiency of the fins. Supposing, for the sake of argument, the efficiency to be 25 per cent, the propelling capacity in a moderate sea works out to the fraction of a man's power.

Considering these circumstances it seems doubtful, even with

considerable rocking and using boats of more advantageous forms than mine, if it will be possible to have a much higher speed than 2000 metres per hour. It appears also that the available force will be hardly sufficient to struggle successfully against strong winds and currents.

I do not therefore prognosticate too confidently any practical value to the motor, but should be very glad if some of your readers would inform me as to any similar experiments which may already have been made. H. LINDEN

Zoological Station, Naples, February 19.

Blind Animals in Caves

As a reader of Mr. Herbert Spencer's writings and a disciple of his, I shall be very glad to lift Prof. Lankester's glove. In the first place I would point out that the process he describes is not natural selection in the ordinary sense; natural selection is the death of the unfit and the survival of the fittest. In the suggested process neither the animals with perfect eyes, nor those with imperfect, are destroyed in the struggle for existence; they are simply segregated. But this is of minor importance. The question is whether there is any foundation for the hypothesis suggested.

Prof. Lankester supposes that the individuals born with defective eyes have remained in the dark places, while those with perfect eyes have followed the glimmer of light and escaped. But he has overlooked the fact that blind cave-animals are *born or hatched at the present day with well developed eyes*. It is clear, therefore, as in every other case to which the law of recapitulation applies, that the variations to which the evolution is due occurred at a comparatively late period in the life of the individual. Why did not all the individuals escape when they were young, and could still see without spectacles? When the imperfection of the eyes did occur, what ground is there for assuming that it was a congenital variation? It seems to me perfectly certain that it was a deterioration of the eyes caused by the fact that the individual had lived in the dark all its life. In short, I hold that the law of recapitulation in development, the law of metamorphosis, or biogenetic law, as Haeckel called it, is itself a sufficient proof of the inheritance of acquired characters. This argument has never been met or even considered by any of those who talk of congenital fortuitous variations without defining them.

The evidence for the statement I have made is, I confess, not quite complete, but it is sufficient for my present purpose. In Semper's "Animal Life," p. 80, there is an account of *Pinnotheres Holothuriæ*, based on the author's direct observations. This species lives in the respiratory trees of Holothurians, and in the adult the eyes are degenerate and invisible on the exterior of the animal. The young is hatched as a zoœa with perfect typical eyes; even when it enters the host it retains its eyes, but afterwards the eyes degenerate and become covered over by the carapace. In the common mole, to take an instance among mammals, the optic nerves are degenerate in the adult, so that there is no connection between eye and brain; but in the embryo both eyes are connected with the brain by well developed optic nerves. I am not at present acquainted with any observations on the young of Proteus, or the blind fish Amblyopsis, or the blind Crayfish of the mammoth cave, but I am quite confident that the young in all these cases have relatively well developed eyes. At any rate Prof. Lankester to support his theory must prove that they are blind from the beginning; for if they are not then it is clear that the variations which we have to consider took place during the life of the individual living in the dark, and consequently the support of Prof. Lankester's suggestion vanishes.

Prof. Lankester again writes of the deep sea as though it were as destitute of light as the mammoth cave, or the subterranean home of the Proteus, but this is notoriously not the case. With regard to fishes, Dr. Günther says that below the depth of 200 fathoms small-eyed fishes as well as large-eyed occur, the former having their want of vision compensated for by tentacular organs of touch, whilst the latter have no such accessory organs, and evidently see only by the aid of phosphorescence; in the greatest depths blind fishes occur with rudimentary eyes, and without special organs of touch. Dr. Günther mentions fifty-one species of fishes living at depths beyond 1000 fathoms, and among these only three *Aphyonus gelatinosus*, *Typhlonus nasus*, and *Ipnops Murrayi* are blind. It is, I think, sufficiently evident that the biology of the deep sea is quite different from that of subterranean caves or habitats. J. T. CUNNINGHAM

Plymouth, February 27.

BESIDES panmixia and emigration of the more perfect eyed individuals, as explained by Prof. E. Ray Lankester, allow me to suggest another cause for the dwindling of the eyes in cave-dwelling animals.

Prof. Weismann says that the degeneration "can hardly be of direct advantage to the animals, for they could live quite as well in the dark with well developed eyes." I submit, however, that in a place permanently dark the eye is not merely useless, but, as a delicate and vulnerable part, it becomes a positive source of danger to the animal. No longer helping the creature to avoid obstacles or danger, it is, in proportion to its size, exposed to injury, destructive inflammation, and the attacks of parasites, in a manner which must not seldom lead to the death of the individual. As other senses become more acute, and the eye recedes, this danger diminishes, and when the eye has become a mere rudiment, "hidden under the skin," its presence ceases to be a disadvantage, and so degeneration does not proceed to complete suppression.

It is a wonder that Mr. H. Spencer should have overlooked Prof. Lankester's explanation, for the English editor of Prof. Weismann's fifth essay has not failed to call attention to it.

Mirfield, February 27. A. ANDERSON

[Darwin has himself drawn attention, in regard to burrowing animals, to the conditions pointed out in the above ("Origin of Species," 6th edition, p. 110).—ED.]

Foraminifer or Sponge?

I AM glad to find that Mr. Pearcey agrees with me in regarding *Neusina Agassizi*, Goës, as identical with *Stannophyllum zonarium*, Hæckel. But with respect to its systematic position I do not as yet see sufficient reason to differ from Prof. Hæckel in regarding it as a sponge, although I have never observed flagellated chambers and cells any more than he. The large masses of foreign bodies always present in this organism offer very serious difficulties in sectionising it, and as long as we are not absolutely certain about its cellular structure we are justified in thinking with Hæckel that general appearance and the presence of oscula, pores, subdermal cavities, horny skeleton, &c., are sufficient to characterise the form as a sponge.

Mr. Pearcey mentions six genera of Foraminifera which he thinks approach closely to *Stannophyllum*. I am sorry I cannot see much similarity. The chitinous lining in the tube like body of some Foraminifera certainly bears not the slightest resemblance to the distinct fibrous stroma of *Stannophyllum*, which reminds me much more of the filaments of the true horny sponge *Hircinia*. If anything tells in favour of Mr. Pearcey's view, it is the concentric lines of *Stannophyllum*, which recall the foraminiferal rather than the sponge type of growth.

The final decision of this question can of course only be expected from an examination of the cell structure.

University College, Liverpool, February 25. R. HANITSCH

A Magnetic Screen

DURING the last vacation St. John's College, Oxford, has been lit with the electric light, and a transformer of the dynamomotor type, weighing over seven tons, has been placed within about sixty feet of the electrical testing room of the Millard Laboratory, which is furnished with several reflecting galvanometers. I greatly feared that the instruments would suffer much from the magnetic field of the large transformer. When it was found that no other space could be given up for the machine, I devised a method of construction which the Oxford Electric Lighting Company very kindly carried out for me when building their dynamo house. My method is to construct a wall of scrap iron round the three sides of the dynamo nearest to our laboratory. The iron wall is about eight inches thick, and is made by building two brick walls parallel to one another, and filling the interspace with scrap-iron; a delicate magnetometer used for testing the field at unprotected and protected points equidistant from the magnets, when the machine is in action and not so, shows that the iron wall is an effective barrier to the magnetic influence. I venture to make known this method of shielding off a magnetic field, because in these days of electrical invasion it may be of use in protecting physical instruments from being seriously disturbed, and rendered useless for any but the roughest determinations. FREDERICK J. SMITH

Trinity College, February 28.

ON ELECTRIC SPARK PHOTOGRAPHS, OR, PHOTOGRAPHY OF FLYING BULLETS, &c., BY THE LIGHT OF THE ELECTRIC SPARK[1]

II

GOING back now to the photographs, the next one was taken with the view of illustrating the effect on the inclination of the waves of the velocity of the bullet. In this case the bullet was aluminium; it was only one seventh the weight of the regulation bullet. In consequence of its lightness it travelled about half as fast again as the ordinary bullet (not $\sqrt{7}$ times as fast as it would have done if the pressure of the powder-gases had been the same in the two cases), and in consequence of the higher speed the inclination of the waves is still greater than in the previous case. Further, in this case the bullet was made to pierce a piece of card shortly before it was photographed. The little pieces that were cut out were driven forward at a high speed, but, being lighter than the bullet, they soon lost a large part of their velocity; they had in consequence lagged behind when they were photographed, but though travelling more slowly (they were still going at more than 1100 feet a second) they yet made each its own air wave, which became less and less inclined as the bits lagged more and more behind; each, moreover, produced its own trail of vortices like that following the bullet. The well-known fact that moving things tend to take the position of greatest resistance, to avoid the effect of which the bullet has to be made to spin, is also illustrated in the photograph. The little pieces that are large enough to be clearly seen are moving broadside on, and not edgeways, as might be expected.

In order to illustrate the other fact that the angle of the waves also depends on the velocity of sound in the gas, I filled the box with a mixture of carbonic acid gas, and the vapour of ether, a mixture which is very dense, and through which sound in consequence travels only about half as fast as it does in air, and which will not explode or even catch fire when an electric spark is made within it, or directly act injuriously upon the photographic plate. The increased inclination of the waves is very evident in Fig. 10.

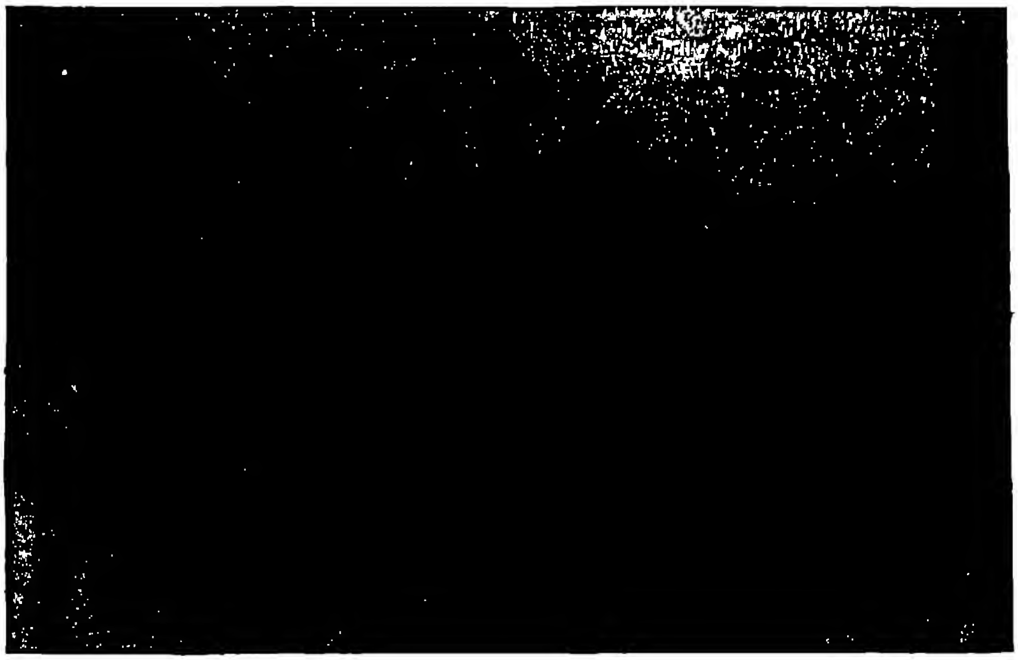


FIG. 10.

These waves, revealed by photography, have a very important effect on the flight of projectiles. Just as in the case of waves produced by the motion of a ship, which, as is well known, become enormously more energetic as the velocity increases, and which at high velocities produce as a matter of fact an effect of resistance to the motion of the ship of far greater importance than the skin friction, so in the case of the air waves produced by bullets, in its flight the resistance which the bullet meets with increases very rapidly when the velocity is raised beyond the point at which these waves begin to be formed. This being the case, I have thought it might be interesting to see whether the analogy between the behaviour of the two classes of waves might be even nearer than has already appeared, and on turning to the beautiful researches of Mr. Scott Russell, published in the Report of the British Association for the year 1844, in which he gives a very full report on water waves and their properties, I found that he had made experiments and had given a diagram showing what happens when a solitary wave meets a vertical wall. The wave, as would be expected, is, under ordinary conditions, reflected perfectly, making an angle of reflection equal to the angle of incidence, and the reflected and incident waves are alike in all respects. This continues to be the case as the angle gets more and more nearly equal to a right angle, *i.e.* until the wave front, nearly perpendicular to the wall, runs along nearly parallel to it. It then at last ceases to be reflected at all. The part of the wave near the wall instead gathers strength, it gets higher, it therefore travels faster, and so causes the wave near the wall to run ahead of its proper position, producing a bend in the wave front, and this goes on until at last the wave near the wall becomes a breaker.

In order to see if anything similar happens in the case

[1] Lecture delivered at the Edinburgh meeting of the British Association by C. V. Boys, F.R.S. Continued from page 421.

of air waves, I arranged the three reflecting surfaces of sheet copper seen in Fig 11, and photographed a magazine rifle bullet when it had got to the position seen Below the bullet two waves strike the reflector at a low angle, and they are perfectly reflected, the dark and the light lines changing places as they obviously ought to do The left side of the V-shaped reflector was met at a nearly grazing incidence, there there is no reflection, but, as is clear on the photograph, the wave near the reflector is of greater intensity, it has bent itself ahead of its proper position as the water wave was found to do, but it cannot form a breaker, as there is no such thing in an air wave The same photograph shows two other phenomena which are of interest The stern wave has a piece cut out of it by the lower reflector, and bent up at the same angle Now if a wave was a mere advancing thing the end of the bent-up piece would leave off suddenly, and the break in the direct wave would do the same. But according to the view of wave propagation put forward by Huygens, the wave at any epoque is the resultant of all the disturbances which may be considered to have started from all points of the wave front at any preceding epoque The reflector, where it has cut this wave, may be considered as a series of points of disturbance arranged continuously in a line, each, however, coming into operation just after the neighbour on one side and just before the neighbour on the other The reflected wave is the envelope of a series of spheres beginning with a point at the place where the wave and the reflector cut, growing up to a finite sphere about the end of the reflector as a centre, beyond this there are no more centres of disturbance, the envelope of all the spheres projected upon the plate, that is, the photograph of the reflected wave, is not therefore a straight line leaving off abruptly, but it curls round, as is very clearly shown, dying gradually away to nothing The same is the case, but it is less marked, at the end of the direct wave near the part that has been cut out

The other point to which I would refer is the dark line between the nose of the bullet and the wire placed to receive it This is the feeble spark due to the discharge of the small condenser which clearly must have been on the point of going off of its own accord The feeble spark precedes or is to all intents and purposes simultaneous with, it cannot follow—the main spark which makes the photograph The feeble spark heated the air, and the light from the main spark coming through this line of heated air was dispersed, leaving a clear black shadow on the plate One spark casts a shadow of the other Now it is evident that if the spark at the nose of the bullet had followed instead of having preceded the main spark by even so much as a three-hundred-millionth of a second, the time that light took to travel from one to the other, it would not have been able to cast a shadow We have the means of telling, therefore, which of two sparks actually took place first, or perhaps the order of several, even though the difference of time is so minute Perhaps this method might be of some use in researches

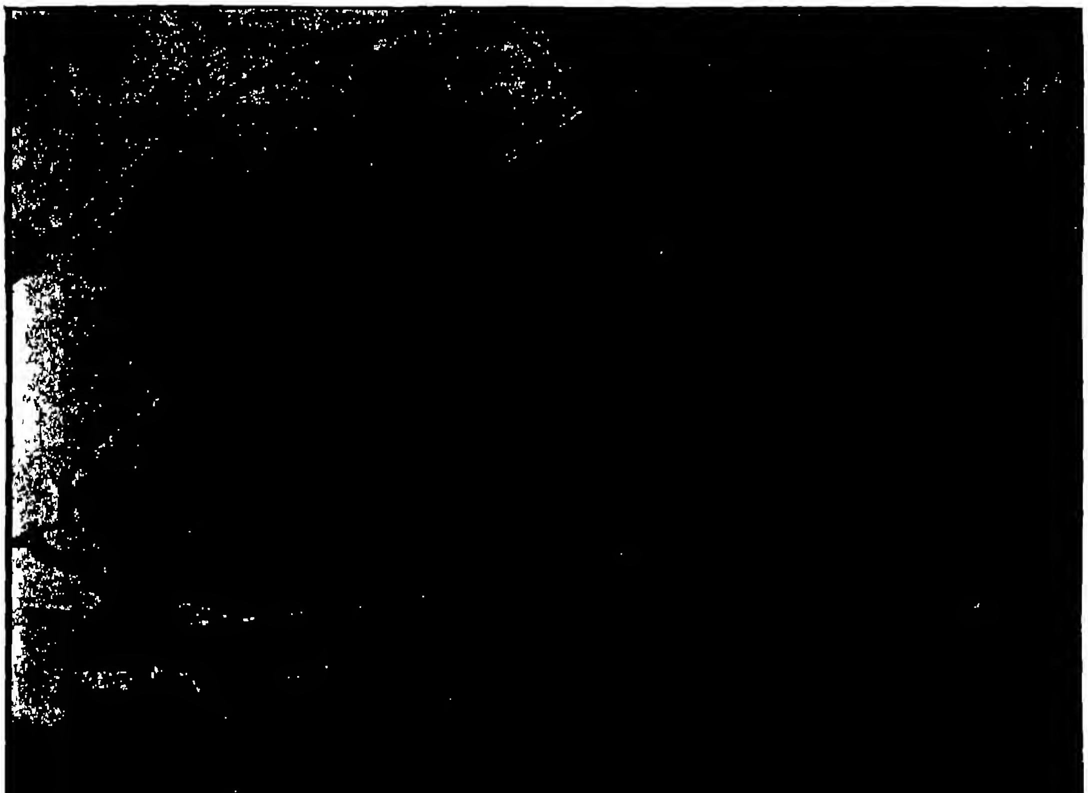


FIG 11

now attracting so much interest in connection with the propagation of electrical waves.

On returning to the non-reflection of the air wave in the upper part of the figure we have here, I imagine, optical evidence of what goes on in a whispering gallery. The sound is probably not reflected at all, but runs round almost on the surface of the wall from one part to another.

We are now in a position to see how the reflection or non-reflection of air waves produced by a passing bullet, when they meet with some solid body, may produce a practical result which might be of importance in some cases. Suppose a bullet to be passing near and parallel to a wall. Then if the velocity of the bullet and its distance from the wall are such that the head wave meets the wall at an angle at which it can be reflected, especially, as in the case of Fig. 11, if the reflected ray can only return into the path of the bullet after it has gone, then no influence whatever can be exerted upon the bullet by its proximity to the wall. If, however, the head wave would, if undisturbed, meet the wall at such an angle

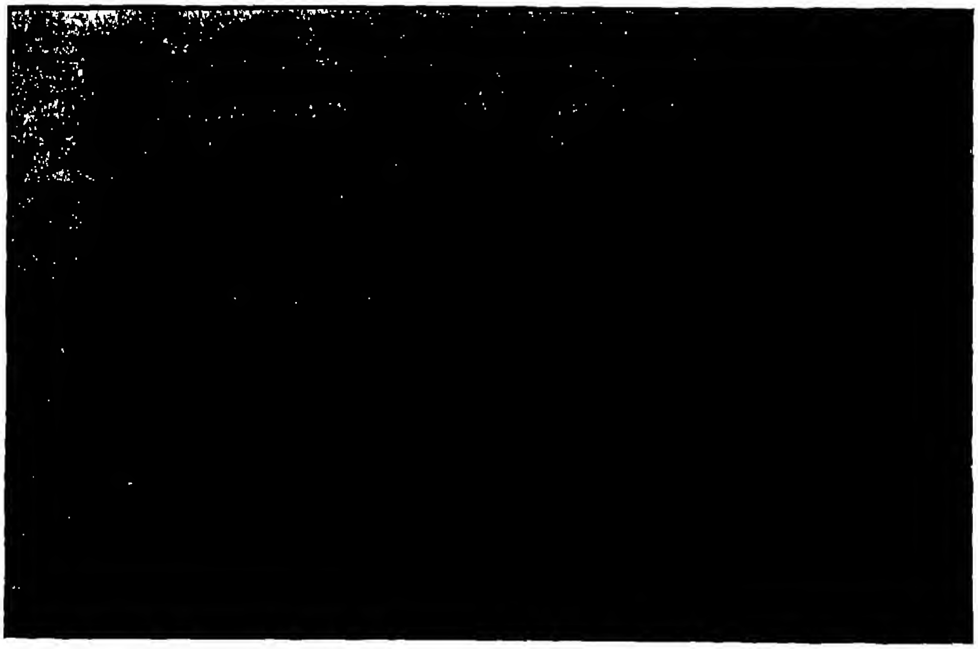


FIG. 12

that it could not be reflected, as for instance, in Fig. 12, when the head wave can be reflected by neither of the walls between which the bullet is passing, obviously the wave will become stronger and the resistance which it offers will, I imagine, become greater, and if in this case the upper plate be removed this extra resistance will be one-sided and must tend to deflect the bullet. This is quite distinct from the well-known effect of a bayonet upon the path of a bullet; when a bayonet is fixed the rush of powder gases between the bullet and the bayonet is quite sufficient to account for the deflection which every practised marksman allows for.

I have devised a method by which a problem of some difficulty, about which authorities are, I believe, by no means in accord, may be solved with a fair degree of certainty. The problem is this, to find what proportion of the velocity of a bullet is given to it after it has left the barrel, or, what comes to the same thing, to find the position in front of the barrel at which the speed is a maximum. The cause of this is evident. When the bullet has left the muzzle the imprisoned powder gases, under enormous pressure, rush out, making a draught past the bullet of the most tremendous intensity tending obviously to drive it forward. While this draught does most assuredly hurry the bullet on its forward course, it does not tend to make it spin round any faster. Now if the bullet were not hurried on at all after it left the muzzle it would, travelling as in a screw of the same pitch all the way from the breach of the rifle up to the point at which it is photographed, have turned round a certain number of times which depend upon the distance travelled and the pitch of the screw. If, however, the longitudinal motion is hurried and the rotational is left unaltered the pitch will be lengthened outside the barrel and the rotation will have been less for any position than it would have been if the bullet had not been accelerated in this way. If, therefore, we can find to what extent the bullet has turned actually at the place at which it has been photographed, we can find the apparent rotational lag and so working backwards get a measure of the velocity acquired after leaving the muzzle. In order to accomplish this I drilled a series of holes transversely through the bullet, each one at an angle to the previous one, the whole series being such that to whatever extent the bullet had twisted, one at least, and perhaps two, would allow the light of the spark to shine through it upon the photographic plate. Then from the photograph it is easy to see through which hole the light shone, and knowing in what position this was in the breach, it is easy to find what fraction of half a turn over or above any whole number of half turns the bullet has twisted. Strictly the measure should be made at different distances to eliminate all uncertainty, but the only shot I have taken was sufficient to show that there was a rotational lag equivalent, according to the measure made by Mr. Barton, to something under a two per cent. acceleration outside the barrel. I do not attach any importance to this figure; the experiment was made with a view to see if the method was practicable and this it certainly is. I would recommend, where accuracy is required, that having found as above about how much the

bullet has turned, that a second bullet should be drilled with a series of holes at about the corresponding position differing very slightly from one another in angular position, so that several would let the light through and thus give a more accurate measure of the rotation

There is a point of interest to sportsmen which has given rise to a controversy which the spark photographs supply the means of settling The action of the choke bore has been disputed, some having held that the shot are made to travel more compactly altogether, while others, while they admit that the shot are less scattered laterally, as may be proved by firing at a target, assert that they are spread out longitudinally, so that if this is the case the improved target pattern is no criterion of harder hitting, especially in the case of a bird flying rapidly across the direction of aim

shot is filled with air waves of the greatest complexity They are not due to the cause already explained, but are, I believe, formed by the imperfect mixture of air with powder gases still accompanying the shot The imperfect mixture of the two gases causes light to be deflected in its passage, thus producing striæ just as at the first mixing of whisky and water, striæ are seen (sometimes attributed to oil !), which disappear when the mixture is complete I would mention, for the benefit of any one who may be tempted to continue these experiments, that a pair of wires such as are found to do so well when bullets have to be caught are not suitable, as one is sure to be shot away before such a bridge of shot is made between them as will allow a spark to pass However, by using thick copper wires, one bent in the form of a screw, with the other along the axis, no such failure can occur and every shot that I have taken in this way

FIG 13.

has been successful One can of course test the action of any material mixed with the shot For instance, in one case I mixed a few drops of liquid oil with the shot and found them more widely scattered in consequence, not, as has been stated, held together by the oil as if they were in a wire cartridge. Of course, solid grease or fat may, and no doubt does, produce such a result, but liquid oil certainly does not

I was unfortunately not able, in the limited space and time that I have been able to employ, to take photographs of the shot at a reasonable distance from the gun, but I have taken comparative photographs at three or four yards only in which every shot is clearly defined, and in which it is even easy to see on the negative where the shot have been jammed into one another and dented The difference in the scattering at this short distance is not sufficient for the results to give any information beyond this, that shot are as easily photographed as bullets, and that no difficulty need be apprehended in attempting to solve any question of the kind by this method The photograph, Fig. 13, represents the shot from the cylindrical or right-hand barrel, as the velocity now is so low that individual waves are no longer formed by each shot. The whole space, however, occupied by the

And now I wish to conclude with a series of photographs which show how completely the method is under control, how information of a kind that might seem to be outside the reach of experiment may be obtained from the electric spark photograph, and how phenomena of an unexpected nature are liable to appear when making any new experiment The result, however, is otherwise of but little interest or importance.

I thought I should like to watch the process of the

piercing of a glass plate by a bullet from the first shock step by step, until the bullet had at last emerged from

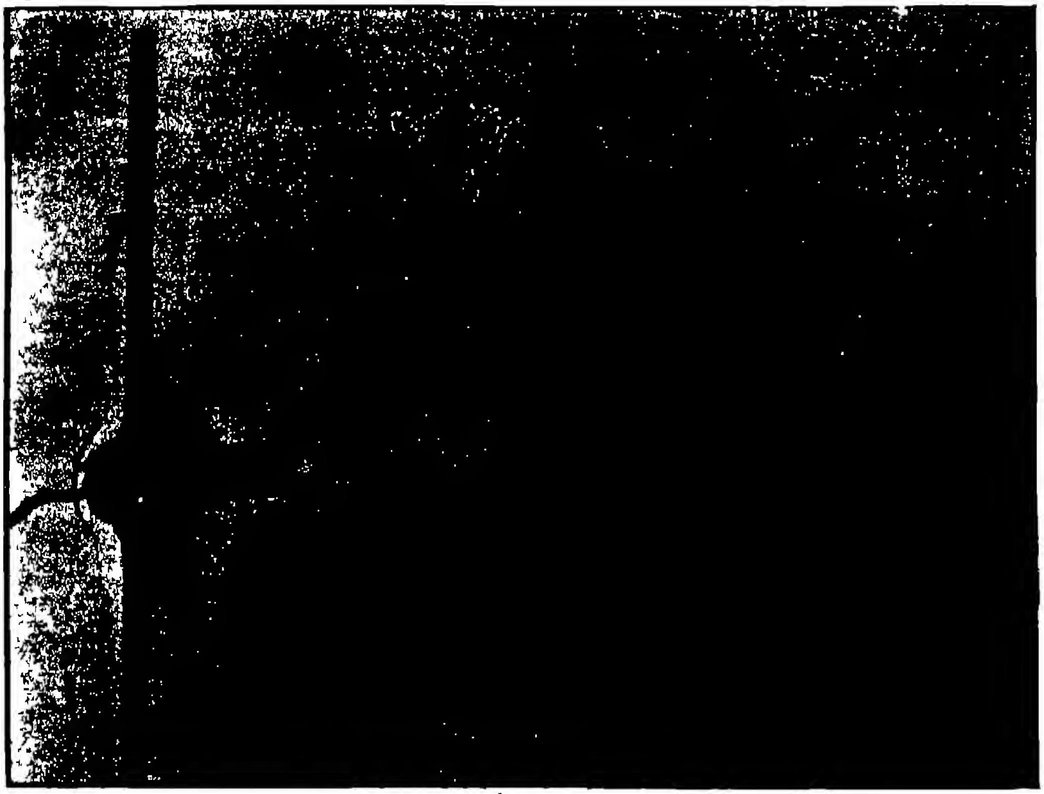


FIG. 14.

the confusion it had created. In Fig. 14 the glass plate is seen edgeways just after the bullet has struck it. It is clear at once that the splash of glass dust backwards is already four or five times as rapid as the motion of the bullet forwards. A new air wave is just beginning to be created in front of the glass-coated head of the bullet and two highly-inclined waves, one on either side of the glass, reaching about three-quarters of the way to the edge, have sprung into existence. These are more clearly seen in the next figure; meanwhile it may be well to point out that the fragments of paper which are following the bullets have in this case—as the card was much nearer to the glass plate than in those previously taken—some of them lost so much of their velocity and have in consequence lagged behind in a still higher proportion than the others, that they are travelling at less than 1100 feet a second; the more backward ones carry in consequence no air waves and there is no means of telling from the photograph that they are moving at all. In Fig. 15 the bullet has struggled about half way through the plate. The waves on either side of the plate have now reached the edge and are on their way back towards the centre again. They are caused in this way. When the bullet strikes the plate the violent shock produces a ripple or tremor in the glass which travels away radially in all directions, leaving the glass quiet behind. The rate at which this ripple travels may be found from the angle which these new air waves make with the plate, for taking any point on the plate and measuring up to the point where the air wave meets the plate and also the distance in air to the nearest point of the inclined air wave, we get two distances, the ratio of which is the ratio of the velocity of the disturbance in the glass to the velocity of sound in air. But much more than this is shown. An examination of the negatives or of a photographic print and even, but less clearly, of the print in the text shows that these inclined air waves are made up of a series of dark and light lines at a very slight

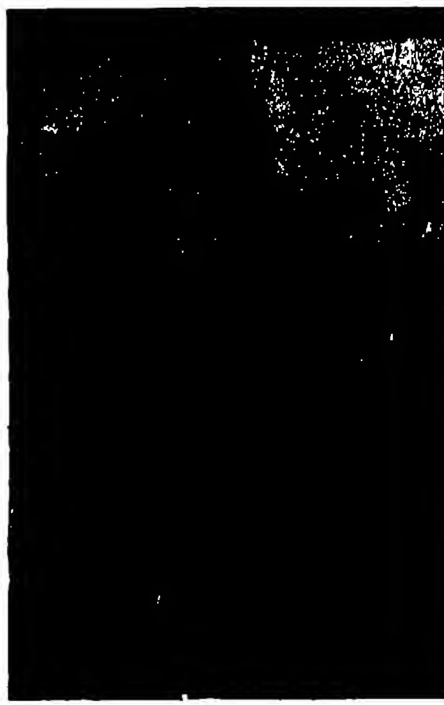


FIG. 15.

inclination to the air wave itself, so that as we travel

Fig. 16

along the air wave it is alternately dark outside and light outside These indicate the successive positions in which

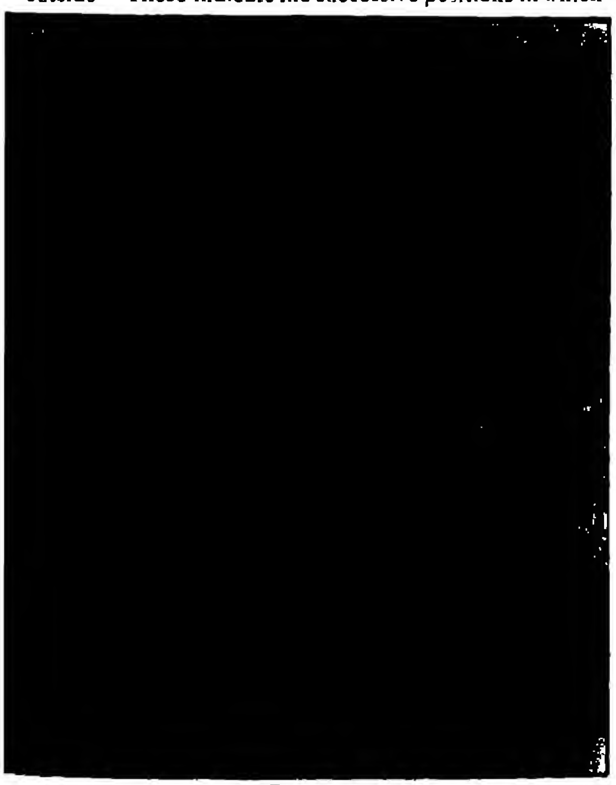


Fig. 17

the glass first moved outwards to compress the air or first moved inwards to rarefy it so that the wave length of the ripple may thus be found, and finally it is seen that where the waves are waves of compression on one side of the plate they are waves to rarefaction on the other, indicating that it was a transverse and not a mere longitudinal disturbance that ran along the plate from the centre outwards and back again after reflection from the edge In addition to this the fact that the reflected wave is still on its inward course proves that up to this time the plate is whole, as a wave cannot be propagated in a broken plate Fig 16 illustrates the state of affairs when the bullet has travelled about five inches beyond the plate It has not yet emerged from the cloud of glass dust. The new head wave is very conspicuous In the original negative, about half way between the bullet and the plate, the inclined waves due to the tremor in the glass plate may be detected, but they are too delicate to be reproduced by the printing process They supply the information as to how long the plate remained whole or rather if the bullet had been caught a little sooner before these faint waves had lost so much of their distinctness they would supply this information with great exactness Meanwhile the figure shows that the plate is now broken up completely It is true it is still standing, and the stern air wave is seen reflected from the upper part of it, but this is because the different parts have not yet had time to get away; their grinding edges, however, have cast out from the surface little particles, and these are seen over the whole extent of the plate After about fifteen inches the bullet is quite clear of the cloud of dust (Fig 17), one piece only of the glass, no doubt the piece that was immediately struck, has been punched out and is travelling along above the bullet at a speed practically equal to its own. I am also able to show the plate itself in this and a still later stage, when at last the separate pieces have begun to be visibly moved out of their position and in some cases slightly turned round

I have merely given this evening an account of a few experiments which in themselves perhaps are of little

interest, but they at any rate show the capability of this method for the examination of subjects which would in the ordinary way be considered beyond the reach of experiment It is hardly necessary to say that the examples given by no means reach the limit of what may be done, I have examined the explosions produced by fifteen-grain fulminate of mercury detonators and of heaps of iodide of nitrogen, a material which is rather unmanageable, as if a fly even walks over it it violently explodes. In these cases the explosive flash was used to make the B gap of Fig 4 conducting, for which it answered perfectly One might in the same way examine the form of the outrush of powder gases past the bullet, and so find at once their velocity with respect to the velocity of the bullet, and I see no great difficulty in tracing, if this should be desired, the whole course of a single bullet for perhaps as much as 100 yards by means of photographs taken every few inches on its way Though it may not be evident that these or similar experiments are of any practical importance, there can be no doubt that information may be readily obtained by the aid of the spark photograph, as in fact has been shown by Prof Mach, Lord Rayleigh, Mr F J Smith, and others, which without its aid can only be surmised, and that if, as in other subjects, the first wish of the experimentalist is to see what he is doing, then in these cases surely, where in general people would not think of attempting to look with their natural eyes, it may be worth while to take advantage of this electro-photographic eye

I wish in conclusion to express my obligation to the gentlemen to whom I have already referred, to Messrs Chapman and Colebrook for their assistance, and to Messrs. Moore and Grey for having supplied me with weapons and ammunition

MICRO-ORGANISMS AND THEIR INVESTIGATION[1]

As the field of bacteriological investigation becomes extended, we have of necessity constant additions to the various methods rendering possible the pursuit of researches in these novel directions We have only to look at the first edition of Hueppe's "Methoden der Bakterien-Forschung," published in 1885, consisting of 174 pages, and compare it with the bulky volume of 488 pages which forms the fifth edition, to see at a glance the advance which has been made in the matter of methods alone In Flugge's "Die Mikro-organismen" we have another type of book, dealing exclusively with micro-organisms themselves, and the information which has been gathered together concerning them, whilst all details of bacteriological practice are purposely omitted Dr Gunther has attempted a welding together of these two types of book, special attention being given to microscopical technique with which his name is indeed more particularly associated

The first part is devoted to a survey of our knowledge concerning bacteria in general, commencing with the earliest observations of Leeuwenhoek in 1683 In this review we find an account of their morphology, the principles upon which their classification is attempted, &c, together with a detailed account of the most recent methods for their cultivation and subsequent study, including careful directions for the use of the microscope, and a most elaborate description of the available means for staining bacteria

The second part is confined to a consideration of the best-known pathogenic and non-pathogenic micro-organisms

There could not be a more admirable account of the numerous manipulations involved in bacteriological investigations, all the minutiæ are described with the utmost care, and what is usually left for the student to learn in "profiting by his experience" is here carefully anticipated, and if he tumbles into any pitfalls, it is not because he has been without warning

With such a big task as Dr Gunther has set himself it is not surprising to find some parts less amply dealt with than they would seem to deserve Thus we find but a very meagre supply of culture media given, there is no mention of the preparation of milk, or of the special solutions employed by Pasteur, Naegeli, and others, neither is there any account of Kuhne's silica jelly, which since our knowledge of the fact that certain organisms will only flourish in media devoid of all organic matter, ought surely to have been included

On the other hand a minute description is given of gelatine-plate, dish and tube cultures, as well as of the most modern methods for the anaërobic cultivation of bacteria, &c, In connection with the abstraction of certain colonies from gelatine-plates, mention may be made of a piece of apparatus (the description of which was only published after Dr Gunther's book appeared) originally devised by Fodor, and called 'Bakterien Fischer,' which has been, under the name of "Bakterienharpune," more recently modified and considerably cheapened by Unna Every one has experienced the difficulty of fishing out a particular colony in a crowded plate, how it is almost impossible to look through the microscope and fix upon the centre to be abstracted, and at the same time keep the needle steady and ensure touching only the one colony which is required By using the above contrivance, which can be attached to the microscope, the fishing out of such centres is greatly facilitated

The examination of air for micro-organisms is only very slightly touched upon, as is also the bacteriological investigation of water It is a little rash to assert that "pathogenic micro-organisms can live for a long time in sterilised water," considering that it has been shown in some cases that their *immersion* only is sufficient to destroy them Again, no mention is made of Hansen's special methods for the examination of particular waters, although they are opposed to the Koch school, this ought not to preclude a reference to what has been proved by a large number of investigations to be, in some cases, of great practical utility

The second part opens with a short introduction, in which the nature of pathogenic organisms in general is described, and an account given of the rigid proof which is required before a particular organism may be said to be the cause of a particular disease Protective inoculation and immunity are briefly referred to, and Metschnikoff's brilliant theories of phagocytosis summarily dismissed, and declared incapable of standing the test of the "careful experimental criticism to which they have been submitted by Flugge, Baumgarten, and the author's own pupils"

As many as twenty-seven different varieties of micro-organisms are described in the section on the most important pathogenic bacteria. Amongst these we find the micro-organisms associated with anthrax, tuberculosis, diphtheria, cholera, pneumonia, tetanus, typhoid fever, and chicken-cholera, more especially dealt with, an exceedingly useful and comprehensive summary being given in each case of what is known concerning them, together with numerous references to original papers published on the subject That Dr. Günther is an ardent disciple of Koch's will at once be admitted, when we read the terms in which he speaks of the *Tuberculinum Kochii*. "Eine neue Aera begann nicht allein für die Tuberculoselehre, sondern für die gesammte Medicin, mit der grossen Entdeckung Koch's der Heilung der Tuberculose."

[1] "Einführung in das Studium der Bakteriologie" By Dr Carl Günther. Second Edition (Leipzig Georg Thieme)
"Technique Bactériologique" By Dr R. Wurtz Encyclopédie Scientifique des Aide-Mémoire. (Paris, Gauthier-Villars et fils, 1892.)

Amongst the non-pathogenic forms we find an account of the *Micrococcus agilis*, which was found by Ali-Cohen in drinking water. This was not the first motile coccus found, as is stated by Gunther, for previous to this, Mendoza isolated and described a motile form which he called *Micrococcus tetragenus mobilis ventriculi*. The *Micrococcus agilis* was the second variety found; whilst later, in 1890, Loeffler also discovered and described a motile coccus. It is surprising, therefore, to read that Ali-Cohen's variety is the only motile micrococcus known. The list has further been quite recently (1892) enriched by the discovery by Maurea of a motile sarcina, which he has designated *Sarcina mobilis*.

A fine set of seventy-six photographs, mostly taken from original preparations, together with a very exhaustive index, completes the volume. Amongst the photographic figures the series of twelve representing anthrax in every stage of development from the individual bacteria to their appearance as colonies on gelatine-plates, and growing in test-tube cultivations, are particularly beautiful; the surface colonies photographed after forty-eight hours' growth are especially characteristic and successful.

In the handy little volume "Technique Bactériologique," of Dr. Wurtz, chief of the laboratory for experimental pathology in the Faculty of Medicine in Paris, we have an entirely different stamp of book. We read in his preface: "On ne trouvera, dans ce précis de Technique bactériologique, ni l'historique, ni l'exposé detaillé des nombreuses méthodes techniques qui ont été préconisées jusqu'à ce jour en microbiologie. Conformément au programme tracé par la Direction de *l'Encyclopédie Scientifique des Aide-Mémoire*, nous nous sommes efforcés d'exposer, aussi clairement que possible, les notions qu'un debutant doit posséder à fond avant d'aborder l'étude proprement dite des microbes."

Proceeding on these lines Dr. Wurtz gives us a very clear and precise account of all the various important stages passed through in bacteriological manipulations, commencing with a chapter on the principles of sterilisation.

But a novel feature in this volume is the description of the various methods of conducting experiments on animals for bacteriological purposes. This is carefully recorded and supplemented by woodcuts, and would appear to be a most useful addition, for although the possibilities of carrying out such experiments in this country are very limited, yet in those cases where they are permitted such an accurate description of the methods to be adopted should prove very helpful, more especially as in very few of the German and English bacteriological text-books is any account to be found for the information of those desiring to undertake such investigations. A chapter is also devoted to the enumeration of the substances, in as far as they have been investigated, which are elaborated by micro-organisms and a description of the most convenient methods for their successful extraction.

The crisp and concise language which characterises the book, together with the judgment displayed in its compilation, show that the author possesses, not only a full grasp of his subject, but is also highly skilled in the art of communicating it to others.

GRACE C. FRANKLAND.

THE ORDNANCE SURVEY.

A DEPARTMENTAL committee was appointed by the Board of Agriculture in April, 1892, to inquire into the condition of the Ordnance Survey. The committee consisted of Sir John E. Dorington, M.P. (chairman), Sir Archibald Geikie, F.R.S., Mr. Henry W. Primrose, Mr. William Mather, M.P., Mr. H. J. Roby, M.P., and Mr. Charles Fortescue Brickdale, with Major Duncan A. Johnston, R.E., as secretary. The matters referred to them were:—

1. What steps should be taken to expedite the completion and publication of the new or revised one-inch map (with or without hill-shading) of the British Isles?
2. What permanent arrangements should be made for the continuous revision and speedy publication of the maps—1 in 500 (towns), 25 in., 6 in., and 1 in. scales?
3. Whether the maps as at present issued satisfy the reasonable requirements of the public in regard to the style of execution, form, information conveyed, and price, and whether any improvement can be made in the catalogue and indexes?

After the appointment of the committee Mr. T. Ellis, M.P., asked in the House of Commons a question which showed that there was dissatisfaction with regard to the inaccuracy and incompleteness of the names of places in the map of Wales; and this question was also referred to the committee.

The report of the committee has just been issued, and includes the following recommendations:—

1. That the 1 in. map be produced in the following forms:—
(*a*) An engraved outline map, with contours in black.
(*b*) A black engraved map, with hill shading either in black or in colour.
(*c*) A coloured map on thin paper, adapted to military purposes, but also on sale to the public.
(*d*) A cheap map by transfer to zinc or stone.
2. That the character of the roads on the 1 in. map be shown in four classes with distinct characteristics.
3. That parish boundaries be omitted from the 1 in. map.
4. That the contours of the sea bottom round the coast line and the depths of inland waters be shown.
5. That experiments be made in the practical application of heliogravure, and that, if results not inferior to an Austrian specimen map which we have seen be produced, that process be substituted for the existing method of engraving hills, and for so much of the country as is then uncompleted in its hill engraving.
6. That special arrangements be made to revise the 1 in. map within the next four years independently of the maps on the larger scales, and that subsequently this map be constantly revised within periods of fifteen years.
7. That the cadastral maps be revised and brought up to date in the next ten years, and that subsequently they be kept revised within periods of fifteen years.
8. That the publication of these revised maps be carried out by contract, if necessary.
9. That detail, such as single trees, footpaths in gardens, &c., be omitted.
10. That the skeleton and coloured forms of the 25 in. and town maps be abandoned, and the uses of both be combined in one edition having the houses cross-hatched.
11. That the reference numbers to parcels of land on the 25.344 in. plans be abandoned on revision.
12. That to a limited extent additional contour lines be added to the 6 in. map.
13. That on the 6 in. map the contours be always in black.
14. That certain of the engraved plates of the 6 in. map which are not now filled up beyond the county boundary be as soon as possible filled up to the margin of the plate with the detail of the adjoining county.
15. That the cost of the engraved sheets of the 6 in. map and that of the quarter-sheets of the photo-zincographed 6 in. map be equalised by a change of their respective selling prices.
16. That the Welsh names be gone over and corrected before the first revision of that map.
17. That the cadastral maps on the town scales be no longer entirely made or revised at the cost of the State, but that the town authorities be required by statute to maintain these maps.
18. That around towns and in tourist districts the existing sheets of the Ordnance Survey on the 6 in. and 1 in. scales be united so as to form special maps of such districts, and that advantage be taken of these maps to introduce any novelties in cartography that may be thought desirable, as these maps are not required to be joined to the general maps of the United Kingdom.
19. That certain authorities be placed under statutable

obligation to supply information to the Ordnance Survey Department in order to enable current revision to be better carried on

20 That in future the term "revision" should be confined to the bringing up to date on its existing scale of a map already published, and that the term "resurvey" be applied to the operations necessary for the production of maps on a scale larger than that on which they were originally published

21 That the Ordnance Survey Department be allowed to control its own supply of paper and printing material

22 That the map on the scale of four miles to an inch be revised as soon as the 1 in map is out of hand, and be completed with hill-shading

23 That great freedom be allowed to private publishers desirous of bringing out other classes of maps than those specially published by the Survey Department, and that transfers of the maps on the 1 in and smaller scales be supplied to publishers at cost price, a small sum being paid as an acknowledgment, and that all other reproduction of Ordnance Survey maps be prohibited

24. That certain recommendations as to indices and catalogue be carried out

25 That a book or pamphlet of information as to the Ordnance Survey be published, general in its main features and special for each county, containing the county indices or diagrams (on a reduced scale) and the information formerly contained in the parish area books, and also the table of parish areas now printed on the index of the 6 in map, which table should in future be omitted from that map, and that copies of the small indices in this pamphlet be freely distributed for public information

NOTES

OWING to the large demand for tickets for the Croonian Lecture, which is to be delivered by Prof Virchow before the Royal Society and their friends next Thursday, it has been decided to hold the meeting in the theatre of the London University, which has been lent for the occasion by the kind permission of the Senate

THE public dinner which is to be given in honour of Prof Virchow will be held on March 16, after the delivery of the Croonian lecture, at the Hotel Métropole Lord Kelvin will preside, and will be supported by the Presidents of the Royal Colleges of Physicians and Surgeons as vice chairmen

AT the Nottingham meeting of the British Association, over which Prof Burdon Sanderson will preside, Lord Salisbury will be nominated president of the Association for the Oxford meeting in 1894 The following gentlemen have consented to act as presidents of sections at Nottingham —Section A, Mathematical and Physical Science, Prof Clifton, F R S , Section B, Chemistry and Mineralogy, Prof J. Emerson Reynolds, F R.S , Section C, Geology, Mr J J H. Teall, F R.S , Section D, Biology, the Rev Canon Tristram, F R S , Section E, Geography, Mr Henry Seebohm, Sec R G S ; Section F, Economic Science and Statistics, Prof J S Nicholson , Section G, Mechanical Science, Mr Jeremiah Head , and Section H, Anthropology, Dr Robert Munro

AT the ordinary meeting of the Royal Meteorological Society, to be held at 25, Great George Street, Westminster, on Wednesday, the 15th instant, at 7 p m , a lecture will be given by Mr Shelford Bidwell, F R S , on some meteorological problems, which will be illustrated by experiments

DR. R THORNE THORNE, Medical Officer of the Local Government Board, and Mr. H. Farnall, of the Foreign Office, have gone to Dresden, the former as British delegate to the International Sanitary Conference in that city, the latter as assistant delegate

THE students of the Royal College of Science propose to hold a conversazione in the South Kensington Museum on the evening of March 23 next In the course of the evening Mr Boys, F R S , will deliver a lecture on soap bubbles, illustrated by his own interesting experiments The evening will be further enlivened by various public singers, and a selection of music will be played by the band of the Grenadier Guards

IN reply to a question put by Sir Henry Roscoe in the House of Commons on Friday last with regard to the proposed new buildings for the Royal College of Science, Mr Shaw Lefevre said —"The accommodation at the Royal College of Science is now undoubtedly inadequate, and in my opinion new buildings must be undertaken at some early opportunity Block plans were drawn up in 1891 by the professors of the Royal College of Science, showing a suggested appropriation of the land on the south side of the Imperial Institute Road, for the purposes both of the Royal College of Science and of the Science Museum, and these plans were submitted to the Office of Works , but that Department pointed out that it would be premature for them to consider the plans until the Science and Art Department had obtained the sanction of the Treasury to an organisation of their teaching and exhibition establishments on the scale contemplated in the plans I understand that the Science and Art Department are now in communication with the Treasury in this sense " Sir H Roscoe having asked when the report from the Science and Art Department would be issued, Mr Shaw Lefevre said it was not in the nature of a report that could be issued to Parliament, but he should be happy to show it to the hon member

LAST week a meeting, convened by the Duke of Westminster as president of the Royal Agricultural Society, was held at 12, Hanover Square, to consider the best means of commemorating the completion of the first half century of the agricultural experiments which have been continuously carried on by Sir John Lawes at Rothamsted since the year 1843. The Prince of Wales presided On taking the chair his Royal Highness stated the objects of the meeting The Rothamsted experiments had from the commencement been entirely disconnected with any external organisation and had been maintained at the sole cost of Sir John Lawes For the continuance of the investigations after his death Sir John had recently made the munificent endowment of £100,000, besides the famous laboratory and certain areas of land, and had nominated some of the most distinguished men of science of the day to administer the trust In view of all these facts, and the great national importance of the Rothamsted experiments, it was only fitting that some public recognition should be made of the invaluable services rendered to agriculture by Sir John Lawes and his distinguished colleague, Dr Gilbert The Duke of Westminster said they all hoped that Sir John might live for many years to continue to carry on these experiments for the benefit of agriculture. He had great pleasure in proposing the following resolution —"That, having regard to the great national importance of the series of experiments which have been carried on at Rothamsted during the last fifty years, it is desirable that some public recognition should be made of the invaluable services thus rendered to agriculture by Sir John Lawes, and also by Dr Gilbert, who has been associated with the experiments during the whole period. That, with this object, subscriptions, to be limited to two guineas, be invited from all interested in agriculture, whether scientific or practical" Mr. Thiselton Dyer, F.R.S , seconded the resolution—not as an agriculturist, but as one officially and all his life deeply interested in everything that was concerned with botanical science The extraordinary merit of the work carried on at Rothamsted lay in the fact that those experiments had been continuously carried on under uniform conditions for so long a

period He ventured to say, as a scientific man, that he knew nothing in the whole records of scientific research more honourable to this country than those experiments which were being carried on at Rothamsted with such self denying skill The resolution was then put by the chairman, and carried unanimously Sir John Evans moved —"That, in the opinion of this meeting, the testimonial might advantageously take the form of —(1) a granite memorial, with a suitable inscription, to be erected at the head of the field where the experiments have taken place, (2) addresses to Sir John Lawes and Dr Gilbert, accompanied (if funds permit) by a commemorative piece of plate" This was also carried, and it was unanimously resolved that the following should be requested to act as a committee for carrying the resolutions into effect —The presidents of the Royal, Royal Agricultural, Linnean, and Chemical Societies, the Earl of Clarendon, Viscount Emlyn, Sir John Lubbock, Sir John Evans (hon treasurer), and Mr Ernest Clarke (hon secretary), with power to add to their number The Duke of Westminster moved a vote of thanks to the chairman, and the Prince of Wales said, in response, that nothing had given him greater pleasure and satisfaction than to take the chair on that occasion, and to testify, as an agriculturist, his own sense of gratitude for what Sir John Lawes had done for agriculture Subscriptions to the fund may be sent to any member of the committee, to Sir John Evans, F R S, at Nash Mills, Hemel Hempstead, or to Mr Ernest Clarke, at 12, Hanover Square, W

LORD SALISBURY presided over a meeting held at Oxford last week, in aid of the building fund of the Radcliffe Infirmary He delivered a most vigorous address, in the course of which he said that at Oxford the difficulty connected with medical education was the reverse of that felt in London In London the practical opportunities of exercising medicine were abundant, and the only care, or the main care, which pressed upon those who had charge of education in that respect was lest the more scientific basis of that practice should be neglected or receive inadequate attention At Oxford, on the contrary, they had abundant means of teaching the group of sciences which were the equipment of the physician But, necessarily, unless they made a great effort to that end, they should not have the means of presenting those opportunities of practical inquiry which were essential to the formation of the professional ideal, and which in large populations necessarily occurred with so much greater frequency This movement—for so he looked upon it—on the part of the rulers of the University, to draw somewhat closer to the science of medicine, was only part of a larger movement which had been going on for some time, which, if he might use the scientific language of the day, was part of the evolution of education in our time He begged to assure the assembly that he had no traitorous views with respect to the study of Greek In fact he was inclined to say that in recent controversies the advocates of the classical languages had been unduly frightened, and that there was not the slightest danger that the study of them would ever pass from the education of youth or the culture of men of intellect. The issue was not between science and languages, ancient or modern; the issue rather was between the science whose chief food was gathered from observation and the science whose chief food was gathered from reflection. This older science was slowly, very slowly, but still quite evidently, giving way to the sciences which relied upon observation He always thought that the science of medicine had scarcely received among us all the tribute which it ought to receive among sciences which rest upon observation. It was a curious fact that the whole tendency of scientific thought appeared to be rapidly concentrating itself upon the fields in which medicine reigned supreme Those infinitely minute beings which certainly for health or sickness deeply affected our existence, and which were so essential to us that some able scientific men said that we consisted of nothing else, that we were not only a Republic, but were in a permanent state of civil war—these bacilli were attracting more and more the attention of the scientific intellect in Europe It was dangerous to prophesy, but he did not think that any one who had watched the course of science would doubt that for the generation to come the investigation of these creatures, which had been revealed by new methods of research and by singularly patient labour, and upon which the lives of millions of human beings depended, would figure more largely in the scientific field than any other study This was the special domain and privilege of medicine He felt, therefore, that in commending this appeal to their consideration he was doing more than preaching a charity sermon He was asking them to help that which contained the most brilliant promise for the intellectual future of science in a University by which science ought to be cultivated and where science ought to reign

AFTER Lord Salisbury's address various resolutions were adopted, among which was one, moved by Prof Dicey, to the effect that the Radcliffe Infirmary, being the chief hospital for Oxford and a large surrounding district, should be brought into a state of efficiency corresponding with the recent advances in hospital management Another resolution, moved by the Master of University, expressed approval of the committee's scheme, consisting of the removal of the sick from the old building into more modern wards and the renovation of the old building

ON Saturday and Sunday last much damage was done in Sandgate, near Folkestone, by remarkable disturbances of land The first disturbance was felt on Saturday at 7 45 P M, when a rocking motion was noticed This soon stopped, but later disturbances were so alarming that many people took their furniture into the streets According to a correspondent of the *Times*, houses "slipped away from each other, leaving gaping sections," while in other cases the walls bulged out, and great rifts appeared in the ground In the area affected by the disturbances most, if not all, of the houses are out of line and show cracking Many of the inhabitants have been brought to great distress by the calamity, and appeals to the public have been issued on their behalf An inquiry into the cause of the disaster was held at Sandgate on Tuesday by Mr Walton, Local Government Board Inspector After hearing evidence the Inspector said that an official report would be sent to the Board What he had seen led him to conclude that the catastrophe was due to the sudden release of impounded subsoil water, a thing which he believed was remediable by the institution of proper water drains If that was attended to there was no reason to suppose that such a disaster would ever recur The *strata* were full of water, which the recent abnormal rainfall had served to increase That water being released had formed kinds of caverns The remedies were proper storm drains and intercepting drains, with free outlets under the road to the sea

THE death of Ludwig Lindenschmit, the well-known German archæologist, is announced He died at Mainz on February 14 in his eighty-fourth year He was the director and one of the founders of the fine Central Romano German Museum at Mainz, and one of the editors of the "Archiv für Anthropologie." Among his works are "Die vaterländischen Altertümer der fürstlichen Hohenzollernschen Sammlungen" and his "Altertümer unserer heidnischen Vorzeit" He began a "Handbuch der deutschen Altertumskunde," but completed only the volume relating to the Merovingian period Lindenschmit was an enthusiastic advocate of the theory that the Aryan race is of European origin

THE temperature during the past week has been generally very high for the season, the daily maxima frequently exceeding

55°, and even reaching 59° in the eastern counties on Sunday, whereas the average maxima for the month, deduced from twenty years' observations at the telegraphic reporting stations of the Meteorological Office, range from about 45° in the north to 50 in the south and south east During the latter part of last week several depressions skirted our north west coasts, and rain fell generally every day, although the amounts measured were not great, but on Sunday the type of weather changed, especially over the southern part of the kingdom An anti-cyclone advanced over our south west coasts from the Atlantic, while the air became dryer and conditions more settled, although there was little sunshine in any part of the kingdom There was a deep depression over Norway on Tuesday, while secondary depressions in connection with it were approaching the north west of Scotland, and occasioning a return of stormy weather in the northern parts of these islands From the *Weekly Weather Report* it appears that for the week ending the 4th instant the rainfall was above the average in all districts except the north of Scotland and the south of Ireland Over the northern parts of England and the east of Scotland the excess was large, owing chiefly to heavy snowfall at the beginning of the period

AMONG the various marine zoological stations which, on the initiative of that at Naples, have sprung up in recent years, the station at Trieste, on the Adriatic, holds an honourable place It has been in existence nearly eighteen years Dr Claus states (*Naturw Rdsch*) that for its double function of instruction and investigation opportunity is afforded both to students and men of science The students are, primarily, those of the professors of zoology at Vienna University, to whom the management is entrusted, also those of the Graz professor, who has a right to four places out of twelve Students of other Austrian Universities are also freely admitted to work, and Austrian and foreign investigators To each worker the ordinary reagents, besides the table, are supplied gratis, also the material, so far as it can be provided without special cost The station further supplies living and preserved marine animals as specimens to the Zoological Institutes of the Vienna and Graz Universities, sending thither about 120 to 140 specimens annually Other institutes are supplied on payment as arranged The number of workers at the station has gone on increasing since it was opened in 1875 Of foreign investigators who have used it may be named Metschnikoff, Kowalevsky, A Schneider, Selenka, R and O Hertwig, Keller, E van Beneden, Fromann, Braun, and F Cohn The results of work carried on there are sometimes published independently, but they chiefly appear in the *Arbeiten* of the Zoological Institute of Vienna University, and the Zoological Station in Trieste, of which ten volumes have appeared The *Denkschriften* and *Sitzungsberichte* of the Vienna Academy and the German zoological journals also witness to the activity of the station The Austrian Government has liberally aided this useful institution.

THE new number of the Journal of the Institution of Electrical Engineers contains a report of some very interesting speeches on a paper by Dr Fleming on experimental researches on alternate-current transformers The same number includes Mr Preece's presidential address, from which we have given some extracts. The vote of thanks to the president for his address was proposed by Mr Spagnolletti and seconded by Sir Henry Mance Sir Henry said there was one point in the address which had struck him with dismay That was the gradual increase of the teredo in the neighbourhood of our shores. This fact had been brought home to him that day by specimens of cable recently attacked by "the insect, or mollusc", and it should teach them—what Mr Preece had told them many years before—that they should not only survey the bottom of the sea for rocks and shoals, but should also examine it near the shores to find whether it was infested by that pest, which had damaged hundreds of thousands of pounds worth of cable

THE results of the solar, meteorological, and magnetical observations made during 1892 at the Stonyhurst College Observatory have just been issued by Father Sidgreaves. They take the commendable form of monthly and annual summaries, so that the most interesting results can be seen at a glance, and compared with the mean results of the last forty-five years The range of barometer readings was only 1 724, or a quarter of an inch lower than the mean, while the range of the thermometer was seven degrees higher than the mean The extreme range of the barometer recorded at this observatory is 3 13 inches Sunshine was recorded for 207 hours in June, 202 1 in April, and only 172 in May From January to April there is a regular increase, and from June to December a regular decrease, the falling off in May being very conspicuous 153 drawings of the sun have been added to the already splendid Stonyhurst series An appendix contains the results of meteorological observations made at St Ignatius College, Malta

WE learn from the *Botanical Gazette* that there are now as many as thirty two botanical stations in the United States carried on by the various State Governments The subject which receives most attention at these stations is that of the fungus and bacterial diseases of cultivated crops and of fruit-trees, and their treatment and cure Some of them give attention to systematic botany, while others are investigating the life history of certain fungi, or carrying on physiological work A laboratory for the study of plant diseases has recently been fitted up in connection with the agricultural experiment station of the University of California at Berkeley It has been arranged that a botanical survey of Nebraska shall be undertaken by the Botanical Seminar of the University of that State The almost unknown flora of the north central portions of Idaho has recently been investigated, as we have already noted, by a commission acting under the auspices of the Botanical Division of the U S Department of Agriculture

IN the first part of Dr Millspaugh's Preliminary Catalogue of the Flora of Western Virginia, published in the Bulletin of the Agricultural Experimental Station of Morgantown, a new feature has been introduced in a list of the rich fossil flora of the State

PROF ANGELO HEILPRIN, of the Peary Relief Expedition, has presented to the Museum of the Academy of Natural Sciences, Philadelphia, the valuable collection of mollusks dredged by him in Greenland waters They have not yet been studied, but the conservator of the conchological section, in his annual report, says he has ascertained the presence of a number of species not before in the collection of the Academy, of the genera *Margarita*, *Buccinum*, *Sipho*, and other Arctic groups The specimens preserved in alcohol are in excellent condition for the examination of the soft parts

MR. J W SALTER, writing to the *Zoologist* from University College, Aberystwith, says that on January 4 last he obtained a polecat about six miles south of Aberystwith There is reason to believe, he says, that the species is by no means extinct in Cardiganshire

THE Pharmaceutical Society of Great Britain has issued a volume of papers, most of which describe the results of chemical investigations carried on at its Research Laboratory The editor is Prof. W R. Dunstan The papers are reprinted from the Transactions of the societies to which they were communicated, namely, the Royal Society, the Chemical Society, the Pharmaceutical Society, and the Physical Society Other volumes of a like kind are to follow

THE new number of the Journal of the Royal Horticultural Society includes, besides papers on many other subjects, reports of conferences on the begonia and on apricots and plums. There is also a long series of extracts from the Proceedings of the society.

THE second part of the excellent "Canadian Guide Book," by Ernest Ingersoll, has been issued (W. Heinemann). It deals with western Canada, and the author has been at great pains not only to collect full and trustworthy information, but to present it in a clear and attractive style. There are maps and many illustrations.

THE results of an investigation concerning the nature and properties of metallic ruthenium, particularly with respect to the fusing point of this highly refractory rare metal, are contributed by M. Joly to the current number of the *Comptes Rendus*. M. Joly has accumulated no less than three kilograms of pure metallic ruthenium, and has consequently been enabled to carry out experiments upon it on a comparatively large scale. It will doubtless be remembered that ruthenium and osmium are the two most refractory of the metals of the platinum group. Deville and Debray only succeeded with great difficulty in obtaining a few minute globules of melted ruthenium with the aid of the oxyhydrogen blowpipe. The fusion of this metal is rendered very much more difficult owing to the readiness with which, at these high temperatures, it becomes converted into the volatile tetroxide RuO_4. It was apparent therefore that in order to attain success the temperature must be suddenly raised to a point considerably higher than the melting point of the metal, and in order to effect this a much more powerful source of heat than the oxyhydrogen blowpipe would be required. M. Joly has therefore employed the electric arc, which has recently been shown by M. Moissan to be so admirably adapted for the preparation of refractory metals. At the high temperature of a powerful arc ruthenium is melted in a few seconds, and without sensible loss by volatilisation in the form of tetroxide. Solid ingots of twenty to thirty grams of the metal have been obtained in this manner without difficulty. As the melted metal cools, however, it becomes covered with a coating of the blue sesquioxide Ru_2O_3 and the dioxide RuO_2. In order to remove this the ingot is placed first in aqua regia, which, however, has no action upon either the metal or the oxides, and subsequently in hydrofluoric acid; finally the ingot is heated in a stream of hydrogen, when it loses the last traces of oxide and the pure metal remains. Pure ruthenium thus obtained in tolerably large quantities after fusion is a greyish-white metal, more nearly resembling iron than platinum in appearance. Its hardness is about the same as that of iridium. It possesses a crystalline structure and is brittle. The density of the metal after fusion M. Joly gives as 12.063 at 0° compared with water at 4°. Employing the same electric arc and under equal conditions in all respects, the fusion of ruthenium appears to be attended with appreciably greater difficulty than that of rhodium and iridium, whose melting points are somewhat higher than the melting point of platinum. Moreover, under the conditions which suffice for the ready fusion of ruthenium, osmium merely sinters, traces of fusion being just apparent. Osmium therefore is the most infusible of the metals of the platinum group. M. Joly is now conducting experiments with the view of determining the actual temperatures of these interesting high melting points.

NOTES from the Marine Biological Station, Plymouth.— The week's captures include the Lucernarian *Depastrum cyathiforme* and numbers of the Gephyrean *Petalostoma minutum*, Kef. Ephyræ of *Aurelia* have been abundant; Hydroid medusæ scarcer. Polychæte larvæ and *Nauplii* continue plentiful, and *Cyphonautes* (larva of the Polyzoan *Membranipora pilosa*) has considerably increased in numbers. Echinoderm larvæ (*Auricularia*, *Pluteus*) have made their first appearance in the season's townettings. The Nemertine *Nemertes Neesii* and a large eyeless mud-dwelling species of the Polychæte genus *Polydora* (*flava*, Clap. ?) are now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, presented by Miss Gertrude Farmer; a Macaque Monkey (*Macacus cynomolgus*, ♂) from Java, presented by Mrs. Frank Phillips; a Naked-footed Owlet (*Athene noctua*) European, presented by Mr. Albert Stevens; a Four-horned Antelope (*Tetraceros quadricornis*, ♂) from India, purchased; six Wild Swine (*Sus cristatus*), two Badgers (*Meles taxus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET BROOKS (NOVEMBER 19, 1892).—The following is a continuation of last week's ephemeris for this comet:—

12h. Berlin Mean Time.

1893.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	Log r.	Log Δ.	Br.
Mar. 9	0 46 27	+20 46.1	0.1842	0.3563	0.47
10	47 22	34.4			
11	48 17	23.0			
12	49 11	12.1			
13	50 4	20 1.5	0.1946	0.3731	0.42
14	50 57	19 51.5			
15	51 49	19 41.0			
16	0 52 41	19 31.2			

This comet will soon be lost in the rays of the sun. The unit of brightness took place on November 21.5, 1892.

COMET HOLMES (1892, III.).—M. Schulhof gives the following ephemeris of this comet for the ensuing week:—

1893.	R.A. (app.) h. m. s.	Decl. (app.) ° ′ ″
March 9	2 43 7.1	35 8 11
10	44 52.2	10 58
11	46 37.2	13 46
12	48 23.4	16 35
13	50 9.4	19 24
14	51 55.7	22 14
15	53 42.2	25 3
16	2 55 29.0	27 53

UNIVERSAL TIME.—On February 6 last the Bill declaring the legal time for Germany to be that of the 15th meridian east of Greenwich, that is, one hour in advance of Greenwich time, passed the third reading. This law will be brought into force on April 1. The *Observatory* for March informs us that, in a letter addressed to the Astronomer Royal, it is stated by Dr. Schram that a similar Bill has been laid before the Austrian Government, and "it is hoped that the change will be made simultaneously with Germany." The draft of the latter Bill, which we take from the same number, provides:—

(1) That the legal time in Austria is the mean solar time of the meridian 15° east of Greenwich. The same to replace, on April 1, 1893, the present local times for legal, civil, and all other purposes.

(2) The Government is authorised to make the changes in the school and industrial hours which will become necessary in consequence of the adoption of the above.

THE BIELIDS, 1892.—M. Bredichin, in *Astronomischen Nachrichten*, 3154, has a short note on the Bielids, in which he says that the observations made in America on November 23 last show that the meeting of the densest part of this swarm with the earth has taken place almost four days earlier than in the year 1885, or, in other words, that the descending node of the stream has receded almost 4° to the west during the period between the end of 1885 and the end of 1892. The cause of this recession is, he says, due to Jupiter, the perturbations set up by this planet accounting for the mean daily motion which is nearly equal to that possessed by Biela's comet.

An approximate computation of the special perturbations for the whole period during which Jupiter had any influence gave

for the recession of the node a little over 4°, the inclination decreasing about 0°·6.

THE WOLSINGHAM OBSERVATORY.—In the Report of this observatory for the year 1892 Mr. T. E. Espin tells us that although the zone work was interrupted by attention being given to Nova Auriga, yet one hundred and sixteen new Third-Type Stars were detected in zones + 55° and 56°. In the autumn, as the telescope was going to be devoted to the revision of double stars in connection with the new edition of "Celestial Objects for the Common Telescope," the driving clock was taken out and cleaned, and a new arrangement for letting the clock run for one and a half hours without rewinding was also added. Notwithstanding the pressure of work in this direction, as many as eight hundred and forty seven measures were made in the autumn, "observing being carried on sometimes for twelve hours, and once for thirteen and a half at a stretch." With respect to the new edition of the work mentioned above, Mr. Espin gives a short description of the general scheme. The portions devoted to the planets and the sun (vol. i.) will have several foot notes added to them, Mr. Denning will write a short chapter on comets and meteors, and chapters on celestial photography and spectroscopic work will also be inserted. The second volume will deal with double stars, &c., and will be entirely rewritten; the objects will be arranged in order of Right Ascension, and all double stars whose primaries are above 6·5 magnitude, and whose distance is less than 20″, will be included. The work of bringing the places up to 1900 was at the end of the year completed for the first twelve hours, and considerable progress has already been made in the next eight hours of Right Ascension. Mr. Espin refers to the death of Miss Compton, who took great interest in the work done at the Observatory, and who left a legacy for the purchase of a photographic telescope. This telescope is already in working order, its aperture being eight clear inches, and focal length forty-two inches, and will be devoted to the photography of the zones observed with the spectroscope for detecting variation in light. The Meteorological Department has also been increased by a hygroscope and solar radiation thermometer, the gifts of Miss Brooke.

UNITED STATES NAVAL OBSERVATORY.—From the report of the superintendent (Capt. F. C. McNair) of this observatory for the year ending June 30, 1892, we gather the following few notes. In October, 1891, owing to the retirement of Prof. Asaph Hall, the use of the 26 inch refractor was tendered to Mr. Asaph Hall, junior, the latter observing the satellite of Neptune, satellites of Saturn, and the two outer satellites of Uranus. During the period of opposition of Mars, in August, 1892, the instrument was employed by Prof. Hall for the purpose of securing measures of the satellites, as the superintendent thought that "it seemed fitting that Prof. Hall, the discoverer of these satellites, should have the privilege of observing them once more under such exceptionally favourable circumstances." With the transit circle practically no observations were made, as the instrument was under repairs previous to being set up in the new observing houses; the Meridian transit, on the other hand, was in constant use, chiefly in connection with the time service. The 9·6 inch equatorial was as usual employed in observing asteroids, occultations, &c., while two nights a week were set apart for the accommodation of visitors. The number of visitors at night is about 2500 per annum, the majority of whom are women. In the estimates of appropriations required for the service for the year ending June 30, 1894, we see that the superintendent asks for an expert elevator conductor, which is essential to prevent accident. Among the estimates for the new observatory is a request for three dwellings for observers, and this is accompanied by a note which we print here, and the truth of which every astronomer will endorse:—"In order that the work of a large observatory may be properly and economically done, it is absolutely necessary that the observers be within prompt call to their instruments throughout day and night. Very important observations can often be secured from the clearing of the sky for a few hours, or even in some cases for a few minutes, if the observer be within easy call by the watchman. This can only be accomplished, in the isolated situation of the new Observatory, by having dwellings upon the grounds for the observers. The Government erects dwellings at all its navy-yards, arsenals, forts, and schools for the officers on duty there. But no service requires such unremitting attention and constant presence at all hours as that of the astronomer, and no observatory can be regarded as economically managed which does not furnish dwellings for all its observers close by their instruments. It is estimated that with the observers living on the grounds of the new Observatory, not only will two or three times as much work be done as it will be possible to do otherwise, but the quality of this delicate work will be materially improved on account of the observers being in a proper physical condition to begin their labours, instead of with nerves unstrung from hurrying some miles from their homes immediately after meals, or at unreasonable hours of the night."

YALE ASTRONOMICAL OBSERVATORY.—Vol. i. Parts 3 and 4 of the publications of the Astronomical Observatory of Yale University contains (1) "A Triangulation of Stars in the Vicinity of the North Pole," by Prof. William L. Elkin, and (2) "Determination of the Orbit of the Comet 1847 VI.," by Miss Margaretta Palmer. With regard to the former paper, this was undertaken to determine the relative positions of some north polar stars to serve as fundamental points for a photographic survey of that region. Twenty-four stars, covering a considerable area, were selected for this work, and all the distances measured were large—that is, above 1000″. Out of 276 possible combinations of measuring the intermutual distances within the range of the heliometer, Prof. Elkin managed to employ 146, each combination undergoing three separate measurements. In the reduction of the measurements he gives full information as to the methods employed, showing the means of eliminating the systematic errors, &c., concluding with tables of the final results in Right Ascension and Declination and precessional tables. Miss Palmer prefaces her determination of the orbit of comet 1847 VI. with a short reference to its discovery and history, remarking that it is probably the only comet ever discovered independently by two women. Rumker in 1857 found the orbit to be of a distinctly hyperbolic nature, and the result of the present determination, by employing modern places for the sun and allowing for perturbations, &c., show that the observations can be best explained on the hypothesis of the hyperolic orbit, the new value for the elements differing slightly from the old ones.

GEOGRAPHICAL NOTES.

A COLONY only accessible through foreign territory is naturally unsatisfactory to its holders, and since the development of German South-west Africa, the inconvenience of having Walfish Bay as the only landing place for the interior has gradually increased. It is now announced that a new harbour has been found on German territory in the mouth of the Swartkop river. The stream is so small that it is marked on few general maps of Africa, and it may even turn out to be in the British sphere.

A PAPER for the next German Geographentag has been published in advance, by Prof. W. Koppen, under the title "Die Schreibung geographischer Namen." It deals in a very thorough manner with the principles which ought to regulate the orthography of place-names, and treats the whole matter of authoritatively published rules in a historical way from the first formulation of the Royal Geographical Society's Rules in 1885 to the new German rules (see NATURE, p. 89) adopted in 1892. Prof. Koppen has fully mastered his subject, and, from a thorough study of the phonetics of language, he has been able to formulate a scheme by which the Roman alphabet may be employed, with the aid of diacritical signs and groups of consonants, to represent almost every possible sound. The methods adopted in the official systems of the Royal Geographical Society and the German Colonial Office appear to the author of the pamphlet to be incomplete and unsatisfactory. The subject is one eminently adapted for full international discussion, and we hope that Prof. Koppen will not fail to bring the matter before the next international Geographical Congress.

POLAR exploration seems to have received a fresh stimulus, and we note with satisfaction the announcement in the American newspapers of Mr. Peary's new programme. He sails for Greenland in June, and will spend the winter not far from the site of his last winter's camp. A novelty in transport on the inland ice is to be the use of ponies shod with snow-shoes of a special pattern, experience in Alaska and Norway appearing to establish the practicability of the idea. The main object of the expedition is to survey the Arctic Archipelago immediately north of Greenland, and to determine the whole north coast of

the mainland Mr Peary has no theories, and expects to have to modify his plans according to circumstances He expects to reach higher latitudes than have previously been attained, but has no sentimental views as to reaching the pole The whole of the expense of the expedition he hopes to defray by his lectures and the book describing his last year's experience, which will be published in June

STROMBOLI[1]

ON June 24, 1891, an earthquake and volcanic explosion took place, followed by another shock on June 30 Some days after, the authors spent three days at Stromboli, and subsequently studied at their homes the materials they collected

The paper commences with a description of the island, which not only adds nothing to what has already been published, but is inferior to what has been described by others Mention is made of many changes during the last century, but great care is taken not to mention several writers who have described and illustrated the changes during the last few years The writer, who was the first to photograph the crater of Stromboli, and has since published new photographs, is not even referred to, yet those photos are the best so far published of the volcano It is regretable to see the frequency with which Prof Mercalli quotes himself to the exclusion of several of his own countrymen, and especially foreigners Since 1887, the single crater has been replaced by a number of cones which, according to the authors, are the same as those of 1889 I myself visited the crater in 1889, and those in the plates of this paper are very different in situation, which I can confirm by photos in my possession The matter is of little importance, but more care should be shown in such statements. Those who have a good practical experience of active volcanoes know how often, from day to day these central conelets change

The shock of the present eruption was quite local and was unobserved at Lipari It was much more violent on the upper part of the mountain than lower down, and the authors reasonably conclude that the explosion was limited to the actual crater Several landslips occurred on the crumbling slopes of the island A column of vapour and lumps of incandescent lava were ejected to a level with the summit of the island, that is for a height of 225 m Dust and lapilli were spread over the island though not to any great amount Lava immediately began to flow from a short rift

On June 30, another shock occurred, sufficiently strong to disturb the Milne seismoscopes of Lipari After the usual ejection of lava cakes, lapilli, stones, &c , another lava stream started from a point near the eastern mouths By July 6, when the authors visited the crater, the excessive activity had so diminished that no more lapilli or dust was being ejected Three currents of lava flowed down the Sciarra to the sea, and as one divided into two branches, four reefs were formed at the water-line which it appears are being rapidly swept away by the waves.

The microscopic and chemical examination of the lava shows it to be a basalt verging on an andesite with 50 per cent of SiO_2, with a little more potash than soda The scoria ejecta resemble the lava in composition, except so far as their different rate of cooling modifies them Besides the *essential*, some *accessory* ejecta were thrown out, which were old fumarolised materials from the new crater walls The dust, or ashes, as the authors call it, was partly composed of black vitreous particles and glass fibres mixed with a brownish powder from the trituration of older volcanic materials.

No relation was found to exist between the eruptive spasm of Stromboli with several earthquakes that occurred before and after. A list of known eruptions of Stromboli are given, but it is a most imperfect one; for example the eruption of 1768, which was actually figured by Sir William Hamilton in his masterly work, is not even referred to, although lava not only issued from the crater, but also from a lateral opening on the western side of the Stromboli, and also was the first recorded issue of lava from this volcano. This list is more complete of late years, there being no less than fourteen eruptions from 1879 to 1888. Prof Mercalli thinks there is a sympathetic action between the outbursts of Stromboli and Etna, and also the seismic foci of South Italy He likewise finds a faint relationship between the position of the sun and moon when in opposition and conjunction but not with barometric pressure, but says that the daily variation in activity may so be related, as stated by the inhabitants

H J JOHNSTON LAVIS

[1] "Sopra il periodo eruttivo dello Stromboli cominciato il 24 Giugno, 1891." By A Ricco and G Mercalli Con appendice dell Ing S Arcidiacono. *Ann. d. Ufficio C Met e Geodinamico* ser sec., pt iii, vol. xi 1889 (Paper printed 1892.)

FORTHCOMING SCIENTIFIC BOOKS

MR MURRAY has in preparation —"The Life of Prof Owen," based on his correspondence, his diaries, and those of his wife, by his grandson, the Rev Richard Owen, with portraits and illustrations, 2 vols , "Alone with the Hairy Ainu ; or, 3,800 Miles on a Pack Saddle in Yezo and a Cruise to the Kurile Islands, by A H Savage Landor, with map and numerous illustrations by the author , "A Manual of Naval Architecture," for the use of officers of the navy, the mercantile marine, ship-owners, ship-builders, and yachtsmen, by W H White, F R S , third edition, thoroughly revised and in great part re written, with 150 illustrations , "The Physiology of the Senses," by Prof John McKendrick and Dr Snodgrass, with illustrations (1) touch, taste, and smell (2) the sense of sight (3) sound and hearing , "Chapters in Modern Botany," by Prof Patrick Geddes, with illustrations , "The Philosophy of the Beautiful, Pt II ," by Prof Knight , "Logic, Inductive and Deductive," by Prof William Minto , "The Metallurgy of Iron and Steel," by the late Dr John Percy, F R S , a new and revised edition, with the author s latest corrections, and brought down to the present time, by H Bauerman, with illustrations

Messrs Longmans announce —"Theosophy or Psychological Religion," the Gifford lectures delivered before the University of Glasgow in 1892, by Prof F Max Muller ; "Telephone Lines and their Properties," by Prof W J Hopkins , "Essays on Rural Hygiene," by Dr George Vivian Poore , "Abdominal Hernia,' by John Langton, M R C S , "A Treatise on Electricity and Magnetism," by G W De Tunzelmann in 2 vols , "Papers and Notes on the Glacial Geology of Great Britain and Ireland," by the late Prof Henry Carvill Lewis, edited from his unpublished MSS , with an introduction by Dr Henry W Crosskey , "The Making of the Body, a Reading Book for Children on Anatomy and Physiology," with many illustrations and examples, by Mrs S A Barnett , "A Manual of Machine Drawing and Design," by David Allan Low (Whitworth scholar) and Alfred William Bevis (Whitworth scholar), with over 700 illustrations , "Diseases and Injuries of the Teeth, including Pathology and Treatment," a manual of practical dentistry for students and practitioners, by Morton Smale, M R C S , and J F Colyer, L R C P , "Cotton Weaving and Designing," by John J Taylor, "Clinical Lectures on Abdominal Hernia," chiefly in relation to treatment, including the radical cure, by William H Bennett, F R.C S , with twelve diagrams in the text "The Elements of Bacteriology," a manual for practitioners and students, by Prof S L Schenk, translated by Dr W R. Dawson, with 100 illustrations, some of which are coloured , "Esquimaux Life," by Fridtjof Nansen, translated by William Archer, with illustrations

Among Messrs Macmillan and Co 's announcements are —"William Kitchen Parker, F R S," a short memoir by his son, Prof T Jeffery Parker, F R.S , "Text-book of Pathology Systematic and Practical," by Prof D J Hamilton, Vol II , "A Uniform Edition of Prof Huxley's Essays," in 6 vols , comprising Lay Sermons, Addresses and Reviews, Critiques and Addresses, Science and Culture, American Addresses, Man's place in Nature, &c ; "Lectures on Sanitary Law," by A Wynter Blyth, M R.C S ; "A Text book of the Physiological Chemistry of the Animal Body," including an account of the chemical changes occurring in disease, by Prof Arthur Gamgee, F R S , with illustrations, Vol II , "Tables for the Determination of the Rock-forming Minerals," compiled by Prof F L. Loewinson Lessing, translated from the Russian by J. W Gregory, with a glossary added by Prof G A J Cole ; "Text-book of Geology," by Sir Archibald Geikie, F R S , with illustrations, third edition, thoroughly revised , "Atlas of Classical Antiquities," by Th. Schreiber, edited for English use by Prof. W C. F. Anderson , "The Soil in Relation to Health," by Henry A. Miers and Roger Crosskey , "Elementary Treatise on Modern Pure Geometry," by R Lachlan ,

"Exercises in Euclid," by William Weeks, "Utility of Quaternions in Physics," by Alexander McAulay

In the Clarendon Press list are —Locke's "Essay concerning Human Understanding," edited by Dr A C Fraser, "Mathematical Papers of the late Prof Henry J. S Smith, with portrait and memoir, two volumes, "A Supplementary Volume to Prof Clerk Maxwell's Treatise on Electricity and Magnetism," by Prof J J Thomson, F.R S, "A Manual of Crystallography," by Prof M H N Story Maskelyne, F R S, "Analytical Geometry," by W J Johnston, "A Treatise on the Kinetic Theory of Gases," by Dr H W Watson, new edition, "An Elementary Treatise on Pure Geometry," with numerous examples, by J W Russell, "Index Kewensis Nominum Omnium, Generum et Specierum, Plantarum Phanerogamarum,' '1735–1885, Part I, "Hospital Construction," by Sir Douglas Galton, F R S

Messrs. Swan Sonnenschein and Co's list contains — "Philosophy and Political Economy in their Historical Relations," by Dr James Bonar, "Appearance and Reality," by F H Bradley, "The Principles of Psychology," by G F Stout, "History of Philosophy," by Dr Johann Eduard Erdmann, translated and edited by Prof Williston S Hough, third edition, revised, three volumes, "A Student's Text Book on Botany," by Prof Sidney H Vines, F R S, copiously illustrated, "Text-book of Embryology Invertebrates," by Drs Korschelt and Heider, translated and edited by Dr E L Mark and Dr W M Woodworth, fully illustrated, "The Cell its Anatomy and Physiology," by Dr Oscar Hertwig, translated and edited by Dr H J Campbell, fully illustrated, "Text-Book of Palæontology for Zoological Students," by Theodore T Groom, fully illustrated, "Lectures on Human and Animal Psychology," by Prof Wilhelm Wundt, translated and edited by James Edwin Creighton and Edward Bradford Titchener, "Hand-book of Systematic Botany," by Prof E Warming, translated and edited by M C Potter, fully illustrated, "An Elementary Treatise on Practical Botany," by Prof E. Strasburger, translated and edited by Prof W. Hillhouse, with 149 illustrations, third edition, "The Photographer's Pocket Book," by Dr E Vogel, translated by E C Conrad, with 63 illustrations, "How Nature Cures," by Dr. Emmet Densmore, "Beauty and Hygiene for Women and Girls," by a Specialist, "A Popular History of Medicine," by Edward Berdoe, M R C S, "Introduction to the Study of the Amphioxus," by Dr B Hatschek and James Tuckey, illustrated, "Practical Bacteriology," by Dr Migula, translated and edited by Dr. H. J Campbell, illustrated, "Geology," by Dr Edward B Aveling, illustrated with a Geological Map and numerous woodcuts, "Zoology," by B Lindsay, illustrated, "Fishes," by the Rev H A Macpherson, "Flowering Plants," by James Britten, "Grasses," by W Hutchinson, "Mammalia," by the Rev H A Macpherson

Messrs George Philip and Son will publish —"Philip's Atlas Guide to the Continent of Europe," a series of 72 plates, with descriptive letter-press, by J Bartholomew, "Philip's Systematic Atlas for Higher Schools and General Use," a series of physical and political maps, with diagrams and illustrations of astronomy and physical geography, by E H Ravenstein, "Philip's Anatomical Model of the Human Body," illustrating the construction of the Human Frame and the relative positions of its various organs by means of superimposed plates printed in colours, "The Celestium, or Patent Astronomical Calendar for recording and illustrating in miniature the daily and hourly positions of the heavenly bodies as they pass through the Sign of the Zodiac"

Messrs. Percival and Co give notice of —"The School Euclid," an edition of Euclid, Books III to VI, with notes and exercises, by Daniel Brent, The Beginner's Text Books of Science. "Chemistry," by G Stallard, "Geology," by C L Barnes, "Electricity and Magnetism," by L Cumming, "Heat," by G Stallard, "Light," by H P Highton, "Mechanics" (treated experimentally), by L Cumming, "Physical Geography," by C L Barnes, "Practical Physics," an introductory handbook for the physical laboratory, in three parts, by Prof W F Barrett, Part II Heat, Sound, and Light Part III Electricity and Magnetism, Electrical Measurements, "Practical Lessons and Exercises in Heat for use in schools and Junior University classes, by A D Hall.

In Messrs. A and C Black's announcements we notice.—"Illustrated Text Book of Invertebrate Zoology," by A. E Shipley; "History of Astronomy during the Nineteenth Century," by Agnes M Clerke, third edition, revised and enlarged, "Algebra, an Elementary Text Book for the Higher Classes of Secondary Schools and Colleges," by Prof George Chrystal, Part I, third edition

Messrs Crosby Lockwood and Son have in hand —A new and enlarged edition (the third) of Prof R Wallace's "Farm Live Stock of Great Britain," containing additional phototype engravings of notable specimens of live stock, and a new volume by Prof Sheldon on "British Dairying"

Mr Walter Scott will issue in the "Contemporary Science Series" —"Modern Meteorology," by Dr Frank Waldo, with 112 illustrations

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford —Two Radcliffe Travelling Fellowships, each of the value of £200 per annum, and tenable for three years, have been awarded this week One, which has been gained by Mr F A Minchin, of Keble College, was thrown open last year to candidates in all branches of science, and the usual declaration that the Fellow intends to graduate in medicine and to travel abroad with a view to his improvement in that study has been dispensed with Mr Minchin was placed in the first class in the Honour School of Natural Science (Morphology) in 1890 The other Fellow, Mr W. Ramsden, of Keble College, is subject to the usual conditions attached to these Fellowships Mr Ramsden obtained a first class in Natural Science (Physiology) in 1892

The new laboratories for the department of human anatomy are rapidly approaching completion, and will, when finished, add very much to the convenience and advantages of medical students The buildings have been designed after the plans of Mr. Arthur Thompson, and include a large dissecting room and several additional laboratories and private rooms, a lecture theatre, and a large basement

Cambridge.—The Council of the Senate report that the Royal Geographical Society have renewed their generous offer to provide £150 a year as part of the stipend of a geographical lecturer for the ensuing five years, and to award biennially exhibitions or prizes for the encouragement of geographical research in the University. The Council recommend that the proposals of the society be accepted, and that a lecturer be appointed, under the supervision of a joint committee of management, before the end of the Easter Term, 1893

The Sedgwick Memorial Syndicate report that they have made certain alterations in the plans for the proposed Geological Museum in Downing Street, with a view to meeting objections that were raised and to reducing somewhat the cost of the building The Syndicate ask to be authorised to obtain tenders for the immediate construction of the museum

SCIENTIFIC SERIALS

American Meteorological Journal, February —Hot winds in Texas, May 29 and 30, 1892, by I M Cline. Hot winds occur to some extent every year, but rarely with sufficient intensity to injure vegetation It was estimated that in the present case 10,000 acres of cotton were destroyed, and corn suffered severely The temperatures reported ranged generally from 90° to 100°, and in some parts from 105° to 109°. These winds appear to have resulted from the same causes which produce the Fohn in Switzerland, the descent of dry air which has deposited its vapour during its ascent —The electrification of the lower air during auroral displays, by A McAdie The author gives an account of some experiments made at Blue Hill observatory, for obtaining, by means of a kite flown during thunderstorms, a better record of the potential of the air than could be given by a collector near the ground, by which plan some remarkable results were obtained, and he suggests similar experiments for showing the electrification of the lower air during displays of aurora. He also proposes a new classification of the various auroral phenomena, distinguishing between the highly coloured displays, and those of less intensity, which probably occur in the lower atmosphere —Practical koniology, by Prof. Cleveland Abbe. He applies this term to the study of atmospheric dust and floating germs, and shows how their injurious effects on

certain industries may be obviated —The sling psychrometer, by Prof H A Hazen, and the aspiration *versus* the sling psychrometer, by A. L Rotch Both papers deal with the comparative merits of the two instruments for balloon observations

Wiedemann's Annalen der Physik und Chemie, No 2 — Among the papers in this number are the following —A modified astatic galvanometer, by H E. J G. du Bois and H Rubens. To minimise the effects of disturbing vibrations as producing false oscillations about a vertical axis, the suspended system is given perfect "inertia symmetry" about the axis of the fibre, and all flat parts of it are distributed so as to have equal areas in two mutually perpendicular planes Quartz fibres are used for suspension —Bolometric investigations of the grating spectrum, by F. Paschen —The fundamental law of complementary colours, by Paul Glan To determine the amount of light absorbed by the pigment of the yellow spot during transmission to the optically sensitive nerves, two candles of equal luminosity were observed with one eye through glasses of various colours, the one direct, and the other at such an angle that its image fell outside the margin of the yellow spot The candles were shifted till both appeared equally bright, and their respective distances were measured Taking the coefficient of absorption for red light as = 1, that for yellow (5828) was 0 889, for wave-length 5222 it was 0 171, 4856 (blue) 0 269, and for white light 0 424 In this way the conclusion was arrived at that the intensities of complementary colours reaching the retina must be equal in order to give the impression of white —Experiences with the self-acting mercury pump, by A. Raps Several improvements are described, tending to make the working more rapid It was found that the fear of contaminating the mercury by the use of black flexible india-rubber tubes was unfounded

SOCIETIES AND ACADEMIES

LONDON

Entomological Society, February 22 —Mr Henry John Elwes, President, in the chair —Mr F J Hanbury exhibited, on behalf of Mr Percy H Russ, of Sligo, several long and very variable series of *Agrotis tritici*, *A valligera*, and *A cursoria*, together with Irish forms of many other species, some of which we believe to be new to Ireland Mr W H B Fletcher made some remarks on the species —Mr R W Lloyd exhibited specimens of a species of *Acarus* found in New Zealand wheat He stated that Mr A D Michael had examined the specimens, and pronounced them to belong to *Tyroglyphus farinæ*, a species which had been known for over a hundred years as a destroyer of corn, and was only too abundant all over Europe, and probably over the temperate regions of the world —Mr E B Poulton, F R S, exhibited, and made remarks on, a number of cocoons of *Halias prasinana*, in order to show the changes of colour produced in them by their surroundings, he also exhibited the coloured backgrounds employed by him in his recent experiments on the colours of larvæ and pupæ, and illustrated his remarks by numerous drawings on the blackboard —Dr T A Chapman exhibited by means of the oxy hydrogen lantern, photographs of the larva of *Nemeobius lucina* in its first stage, showing the conjoined dorsal tubercles, each carrying two hairs, which are remarkable in being divided into two branches. For comparison he also showed, by means of the lantern, drawings of the young larva of *Papilio ajax*, after Scudder, and of a portion of a segment of *Smerinthus populi*, as the only instances known to him of similar dichotomous hairs in lepidopterous larvæ. Mr Poulton pointed out that he had described the forked hairs of *Smerinthus* in the Society's "Transactions" for 1885, and that such hairs were even better developed in the genus *Hemaris* originally described, as he believed, by Curtis. Mr Poulton, also said that he had noticed similar forked hairs covering the newly-hatched larvæ of *Geometra papilionaria* —Dr. Chapman read a paper—which was illustrated by the oxy-hydrogen lantern —entitled "On some neglected points in the structure of the Pupa of Heterocerous Lepidoptera and their probable value in classification." A discussion ensued, in which Mr. Poulton, Mr. Champion, and Mr Merrifield took part.—Dr F. A. Dixey communicated a paper entitled "On the phylogenetic significance of the variations produced by differences of temperature on *Vanessa atalanta*." The President, Mr. Merrifield, Mr Poulton, Dr. Chapman, and Mr Tutt took part in the discussion which ensued.

Zoological Society, February 28 —Sir W H. Flower, F R S, President, in the chair —Mr A. D Michael exhibited some specimens of the *Ixodes*, known locally in the West Indies as the "St Kitts" or "Gold Tick," received from Mr. C A Barber, of the Agricultural Department, Antigua.—A communication was read from M A Milne Edwards respecting *Lemur nigerrimus*, Sclater, a species of lemur originally described from an example living in the Society's Gardens It was pointed out that *Prosimia rufipes* of Gray had been based on a female of this species —Mr Howard Saunders exhibited and made remarks on a specimen of the American stint (*Tringa minutilla*), shot at Northam Burrows, North Devon, by Mr Broughton Hawley, in August, 1892 —Mr Sclater (on behalf of Mr R. M Barrington) exhibited a specimen of the Antarctic Sheathbill (*Chionis alba*), killed at the Carlingford Lighthouse, co Down, Ireland, in December last —Dr C J Forsyth-Major read a memoir on some of the miocene squirrels, and added remarks on the dentition and classification of the *Sciuridæ* in general The author proposed a new division of this family into three subfamilies—Sciurinæ, Pteromyinæ, and Nannosciurinæ The genera *Spermophilus* and *Arctomys* and the allied forms were united to the Sciurinæ The last part of the paper dealt with the primitive type of the Sciurine molar —Mr Henry O. Forbes read a paper entitled "Observations on the Development of the Rostrum in the Cetacean Genus *Mesoplodon* with remarks on some of the Species" Mr Forbes showed that in this genus the vomerine canal in the young animal is filled with cartilage, and in the adult with a dense petrosal mesorostral bone From the examination of thirteen specimens of *Mesoplodon grayi* and four of *M layardi*, of which he had made a large number of sections in various stages of growth, the author concluded that the mesorostral bone was not, as had been generally believed, an ossification of the cartilage, but an actual growth of the vomer and of the premaxillaries, with perhaps, in some cases, additions from the ossification of the cartilage of the vomerine spout. The cause of the growth in the vomer might be accounted for by the pressure communicated to it by the growth of the premaxillaries, induced, perhaps, by the movement, which appears to take place, of the maxillaries over the premaxillaries

Linnean Society, March 2 —Prof Stewart, President, in the chair —Mr Miller Christy exhibited some photographs of the American bison taken from living wild animals, and gave some account of the present restricted distribution of the species Mr A G Renshaw and Mr W Carruthers detailed what they had been able to learn respecting it while travelling in its former haunts —Mr J M Macoun gave an account of the flora of the Behring's Sea Islands from personal exploration —On behalf of Mr H N Ridley the Secretary read a paper on the flora of the eastern coast of the Malay archipelago —The meeting then adjourned to March 16

Anthropological Institute, February 21.—Prof A. Macalister, F R S, President, in the chair —A paper, by Mr E H Man, on Nicobar pottery was read He stated that the little island of Chowra has held for generations a monopoly of the manufacture Preparing the clay, and moulding and firing the finished utensil, devolves on the females The value of trade marks is recognised, the device of its maker being affixed to each vessel. Experience having taught them that pots are more serviceable if allowed to harden gradually, they store newly-made utensils on a lattice platform in the roofs of their huts. In a year the heat and smoke render them hard and durable Indian pots and jars are readily purchased from the traders, who occasionally visit the islands, but they are deemed unsuitable for certain culinary operations There are no special vessels made for funeral purposes, but, in accordance with the almost universal custom of uncivilised races, cooking pots are among the personal and household requisites which are laid on a grave after an interment —A paper, by Lieut. Boyle, T Somerville, R N., on some islands of the New Hebrides was read The habits of the natives of adjacent islands sometimes vary exceedingly, and in this paper reference was made only to a small portion of the group, including the Efate Islands, the Shepherd Islands, and the East Coast of Malekula. A child calls all his uncles on both sides, "father," all his aunts, "mother," and his first cousins on both sides, "sister" or "brother" A man cannot marry a woman of his own tribe, and the children belong to their mother's tribe; the property of their father going, at his death, to his sister's children It sometimes happens that a man will

call a small girl much younger than himself "mother" Circumcision takes place between the ages of five and ten Till then a boy goes naked, but afterwards he is costumed like the men When a Malekulan is old and decrepit, he has nothing to look forward to but burial alive Should an old person become bedridden, or a burden, he or she is told quite simply that his or her burial will occur on such a day Invitations to the funeral feast are then sent out, and, dead or not dead, on that date the unhappy person is buried

PARIS

Academy of Sciences, February 27 —M de Lacaze Duthiers in the chair —On the attempt at oyster culture in the Roscoff laboratory, by M de Lacaze Duthiers In April, 1890, a set of seed oysters were introduced into a tank in the grounds of the observatory, which lies opposite Batz Island, in the Channel They were always submerged, but exposed to tidal changes of level In a year they had acquired a considerable size, but had not yet "fattened" Last November they had a size and flavour which, in M Chatin's opinion, surpassed the qualities attained in any other locality along the coast, although in the warmer months preceding (the months without R) they had shared the decline common to all oysters at that period It was also found that the oysters in the tank acquired longer "beards," and also increased in length, whilst others cultivated on the shores of Batz Island, and often left dry at low water, were more developed in the direction of thickness As regards reproduction, the results have been fairly favourable, although definite data have not yet been obtained In one case, where part of the tank water had been pumped into a reservoir used for supplying an aquarium, some embryos were drawn up through the pipes, and fixed themselves on the wooden level-ball, where a colony of about a dozen well-developed oysters was subsequently found, some of which now measure 6 cm across —On the exact determination of the pepto saccharifiant action of the organs, by MM R Lépine and Metroz —On the photographs of the moon enlarged by Prof Weinek, by M Faye These photographs are enlargements by twenty times of some of the Lick photographs of the moon, obtained by an exposure lasting several days On their being exhibited, several members expressed their opinion that they had been retouched —On the urea contained in the blood in cases of eclampsia, by M L Butte It is found that in cases terminating fatally the amount of urea contained in the blood is less than in cases of recovery, owing to hepatic alterations, which in the former cases impair the secretion of urea From the point of view of prognostication, therefore, recovery can be anticipated if the amount of urea is two or two and a half times the normal amount, but a fatal issue if the amount closely approximates to the physiological figure —On the general problem of integration, by M Riquier —On certain differential equations of the first order, by M Vessiot. — Remarks concerning a preceding note on a generalisation of Lagrange's series, by M E. Amigues — Physical properties of fused ruthenium, by M A Joly (see Notes) —On Stas's determination of the atomic weight of lead, by M G Hinrichs. In Stas's determinations of the atomic weight from the sulphate and the nitrate the weight of substance taken, according to M Hinrichs, enters as a continuously changing element into the result, owing to a systematic error in Stas's arrangement In plotting the atomic weights in terms of weight of substance taken, curves are obtained showing a minimum at about 150 gr The method of averages is therefore inadmissible, and a new method is promised in a forthcoming communication —On the aldehydes of the terpenes, by M. A. Étard —On the constitution of hydrated alkaline phosphates, by M de Forcrand —On the alkaloids of cod-liver oil, their origin and therapeutic effects, by M J. Bouillot —On a pathogenic microbe of blennorhagic orchitis, by MM L. Hugounenq and J Eraud —Crustacea and cirrhipeds commensal with the Mediterranean turtles, by MM E Chevreux and J de Guerne.—On a terrestrial leech of Chili, by M Raphael Blanchard. This animal, which has been named *Mesobdella brevis*, forms a link between the Glossiphonidæ and the Hirudinidæ. Among the latter it approaches most closely the Hemadipsinæ by its mode of living and its ten large black eyes, but differs from the whole family by the great condensation of its somites.—Mineralogical and lithological examination of the meteorite of Kiowa county, Kansas, by M. Stanislas Meunier The metallic portion presents two principal alloys of iron and nickel, which an attentive study has succeeded in characterising: Tænite (Fe_6Ni) and plessite ($Fe_{10}Ni$) In composition it agrees closely with the entirely metallic type called jewellite, but it differs from the latter in structure Apart from the peridotic portions the mass consists of lamellæ of tænite arranged in bundles which frequently intersect at the angles of the octahedron The intervals are filled up with plessite which may be distinguished at once by its dark grey colour, contrasting with the polished steel tint of the other alloy Some specimens of the meteorite show quite exceptional characters With the usual structure and cohesion they are formed of opaque black mineral grains cemented by a network of oxidised iron These have probably been produced by an alteration of the normal specimens, in which the metallic skeleton has been oxidised

GOTTINGEN.

Royal Society of Sciences —From July 27 to December 28, 1892, the following papers of scientific interest have appeared in the *Nachrichten* —

July —Drude Current theories of light practically tested —Ehlers On *Arenicola marina*, L (five pages) —Rhumbler The so called germ spherules (Max Schultze) of *Foraminifera* (these are stated to be merely deposits of iron silicates) —Nernst The change of free energy in the mixture of concentrated solutions —Hilbert Third note on algebraical invariants

September.—Fricke A general arithmetical principle in the theory of automorphic functions —Kohlrausch On the influence of time upon solutions of sodium silicates

November —Peter Botanical work in the summer of 1892 —Voigt On a problem in fluid motion —Sella and Voigt The rupture coefficient of rock salt —Kallius The neuroglia cells of peripheral nerves

December —Wagner · The third (Peter Apian's) map of the world (1530)

CONTENTS.

THURSDAY, MARCH 16, 1893

MACPHERSON'S FAUNA OF LAKELAND

A Vertebrate Fauna of Lakeland, including Cumberland and Westmoreland, with Lancashire North of the Sands By the Rev H A Macpherson, M A, with a Preface by R S Ferguson, F S A (Edinburgh D Douglas, 1892)

INTRODUCED to the vocabulary of naturalists by Mr H Cottrell Watson, more than fifty years ago, and that in the most prosaic way, the word "Lakes," as the name of an English district, still keeps its poetic fragrance, which is perhaps even intensified by its modern modification into "Lakeland," notwithstanding the very technical prefix, as in the title of this book, of "A Vertebrate Fauna" One is naturally led to think of that school of versifiers whose early efforts excited so many conflicting feelings when the century was young, but whose later lays have at length brought conviction of their worthiness to the minds of most One of their company, he who furnishes the motto of this journal, has especially been hailed as *the* Poet of Nature, and not only does the fame of Wordsworth wax yearly, but there are those who greet every line he wrote with adulation To such admirers the author of the book before us will seem to have missed his opportunity, in that we fail to find in the whole volume any indication of the penultimate Poet Laureate having ever belonged to the "Vertebrate Fauna of Lakeland." Does this signify that naturalists are not poetical or that the great "Poet of Nature" was not a naturalist? The question is so momentous that we leave it for consideration by our readers, not daring to vouchsafe a reply, nor venturing to suggest to Mr Macpherson that he has been wrong in resisting the temptation to illustrate his work by quotations, that might be gathered by the handful from the thousands of verses which flowed from the pen of the "bard of Rydal," or any of his brethren

We must acknowledge that we took up this volume with a slight prepossession against it We did not see why Mr Macpherson, already the joint author of a well-known and well-esteemed little book on the "Birds of Cumberland," to say nothing of various contributions to Natural History journals, should need a preface for his new work by a gentleman who—whatever may be his legal and antiquarian renown (which we believe to be not small)—is entirely unknown as a naturalist, and it seemed to us as though a kind of sub-episcopal *imprimatur*, which would be derogatory to a man of science, had been sought from the Chancellor of the diocese of Carlisle We have been glad to find this suspicion, perhaps ill-natured in its inception, wholly unfounded as we became acquainted with the contents, and we hereby make confession of our error, duly cautioning all others, and there may be a good many of them to whom the same thought may occur or have occurred, that any such hesitation is unnecessary The Preface, it is true, contains a benediction, but none can say it is a benediction that is undeserved The book is a real honest book, and one that no true zoologist can fail to discover has been wrought at with conscientious care, unbounded labour, and a deep sympathy with the subject We are not going to hold it up as a model "Fauna", there is evidence, notwithstanding what we have just said, of too much haste in its composition for that, but it certainly belongs to the first class of books of its kind, while, should it be the author's good fortune to have another edition demanded, a severe revision might give it a high place in that class We do not assume ourselves to be purists in style, but it does seem to us that the English language, as written by men of acknowledged literary merit, is wide enough to cover every shade of meaning, without the least necessity of bringing in words or phrases that border upon slang, and certainly without using slipshod expressions that, if not altogether inappropriate, are in many cases vague and therefore unseemly in a book that may fairly claim to rank among scientific works We assure the author in all good will that these shortcomings, which might be so easily remedied, greatly diminish the pleasure we derive from reading his volume

Apart from Mr Ferguson's scholarly Preface, the book opens with more than one hundred pages of Prolegomena, and we are mistaken if the greater part of these will not prove to have greater interest for that incomprehensible person the General Reader than all that follow—the particulars given in the bulk of the volume being mostly of especial and local value Not that we use this last epithet in any invidious sense, for what should a local Fauna be but local? and Mr Macpherson has avoided a great error (into which the authors of some modern local Faunas have fallen), by rightly taking it for granted that the zoological readers who will use his book do not want to be instructed on points or matters concerning which they can obtain full information from many other and more original sources, and thus he is able to husband his space for particular details, which are given in most cases with great precision But first of these Prolegomena aforesaid—They begin, as every book of this sort ought, with what is practically a history of the subject, for it is a biographical notice of former Lakelandish worthies who have contributed to the Vertebrate Zoology of their district, and of these there is a good show, though there is no wonder that the earliest writers on the subject should possess but little scientific knowledge It is not every county that can produce a Willughby, a Sir Thomas Browne, or still less a John Ray—but probably the earliest of the naturalists celebrated by Mr Macpherson were the equals of Charleton, Plot, or Leigh—all men worthy to be praised in their own line Yet setting aside these lesser lights, many of whom are lost to view in the glare that radiates from their successors, the two Heyshams (John, born 1753, died 1834, and Thomas Coulthard, born 1791, died 1857), and the two Goughs (John and Thomas, whose joint lives cover all but a century and a quarter, 1757–1880)—in each case father and son—were men deserving commemoration in any county, and the biographical notice of all four, written in excellent taste, will be gladly read by many who are not naturalists at all. For our own part we cannot help wishing that these biographical details had been longer, but the papers of the elder Heysham are not forthcoming, neither is the manuscript Cumberland Ornithology, which the younger is supposed to have left at his death The former, if still

existing, would no doubt throw much light on more than fifty years of Cumbrian Natural History, but most likely everything of value in the latter was communicated to Bell or Yarrell, with whom its author was in frequent correspondence, and during his later years he led a life of seclusion The elder Gough was an extraordinary instance of a naturalist successfully pursuing his vocation under a grave difficulty, for the like of which we can only call to mind Huber and M Van Wickevoort-Crommelin, since at an early age he became blind from small-pox, and if he was thereby disabled from advancing investigation according to his bent, it did not hinder him from training his son to follow his footsteps and indoctrinating him with so wide an attachment to science that he became an intimate friend and correspondent of Sedgwick the geologist and of Cornelius Nicholson the antiquary, establishing with the latter's aid the Kendal Literary and Scientific Institution The pious duty of celebrating his predecessors' obsequies being performed, Mr Macpherson next turns to other extinct mammals of Lakeland, and his researches respecting the Wolf (an entire skeleton of which, found in a cave by Mr John Beecham, is preserved in the museum at Kendal) and the Wild Boar have been rewarded by the discovery of documentary evidence not without interest, even if it does not add much that is of value to our information concerning these ancient beasts We have too some facts in relation to the Red Deer and the Wild Ox, though more is said of them, and some of it is of importance, in the body of the work (pp 50–76), and we do not see why the former at least of them should be called extinct, seeing that though greatly restricted in range it still exists in freedom, while the latter, whose right German name Mr Macpherson persistently curtails, misspelling it "Auroch" for *Aurochs*, was undoubtedly the ancestor of the white breed, of which the last herd in the district, having been emparked at Thornthwaite near Haweswater, was removed in or soon after 1630 to Naworth, and by 1675 had ceased to exist A chapter devoted to "The Destruction of Wild Animals" will be instructive reading to many people It contains what will be a revelation to those who can appreciate the facts of "how not to do it" Our excellent forefathers (and many of their descendants are not much wiser) knew very little of the way in which wild beasts could be extirpated, and consequently the warfare against them lasted for centuries Some few, still accounted enemies of the human race, yet defy their persecutors, but the greater number have perished, and in the present depleted state of the Mammalian Fauna of the British Islands, it would be inexpedient to point out how the extinction, at least in parts, of some two or three species might be accomplished in perhaps twice as many years The average gamekeeper (fortunately or not) has very little knowledge of zoology, and the average master even less. On this particular we have no wish to enlighten either, so we shall preserve a silence that all animals' friends will admit to be golden. But we must always remember that by far the most destructive four-footed "vermin" of our day is religiously and rigorously preserved by a general sentiment, so much stronger than any law, in a way that would have caused to wonder those who "kenned John Peel" and his forefathers. In favour of Mr Macpherson's next treatise on the Variation of colour in Animals not much is to be said, and this *capitulum* will disappoint most who consult it, while we take leave to observe that though many authorities are cited from the *Carlisle Patriot* of these times to Dr Caius of 1570, that learned man assuredly never wrote a book with a title so tautological as "*De rariorum animalium et avium stirpibus*," which must have been taken (p. lxxvi, note) at second hand from one of the popular writers, who imagine that birds are not animals and do not know the technical meaning of *stirpes* Albinescent specimens if not albinos have, it is well known, a great charm for some collectors—why, scarcely any reasonable being can say—and it is of them that our author chiefly discourses (using too a word—"leucotism"—quite unfamiliar, but apparently meaning the same as the recognised "albinism") though so far as we know little scientific interest attaches to them, but we do not quite see the point of his remarks (p lxxviii) on "the tendency in the direction of variation" of the Lakeland Viper He only mentions two examples, and what are they among so many? Nevertheless the one figured is strange-looking enough, and it would have been satisfactory to be assured that there can be no mistake in the determination of the species The succeeding chapter is devoted to Hybrid Birds, but here again we find not much of interest in a general way on that little-known and extremely interesting, not to say important, subject Mr Macpherson has been so fortunate as to see more than one wild hybrid between the two British species of Sparrow (*Passer domesticus* and *P montanus*) and considering that these are species in what some would call the "physiological" sense—the sexes being outwardly alike in the latter and wholly different in the former—the question deserved further attention than is bestowed upon it (pp lxxx—lxxxi)

More instructive is what follows on "Bird Fowling" (as the author redundantly terms it) or rather we should say more instructive it might be There is mention (p lxxxviii) of the netting of Razorbills and Guillemots on the rocks of St Bees', taken, we are told, from the "Sandford MS p 18," but where this manuscript is to be seen or of what age it may be we are not told, and the language of the passage quoted only shows that it is not exactly of yesterday Now the netting of *Alcadæ* is not, so far as we are aware, known to have been practised elsewhere in Britain, and Mr Macpherson says the custom is obsolete in Cumberland, probably from there not being birds enough left to make its continuance worth the while of the "Hivites," for it may be accepted as a universal rule that the taking of birds at their breeding haunts year after year, unless under such conditions as St Kilda presents, must end in their diminution and may easily be carried on to their extinction

For the rest of the Prolegomena there is no need to say anything, and we willingly pass over the useless representation (p xcvi) of the Polish Swan's trachea, though we congratulate Mr. Macpherson on being able to figure (p cii) the foot of a real Westmorland Sea-Eagle, not a mere "marauder from over the border"—as most of the examples killed in England are—but a mournful relic for all that.

Into the details of Lakeland species we shall not attempt to enter To criticise that portion of the volume

the critic should have nearly as much local knowledge as the author, and we pretend to none To some though not to a great extent the besetting sin of nearly all "Faunists" is evident, and that is the tendency to exalt the importance of the capture of stray individuals, this especially among birds The occurrence of these wanderers is undoubtedly worth recording, but that a zoologist should claim consideration for Cumberland because a *Saxicola isabellina* was shot there, or for Furness because a *Pelagodroma marina* was washed up on Walney, is an indication that he takes rather a narrow view of things—though we are bound to admit that Mr. Macpherson at the same time descants on the merits of the Wheatear as a characteristic Lakeland bird, and, especially as befits one by descent "servile to *Skyey* influences", laments the almost complete absence from the Lakeland seas of the Manx Puffin, due no doubt to its extirpation in the neighbouring island, or its Calf, that gives it an English epithet nowadays inappropriate Indeed there is no fault to find with our author in his sympathy for the *true* denizens of his district, and the highest praise is due to him for the labour he has exercised, of which almost every page bears witness, in telling their story To wind up we must add, what perhaps we ought to have said before, that for the purpose of this work "Lakeland" consists of the counties of Cumberland and Westmorland, together with that part of Lancashire known as Lancashire Over-Sands, being identical, the Isle of Man excepted, with the "twelfth Province" of Mr Watson's *Cybele Britannica*, but the want of a map of the entire district is a grievous drawback, for which even the dozen or more excellent etchings, showing as many places of interest, do not wholly make amends

THE EVOLUTION OF DOUBLE STARS

Die Entwickelung der Doppelstern-Systeme. Von T. J. J. See 60 pp (Berlin R Friedlander und Sohn, 1893)

THE essay which we review is a dissertation for the doctorate of philosophy of Berlin, and the author, Mr See, is an American, although he writes in German

The component stars in double systems appear to be usually of comparable magnitudes, and are found to move in highly eccentric orbits This case the author holds to be the normal one, whilst the solar system, with its one preponderant mass, and its nearly circular orbits, would be exceptional.

He attributes the observed high eccentricity of orbit to the influence of tidal friction, and accordingly the greater part of the paper is devoted to the consideration of the results which will ensue from the supposition that each of two bodies raises in the other tidal disturbances, which are subject to frictional resistance.

If the rotations of the two bodies differ in speed, the problem is an insoluble one, without some postulate as to the law of the frictional resistance The author is, however, of opinion that sufficient insight may be gained from the solution in the case where two equal bodies rotate with equal speed. This opinion seems justifiable, but it might have been well if the dynamical stability of equality of rotations had been explicitly pointed out. That there is such stability is clear from the consideration that, if one of the bodies rotates more rapidly than the other, it is subjected to a more rapid retardation of rotation, and there is accordingly a tendency towards the restoration of equality

The influence of tidal friction on the elements of the orbit of a satellite and on the rotation and obliquity of a planet have been investigated in my several papers, and Mr See here adapts my conclusions to the case of the double tidal friction of two stars The adaptation is not difficult, for whilst the rate of change in the rotation of each star remains the same as though the other did not rotate, the rates of change of the elements of the orbit are exactly doubled Mr See has then redrawn the curves which exhibit the gradual transformation of the system, and, as might have been expected, finds them to have features closely similar to those of my curves

The generality of these solutions is limited by the supposed smallness of the eccentricity and of the inclinations of the orbit and of the two equators to the plane of reference The author, however, then passes to a second case, which is more special in that the equators of the stars remain coincident with the plane of the orbit, but which is more general in that the eccentricity is not treated as being necessarily small The object is to obtain a numerical solution of the following problem —Two equal stars, each of three times the sun's mass, revolve in a nearly circular orbit at a distance equal to that of Neptune from the sun, and the rotation of each star is nearly equal to its orbital motion, it is required to find the greatest mean distance and the greatest eccentricity of orbit to which the system will change under the influence of tidal friction

Mr See solves this problem by methods analogous to those which I have employed, and finds that the mean distance will increase from 30 (Neptune's distance) to 50, and that the eccentricity will increase from an assumed initial value of one tenth to a maximum of about three-fifths, which is attained a little earlier than the maximum of mean distance

It may be remarked that these results can only be very rough approximations to the truth, because the calculation is conducted on the supposition that the moment of inertia of each star is the same as that of a homogeneous sphere of the same mass and radius, whereas it is obvious that the stars would really be highly condensed spheroids of great oblateness

It is to be regretted that the calculation has not been repeated with variations of the assumed initial conditions It is easy to see that a change in the assumed degree of concentration of the stars would give very different results Supposing, for example, the stars had had only half the diameter assumed, the rotational moment of momentum would have had a quarter of its value in Mr See's example. Now the enlargement of orbit is due to the transference of rotational to orbital moment of momentum, and thus the transferable moment of momentum would only have amounted to one quarter of its former value. But the orbital moment of momentum varies as the square root of the mean distance, and hence the enlargement of the orbit could not have been so much as one-sixteenth of its former value. We may feel sure that

the increase in the eccentricity of orbit would also have been largely reduced

Notwithstanding this criticism, it appears to me that Mr See fairly establishes the proposition that a high eccentricity is explicable by means of tidal friction

Turning, then, to the question of the relative masses of the components of double star systems, Mr See remarks with justice that the comparable brightness of the components renders it highly probable that the masses are also comparable, and he sees in certain results of M Poincaré and of my own an evolutionary explanation of this fact

Jacobi first showed than an ellipsoid of homogeneous fluid, with its three axes bearing to one another proper proportions, is a figure of equilibrium when it rotates about its smallest axis with a proper angular velocity M Poincaré next showed that if the length of the Jacobian ellipsoid exceeds the breadth in a certain ratio, the equilibrium becomes unstable, but that there is a stable figure which may be described as a Jacobian ellipsoid with a furrow nearly round the middle, so that it resembles an hour-glass with unequal bulbs If we trace the further development of the hour-glass we find its neck gradually thinning, and finally rupturing the figure of equilibrium, henceforth consists of two detached masses

My own attack on this problem was from the opposite point of view, for I endeavoured to trace the coalescence of a pair of detached masses so as to form an hour-glass or dumb-bell.

Mr See reproduces the figures illustrative of both these investigations, and remarks that they both show that when there is a gradual detachment from a rotating figure of equilibrium, the detached portion will not normally be a ring, but that there will ensue two quasi-spheroidal masses of matter of comparable magnitude He also remarks that if the fluid be heterogeneous, the ratio of the masses will be much smaller than when it is homogeneous

In the discussion of these figures of equilibrium the wording of the essay appears a little careless, for it might naturally be supposed to mean that increase of angular velocity is a necessary concomitant of the rupture of the neck of the hour-glass Now it is a somewhat paradoxical fact that, with constant density, the longer elongated figures of equilibrium rotate more slowly than the shorter ones, and it might therefore seem that the rupture of the neck should go with retardation of angular velocity But it is the value of the square of the angular velocity divided by the density which determines the length of the elongated figures, and thus increase of density tells in the same way as retardation of angular velocity In the history of a nebula the only condition for rupture which can be specified is that of contraction

The probability of this view of the genesis of double stars is strikingly illustrated by a number of drawings by Sir John Herschel of various nebulæ The great similarity between Herschel's nebulæ and the theoretical hour-glass is obvious It may be hoped that in the book which Mr See promises he will also illustrate this point by photographs

Annulation is usually accepted as the mode of separation in the nebular hypothesis, but, as already stated, this is held by Mr See to be exceptional He thus regards the ring of Saturn as being as exceptional in its history as it now is in appearance. Where he maintains that Saturn's ring will never coalesce into a satellite, he might with advantage have referred to the remarkable investigations of M Roche,[1] who showed that a satellite would be torn to pieces by tidal action if it revolved at a distance of less than 2·44 times the planet's radius We may here note the interesting fact that whilst Saturn's ring almost touches "Roche's limit" on the inside, the Martian satellite, Phobus, and the fifth satellite of Jupiter[2] almost touch it on the outside[3]

In order to prove his thesis as to the highness of the eccentricity and the comparability of masses, Mr See gives a careful table of the observed elements of the orbits and of the relative brightnesses of seventy-three pairs of double stars The values of the elements are of course open to much uncertainty, but the mean eccentricity, which is found to be ·45, must lie near the truth In the few cases in which the masses have been determined, they are found to be comparable, and the comparability of the brightnesses confirms the generality of this law. Thus the facts of observation agree with our author's ideas

Mr See must be congratulated on having written an essay of great cosmogonical interest, and although his theory may never be susceptible of exact proof, yet there is sufficient probability of his correctness to inspire us with fresh interest in the observations of double stars

G H. DARWIN

MAGNETIC INDUCTION IN IRON AND OTHER METALS

Magnetic Induction in Iron and other Metals By J A. Ewing, F R S (London *Electrician* Office)

IN this admirable book Prof Ewing has brought together matter which was before to be found only in the journals of learned societies, and he has also given a full account of his own researches in magnetism. The book is written in a lucid style, and is supplied with numerous references to original papers

In Chapter I Prof Ewing explains clearly the meaning of such terms as "intensity of magnetisation" and the like, which many students have difficulty in understanding As stated in the preface, he has "endeavoured to familiarise the student with the notion of intensity of magnetisation (I) as well as with the notion of magnetic induction (B)" When endless magnetic circuits are discussed, it is convenient to talk of "permeability" and "induction", on the other hand, "magnetic poles" and "magnetisation" are just as important when permanent magnets are dealt with. The magnetisation of ellipsoids and the influence of the shape and dimensions of magnetised bodies upon magnetic quality are fully treated.

[1] "Acad des Sciences de Montpellier," vol. i (1847–50), p. 243. See also Darwin, *Harper's Magazine*, June, 1889.

[2] The values given by Barnard (NATURE, p 377) make the distance 112,000 miles, and Roche's limit 107,000 miles.

[3] It is proper to warn the reader that Roche's limit depends to some extent on the density of the planet For the sun it will be about one-tenth of the earth's distance from the sun. Thus a body of planetary size cannot move in a highly eccentric orbit, so that its perihelion distance is one-tenth, without being broken up into meteorites, and conversely a flight of meteorites with less than the same perihelion distance can never coalesce into a planet.

Chapters II and III. are devoted to measurements of magnetic quality by the magnetometer and ballistic methods With respect to the former very full information is given as to the construction of the apparatus and its use.

The earth's coil as a means for calibrating the Ballistic Galvanometer is fully explained, as also that of a solenoid and current Mention is not made of a convenient method of calibration in which the quantity of electricity passed is given directly by $Q = \frac{A}{a} \frac{\tau}{2\pi}$, where A is the deflection corrected for decrement, a is the steady deflection due to unit current, and τ is the periodic time of the ballistic needle Here a and τ are quantities very readily obtained

The chapter concludes with a full description of Dr Hopkinson's "Bar and Yoke" method

Chapter IV contains valuable information with regard to curves of induction and hysteresis in the case of wrought iron, steel, and cast iron, which will be of use to the electrical engineer in the design of dynamo electric machinery. The effects of annealing and stretching iron are brought forward and well illustrated

The next chapter, on magnetic hysteresis, is perhaps the most important in the book It commences by giving a clear definition of hysteresis, the effects of which are amply illustrated by curves, and stress is laid upon the definition of permeability as being the ratio of B to H *with certain limitations*

The dissipation of energy through magnetic hysteresis -which plays such an important part in the design of cores for transformers, and the armatures of dynamos—is fully treated.

The remarks on magnetic viscosity towards the end of the chapter are worthy of very careful consideration The author points out that in the case of quick cycles, $\int H dI$ may be widely different from what is found to be the case by static methods, and further remarks that experimental evidence is wanting under this head [1]

Chapter VI. treats of magnetism in weak fields. The author refers to experiments by Lord Rayleigh and himself, in which the time effect upon magnetism is clearly shown—the creeping up of the magnetism going on for a considerable time.

Magnetism in strong fields is discussed in Chapter VII. The "Isthmus Method" introduced by the author and Mr. W. Low in 1887 is capable of producing magnetic fields of enormous strength In giving his conclusions from experiments by the isthmus method the author states, "there is apparently no limit to the value to which the induction may be raised. But, when we measure magnetisation by the intensity of magnetism I, we are confronted with a definite limit—a true saturation value, which is reached or closely approached by the application of a comparatively moderate magnetic force"

A full account of Dr Hopkinson's researches on the effect of temperature on magnetism is given in Chapter VIII., and reference is made to the identification of recalescence with recovery of the magnetic state In the latter part of the chapter hysteresis, in the relation of magnetic susceptibility to temperature, is dealt with, and mention is made of the wide range of temperature through which the alloys of iron and nickel may exist in either the magnetic or non-magnetic state.

Reference is made to the researches on recalescence of Osmond, who has since shown the marked influence of the initial temperature, and the rate of cooling on recalescence in the case of chromium steel Dr Bottomley has shown that the alloys of chromium and steel in the unannealed state have exceptionally high magnetic qualities, which are confirmed by experiments of Dr. Hopkinson.

In Chapter X the magnetic circuit is discussed, and the way in which it is applied to the design of dynamo electric machines and transformers. Reference is made to the important work of Drs J and E Hopkinson and Kapp upon this subject — more especially in connection with dynamo electric machinery In pursuing the analogy of the magnetic circuit to the ordinary conduction equation, Prof Ewing lays stress upon the fact that the permeability (μ) is a function of the induction (B), and this is a point which cannot be too strongly urged Much that is in this chapter has great practical importance—the treatment of the subject being considered from a graphical, as well as analytical, point of view The chapter ends with an account of the influence upon magnetism by cuttings and the compression of joints in magnetic circuits

The last chapter gives a complete account of the different theories of magnetism Weber's theory is discussed with modifications by Maxwell and Wiedemann, to which are added Prof Ewing's own views of the subject He goes on to show that the reduction of hysteresis by vibration is explained by the molecular theory of magnetism,—and further supposes that time-lag in magnetism can be accounted for by it The book ends with an account of Ampère's hypothesis of magnetic molecules

E WILSON.

[1] For recent experiments upon Magnetic Viscosity see a paper by J. Hopkinson, F.R.S, and B. Hopkinson in *Electrician*, September 9, 1892.

OUR BOOK SHELF.

Forschungsberichte aus der Biologischen Station zu Plon Theil I Faunistische und biologische Beobachtungen am Gr Plöner See Von Dr Otto Zacharias, Direktor der Biologischen Station. (Berlin R Friedländer und Sohn, 1893.)

THE first report of investigations from the biological station of Plön, in Holstein, has just been issued It is a journal of 52 pages with one plate, bearing on the front of the cover a neat representation of the turreted three-storey building reflected in the quiet waters of the inland lake, and on the back a list of the regulations observed in the management of the station

In his introductory remarks the Director, who has already made his views known with regard to the importance of freshwater laboratories in the pages of several German scientific periodicals, gives a brief sketch of the advance already made in this direction in Italy, France, and America.

The first paper gives a list of the fauna at present known to inhabit the lake. This occupies seven pages; and fourteen names, being printed in italics, signify that they are new to science. The new species and genera are treated in detail in the second paper The greatest

number occur amongst *Rotatoria*, but additions are also made to the *Rhizopods*, *Heliozoa*, and *Infusoria*. No new forms appear to have been found amongst the crustacea, mollusca, or fishes.

A third paper deals with the distribution and special natural history of the forms met with, and with the comparison of the plankton at different seasons.

There are no foot-notes through the number, but all references to literature are formed into a numbered table at the end. The plate, which is one of Klinkhardt's, of Leipzig, shows a number of the new forms discovered.

The investigations are almost entirely on the minute floating organisms, as must necessarily be the case at this date with all freshwater work not connected directly with pisciculture.

The British Journal Photographic Almanac for 1893. Edited by J. Traill Taylor. (London: Henry Greenwood, and Co., 1893.)

THIS annual volume contains, as usual, a vast amount of useful information gathered from workers in all the various applications of photography. After a brief summary, in which the editor refers to some of the chief advances made in the science of photography during the past year, mentioning, for instance, Mr. Dallmeyer's telephotographic lens, Mr. Willis's improvement in the platinotype process, &c., he devotes a few pages to "some photographic methods of book illustration." Then come short contributions in which everyone has something special to say, whether it relates to a new mounting medium, a permanent toning bath, or pinhole pictures, &c. They are far too numerous to mention individually, but will be found most interesting reading. "Epitome of Progress" is the title of a series of notes by Mr. Traill Taylor, in which he refers briefly, and in some cases at length, to new methods, remedies, &c., and instruments used in the practice of the art. The formulæ and tables are as numerous as ever, while all the other information, such as lists of photographic societies, &c., have been brought up to date. The volume is copiously illustrated.

Studies in Corsica. By John Warren Barry, M.A. (London: Sampson Low, Marston, and Co., 1893.)

MR. BARRY has twice visited Corsica, the first visit being of less than five months' duration, while the second extended from September 1882 to February 1885. He has thus had ample opportunities for the study both of the island and of its people, and in the present volume he sums up his impressions very brightly and pleasantly. Most readers will probably like best the chapters on life at Ajaccio, but they will also find much to interest them in what the author has to say about the Bush of Corsica and of the Mediterranean region.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Luminous Earthworms.

I HAVE recently received from a correspondent a statement which is sufficiently valuable to crave public attention. It opens up withal a very fascinating field of investigation, and one which, though it has by no means been altogether neglected by foretime naturalists, is as yet far from being fully understood.

Writing from Richmond, Surrey, the Rev. Alfred Geden, M.A., says:—"I have just heard of a phenomenon in the worm world which is new to me. My sister declares that one day last summer, in a village on the Thames, she saw a 'phosphorescent worm,' and describes the creature as about one and a half inches long, worm-like in all respects. My sister is sure it was not an ordinary glow-worm, with which she is perfectly familiar; and, moreover, she called the attention of a cousin to the creature at the time, who corroborates her account. Are there worms in England capable of emitting light besides the glow-worm? If so, are they at all common?"

In reply to a series of questions, I was able to elicit these further particulars:—"It was in a garden in the village of Long Wittenham, near Didcot, on a dark evening in the latter part of September last [1892], or the beginning of October. My sister's attention was attracted by the light on the ground, and she picked the worm up. While she cannot positively assert that she saw it in motion on the ground, it certainly wriggled in her hand. For a few seconds also after putting it down her fingers remained phosphorescent."

The notice of the public, so far as I have been able to ascertain, was first directed to this phenomenon among earthworms by Grimm in 1670, but scientific observation, as we now understand it, was then scarcely known. A century elapsed before any further record was made in the periodicals of Europe which I have consulted, then came a paper by Flaugergues in 1781. This article, which appeared in Lichtenberg's magazine, was written in German. In 1873 Cohn's observations on the same subject were published in the well known *Zeitschrift fur Wiss. Zool.*, while numerous recent writers have further contributed to our knowledge, especially in relation to the Continental species.

Thus in 1872 an article appeared in the French Annals of Natural Science, by Panceri, entitled "Studies in the Phosphorescence of Marine Animals," in which he states that the luminosity observed in the case of certain (earth) worms is due to a secretion from the girdle, where special glands exist, and that by the evolution of light there was no perceptible raising of the temperature. In this respect, therefore, the earthworm's glow corresponds with that emitted by the firefly, Noctiluca, and glow-worm. One investigator at least has tested the colour and composition of the luminosity by the spectroscope, and says that it is not uni-coloured or monochromatic, but compounded chiefly of the red and violet rays. Other students regard the substance which produces the light as homogeneous.

In 1838 Eversmann published an article on a night-shining worm in Russian, and in 1871 an English naturalist named Breese delivered an address on the earthworm before the West Kent Natural History Society, from a meagre abstract of which we learn that he had spent some years on the subject of annelid luminosity, having studied it historically from the year 1805, when Viviani wrote on the phosphorescence of the sea, down to the date of his own delivery. According to Breese the luminosity exists in the excreted glutinous material with which the outer skin of the animal is covered.

More than one creature has at different times borne the name of the phosphorescent worm. In 1837 Dugès, a French writer, described a species under this name (*Lumbricus phosphoreus*), with a girdle extending from the 13th to the 16th segments, and a somewhat flattened body behind. After the lapse of exactly half a century this curious creature was examined again, and named by Giard Photodrilus, or the luminous worm. It has eight setæ, just as our common species have, but they are separate, and not in couples. There is no gizzard, nor does the lip dovetail into the segment behind. It is a small, transparent, rose coloured worm, and decidedly phosphorescent.

In 1843 when the British Association met at Cork, specimens of an annelid were exhibited by Dr. Allman, which he had discovered in the bogs of the south of Ireland, and which was the cause of a luminous appearance. When irritated the worm gave out a phosphorescent light, which is said to have been much increased by exposing the creature to the vapour of alcohol. The light was of that peculiar soft greenish hue which is characteristic of the phosphorescence observed in light-giving animals, and familiar to most readers in connection with the glow-worm. Another gentleman was reported to have observed the same peculiarity in some annelids which exist in the bogs of Connaught. I have been unable to find any recent reference to or confirmation of these curious observations. Ten years later Mr. Henry Cox exhibited an earthworm which was phosphorescent at a meeting of the Literary and Philosophical Society of Liverpool, held November 14, 1853.

While few records of a trustworthy nature respecting the observation of luminous worms in Britain are available, a good deal has been done by our Continental fellow-workers. Vejdovsky, who wrote a very valuable work on the various species of an-

nelids in 1884, gives us some results of his personal experience, which I believe have never been placed before the English reader He says that he had the good fortune once at least to observe an interesting case of phosphoresence in connection with the brandling It was one warm July night in the year 1881, when he was exploring a dung heap Naturalists do not usually work with kid gloves and diamond rings Presently a spot of soft, bluish white light appeared, which, however, was changeful and unsteady Now it would disappear, then return anew and shine forth over a larger space, though never with a brilliant hue He thereupon removed a portion of the manure from the spot where he had observed the luminosity, and found that the light appeared brighter, and shone for a longer time without disappearing, or before it migrated to another spot By means of a lantern Vejdovsky was able to secure a large number of specimens of the brandling from the dung heap, which he placed in a vessel for the purpose of subjecting them to careful observation To his great surprise he found that his finger soon glowed in the darkness with the phosphorescence, which extended generally over the hand where it came into contact with the worms. It was therefore apparent that the luminosity was the product of a fluid secreted by the cutaneous glands, which had attached itself to the hand of the investigator, and now manifested itself in this curious way

We have an interesting observation on the same subject by Prof von Stein, which was published at Leipzig in 1883 One evening in the middle of September the Professor was spending some time with a circle of friends at a parsonage not far from Potsdam, when the conversation turned upon phosphorescence and the phenomena of light Hereupon one of the younger members of the family—who are usually the keenest and most shrewd observers of Nature, and the best friends of the naturalist—observed that there were fountains in the adjoining gardens, the water from which was frequently observed to be full of light-bearing creatures when it was violently agitated He regarded the affair at first simply as a hoax, or an attempt to make a fool of him—as people are ever ready to do with a hobby-rider—but ascertained eventually that the luminosity was due to the presence of a species of worm which possessed the property of shining when disturbed As with Vejdovsky, so with Prof von Stein, the finger which had come into contact with the worm continued to glow for some time after What species of worm was under observation is not recorded

It now becomes a question, What end could be served thereby? The philosopher no sooner learns a new fact than he begins to pry into the secret which lies beneath, and stands to it as cause to effect We have analogy to guide us The water worms may be compared with the marine animals which produce phosphorescence, while the brandling may be studied in the light of the glow-worm It may be objected that as worms have no eyes there can be no advantage in their luminosity But such an argument would be based on the erroneous assumption that a creature without eyes is incapable of receiving impressions from light That worms are influenced by light is proved both by their habit of avoiding light, and by the experiments which have been carried out by various students Darwin remarks that as worms are destitute of eyes he at first thought they were quite insensible to light. He found, however, that "light affects worms by its intensity and by its duration" Hoffmeister states that with the exception of a few individuals worms are extremely sensitive to light, and from my own observations I have been able to demonstrate that there are marked differences in the susceptibility of the different species—some being very much more susceptible than others.

Now it follows that if a number of species of worms lived together in one place, as they usually do in a manure heap, it would be a great advantage for a given species to possess a distinguishing feature, such as that of luminosity, to enable two individuals to discover each other's whereabouts, just as the male glow worm detects the female by the light emitted from her upturned abdomen. We have, moreover, the fact that certain species of earthworm are characterised by a peculiar odour, which must be of great service in preventing promiscuous copulation and hybridity. Though earthworms are destitute of nasal organs they can detect odours, and though sightless they are affected by light

Viewed in this light a new field of research is opened up which hitherto has been totally unworked, but which may be hoped to yield remarkable results if diligently, patiently, and intelligently tilled.

It would be an easy thing for any one living in the country, with access to an old manure heap, where the brandling (*Allolobophora fœtida*, Sav) usually abounds, to ascertain whether such luminosity is of common occurrence, and it would be exceptionally valuable to record the period of the year, the state of the atmosphere, the age of the moon, and other data which would enable the specialist to arrive at a satisfactory conclusion I shall be glad to receive communications, addressed "The Grove, Idle, Bradford," from observers who may find pleasure in such pursuits HILDERIC FRIEND

Quaternions and the Algebra of Vectors

IN a recent number of this Journal (p 151) Mr McAulay puts certain questions to Mr Heaviside and to me, relating to a subject of such importance as to justify an answer somewhat at length I cannot of course speak for Mr Heaviside, although I suppose that his views are not very different from mine on the most essential points, but even if he shall have already replied before this letter can appear, I shall be glad to add whatever of force may belong to independent testimony

Mr McAulay asks "What is the *first* duty of the physical vector analyst *quâ* physical vector analyst?" The answer is not doubtful It is to present the subject in such a form as to be most easily acquired, and most useful when acquired

In regard to the slow progress of such methods toward recognition and use by physicists and others, which Mr McAulay deplores, it does not seem possible to impute it to any want of uniformity of notation I doubt whether there is any modern branch of mathematics which has been presented for so long a time with a greater uniformity of notation than quaternions.

What, then, is the cause of the fact which Mr McAulay and all of us deplore? It is not far to seek We need only a glance at the volumes in which Hamilton set forth his method No wonder that physicists and others failed to perceive the possibilities of simplicity, perspicuity, and brevity which were contained in a system presented to them in ponderous volumes of 800 pages Perhaps Hamilton may have intended these volumes as a sort of *thesaurus*, and we should look to his shorter papers for a compact account of his method But if we turn to his earlier papers on Quaternions in the *Philosophical Magazine*, in which principally he introduced the subject to the notice of his contemporaries, we find them entitled "On Quaternions, or on a New System of Imaginaries in Algebra," and in them we find a great deal about imaginaries, and very little of a vector analysis To show how slowly the system of vector analysis developed itself in the quaternionic *nidus*, we need only say that the symbols S, V, and ∇ do not appear until two or three years after the discovery of quaternions In short, it seems to have been only a secondary object with Hamilton to express the geometrical relations of vectors,—secondary in time, and also secondary on this, that it was never allowed to give shape to his work

But this relates to the past In regard to the present *status*, I beg leave to quote what Mr McAulay has said on another occasion (see *Phil Mag* June, 1892) —"Quaternions differ in an important respect from other branches of mathematics that are studied by mathematicians after they have in the course of years of hard labour laid the foundation of all their future work In nearly all cases these branches are very properly so called. They each grow out of a definite spot of the main tree of mathematics, and derive their sustenance from the sap of the trunk as a whole. But not so with quaternions To let these grow in the brain of a mathematician, he must start from the seed as with the rest of his mathematics regarded as a whole He cannot graft them on his already flourishing tree, for they will die there They are independent plants that require separate sowing and the consequent careful tending"

Can we wonder that mathematicians, physicists, astronomers, and geometers feel some doubt as to the value or necessity of something so separate from all other branches of learning? Can that be a natural treatment of the subject which has no relations to any other method, and, as one might suppose from reading some treatises, has only occurred to a single man? Or, at best, is it not discouraging to be told that in order to use the quaternionic method, one must give up the progress which he has already made in the pursuit of his favourite science, and go back to the beginning and start anew on a parallel course?

I believe, however, that if what I have quoted is true of vector methods, it is because there is something fundamentally wrong

in the presentation of the subject Of course, in some sense and to some extent it is and must be true Whatever is special, accidental, and individual, will die, as it should, but that which is universal and essential should remain as an organic part of the whole intellectual acquisition. If that which is essential dies with the accidental, it must be because the accidental has been given the prominence which belongs to the essential. For myself, I should preach no such doctrine to those whom I wish to convert to the true faith

In Italy, they say, all roads lead to Rome In mechanics, kinematics, astronomy, physics, all study leads to the considera tion of certain relations and operations These are the capital notions, these should have the leading parts in any analysis suited to the subject.

If I wished to attract the student of any of these sciences to an algebra for vectors, I should tell him that the fundamental notions of this algebra were exactly those with which he was daily conversant I should tell him that a vector algebra is so far from being any one man's production that half a century ago several were already working toward an algebra which should be primarily geometrical and not arithmetical, and that there is a remarkable similarity in the results to which these efforts led (see Proc A A A S for 1886, pp 37, ff) I should call his attention to the fact that Lagrange and Gauss used the notation $(\alpha\beta\gamma)$ to denote precisely the same as Hamilton by his $S(\alpha\beta\gamma)$, except that Lagrange limited the expression to unit vectors, and Gauss to vectors of which the length is the secant of the latitude, and I should show him that we have only to give up these limitations, and the expression (in connection with the notion of geometrical addition) is endowed with an immense wealth of transformations I should call his attention to the fact that the notation $[r_1r_2]$, universal in the theory of orbits, is identical with Hamilton's $V(\rho_1\rho_2)$, except that Hamilton takes the area as a vector, *i e.* includes the notion of the direction of the normal to the plane of the triangle, and that with this simple modification (and with the notion of geometrical addition of surfaces as well as of lines) this expression becomes closely connected with the first-mentioned, and is not only endowed with a similar capability for transformation, but enriches the first with new capabilities In fact, I should tell him that the notions which we use in vector analysis are those which he who reads between the lines will meet on every page of the great masters of analysis, or of those who have probed deepest the secrets of nature, the only difference being that the vector analyst, having regard to the weakness of the human intellect, does as the early painters who wrote beneath their pictures "This is a tree," "This is a horse"

I cannot attach quite so much importance as Mr. McAulay to uniformity of notation That very uniformity, if it existed among those who use a vector analysis, would rather obscure than reveal their connection with the general course of modern thought in mathematics and physics There are two ways in which we may measure the progress of any reform The one consists in counting those who have adopted the *shibboleth* of the reformers, the other measure is the degree in which the community is imbued with the essential principles of the reform I should apply the broader measure to the present case, and do not find it quite so bad as Mr McAulay does

Yet the question of notations, although not the vital question, is certainly important, and I assure Mr McAulay that reluctance to make unnecessary innovations in notation has been a very powerful motive in restraining me from publication. Indeed my pamphlet on "Vector Analysis," which has excited the animadversion of quaternionists, was never formally published, although rather widely distributed, so long as I had copies to distribute, among those who I thought might be interested in the subject. I may say, however, since I am called upon to defend my position, that I have found the notations of that pamphlet more flexible than those generally used Mr McAulay, at least, will understand what I mean by this, if I say that some of the relations which he has thought of sufficient importance to express by means of special devices (see Proc. R. S E, for 1890–91), may be expressed at least as briefly in the notations which I have used, and without special devices. But I should not have been satisfied for the purposes of my pamphlet with any notation which should suggest even to the careless reader any connection with the notion of the quaternion. For I confess that one of my objects was to show that a system of vector analysis does not require any support from the notion of the quaternion, or, I may add, of the imaginary in algebra.

I should hardly dare to express myself with so much freedom, if I could not shelter myself behind an authority which will not be questioned

I do not see that I have done anything very different from what the eminent mathematician upon whom Hamilton's mantle has fallen has been doing, it would seem, unconsciously. Contrast the system of quaternions, which he has described in his sketch of Hamilton's life and work in the *North British Review* for September, 1866, with the system which he urges upon the attention of physicists in the *Philosophical Magazine* in 1890 In 1866 we have a great deal about imaginaries, and nearly as much about the quaternion In 1890 we have nothing about imaginaries, and little about the quaternion Prof Tait has spoken of the calculus of quaternions as throwing off in the course of years its early Cartesian trammels. I wonder that he does not see how well the progress in which he has led may be described as throwing off the yoke of the quaternion A characteristic example is seen in the use of the symbol ∇ Hamilton applies this to a vector to form a quaternion, Tait to form a linear vector function But while breathing a new life into the formulæ of quaternions, Prof Tait stands stoutly by the letter

Now I appreciate and admire the generous loyalty toward one whom he regards as his master, which has always led Prof Tait to minimise the originality of his own work in regard to quaternions, and write as if everything was contained in the ideas which flashed into the mind of Hamilton at the classic Brougham Bridge But not to speak of other claims of historical justice, we owe duties to our scholars as well as to our teachers, and the world is too large, and the current of modern thought is too broad, to be confined by the *ipse dixit* even of a Hamilton

J WILLARD GIBBS

Glacial Drift of the Irish Channel

IT seems of interest to record that the eurite or microgranite containing blue amphibole (Riebeckite), the rock noticed by Mr P F Kendall in the drifts of the Isle of Man and Caernarvonshire, occurs abundantly in the form of small pebbles on the shore at Killiney, co Dublin, doubtless derived from the "glacial gravels" of the coast I have also found a pebble in the raised beach at Greenore, co Down

Mr Teall's description of the rock of Ailsa Craig (*Mineralogical Magazine*, vol. ix, p 219) enabled the very characteristic pebbles collected by Mr Kendall to be referred to that mass as a source, or to formerly existing bosses south of or adjacent to it As far as I am aware, all the material is in the form of pebbles, often only an inch in diameter. This is hardly likely to be its original condition, if removed by ice from Ailsa Craig, and is only one of many points that indicate a redistribution of our so-called "glacial" beds by subsequent action of rivers or other waters.

GRENVILLE A J COLE.

Royal College of Science for Ireland, Dublin,
March 12

THE SACRED NILE

THAT Egypt is the gift of the Nile is a remark we owe to the father of history, who referred not only to the fertilising influence of the stream, but to the fact that the presence of the Nile and its phenomena are the conditions upon which the habitability of Egypt altogether depends That that part of Egyptian archæology and myth which chiefly interests astronomers is also the gift of the Nile is equally true

The heliacal rising of Sirius and other stars at the time of the commencement of the inundations each year, all the myths which grew out of the various symbols of the stars so used, are so many evidences of the large share the river, with its various water levels at different times, had in the national life. It was, in fact, the true and unique basis of the national life.

In this the Nile had a compeer, or even compeers. What the Nile was to Egypt the Euphrates and Tigris were to a large region of Western Asia, where also we find the annual flood to have been in ancient times a source of fertility over an enormous area which is now

desert, the plains being broken by the remains of the ancient canals

What more natural than that Euphrates, Tigris and Nile were looked upon as deities, that the Gods of the Nile valley on the one hand, and of the region watered by the Euphrates and Tigris on the other, were gods to swear by, that they were worshipped in order that their benign influences might be secured, and that they had their local shrines and special cults

The god sacred to the Euphrates and Tigris was called Ea. The god sacred to the Nile was called Hapi

The name Hapi is the same as that of the bull Apis, the worship of which was attributed to Mena.[1] Certainly Mena, Mini, or Menes, as he is variously called, was fully justified in founding the cult of the river god, for he first among men appears to have had just ideas of irrigation, and I have heard the distinguished officers who have lately been responsible for the irrigation system of to-day speaking with admiration of the ideas and works of Menes

Whether the Tigris had a Menes in an equally early time is a point on which history is silent, but, according to the accounts of travellers, the Tigris in flood is even more majestic than the Nile, and yet the latter river in flood is a sight to see—a whole fertile plain turned into, as it were, an arm of the sea, with here and there an island, which on inspection turns out to be a village, the mud houses of which too often are undermined by the lapping of the waves in the strong north wind

There is no doubt that the dates of the rise of these rivers not only influenced the national life but even the religions of the dwellers on their banks The Euphrates and Tigris rise about the time of the spring equinox—the religion was equinoxial, the temples were directed to the east The Nile rises at a solstice—the religion was solstical and the solar temples were directed no longer to the east To the Egyptians the coming of the river to the parched land was as the sunrise chasing the darkness of the night, the sun-god of day conquering the star-gods of night; or again the victorious king of the land slaughtering his enemies

By no one, perhaps, have the impressions produced by the various phases of the river been so poetically described as by Osburn, a writer of vivid imagination, but it must be added that the facts detailed in his description are not exactly capable of being verified by engineering science Osburn thus describes the low Nile

"The Nile has shrunk within its banks until its stream is contracted to half its ordinary dimensions, and its turbid, slimy, stagnant waters scarcely seem to flow in any direction Broad flats or steep banks of black, sun-baked Nile mud, form both the shores of the river All beyond them is sand and sterility, for the hamseen, or sand-wind of fifty days' duration, has scarcely yet ceased to blow The trunks and branches of trees may be seen here and there through the dusty, hazy, burning, atmosphere, but so entirely are their leaves coated with dust, that at a distance they are not distinguishable from the desert sand that surrounds them. It is only by the most painful and laborious operation of watering that any tint approximating to greenness can be preserved at this season even in the pleasure-gardens of the Pacha The first symptom of the termination of this most terrible season is the rising of the north wind (the Etesian wind of the Greeks), blowing briskly, often fiercely during the whole of the day The foliage of the groves that cover Lower Egypt is soon disencumbered by it of the dust, and resumes its verdure The fierce fervours of the sun, then at his highest ascension, are also most seasonably mitigated by the same powerful agency, which prevails for this and the three following months throughout the entire land of Egypt."

[1] Maspero, "Hist. Anc" ii. 10.

Then at last comes the inundation —

"Perhaps there is not in Nature a more exhilarating sight, or one more strongly exciting to confidence in God, than the rise of the Nile Day by day and night by night, its turbid tide sweeps onward majestically over the parched sands of the waste, howling wilderness Almost hourly, as we slowly ascended it before the Etesian wind, we heard the thundering fall of some mud-bank, and saw by the rush of all animated Nature to the spot, that the Nile had overleapt another obstruction, and that its bounding waters were diffusing life and joy through another desert There are few impressions I ever received upon the remembrance of which I dwell with more pleasure than that of seeing the first burst of the Nile into one of the great channels of its annual overflow All Nature shouts for joy The men, the children, the buffaloes, gambol in its refreshing waters, the broad waves sparkle with shoals of fish, and fowl of every wing flutter over them in clouds Nor is this jubilee of Nature confined to the higher orders of creation The moment the sand becomes moistened by the approach of the fertilising waters, it is literally alive with insects innumerable It is impossible to stand by the side of one of these noble streams, to see it every moment sweeping away some obstruction to its majestic course, and widening as it flows, without feeling the heart to expand with love and joy and confidence in the great Author of this annual miracle of mercy"

The effects of the inundation, as Osburn shows in another place, "exhibit themselves in a scene of fertility and beauty such as will scarcely be found in another country at any season of the year The vivid green of the springing corn, the groves of pomegranate trees ablaze with the rich scarlet of their blossoms, the fresh breeze laden with the perfumes of gardens of roses and orange thickets, every tree and every shrub covered with sweet-scented flowers These are a few of the natural beauties that welcome the stranger to the land of Ham There is considerable sameness in them, it is true, for he would observe little variety in the trees and plants, whether he first entered Egypt by the gardens of Alexandria or the plain of Assouan Yet is it the same everywhere, only because it would be impossible to make any addition to the sweetness of the odours, the brilliancy of the colours, or the exquisite beauty of the many forms of vegetable life, in the midst of which he wanders It is monotonous, but it is the monotony of Paradise"

"The flood reaches Cairo on a day closely approximating to that of the summer solstice It attains its greatest height, and begins to decline near the autumnal equinox. By the winter solstice the Nile has again subsided within its banks and resumed its blue colour Seed-time has occurred in this interval The year in Egypt divides itself into three seasons—four months of sowing and growth, corresponding nearly with our November, December, January, and February, four months of harvest from March to June, the four months of the inundation completing the cycle."

In order to show how the astronomy of the ancient Egyptians—to deal specially with them—was to a large extent concerned with the annual flood and all that depended upon that flood, and how the first solar year used on this planet, so far as we know, was established, it is important to study the actual facts of the rise somewhat closely, not only for Egypt generally, but for several points in the line some thousand miles in extent, along which in the earliest times cities and shrines were dotted here and there.

Time out of mind the fluctuations in the height of the river have been carefully recorded at different points along the river. In the "Description de l'Egypt" we find a full description of the so-called nilometer at Assuan (First Cataract) which dates from a remote period, perhaps as early as the 5th Dynasty

In Ebers' delightful book on Egypt space is given to-

the description of the much more modern one located at Rodah

The nilometer, or "mikyas," on the island of Rodah now visible, is stated to have replaced one which was brought thither from Memphis at some unrecorded date Makreezee in 1417, according to Ebers, saw the remains of the older nilometer

The present mikyas is within a covered vault or chamber, the roof being supported on simple wooden pillars In a quadrangular tank communicating with the river by a canal is an octagon pillar on which the Arabic measurements are inscribed These consist of the pic (variously called ell or cubit) = 0 54 metre, which is divided into twenty four kirats, in consequence of the rise of the river bed in relatively recent times, the nilometer is submerged at high Nile to a depth of two cubits

The rise of the Nile can now be carefully studied, as gauges are distributed along the river We have the Aswân gauge from 1869, the Armant gauge from 1887, the Suhag gauge from 1889, and the Asyût gauge from 1882 The distances of these gauges from Aswân are as follows —

	Kilometres
Aswân	0
Armant	200
Suhag	447
Asyût	550
Rodah	941

The Rodah gauge is not to be depended on as the movements of the Barrage regulation destroy its value as a record The heights of the zeros of these gauges above mean sea level are as follows —

	Metres.
Aswân	84 158
Armant	69 535
Suhag	56 00
Asyut	53 10
Rodah	13 14

Great vagueness arises in there being no very obvious distinction between the gauge readings reached in summer and that from which the rise is continuous There are apparently rainfalls in the end of spring of sufficient power to raise the Nile visibly in summer, just as muddy rises have been seen in winter to pass down the valley, leaving a muddy mark on the rocks at Aswân and Manfalût Independently of the actual gauge-reading of the rise, there are facts about it which strike every beholder At the commencement of the rise we have the *green water* This occurs in June, but varies in date as much as the top of the flood varies

From the fact that modern observations show that the very beginning of the rise, and the first flush, second flush, and final retirement vary, it seems evident that the ancient Egyptians could not have had any fixed zero-gauge or time for the real physical fact of the rise, but must have either deduced from a series of observations a mean period of commencement, or a mean arrival of the red water, or a mean rising up to a certain gauge

First to deal with the green water Generally when the rise of an inch or two is reported from the nilometer at Rodah, the waters lose the little of clearness and freshness they still possessed The green colour is the lustreless hue of brackish water within the tropics, and only the finer class of modern filter can render such water clear The colour is really due to algæ

Happily, the continuance of this state of the water seldom exceeds three or four days The sufferings of those who are compelled to drink it in this state, from vesicary disease, even in this short interval, are very severe The inhabitants of the cities generally provide against it by Nile-water stored in reservoirs and tanks.

Col. Ross, R.E., noticed in 1887 and in 1890, when, owing to the slow retreat of the Nile, the irrigation officers had to hold back many basins in the Gizah province, and also in 1888, when the water remained long stagnant, that the basin-water got green—showed the algæ and smelt marshy, just as the June green water does

Hence it has been argued that as the Nile-water in the bed of the stream—even in very slow-flowing back-waters—does not become green, the greenness must be produced by an almost absolute stagnation of the water We know of great marshes up above Gondokoro, and hence it is thought that the green water of summer, which comes on suddenly, is this marsh-water being pushed out by the new water from behind, and that is why it heralds the rise No one has so far minutely observed the gradual intrusion of the green water

The rise of the river proceeds rapidly, and the water gradually becomes more turbid Ten or twelve days, however, elapse before the development of the last and most extraordinary of all the appearances of the Nile, thus described by Mr Osborn[1] —"It was at the end of —to my own sensations—a long and very sultry night, that I raised myself from the sofa upon which I had in vain been endeavouring to sleep, on the deck of a Nile boat that lay becalmed off Benisoueff, a town of Middle Egypt

"The sun was just showing the upper limb of his disc over the eastern mountains I was surprised to see that when his rays fell upon the water, a deep ruddy reflection was given back. The depth of the tint increased continually as a larger portion of his light fell upon the water, and before he had entirely cleared the top of the hill it presented the perfect appearance or a river of blood. Suspecting some delusion, I rose up hastily, and looking over the side of the boat saw there the confirmation of my first impression The entire body of the water was opaque and of a deep red colour, bearing a closer resemblance to blood than to any other natural production to which it could be compared I now perceived that during the night the river had visibly risen several inches While I was gazing at this great sight, the Arabs came round me to explain that it was the Red Nile The redness and opacity of the water, in this extraordinary condition of the river, are subject to constant variations On some days, when the rise of the river has not exceeded an inch or two, its waters return to a state of semi transparency, though during the entire period of the high Nile they never lose the deep red tinge which cannot be separated from them It is not, however, like the green admixture, at all deleterious, the Nile water is never more wholesome or more deliciously refreshing than during the overflow There are other days when the rise of the river is much more rapid, and then the quantity of mud that is suspended in the water exceeds, in Upper Egypt, that which I have seen in any other river On more than one occasion I could perceive that it visibly interfered with the flow of the stream A glassful of it in this state was allowed to remain still for a short time The upper portion of it was perfectly opaque and the colour of blood A sediment of black mud occupied about one quarter of the glass. A considerable portion of this is deposited before the river reaches Middle and Lower Egypt I never observed the Nile water in this condition there, and indeed no consecutive observations exist of the reddening of the water. It is quite clear that the reddening cannot come from the White Nile, but must be the first floods of the Blue Nile and the Atbara coming down"

Rate of Rise of the Nile—The rate in flood is 1¾ days from Wady Halfa to Aswân and six days from Aswân to Rodah (941 kilometres). In very high Niles this is perhaps accelerated to five days. In the early flood rising from, say, one cubit Aswân to six cubits, where there are many dry sandbanks, and the spreading out of the river is considerable, and there is an absence of overlapping

[1] "Monumental Egypt," chapter I

flushes from behind, the rate goes up to fifteen days There is a very great difference in time and rate between Green and Red Nile The rise is 45 ft at Aswân, 38 at Thebes, and 25 at Cairo

From the data obtained at the gauges named which have been kindly forwarded to me by Mr Garstin, the U S. of State of the Public Works Department of Egypt, I have ascertained that the average time taken by the flood to travel now between Thebes and Memphis is about nine days. Although the river bed is now higher than formerly, the land around Thebes, according to Budge, having been raised about nine feet in the last 1700 years, still the same elevation has taken place at Memphis, so that no difference in the velocity of the stream would be produced by this cause

The great difficulty experienced in understanding the statements generally made concerning the Nile-rise arises from the fact that the maximum flood is as a rule registered in Cairo upwards of 40 days after the maximum of Aswân.

For the following account of how this is brought about I am indebted to the kindness of Col Ross, R E —

"The behaviour of the flood at the Aswân gauge is as follows Between August 20 and 30 a good average gauge of 16 cubits is often reached, and between August 27 and September 3 there is often a drop of about 30 centimetres The August rise is supposed to be mostly due to the Blue Nile and Atbara River Between September 1 and 8 the irrigation officers generally look for a maximum flood-gauge of the year at Aswân This is supposed to be the first flush of the White Nile In the middle of September there are generally two small flushes, but the last twenty days of September are generally distinctly lower than that of the first week The final flush of the Nile is seldom later than the 21st to 25th September

"All this water does not merely go down the Nile, it floods the different basins The opening of these basins begins from the south to the north This operation is generally performed between the 29th September and the 22nd October The great Central Egypt basins are not connected with the Nile for purposes of discharge into the river between Asyût and near Wasta, or a distance of 395–90 kilometres = 305 kil

"The country in the middle or Central Egypt is broad, and thus there is an enormous quantity of water poured out of these basins into the lower reaches of the river about the 20th October, which seriously raises the Nile at Cairo, and in a good average year will bring the Cairo gauge (at Rodah) up to the maximum of the year on or about October 22, and hence it is that the guide books say the Nile is at its highest in the end of October

"A gauge of 16½ cubits at Aswân while the basins are being filled does not give more than 21 cubits at Rodah (Cairo), but as the basins with a 16½ gauge will fill by the 10th September, it follows that a 16½ to 16 cubit gauge at Aswân will not give a constant Cairo gauge, as the great mass of water passes by the basins and reaches Cairo Hence we have frequently the paradox of a steady or falling gauge at Aswân showing a steady rise at Cairo

"If the gauge at Aswân keeps above 16 cubits to near the end of September, the basin-emptying is much retarded, as the emptying at each successive basin fills the Nile above the 16 cubit level; *hence the lower halves of the chains of basins do not flow off*, and thus when the great Middle Egypt basins are discharged, they do not raise the Nile so much as they do when the last half of September Nile is below 16 at Aswân

"In years like 1887 and 1892, which differ from each other only in date of maximum gauge at Aswân, the river, having filled the basins in 15 to 20 days instead of in 25 to 30 days, comes down to Cairo in so largely increased a volume that a really dangerous gauge of 25 cubits at Cairo is maintained for over a fortnight (the average October gauge in Cairo is about 23 cubits), and from September 10 to October 25 the river remains from 24 cubits to 25½ cubits, and the Middle Egypt basins discharge so slowly that the opening day is hardly traceable on the Cairo gauge

"In the 1878 flood, which was the most disastrous flood possible, the river rose in the most abnormal fashion, and on October 3 attained 18 cubits at Aswân This breached the Delta, and in addition so delayed the Upper Egypt basins emptying from the reason before given that the wheat was sown too late, and got badly scorched by the hot winds of March and April" [1]

J NORMAN LOCKYER

THE LANDSLIP AT SANDGATE

THE causes of landslips are in general so well known and the localities which are liable to them so clearly defined on geological principles that when on Monday, March 6, the public were startled by the news of a landslip at Sandgate, the probability would be that geologists who knew the district would be by no means surprised, more particularly as the locality of the catastrophe is in the midst of a typical section shown in many of the textbooks, and the town itself gives its name to a subdivision of the Cretaceous rocks

The event, however, does not appear to have been expected, and since it has happened conjectures as to its cause have been numerous, but the true explanation has been wanting

The series of rocks which, in descending order, form the country about Sandgate are the Folkestone beds, the Sandgate beds, the Hythe beds, and the Atherfield clay Amongst these it is natural to look in the first instance for the presence of clays, as the probable origin of a landslip, though very loose sands have also been known to give way The Folkestone beds are for the most part sand and they are bound together by bands of grit Moreover, they are above the affected area The Hythe beds are likewise characterised by bands of hard limestone, separated by calcareous sands There are left the Atherfield clay, whose nature is indicated by its name, and the Sandgate beds

The most recent description of these is that of W Topley, F R S, in the *Comptes Rendus* of the Congrès Géologique International, 1888, in which they are briefly characterised (p 257) as "*Argiles vertes et sables*" The same writer's description of them in 1883 (quoted also by H B Woodward in 1887) is somewhat different, but in his "Geology of the Weald," 1875, they are said to consist of dark clayey sand and clay, the total thickness being given as 80 ft In his more detailed description, however, Mr F G H Price divides these 80 ft into four parts, the lowest 20 ft being all "clayey beds" (Proc Geol Assoc., vol iv p 554) In a still earlier account by Prof Morris (*l.c* vol ii p. 41) we have the following interesting statement — "The dark-greenish sub-argillaceous sands, known as the Sandgate beds, rise on the shore at a short distance west of Folkestone The low undercliff which skirts the shore from Folkestone nearly to Hythe owes its origin to the presence of these beds, which from their retention of water and slight coherency of structure have caused the frequent subsidence of the beds above"

It would appear, then, that there are two possible sources of the slipping—the Atherfield clay and the clayey bands of the Sandgate beds, and thus much was indicated at once by Mr. F. W. Rudler (*Daily Graphic*, March 8).

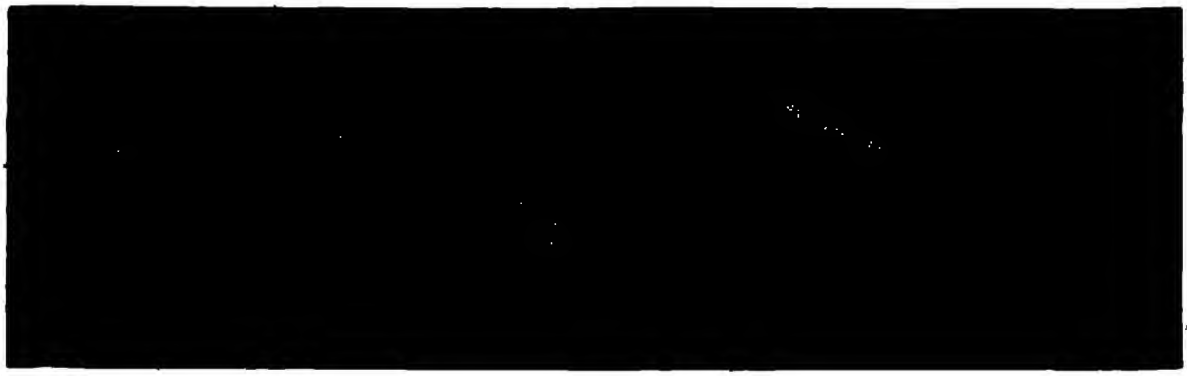
On a personal examination of the area the whole history of the subsidence becomes clear enough. At

[1] The modern Egyptians still hold to the old months for irrigation 7 Tuba = January 15 is commencement of wheat irrigation, 30 Misra is the last safe day for sowing maize in the Delta, 1st Tut is the date of regulating the bridges = September 8 in Upper Egypt

Sandgate itself neither the Atherfield clay nor the Sandgate beds are well exposed, but on the seashore between there and Folkestone we meet with the white-weathering massive limestone of the Hythe beds at Mill Point, and to the west of it. They are here dipping east at a moderate angle, and if this dip is continued, as the beds rise to the west, there would be room for the 60 feet of them which are seen at Hythe, between their probable outcrop in the lower part of the Enbrook Valley and low-water mark, opposite its debouchure It must be here, if anywhere, that the recorded appearance of Atherfield clay occurs—for the state of things above described must here be terminated by a fault, as will be presently explained, and nowhere else along the coast till Sandgate is entirely passed can this clay occur within 40 yards seaward of low-water On the east side of Enbrook, however, there is no landslip, and the actual landslip is thus shown to have nothing to do with the Atherfield clay

Above the strong bands of Hythe limestone, however, west of Mill Point, are seen about 20 feet of soft, crumbling clay, occupying the base of the low cliff and becoming sandier above, as described by Mr Price, and it is easily seen that the bottom of the Enbrook Valley is excavated in clay The same clay is admirably seen on the other side of Sandgate, in the first cutting beyond Hythe Station on the branch line from Sandling Junction, so spring, which may indicate the line of another fault; or it may be that all this is only a surface slip; but, in any case, Folkestone beds occupy the actual surface

The strike faults thus indicated are only what we might expect if the strata broke, as they so often do, during their upheaval. It is plain that such faults will rather complicate the surface exposure of the clayey rocks which overlie the Hythe limestone. Now, if we allow some 100 feet for the Sandgate beds, so as to include in the title all that portion of the series above the clay band at the base, which is not strengthened by the occurrence of indurated bands, and draw, from the purely geological considerations detailed above, the boundary of their surface exposure, which will not be an entirely simple one, *it exactly coincides with the boundary of the disturbed area* Thus the upper boundary commences just beyond the town on the west, and runs very nearly along the line of the most westerly fault, till the latter has Folkestone beds on both sides of it, it then changes direction, and runs parallel to the outcrop of the Hythe beds on the foreshore, sloping down to a point above West Lawn, that is, to the probable position of the second fault, it is then thrown back along the probable line of that fault It then again changes its direction and runs at first parallel to the second outcrop of the Hythe limestone, afterwards sloping down rapidly to the shore, so as to follow what



that though it is not now well exposed in Sandgate itself, we may be sure that it forms a continuous band immediately above the Hythe limestone

Now, continuing to examine the coast below Sandgate on the west side of Enbrook we find an outcrop of Hythe limestone nearly opposite Farleigh House Here also it has a dip towards the east, but it has also an abnormally high dip—perhaps 10°—inshore, such a dip in itself indicates a dislocation in the neighbourhood, but independently of this, the position of this band at the same level as that at Mill Point, while both bands dip, proves that there is a fault between the two, probably along the Enbrook Valley, with a downthrow on the west. This brings down the clay band at the base of the Sandgate beds to the sea level immediately to the east of the limestone above mentioned, and further on, to the east of the coastguard station, the sandy beds of the Folkestone series, which may, however, have slipped

Going further west, we find the same band of Hythe limestone exposed on the sloping shore, having a similar easterly dip; but not so great an inshore dip, which, unless this were a lower band of Hythe limestone (which other observations negative), proves a second fault between these two, with a downthrow also to the west, but of smaller amount. Further west again, and just beyond the town, the sandy Folkestone beds are found at a lower level than they should be if the stratification were regular, and in the slight valley intervening there is a would be probably the line of outcrop of the first hard band in the possibly slipped mass of the Folkestone beds The conclusion from this seems inevitable. *The whole disturbance is due to a motion of soft Sandgate beds where they are unprotected by the overlying hard bands of the Folkestone beds*

The nature of the motion can be determined by an examination of its upper, and particularly of its lower limit The greatest amount of visible disturbance has taken place along the upper limit, here the ground is seen to have slipped downwards and forwards This might be caused by the collapse of an underground hollow if such a thing were possible, but the loose sandy and clayey nature of the rocks would not admit of such a hollow being formed, and the thick clay band at the base would effectually shield the Hythe limestones from chemical erosion The lower limit, however, shows very plainly that the motion has been a simple slip in a south-east or east south-east direction In the first place the westerly band of Hythe limestone on the foreshore which abuts against a concrete groin is absolutely unmoved, and the sea-wall above is quite intact (which is a second proof—if, after what has been said above, any further proof were needed, that the Atherfield clay has nothing whatever to do with the matter). In the second place, immediately to the east of this outcrop, the sea-wall has bulged forward by about three feet, as shown by the next, wooden, groin, and near low-water mark the overlying clay is seen

to be bulged up, so as to form a mound on the foreshore, which is being rapidly destroyed by the sea, while further east, opposite the end of Wellington Terrace, the overlying more sandy clays are also seen bulged up Along the main road also, in front of West Lawn, on the western side of the supposed fault, the surface has been squeezed up. On the eastern side of this fault, further cracks, indicating a forward motion, are seen at the entrance to Encombe grounds; and, finally, the Coast Guard houses and the wall in front bulge forward at least three feet, and probably more, and the two sides of the street opposite have been squeezed together

Thus the whole disturbance has been caused by the slipping downwards of the overlying soft beds over the inclined plane formed by the basement band of clay which rests on the Hythe limestone as a firm foundation, the direction of motion having been somewhat modified by the resisting mass of rock which lies to the east, and by the natural tendency of the sliding mass to take the shortest course to a lower level

It is thus seen that the circumstances of the locality exactly fulfil the usual geological conditions for a landslip—*i.e.* a sloping bed of clay, which is liable to become slippery, and whose dip is towards the lower surface level where the overlying rocks find no support Hence it may safely be said that any geologist, whose attention had been specially directed to the question, could have predicted that such an occurrence was extremely likely, sooner or later, to happen There is, however, one necessary condition, which does not depend on the lie of the strata and the form of the ground, and that is that the clay should become slippery This condition will probably account for the fact that in the area to the east of the Enbrook fault where all the other conditions are satisfied, *i e* in the neighbourhood of Radnor Cliff, no landslip has occurred Clay is of course rendered slippery by the access of water Now water will easily find its way through sandy strata, and there are sandy beds even in the lower portion till we come to the band of clay itself As this is equally true in both localities the only difference can be in the amount of water

Now there is a natural tendency for water to run down the dip slope of the strata, especially when there are hard bands as in the Folkestone beds, so that in this case most of the water will come from the west, and this source is cut off from the Radnor Cliff side by the Enbrook Valley, to the east of which there is little or no gathering ground, but to the west and north-west of the disturbed area there is a wide expanse of high ground, mostly rising 100 feet above the level of the Sandgate beds, and the water which falls on this finds its easiest outlet into these beds. They are therefore exactly in a position to get waterlogged, and that they are so is shown by the numerous springs that may be seen along the upper limit of the disturbed area.

The above considerations show that this area always has been and always will be liable to landslips The lie of the beds which produces this liability cannot be altered by human agency, but the liability may be reduced to a minimum by a suitable system of drainage, which shall prevent the access of so large a body of water to so dangerous an area.

In the meantime the inhabitants of Sandgate may congratulate themselves that the shoreward dip of the beds and fault which breaks their continuity have reduced the result of the slip to a minimum, and rendered possible the remarkable circumstance that, though it happened in an area covered with houses, not a single house has been actually thrown down—not a single life lost

As to the *immediate* cause of the occurrence, it is perhaps scarcely necessary to look for it. The landslip must necessarily have occurred at some time or another, and the conditions must for a long time have been gradually accumulating, by the constant access of water and the wearing action of the sea. If, however, the free discharge of the water from the beds has been in any way interfered with—by the stoppage of wells, or the construction of imperforate sea-walls—this would doubtless tend to the acceleration of the catastrophe, and an exceptionally wet season, like that we have recently experienced, might suffice to determine it It would be scarcely necessary to add, except that the idea has been mentioned in the House, that the blowing up of the *Benvenue* and the *Calypso* could have absolutely nothing to do with it in the first place, because the scene of the explosions was to the west of the disturbed area, and cut off from it by the massive Hythe beds, which are absolutely undisturbed—to say nothing of the Atherfield clay at sea which must necessarily intervene, secondly, because such a cause could not require several months to operate, and, lastly, because a vibration would rather tend to cause such beds to settle than to slip.

J F BLAKE

NOTES

PROF VIRCHOW will deliver the Croonian Lecture this afternoon, and in the evening he will be entertained at the public dinner which is to be given in his honour at the Hôtel Métropole It may at the same time be noted that an important scientific work, in three volumes, has just been issued by the Berlin publisher, August Hirschwald, in memory of the celebration of Prof Virchow's seventieth birthday The work is entitled "Internationale Beitrage zur Wissenschaftlichen Medicin," and among the contributors to it are Sir James Paget, Sir Joseph Lister, and other English writers.

A MOVEMENT has been started for the celebration of the hundredth anniversary of the birth of the illustrious Russian mathematician, Lobatcheffsky, who was described by the late Prof Clifford as "the Copernicus of geometry" He was born on October 10, 1793 It is proposed that honour shall be done to his memory at the Imperial University of Kasan, with which he was for many years connected as a professor and as rector The Physico-Mathematical Society of the University, which has taken the matter in hand, hopes to be able either to establish a prize with Lobatcheffsky's name for researches in mathematics, or to erect a bust of the great investigator in the University buildings If the funds suffice, both of these things will be done. Subscriptions should be sent to the Physico-Mathematical Society, Kasan

THE German Congress of Naturalists and Physicians, which was postponed last year on account of the outbreak of cholera, is to meet this year at Nürnberg.

PROF W. C ROBERTS-AUSTEN, F R.S, chemist and assayer to the Royal Mint, and Mr Thomas Bryant, President of the Royal College of Surgeons, have been elected members of the Athenæum Club, under the provisions of the rule by which the Committee is empowered to elect annually nine persons "of distinguished eminence in science, literature, the arts, or for public services."

THE half yearly general meeting of the Scottish Meteorological Society was held at Edinburgh on Monday, March 13 The council of the society submitted its report, and the following papers were read —On the temperatures of Lochs Lochy and Ness as affected by the wind, by Dr Murray, mean temperature of London from 1763 to 1892, by Dr. Buchan, hygrometric researches at the Ben Nevis Observatories, by A. J Herbertson.

WE understand that an enormous iron meteorite weighing nearly one ton (2044 lbs) has just been received by Mr. J R

Gregory, of Charlotte Street, Fitzroy Square, from the same locality as the one described by him in NATURE in November last, it is 4 feet 2 inches long by 2 feet 3 inches wide and 20 inches thick It comes from Youndegin in Western Australia

THE secretary of the Physical Society asks us to say that in the report of the Society's annual general meeting (NATURE, March 2, p 429) the name of Mr. J T Hurst was wrongly included in the list of members lost by death

ATTENTION is called in the North Atlantic Pilot Chart to the fact that the great astronomical event of the month of April—the eclipse of the sun on April 16—will have certain features of special interest to the science of marine meteorology Masters of vessels and observers who may be within the limits of the visibility of this eclipse are earnestly requested to make reports of their observations The chart shows graphically the path of the total eclipse, the northern limit of visibility, and curves showing at what places the eclipse begins at 1 hour, 2 hours, and 3 hours, and when it ends at 3 hours, 4 hours, and 5 hours, Greenwich mean time, April 16 It is pointed out that there are observations which any one can make, and that these may prove to be of great interest and value The following are particularly desired (1) any changes in the clouds accompanying changes of temperature during the eclipse, (2) reading of the barometer every half hour from 11 30 to 5 30 G M T, while in the path of total eclipse, (3) temperature of the air, both wet and dry bulb, during the same interval, (4) any peculiar appearance of light during the eclipse, (5) the altitude and azimuth of any faint comet that may be detected during the eclipse.

THE weather during the latter part of last week was exceptionally fine over England, the daily maxima being frequently above 60°, and reaching 66° in the midland counties on Sunday, a temperature which is nearly 20° above the mean maximum for the time of year The nights, however, were very cold, owing to the radiation under a clear sky, in some localities the readings on the grass were as low as 23° to 25°, and little, if any, above freezing in the shade These conditions were occasioned by the distribution of atmospheric pressure, there being a well defined anticyclone over the southern parts of England and over part of the continent But in Scotland and Ireland the weather was much less settled, low pressure areas lay off the north of Scotland, causing gales and occasional rainfall, while hail occurred at Wick on Friday At the beginning of the present week the barometer fell decidedly, the anticyclone moved to the eastward, and the type of weather underwent a complete change, fog becoming prevalent at many places in the southern parts of the kingdom, and on Tuesday a new depression reached the north of Scotland, accompanied by rainy and unsettled weather generally The official report for the week ending the 11th instant showed that bright sunshine was more prevalent than it has been for many weeks, and that it exceeded the average amount in all districts; also that there was a great deficiency in the amount of rainfall in all districts, except in the north of Scotland.

Das Wetter for February contains some particulars respecting the extraordinarily high barometer readings during January At the commencement of that month the isobar between Lapland and Finland indicated the unusual height of 30 9 inches, which increased to 31 1 on the 3rd On this day the centre of high pressure was in the vicinity of the White Sea, the reading at Archangel being 31·2 inches, and at Kargopol, on the Onega, 31 3 inches.* Such high readings in those parts in winter are the more noteworthy, owing to the frequent passage of depressions over the north of Europe during that season. Subsequently the high pressure area shifted to Eastern Siberia, where high readings are more usual. On January 12 the pressure at Irkutsk exceeded 31 5 inches, and on the next day it reached 31 7 According to Dr Hann, such a high reading had only been recorded once before, viz on December 16, 1877, at Semipalatinsk But on the morning of January 14, the reading at Irkutsk, reduced to sea level and corrected for gravity, attained the unprecedented height of 31·8 inches. So far as it is known this is the highest reading that has ever been recorded on the globe These high pressures were also accompanied by very low temperatures On January 14 the thermometer at Irkutsk fell to minus 51° 3, or about 40° below the mean for the time of year In the north of Sweden the thermometer fell to minus 76°, or 38° below the freezing point of mercury

SOME shocks of earthquake have lately been felt at Quetta Two occurred on February 13 at 9 50 p m, and another shock on the 14th at about 3 a m These shocks caused a considerable scare, and many people rushed out of doors, the condition of many houses in Quetta being anything but safe The *Pioneer Mail* says that several houses have since fallen at Quetta, and a number of people have been injured, and two killed thereby

DR D D CUNNINGHAM is carrying on a series of microscopical investigations into the Indian potato blight. Elaborate experiments are also being made in the practical treatment of the crop and of diseased soils The results, according to the *Pioneer Mail*, are expected to be important, and will be made public in due course

IT appears from the Ceylon Census Report for 1891 that the bulk of the population of the island live by agriculture The proportion of the agricultural class to the general population is in Ceylon 70 5, in India 64 09, in England and Wales 15·44 Next in order of number comes the industrial class, which includes something less than one-sixth, and after it the commercial class, holding one twentieth The *Ceylon Observer* notes as remarkable the fact that in the Southern Province there is a larger Sinhalese industrial population than in any other province—a result, it is supposed, attributable to the large number of people engaged in utilising the products of the cocoa nut tree, with a certain number of workers in jewellery, tortoise shell, &c

TWO Akka girls, who were rescued from Arab capturers by Dr Stuhlmann and his companions, have been brought to Europe, and will remain in Germany for some months In the summer they will be taken back to Africa, where they will be placed in some mission house, or otherwise provided for They are supposed to be between seventeen and twenty years of age A correspondent of the *Daily News*, who saw them at Naples, says they are well proportioned, and as tall as a boy of eight years of age Their behaviour is "infantile, wild, and shy, but without timidity" One of them was always cross, bending her head, and glaring from beneath frowning brows, while the other often laughed joyously, was pleased with bead bracelets and other trinkets given to her, and expressed by a queer sniff of her flat nose her appreciation of some chocolate bonbons. After making "a capital dinner on rice and meat," they greatly enjoyed the sunshine in a pretty garden, where they gradually grew more confident, and finally allowed themselves to be photographed arm-in-arm with the little son of their hostess. "The coquettish one shook with laughter, and seemed to guess that a process was going on flattering to her vanity, while the cross one still looked gloomy and suspicious They showed neither wonder nor admiration of the people and things around them in the artistically furnished house and tasteful garden; their eyes, though large and lustrous, have less expression than the ugly eyes of a monkey." These interesting representatives of one of the pygmy races of the world are to be presented to various scientific societies in Berlin.

AN interesting address delivered by M Paul Richer at the last meeting of the French Association for the Advancement of Science is printed in the current number of the *Revue Scientifique* The subject is the relation of anatomy to art M Richer gives a lucid account of the canons of the human figure which have been adopted during various periods in the history of art, referring especially to those of the Greek sculptors Polycleitos and Lysippos and to those of Leonardo da Vinci, Albert Dürer, and Jean Cousin He then shows that we now have materials for the establishment of a scientific type of the proportions of the human body, so far at least as the white race is concerned This type is not, of course, to be reproduced in the works of artists, but M Richer thinks it may be of real service to them as a guide in the appreciation of the proportions of the different models they have from time to time to study

MR A C MACDONALD contributes to the *Agricultural Journal* of Cape Colony a full and interesting account of what has been done to develop the dairy industry in Great Britain Speaking of the same industry in Cape Colony, he says that it is there only in its infancy This is largely due to the difficulty which farmers otherwise favourably circumstanced have had hitherto to contend with in the transport of their dairy products to market in good condition Now, however, the extension and union of railways have more or less removed this difficulty, and many of the leading farmers, taking advantage of the facilities afforded by such extension and union, have greatly increased their butter production. In fact, within the last two years the increase in the manufacture of this commodity in the colony has been very large Mr Macdonald sees no reason why in districts such as Alexandria, Bathurst, Peddie, Victoria East, Fort Beaufort, Albany, Port Elizabeth, Uitenhage, and East London, where it has now become difficult to farm with small stock or grow grain profitably, dairying should not prove as great a success as it has done in the Australian colonies, which in some respects are not so favourably situated as Cape Colony, provided that the same means are used

THE nucleus of a palæontological collection was formed at the Johns Hopkins University five years ago by Dr W B Clark from the deposits of the Atlantic coastal plain He was able to gather together a very large amount of material owing to the richness of the formations in fossils and their accessibility to the city of Baltimore, and since that time additions have been made each year by collection and by exchange with the National and State Surveys and educational institutions We learn from the new number of the University's "Circulars" that there was a greater increase of the fossil collections during the past year than during any preceding one This was accomplished mainly by exchange and purchase, although a considerable amount of material was collected in the field. Among the more notable additions was a collection sent in exchange by Mr G F. Harris, of the British Museum This collection is very rich in tertiary fossils, illustrating many of the typical English localities It contains hundreds of species from the Eocene, Oligocene, and Pliocene of England Owing to the fact that the richest and finest collections of the Palæontological Museum of the University are from the American tertiary, these English tertiary fossils are said to be of the highest interest and usefulness to students of geology.

AN interesting paper on Artesian wells as a water supply for Philadelphia was lately read by Prof O C S Carter before the chemical section of the Franklin Institute A long-continued drought caused much inconvenience at Philadelphia during the summer of 1892, so that the inhabitants would be likely to welcome any practicable suggestion for providing them with new supplies of fresh and wholesome water Prof. Carter, after careful investigation, strongly recommends the use of artesian wells, the water of which, he says, would be of considerable quantity and excellent quality

AN instrument for measuring densities of liquids, which for simplicity can hardly be surpassed, is described by A Handl in the *Wiener Berichte* It consists of two glass tubes joined by an indiarubber tube One of them is 30 cm long and about 1 cm wide, and bears two marks scratched into the glass at a distance of 20 cm This tube is immersed in the liquid to be examined up to the lower mark Meanwhile the other tube is totally immersed in water On pulling it out the liquids in both tubes rise until that in the first tube reaches the second mark. The height of the water-column, read off on a suitable scale, measures the density of the liquid

MESSRS SIMPKIN, MARSHALL AND CO have issued Miss Eleanor A Ormerod's "Report of Observations of Injurious Insects and Common Farm Pests, during the Year 1892, with Methods of Prevention and Remedy" This is Miss Ormerod's sixteenth report She notes that during 1892 most of the insect infestations commonly injurious to field crops and fruit were present to such an extent as to cause inquiry as to their nature and as to methods of prevention, but that for the most part they did not affect large districts to a serious extent

A NEW scientific journal devoted to the interests of general systematic botany has made its appearance, published at Chambesy, near Geneva, under the title *Bulletin de l'Herbier Boissier*.

A BOTANICAL DICTIONARY, by Mr A A Crozier, has just been published by Holt and Co, of New York, containing definitions of over 5000 words.

MESSRS PERKEN, SON, AND RAYMENT have issued an illustrated catalogue of photographic apparatus, magic lanterns, and optical instruments

MESSRS WHITTAKER AND CO will issue in their Specialists' Series a work on "The Dynamo," by C C Hawkins and F Wallis, and a new edition of Sir David Salomons' work on "The Management of Accumulators." They have also in preparation in the Library of Popular Science an introductory work on "Electricity and Magnetism," by S Bottone, and one on "Geology," by A J Jukes-Browne Mr Perren Maycock has completed the second part of his work on "Electric Lighting and Power Distribution," and it will be issued in a few days An illustrated work on "British Locomotives," by C J Bowen Cooke, of the London and North-Western Railway, is in the press, and will probably be issued in May Messrs Whittaker have also in the press a new work by J Horner ("A Foreman Pattern Maker"), entitled "The Principles of Fitting," and the second part of Mr. Brodie's "Dissections Illustrated"

MESSRS GRIFFIN AND CO. announce "A Manual of Dyeing," by Dr Knecht, Mr Chr Rawson, and Dr R. Loewenthal, "Oils, Fats, Waxes, and Allied Materials, and the Manufacture therefrom of Candles, Soaps and other Products," by Dr C R Alder Wright, "Painters' Colours, Oils, and Varnishes, by Mr Geo H. Hurst, "Griffin's Electrical Price-Book," edited by Mr. H J Dowsing, the tenth annual issue of the "Year-Book of Learned and Scientific Societies," "A Treatise on Ruptures," by Mr. J F. C Macready, "Forensic Medicine and Toxicology," by Prof. Dixon Mann; "The Medical Diseases of Children," by Mr. Bryan Donkin, "A Medical Handbook for the Use of Students," by Mr R S Aitchison, "The Physiologist's Note-Book," by Dr W Hill, and "A Text-Book of Biology," by Prof J R Ainsworth Davis.

MESSRS. L. REEVE AND CO. have in preparation a new work on the British Aculeate Hymenoptera from the pen of Mr.

Edward Saunders, uniform with the same author's work on the Hemiptera Heteroptera, just completed.

The extreme difficulty which is experienced in the separate identification of the typhoid bacillus and the *B coli communis* in consequence not only of their great resemblance microscopically, but also in the appearances to which they give rise when grown in artificial culture media, has caused much doubt to be cast upon the alleged detection of the former in water It is well known that the *B coli communis* is an almost constant attendant upon the typhoid bacillus, being normally present in the alimentary canal, and being, moreover, frequently found in large numbers in polluted streams and contaminated well-water In nearly all cases, therefore, where a water is suspected of harbouring the typhoid bacillus the *B coli communis* may also be expected to be present Unfortunately, the many methods which have been devised, some of which are extremely ingenious, for separating out the typhoid bacillus from other organisms, are based upon the idea that few, if any, micro-organisms can flourish in as acid a medium as this bacillus, and no account has been taken of the refractory nature in this respect of the *B. coli communis* This organism is, in fact, possessed of far greater powers of resistance than its more dangerous companion, and whilst the proportion of citric acid or phenol to be added, whether directly to the water or to the culture medium, is such that in some cases the other organisms present are destroyed whilst the typhoid bacillus and the *B coli communis* are left untouched, in other methods the amount of acid prescribed is sufficient to entirely obliterate the typhoid bacillus, leaving, however, the *B coli communis* sole master of the field In an extremely interesting paper which has appeared in the *Zeitschrift fur Hygiene*, vol xii p 491, 1892 ("Ueber den Typhusbacillus und den *Bacillus coli communis*"), Dunbar discusses very fully all these points, and gives an account of the principal methods in vogue for the isolation of the typhoid bacillus, together with a critical commentary based upon his own experimental observations, as well as those of other investigators. As a result of these researches Dunbar maintains that no absolutely trustworthy method at present exists for the successful identification of the typhoid bacillus in the presence of the *B coli communis*, and that it is highly probable that the latter has in many cases been mistaken for the former in water supposed to contain the typhoid bacillus There can be no doubt, however, that, with a knowledge of these imperfections, the judicious application of some of these methods may very greatly facilitate the isolation of the typhoid bacillus in the presence of other organisms, and that, moreover, a method which is able to restrict the varieties present on any given gelatine plate to the *B coli communis* and the typhoid bacillus already removes some of the chief obstacles.

A further communication from M Moissan concerning the chemical properties of the diamond is contributed to the current number of the *Comptes Rendus* In the first place precise determinations have been carried out of the temperatures at which various kinds of diamonds undergo combustion in pure oxygen. As the action of oxygen upon the diamond has so long been known, it appears somewhat singular that, as M Moissan states, no exact data concerning the temperature of combustion should hitherto have been obtained. It will doubtless be remembered that Dumas and Stas, in their celebrated experiments in connection with their determination of the atomic weight of carbon, burnt diamonds in a current of oxygen in a porcelain tube heated in an ordinary earthenware table furnace. Other chemists have since performed similar experiments with the aid of the combustion furnaces employed in organic analysis. In order to be able to determine the temperature of such combustion with precision, M. Moissan has employed a modification of Le Chatelier's thermo-electric apparatus, placed along with the diamond in a wide porcelain tube closed at the ends with glass plates through which the combustion in oxygen could be viewed It was found that when the temperature is slowly raised under these conditions the combustion proceeds gradually without the production of light But if the temperature is raised 40° or 50° above the point at which this slow combustion commences, a sudden incandescence occurs, and the diamond becomes surrounded by a brilliant flame Various deeply-coloured specimens of diamonds burnt with production of incandescence and flame at temperatures of 690°–720°, but transparent Brazilian diamonds did not attain the stage of slow combustion without incandescence till the temperature of 760°–770° was reached A Cape diamond suffered gradual combustion at 780°–790° Specimens of exceedingly hard boort likewise commenced to combine with oxygen at 790°, and burnt brilliantly at 840°–875° When Cape diamonds were heated in a current of hydrogen to a temperature of 1200° they remained unchanged, but if the stones had previously been cut they frequently lost their brilliance and transparency Dry chlorine gas was found incapable of reacting with the diamond until a temperature of 1100°–1200° was attained Hydrofluoric acid vapour likewise only reacted at about the same high temperature Vapour of sulphur also requires to be heated to 1000° before reacting, but in the case of black diamonds bisulphide of carbon is produced at about 900° Metallic iron, at its melting point, combines with the diamond in a most energetic manner, and it is a point of considerable interest that crystals of graphite are deposited as the fused mass cools, hence the experiment forms a striking mode of converting the allotropic form of carbon which crystallises in the cubic system into that which crystallises in the hexagonal system Melted platinum likewise combines with the diamond with great energy A most curious reaction has been observed to occur between the diamond and the carbonates of potassium and sodium When a diamond is placed in the fused carbonate contained in a platinum dish it rapidly disappears, and carbonic oxide is copiously evolved Fused nitre or potassium chlorate, however, have not been observed to exert any action upon diamonds

Notes from the Marine Biological Station, Plymouth — Recent captures include examples of the Hydroid *Myriothela phrygia*, the Opisthobranchs *Aplysia punctata* and *Oscaniius membranaceus*, and the "cotton-spinner" (*Holothuria nigra*) The week has been marked by a rapid increase in the numbers of Echinoderm larvæ, especially of *Auricularia* and *Bipinnaria*, but *Plutei* are still relatively scarce Ephyræ of *Aurelia* continue plentiful, and have grown appreciably Among the Anthomedusæ, *Rathkea octopunctata*, *Sarsia prolifera* (without buds), and the gonozooid of *Podocoryne carnea* have been noticed, among Leptomedusæ, the *Eucopium* and *Eucope*-stages of *Clytia Johnstoni* have made their appearance, together with *Thaumantias Forbesii* (Haeckel) and small *Obelia* medusæ Several *Muggiæa* and a single *Pilidium* were seen on the 11th inst. The Nemertine *Amphiporus lactifloreus*, and the Anomoura *Eupagurus Prideauxii*, *Galathea dispersa* and *intermedia* have begun to breed

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. G. J. Sheppard; a Leopard (*Felis pardus*) from Kiamaya, East Africa, presented by Mr J Ross Todd; a Spotted Ichneumon (*Herpestes nepalensis*) from Nepal, presented by Lieut. Philip Egerton, R.N., six Vulturine Guinea Fowls (*Numida vulturina*) from East Africa, presented by Mr. R. J. Macallister; a Black Tanager (*Tachyphonus melaleucus*) from South America, presented by Miss Trelawny; a Greater Sulphur-crested Cockatoo (*Cacatua*

galerita) from Australia, presented by Miss Amy M Dundas, three white-tailed Gnus (*Connochætes gnu*, ♂ ♀ ♀) from South Africa, deposited, a Burchell's Zebra (*Equus burchelli*, ♀), two Silver-backed Foxes (*Canis chama*), a Cape Bucephalus (*Bucephalus capensis*) from South Africa, a Salvin's Amazon (*Chrysotis salvini*) from South America, purchased, four Upland Geese (*Bernicla magellanica*) from the Falkland Islands, received in exchange; four Coypus (*Myopotamus coypus*) born in the Gardens

OUR ASTRONOMICAL COLUMN

COMET HOLMES (1892 III) —This comet has now become rather a difficult object, but the following ephemeris may be useful for those employing large instruments —

12h Paris Mean Time

1893	R A (app) h	m	s	Decl (app) °	′	″
March 16	2	55	29 0	+ 35	27	53
17		57	16 1		30	43
18	2	59	3 5		33	33
19	3	0	51 1		36	23
20		2	38 9		39	13
21		4	27 0		42	2
22		6	15 3		44	51
23	3	8	3 8	35	47	40

THE SIZES OF JUPITER'S SATELLITES —M J J Landerer describes in the *Comptes Rendus* some experiments made to test the accuracy attainable in measuring the diameters of satellites by their shadows cast on the primary He took a finely ground glass plate and blackened it, leaving a space in the middle representing the appearance of Jupiter with its bands and small black spots representing shadows He then placed it at a distance of 314 m, illuminated it by a suitable light from behind, and sketched the disc through the telescope used for the actual observations With some practice it was found possible to draw such spots correctly to within one-tenth per cent M Landerer then applied his method to the satellites themselves, and found the following numbers for their radii —0 0199, 0 0184, 0 0435, and 0 0419 The number of observations was twenty-six for the first satellite, seventeen for the second, thirty for the third, and twenty two for the fourth The commonly accepted numbers, obtained by micrometric measurements of the bright satellites, are 0 0291, 0·0259, 0 0431, and 0 0367

OBSERVATIONS OF THE ZODIACAL LIGHT —In No 3155 of the *Astronomischen Nachrichten* Mr Arthur Searle gives an account of the experimental work he and Prof Bailey have been carrying on with respect to the best methods of making and recording observations of the zodiacal light Owing to the prevalent use of electric light in the neighbourhood of Harvard College Observatory, the observations were made at some distance away. The general mode of defining the position of the zodiacal light up to the present has been by drawing its outline on a star atlas exactly as it appeared in the sky at the time of observation. The great drawback about this method is that in the majority of cases the zodiacal light has no definite outline, but gradually decreases in brightness as one recedes from the axis of the figure, eventually fading imperceptibly away That this is so is the general idea and is backed up by observations, but it is also true that the contour, so to speak, of the luminous figure is sometimes sharper at some places than at others. Instead of outline drawings these observers have substituted contour lines in which the degree of light represented by each contour is stated; the latter is accomplished by selecting a portion of the sky "unaffected by the zodiacal light, but of equal brightness with those portions traversed by the contour line." This region would naturally lie near the Milky Way and its situation is defined by the stars in the vicinity To complete the record the geographical position of the observer's station and the time of observation should be included in the statement. In addition to the contour lines two other suggestions are put forward, (1) that the axis of brightness should be indicated by a line, and (2) that should there be distinctly observed by any chance two cones of light, an outer and an inner, such a distinction should be shown in the record by drawing a boundary between them.

WEINEK'S LUNAR ENLARGEMENTS —Since the appearance of the magnificent enlargements obtained by Dr Weinek from the Lick Observatory negatives, many details of surface structure have been brought to light which have up till now evaded even the aided eye. These details, consisting as they do of winding rills, valleys, and hair like markings, appear quite sharp and distinct in contrast with the larger surface features, and it is this fact that has caused some uncertainty about their being actual features on the lunar surface Every one acquainted a little with photography knows that a photograph loses in sharpness the more it is enlarged, and it is here very curious to find a picture after being twenty times enlarged with minute details quite crisp and sharp, and the larger portions quite fluffy, as is the case in the enlargement of Vendelinus, taken on August 31, 1890 As Mr Elger remarks (*Observatory*, March), "if these curious markings represent actual features on the moon's surface, ought they not to be easily seen in any good telescope that shows the formation and its principal details with far greater sharpness than the twenty-times enlarged negative, and many small craters, &c, in addition which are scarcely traceable upon it? One does not understand why this should not be so, unless these objects make an impression on the sensitive plate that they fail to do on the retina, which is hardly likely to be the case" M Faye, in *Comptes Rendus* (No 9) for March, when referring to these enlargements, says that several members, MM Fizeau, Mascart, and Cornu included, reserved their opinions on the interpretation of these markings, which seemed to be the results of retouching "Certain vermiculées appearances," says he, "show a clearness which is strictly in contradiction with the very general 'estompée' appearance of the lunar cliché"

"L'ASTRONOMIE" FOR MARCH—The March number of this magazine commences with some observations of Jupiter made at the observatories in Juvisy, Bruxelles, and in Spain during the past year The numerous drawings which accompany the observations impress one with the incessant change that is taking place in the dense atmosphere, while the large red spot was as usual seen ploughing its way apparently through one of the dark belts The period of rotation of this spot seems to have suffered a retardation during the last twelve months, as will be seen from the following table, which we take the liberty of producing here —

	h m s		h m s
1879	9 55 35 7	1886	9 55 40 1
80	35 0	87	40 1
81	36 1	88	40 2
82	37 2	89	40 3
83	38 1	90	41 5
84	39 2	91	42 2
85	40 1	92	39 3

M. Guillaume, of the Lyons Observatory, contributes some interesting notes on the appearances of Saturn's rings during the same year, at which time it will be remembered we were lying nearly in its plane Besides the drawings showing the general features of the planet, there are some illustrating the different degrees of luminosity observed at various parts of the ring itself "The Circulation of Winds at the Surface of the Globe" is the title of an article by M A Duponchel, in which he gives as an introduction a brief historical account of the early hypotheses, while M Flammarion gives us the fifth chapter on "Comment Arrivera la fin du Monde," dwelling for the most part on the destructive forces at work on the earth's surface.

BERMERSIDE OBSERVATORY —In the advertising sheets of the *Observatory* for March we are sorry to see the following notice — "On sale (the owner giving up astronomical work) the 3-foot Common reflector, with or without dome, complete, in perfect order Mirror by Sir H. Grubb Full particulars on application to J Gledhill, Bermerside Observatory, Halifax"

GEOGRAPHICAL NOTES.

A TELEGRAM from Port Stanley announces the return of the Dundee whaling ships to the Falkland Islands (see NATURE, p. 282) on their way home. In the two months during which they were absent it is improbable that high latitudes were reached, but it is evident that a cargo was rapidly obtained, although it is not reported whether the species of whale hoped for was found.

THE Geographical Studentship at Oxford lately held by Mr. Grundy has been awarded to Mr W H Cozens-Hardy, New

College Mr Cozens Hardy has already made some interesting journeys in Montenegro and the neighbouring little-known parts of the west coast of the Balkan Peninsula which he intends to study further

THE expedition of M Delcommune by Lake Tanganyika appears to have been the most successful of all those sent out by the Katanga Company, as its leader has returned to Leopoldville, and will soon reach Europe to recount his experiences The expeditions of Captain Stairs and Captain Bia, although successful in reaching their destination, were unfortunate in losing their leaders, and all the parties suffered terribly from sickness and famine. One of the interesting circumstances of these expeditions is the fact that a bronze tablet commemorating the death of Livingstone has been fixed to the tree at Old Chitambo's, where the great traveller died This tablet was sent out in duplicate by Mr A I Bruce of Edinburgh, son in-law of Dr Livingstone, through Mr Arnot, who being unable to reach Chitambo's himself, entrusted one of the tablets to Captain Bia, by whose party it was placed in position

MR MACKINDER's educational lectures, of which the eighth was delivered in the hall of the University of London on Friday night, continue to be well attended The subject of the lecture was the Alps as a factor in European history, and the series of fine maps specially prepared for projection by the lantern enabled the development of the historical argument to be followed from point to point

THE March number of the *Scottish Geographical Magazine* contains a valuable note by Prof Mohn on the climate of Greenland, in which he epitomises his discussion of Dr Nansen's results, published in a recent Erganzungsheft of *Petermann's Mitteilungen*, and corrects it by the record of Peary's work The isotherms (reduced to sea level) run parallel to the coast, the interior being coldest at all seasons, 30° F compared with 26° on the coast for January, 30° as compared with 50° for July, and on the average for the year the centre of the land is probably about −10°, while the coast has the temperature of 30°

THE CHATHAM ISLANDS AND AN ANTARCTIC CONTINENT

AT the last meeting of the Royal Geographical Society Mr H O Forbes discussed the question of the former extension of an Antarctic continent in relation to certain observations made during a recent visit to the Chatham Islands The whole surface of these islands, especially Whare kauri and Rangiauria, is covered with a bed of peat in places over forty feet in depth—deeper in the northern part than in the southern—traversable in safety only by those acquainted with the country, for to the inexperienced eye there seems in most places no difference in the surface which can carry with safety both horse and rider, and that on which the lightest footed pedestrian cannot venture without being engulfed The surface of some of the larger and wetter depressions in the ground was covered with a brilliant-coloured carpet of luxuriant mosses, emitting an aromatic fragrance, spread out in artless undesigned parterres of rich commingled green, yellow, and purple, and endless shades of these, warning the traveller of the existence of dangerous bogs beneath, and brightening miles of treeless moorland, which, but for those floating gardens, would be uninviting and uninteresting In many places all over the island this great peat-moss is on fire, and has for years been smouldering underground, or burning in the exposed faces of the great pits which have now been burnt out Dr. Dieffenbach mentions these fires at his visit in 1840, and states that the combustion had begun before 1834. They appear to have been burning in one part or another of the island ever since Dieffenbach's visit. A peculiarity in the main island that strikes the visitor very early is the occurrence of many lakes and tarns These lakes are, for the most part, on the eastern side, at the back of the low hills facing Petre Bay. The largest is fifteen miles long, over forty miles in circumference, and about ten and a half miles broad at its widest part

Mr. Forbes's object in visiting the islands was to look for the remains of a fossil bird, fragments of which had been sent to him in New Zealand These he discovered in considerable numbers, and found that the bird was no other than a species of *Aphanapteryx*, a large and remarkable member of the rail family, which lived contemporary with the celebrated dodo in the Island of Mauritius, and was very similar to one of the extinct flightless birds of that island. Here was the only place in the world where it was known to exist, and where it had with the dodo preserved its fading race down to about two hundred years ago, when both of them passed away and perished for ever from among living things In the Chatham Islands the remains of the *Aphanapteryx* were found in kitchen middens of the Morioris, showing that in this region of the world also it had survived down to comparatively recent date, just as the moa had in New Zealand

In the Chatham Islands there still live several types of flightless birds scarcely represented elsewhere, except in widely separated oceanic islands To account for their distribution it is necessary to reason backwards to former distributions of land and sea The occurrence of similar forms in the three southern continents and in the islands which lie between them is most easily explained by a former Austral continent of considerable northern extension The outlines of this continent it is of course impossible to trace with anything approaching to accuracy till we are in possession of a larger number of soundings But it is not unlikely that the great meridional masses of land—or world ridges—which are probably of primeval antiquity extended to meet prolongations northward of the Antarctic continent There is some evidence that the direct union of South Africa with the other continents was not for so prolonged a period as the others The presence of the *Aphanapteryx* and other ocydromine birds both in the Mascarene and in the New Zealand continental Islands supports other evidence pointing to an extension of that area south by Marion and Kerguelen Islands, and of New Zealand south, or of the Antarctic land north, by way of the Macquarrie, Auckland, and Antipodes Islands It is interesting to observe that the great Pacific trough to the east of the longitude of New Zealand extends far south into the Antarctic region.

It is not necessary to suppose that all the southerly extending arms were connected contemporaneously with an Antarctic continent It is impossible to account for the presence, for instance, of some South American forms in Australia and not in New Zealand, of Mascarene forms in the New Zealand region and not in Australia, or in Africa, or elsewhere, while we are unacquainted with the orography, the rivers and mountain barriers, of the submerged southern continent, and its various commissures may have been open at one time and closed at another As there are, moreover, abundant evidences of great volcanic action over all the region, in New Zealand, South America, Mascarenia, and the Antarctic Islands, the permutations and combinations of the ups and downs of these lands, the openings and closings of the gates, paths, or stepping stones, are beyond our computation

The deductions as to an Antarctic continent, made on biological grounds, are supported by the depth of the circumpolar sea, so far as it is known The submarine plateau of the Austral land slopes northward all round the shores of the known lands more gently than is the case along any other coast, and this would seem to indicate that, if elevated, the land would form in great extent a continuation of the three primal ridges of the globe southward, coalesced and spread out round the Pole, with, between these arms, the terminations of the great and permanent ocean troughs How far these hypotheses—which are but a restatement, in great measure, of the investigations and conclusions of many distinguished naturalists, geologists, and geographers may be substantiated or refuted by future discoveries it is difficult to say, but the discovery of these interesting *Aphanapteryx* bones on the Chatham Islands must always remain an important factor in the solution of this question

There was an animated discussion.

ARCHÆOLOGICAL WORK IN AMERICA.

IN his report, just issued, on the Peabody Museum of American Archæology and Ethnology, Prof Putnam is able to record the results of a very exceptional amount of useful work. This is due to the fact that while the officers of the Museum have discharged their usual duties many special archæological and ethnological researches have also been carried on with a view to the collection of material for the Chicago Exhibition. Prof Putnam says:—

Never before has such an extensive field of anthropological research been covered in two years' time, and it is desirable to place on record what has been accomplished In the north,

Lieutenant Peary's expedition to Greenland has brought back a valuable collection from the little known tribe of Eskimo at Whale Sound, including their summer houses of skins, their boats, sledges, weapons, implements, utensils, ornaments, full sets of garments and carvings in ivory, as well as several hundred photographs of individuals of the tribe and of scenes illustrating their daily life, also several crania, and a complete census of the tribe with a full set of anthropometrical measurements and observations. In Labrador, the Skiles expedition (upon which I obtained positions for two Harvard students, one as a naturalist and the other as astronomer) has brought back 57 of the Labrador Eskimo,—men, women, and children with all their belongings,—making an Eskimo village now on the Fair grounds in Chicago, where it will remain until the Fair is over. On the Pacific side Dr Sheldon Jackson has made ethnological collections in Alaska, and also among the coast tribes of Siberia. Mr Cherry has collected from the tribes of Yucon valley, and by seven other assistants a systematic collection has been made on the north west coast, between the Columbia River and Alaska, particularly from northern Vancouver and the Queen Charlotte Islands. On the Saskatchawan Mr Cowie has made a complete collection to illustrate the life and customs of the tribes of the valley.

Arrangements have been made with the Canadian Commissioner of Indian affairs by which the interior tribes of Canada will be represented living on the Fair grounds, and by the cooperation of the Canadian Government World's Fair Commission a representation of the archæology of Canada has been secured. In the eastern portion of Canada Mr Tisdale and Mr Fenollosa, both Harvard students, have collected anthropological data, and much of ethnological importance. Nearly all the Indian tribes of the United States have been visited by students from Harvard and other universities for the purpose of obtaining anthropological data relating to the physical characteristic of the various tribes and of collecting ethnological material.

The State of New York through its World's Fair Commission has also been brought into this work. The Commissioners are earnestly cooperating with me in securing a large archæological collection, and also a thorough representation of the Iroquis tribes. Families from these tribes will be living on the Exposition grounds in bark houses such as were in use when this powerful nation first came in contact with our race.

South of the United States, the Bureau of Latin American Republics in connection with the State Department has been working with the Ethnological Department of the Exposition, of which its forms a section, and a number of officers of the army and navy were detailed to visit the various republics and arouse an interest in the Exposition, and also to make collections in ethnology and archæology under instructions which I furnished for their guidance. These gentlemen have accomplished much ethnological importance, and have secured several collections from the native peoples of Central and South America. Mr Frederic Ober was sent to the West Indies and made a special research among the Caribs.

In relation to Mexican archæology, Mrs Zelia Nuttal, acting in her double capacity as honorary assistant in the Museum and in the Ethnological Department of the Exposition, has been engaged in a search for objects in Europe, brought there at the time of the Spanish conquest, and has found several interesting things, connected with the period of Cortez, of which she has had facsimiles made both for the Exposition and for the Museum.

Further South in Mexico, Consul E H Thompson has continued the work in connection with his explorations for the Museum among the ancient ruins of Yucatan. During this time he has made about 10,000 square feet of moulds of portions of the ruined buildings, showing the façades, parts of corners of structures, doorways, and the great recess with its pointed arch of the so named "House of the Governor" at Uxmal. He has also moulded both sides of the famous Portal at Labna. Casts are to be made from these moulds in Chicago, and there will be seen on the Exposition grounds facsimiles of these elaborately carved stone structures of Yucatan, over and around which will be the tropical plants native to the region of the ruins. As this work by Mr Thompson was in connection with his explorations for the museum, we can secure such casts from the moulds as we may desire at the cost of making the casts, which, however, will be several thousand dollars.

The Museum Expedition to Honduras, which is an important part of the work of the year, will be specially mentioned further on, but as it forms a link in the chain of explorations it is referred to in this geographical review. Farther south, Mr. G. A. Dorsey, a graduate student in this department of the University, working as a special assistant for the Exposition, has made extensive and important explorations on the Island of La Plata, Ecuador, and in Peru and Bolivia, where he collected a large amount of material. Lieutenants Safford and Welles have secured series of garments, weapons, and other objects illustrating the tribes of portions of the interior of South America. Other officers sent out by the Latin American Bureau have been farther south, and Patagonia and Tierra del Fuego have been drawn upon for representations of their ethnology.

Returning to the United States, archæological work has been carried on in Ohio by Dr Metz, Mr Saville, Mr Moorhead, Mr H I Smith and Mr Allan Cook. In the Delaware valley, Mr Ernest Volk, who in previous years was in the field with me, has been engaged in making a careful exploration of several ancient village sites, burial places, and workshops or quarries, where stone implements were made. Mr Allan Cook of the University also made a brief study of a small burial-place on Cape Cod. Mr M H Saville, a student assistant in the Museum, examined an ancient soapstone quarry in Connecticut from which interesting specimens were obtained both for the Museum and Exposition, and several gentlemen, particularly Dr F. H Williams, Mr Wm C Richards and Mr. James Shepard, who showed him much courtesy, gave to the Museum a number of stone implements found on and near the old quarry. In Maine, Mr C C Willoughby working entirely for the Museum, explored two singular burial places in the Androscoggin valley in which the graves were so old that the skeletons had entirely disappeared, leaving in the graves only masses of red ochre and numerous implements and other objects of stone. This exploration was conducted in a careful manner and the notes, drawings, and photographs of the objects in place show how thoroughly the work was done. A fine lot of implements in perfect condition was found by Mr Willoughby, and several others obtained in former years from the same place were given to the Museum by Mr Elijah Emerson of Bucksport. This remarkable collection will be exhibited in Chicago as part of the Peabody Museum exhibit and will afterwards be arranged in the Museum. At the request of Mr T H B Pierce of Dexter, Me, Mr Willoughby also made a partial examination of a mound near Dexter which may be a burial mound. Further exploration should be made, for if it prove to be a burial mound it would be the only one known in New England.

Important researches in physical anthropology have also been carried on. These were in part based on the observations made by the assistants among the native tribes, and in part upon collections. In this connection Dr Franz Boas, aided by Dr G M West and two clerical assistants, has been engaged in the museum in classifying the anthropological data and in preparing charts, tables, and diagrams to illustrate this subject at the Exposition. Thus for the first time there is being prepared a presentation of the physical characteristics of the native American peoples. Measurements have also been taken, and observations made, on more than fifty thousand children in the public schools in different parts of the United States and Canada, as well as on those in the Indian schools, and on many negro children. In this connection we have secured the cooperation of the authorities of the Japanese schools, and of those of the Hawaiian Islands. We shall thus have the measurements of a number of Japanese and Kanaka children for comparison. To this series of physical measurements has been added a series of tests relating to the mental development of children. These observations and deductions will not only furnish data of importance to educators, but there is reason to believe, from what has already been accomplished in this direction, that they will also give the basis upon which decided reforms in certain directions will be established. It is almost needless to say that the details of this part of the work are entrusted to Dr Franz Boas, who is my earnest collaborator in connection with the Exposition.

This brief review of the work of about 100 assistants shows how much has been done during the year, and as the Peabody Museum is the place from which it has all been directed, and as much of the work has been done by my regular assistants and students, it is eminently proper to refer to it in this report as showing the relation of the Museum to anthropological research in America. It must also be remembered that the directors of the World's Columbian Exposition have not only given to me this grand opportunity for research, but that it has been largely paid for by the funds subscribed by the citizens of Chicago. Never before has there been a year when so much money has

been expended for pure research in anthropology under one direction as during the past year, and praise and honour are due to the business men forming the directory of the Exposition in Chicago, who have so cordially met my proposals and furnished the *means* for carrying them out on so grand a scale. Notwithstanding the vast material interests involved in the Columbian Exposition, it must be admitted that Chicago has nobly supported pure science in this connection and has shown an appreciation of its high aims

On the Honduras Expedition Prof. Putnam reports as follows:—

It was stated in the last report that an expedition had just started to make the preliminary explorations for the ancient ruins of Copan, and in that report is given a brief outline of the origin and plans of this undertaking on the part of the Museum to be carried on by the assistance of patrons of archæological research It is indeed a pleasurable duty to announce that the first season's work of the expedition has proved a decided success, and that although the party had many trials and difficulties to overcome, no serious accidents or sickness occurred Messrs. Saville and Owens returned in safety, in May last, bringing with them a large number of most interesting and important objects illustrating the wonderful carvings in stone, several vessels and many fragments of pottery, numerous ornaments made of stone, shells and bone, stone implements; and portions of human skeletons. Among the latter are several incisor teeth, each of which contains a small piece of green stone, presumbly jadeite, set in a cavity drilled on the front surface of the tooth. We had before received from very ancient graves in Yucatan human teeth filed in a peculiar manner, and now we have teeth from the ancient graves in Copan ornamented in another way This is of particular interest in adding one more to the several facts pointing to Asiatic arts and customs as the origin of those of the early peoples of Central America. A most striking resemblance to Asiatic art is noticed in several of the heads carved in stone,—one in particular, if seen in any collection and not labelled as to its origin, would probably pass almost unchallenged as from Southern Asia These may prove to be simply coincidences of expression of peoples of corresponding mental development brought about by corresponding natural surroundings and conditions At present we must admit that there are many resemblances in architecture, sculpture, ornament, and religious symbolism, between Central America and portions of Asia. The true meaning of these resemblances will be made known as authentic materials for study are obtained by such thorough and exhaustive field work as the Museum has been carrying on, and none is so important for this special subject as that of the Honduras expedition. For this work, however, a large sum of money is required The ten years allowed for the work in Honduras by the edict of that government must be utilised to the fullest extent; and each year must find the Museum ready to put its party in the field well equipped and provided with money for the very expensive work to be performed

It is not my intention to give an abstract of the results of last year's explorations at Copan It is far better that the report should be carefully prepared by those engaged in the actual field work from year to year. After sufficient information has been obtained about the ruins themselves, and the architectural and chronological relationship of the various structures, and after a thorough knowledge of the different modes of burial has been acquired, and all possible objects have been collected, then conclusions can be drawn which will be of scientific value, since they will be based on a thorough knowledge of all the facts. An important beginning was made by the expedition last year, plans of the plaza and of the principal structures forming the great mass of the ruins having been made, many photographs taken, and paper moulds of important sculptures, lines of hieroglyphs and several of the large idols or carved monoliths secured. Considering the difficulties of transportation (wholly by mules to the coast—a seven days' journey), both Messrs. Saville and Owens, and all associated with them must be congratulated on what they accomplished. Since the return of the expedition the photographs have been printed, preliminary reports have been prepared, and casts have been made from the moulds. These casts are now being placed in the Museum, and a series has also been made for the Boston Art Museum, and another for the Columbian Exposition.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Prof Liveing announces a course of demonstrations in spectroscopic chemistry, to be given during the first three weeks of the Easter term, daily (except on Saturdays) at 11, beginning on April 24.

The examination in Sanitary Science for the Diploma in Public Health will be held from April 4 to April 8

The honorary degree of Doctor in Science will be conferred on Prof. Virchow, at a special congregation on Tuesday, March 21

A grant of £65 has been made from the Worts Travelling Scholars' Fund to H. Woods, of St. John's College, for the purpose of palæontological research in Saxony and Bohemia.

Lawrence Crawford, B.A, Fifth Wrangler, 1890, has been elected to a Fellowship at King's College

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 16.—"The Value of the Mechanical Equivalent of Heat, deduced from some Experiments performed with the view of establishing the Relation between the Electrical and Mechanical Units, together with an Investigation into the Capacity for Heat of Water at different Temperatures" By E H Griffiths, M A., Assistant Lecturer, Sidney Sussex College, Cambridge, assisted by G M Clark, B A, Sidney Sussex College, Cambridge. Communicated by R T Glazebrook, F.R S

If a calorimeter is suspended in a chamber, the walls of which are maintained at a constant temperature, we can, by observations over a *small* range across that outside temperature, deduce the rate of rise due to the mechanical work done in the calorimeter, when the supply of heat is derived from stirring only By repeating the observations in a similar manner over ranges whose mean temperature θ_1 differs from that of the surrounding walls θ_0, we obtain the change in temperature due to the combined effects of the stirring, radiation, conduction, and convection at *all points of our whole range of temperature* As the success of the method depends (1) on the possibility of maintaining the exterior temperature unchanged, and (2) on the regularity of the supply of heat due to the stirring, we briefly indicate our method of securing those conditions.

1. The calorimeter[1] was suspended within an air tight steel chamber The walls and floor of this chamber were double, and the space between them filled with mercury The whole structure was placed in a tank containing about 20 gallons of water, and was supported in such a manner that there were about 3 inches of water both above and beneath it The mercury was connected by a tube with a gas regulator of a novel form, which controlled the supply of gas to a large number of jets Above those jets was placed a flat silver tube, through which tap water was continually flowing into the tank, all parts of which were maintained at an equal temperature by the rapid rotation of a large screw. Thus, the calorimeter may be regarded as suspended within a chamber placed in the bulb of a huge thermometer—the mercury in that bulb weighing 70 lbs A change of 1° C. in the temperature of the tank water caused the mercury in the tubes of the regulating apparatus to rise about 300 mm. Special arrangements were made by which it was possible to set the apparatus so that the walls surrounding the calorimeter could be maintained for any length of time at any required temperature, from that of the tap water (in summer about 13° C. in winter 3° C) up to 40° C or 50° C. We know by observation that the temperature of the steel chamber (when once adjusted) did not vary by 1/500° C., and we believe the variations were much less.

2. We experienced great difficulty in devising a suitable form of stirrer; and we attribute the failure of our earlier experiments to defects in the ordinary forms. We find it impossible, without a lengthy description, to give a clear idea of the stirrer ultimately adopted. We can only state here that it was completely immersed when the depth of the water exceeded 1 cm., that

[1] The calorimeter was of cylindrical form, and suspended by three glass tubes. It was made of "gilding metal," which both internally and externally was covered with a considerable thickness of gold. All metal surfaces within the calorimeter were thickly gilded.

its bearings were outside the steel chamber, and that the water was thrown from the bottom to the lid of the calorimeter

More than 100 experiments were performed (many of them lasting several hours) in order to determine the value of $\sigma + \rho(\theta_1 - \theta_0)$,[1] when the calorimeter contained different masses of water. The harmony amongst the results was satisfactory.

The pressure in the space between the calorimeter and the walls of the steel chamber was reduced, as a rule, to between 0 3 and 1 0 mm.[2]

The absolute value of the loss by radiation, &c., at different pressures was ascertained, and it was found that the rate of gain or loss decreased very rapidly when the pressure was reduced below 0 5 mm.

If $\left(\frac{\delta\theta_1}{\delta t}\right)_{\sigma\,\rho}$ is the rate of rise due to the non-electrical supply, and $\left(\frac{\delta\theta_1}{\delta t}\right)$ that due to the electrical supply, then

$$\frac{\delta\theta_1}{\delta t} = \left(\frac{\delta\theta_1}{\delta t}\right)_e + \left(\frac{\delta\theta_1}{\delta t}\right)_{\cdot\,\cdot} \qquad (1)$$

We have indicated the manner in which we determined the last term of this equation, and thus, by direct observation of $\frac{\delta\theta_1}{\delta t}$, we were able to obtain the value of $\left(\frac{\delta\theta_1}{\delta t}\right)_e$ and

$$\left(\frac{\delta\theta_1}{\delta t}\right)_e = \frac{E^2}{J\ R'.M'} \qquad (2)$$

where R′ is the resistance of the coil, and M′ the capacity for heat of the calorimeter and its contents at a temperature θ_1

Throughout the experiments E was kept constant, the arrangement for maintaining the ends of the coil at a constant potential difference worked admirably, and it is probable that in no case did the variations exceed 1/10,000 of the mean potential difference during each experiment

The value of R was determined by a direct comparison (conducted by Mr Glazebrook) with the B A standards and values of R were expressed in true ohms as defined in the B A Report, 1892

The difference between the temperature of the coil and that of the surrounding water was ascertained, and the resulting difference of resistance was found to be such that $\delta R = 00422n^2$, where n was the number of Clark cells by which the potential difference at the end of the coil was maintained

The mercury thermometers were standardised by direct comparison with several platinum thermometers, and a further comparison has (through the kindness of Dr Guillaume) been made with the Paris hydrogen standard. The difference obtained by the two methods in the value of the range is only 005° C.

The various quantities in equation (2) having been determined (with the exception of J and M′), we can deduce from equation (2) the time (T) of rising 1° C at any point of our range when R = 1ω and E is the potential difference of one Clark cell at 15° C

We thus get

$$\frac{J}{E^2} M' = T \qquad (3)$$

If w be the weight of water, and w_x the water equivalent of the calorimeter at the standard temperature, and if f and g be the temperature coefficients of their specific heats, then

$$M' = w(1 + f\overline{\theta_1 - \theta}) + w_x(1 + g\overline{\theta_1 - \theta}),$$

hence

$$\frac{J}{E^2}\{w(1 + f\overline{\theta_1 - \theta}) + w_x(1 + g\overline{\theta_1 - \theta})\} = T_{\theta_1} \quad (4)$$

By repeating observations with different weights of water, w_1 and w_2, and observing T_1 and T_2, the corresponding times, we obtain by subtraction

$$\frac{J}{E^2}(w_2 - w_1)(1 + f\overline{\theta_1 - \theta}) = T_1 - T_2 \qquad (5)$$

Hence when $\theta_1 = \theta$ (i e at the standard temperature) we can find J without first ascertaining the values of f, g, or the water equivalent of the calorimeter, and by repeating the observations over different ranges we can find f without previously obtaining J; or, having obtained f, we can find w_x and g, and then by equation (4) deduce the value of J from a single experiment. We have adopted both methods as a check upon the calculations, which involve much arithmetic. The latter method is the more convenient, as it enables us to ascertain the results of separate experiments, but it cannot be applied until the values of f, g, and w_x have previously been obtained by observations on two different weights at two different temperatures.

We give the values of T at 15°, 20°, and 25° C

TABLE XLI —VALUES OF T AT 15°, 20°, AND 25° C

Temp	Series I		Series II		
	Group B. w = 188 065	Group E. w = 277 931	Group A. w = 139 776	Group C. w = 199 674	Group D w = 259 500
15 000	557 14	740 46	458 87	580·95	702 91
20	557·62	740 60	459·35	581·25	703·05
25	558 09	740 75	459 81	581 55	703 20
No of col } 1	2	3	4	5	6

From this table we obtain the following results —

Specific heat of water at 25° in terms of water at 15°, deduced from columns 4 and 6	= 0 99734
Ditto from columns 4 and 5	= 0·99722
Ditto from columns 5 and 6	= 0 99746
Mean	= 0 99734

Hence, adopting 15° C as the standard temperature, the

SPECIFIC HEAT OF WATER = $1 - 0{\cdot}000266\,(t - 15)$ [1]

Also by means of equation (15) we get the following values of J —

Columns 4 and 6	J = 4 1939 × 10^7
,, 4 ,, 5	J = 4 1940 × 10^7
,, 5 ,, 6	J = 4 1940 × 10^7
Mean	J = 4 1940 × 10^7

This value of J, as previously pointed out (equation 5), is entirely *independent of the value assigned to the water equivalent of the calorimeter*

And we find the water equivalent of the calorimeter at 15° C in terms of water at 15° C = 85 340 grams. The water equivalent of the calorimeter at 25° C in terms of water at 15° C = 86 174 grams

Hence water equivalent = 85 340{1 + 0 000977(t – 15)}

We can now find the capacity for heat of the calorimeter and contents for any weight of water at 15°, 20°, and 25° C, and deduce the value of J from each group separately

TABLE XLIII —VALUES OF J

Group	15°	20°	25°	Mean
A	4 1940 × 10^7	4 1940 × 10^7	4 1939 × 10^7	4 1940
B	4 1930 ,,	4 1941 ,,	4 1949 ,,	4 1940
C	4 1939 ,,	4 1938 ,,	4·1937 ,,	3 1938
D	4·1940 ,,	4 1939 ,,	4 1940 ,,	4 1940
E	4 1938 ,,	4·1940 ,,	4 1943 ,,	4 1540
				4 1940

We have in the above table given the values resulting from the calculation at different temperatures, for the limit of our experimental errors is thus clearly indicated, since the values of

[1] σ = rise in temperature per 1 second due to the stirring. ρ = gain or loss in temperature per 1 second due to radiation, &c., when $\theta_1 - \theta_0$ = 1° C.

[2] The pressures were ascertained by a McLeod's gauge

[1] Over the range 14° to 26° C

J ought (in the absence of experimental errors) to be identical at all temperatures. The close agreement between the values from different groups, and from the same group at different temperatures, is a satisfactory proof of the accuracy of our determination of the water equivalents of the calorimeter, and of the changes in it and in the capacity for heat of the water

Hence, if we assume

1 The unit of resistance as defined in the "B A Report," 1892,

2. That the E M F of the Cavendish Standard Clark cell at 15° C = 1 4342 volts,[1]

3 That the thermal unit = quantity of heat required to raise 1 gram of water through 1° C. at 15° C,

the most probable value of

$$J = 4{\cdot}1940 \times 10^7\ ^{2}$$

This, by reduction, gives the following —

J = 427 45 kilogramme-metres in latitude of Greenwich (g = 981 17)

J = 1402 2 foot pounds per thermal unit C in latitude of Greenwich (g = 32 195)

J = 778 99 foot pounds per thermal unit F in latitude of Greenwich (g = 32 195)

The length of this abstract is already unduly great, and we will, therefore, not enter on any discussion of the results beyond remarking that if we express Rowland's value of J in terms of our thermal unit we exceed his value by 1 part in 930, and we exceed the mean of Joule's determination by 1 part in 350[3]

The difference between Rowland's value of the temperature coefficient of the specific heat of water and ours would, however, cause both his and our values of J to be identical if expressed in terms of a thermal unit at 11 5° C

March 2 —"The Effects of Mechanical Stress on the Electrical Resistance of Metals" By James H Gray, M A, B Sc, and James B Henderson, B Sc, International Exhibition Scholars, Glasgow University Communicated by Lord Kelvin, P.R.S.

This investigation was begun for the purpose of obtaining an easily worked method of testing the effect of any mechanical treatment on the density and specific resistance of metals.

For alteration of density, copper, lead, and manganese copper wires were tested The effect of stretching was always to diminish the density, the alteration being small however for copper about ½ per cent, and for lead ⅐ per cent The effect of drawing through holes in a steel plate was somewhat greater, showing at first an increase of 2 per cent, and, when the drawing was continued, the density began to diminish till, after drawing from diameter 2 mm. to 1 3 mm, it showed an increase on its original value of $\frac{8}{10}$ per cent Several other interesting results on alteration of density were obtained

The most important part of the investigation, however, relates to the alteration of specific resistance of copper, iron, and steel wire due to stretching, and, in connection with this, the authors wish particularly to emphasise the advantages to be gained from using the unit of specific resistance introduced by Weber, who always defined it in weight measure, that is, as the resistance of a length of the metal numerically equal to its density and section unity

The conclusions arrived at are that for practical purposes any mechanical treatment, however severe, does not affect the electrical properties of the metals tested As contrasted with this, it is interesting to note that the smallest impurity in the metal produces a greater change than the most severe mechanical treatment For example, an impurity of ½ per cent. lowers the electrical conductivity by 13 5 per cent., while an impurity of ½ per cent lowers it as much as 30 per cent

"A New Hypothesis concerning Vision" By John Berry Haycraft, M D., D Sc. Communicated by E. A. Schäfer, F R.S

The author pointed out that when a blue pigment is mixed with its complementary pigment—orange yellow—it makes a grey, not a green as is generally stated. This can be shown by the use of transparent colours, such as watery solutions of the aniline dyes. When you mix an opaque oil blue with its complementary orange yellow and get a green it is because the light only passes through a very thin superficial film of the mixture, and a paint which is orange yellow in the mass is only a pale yellow in a thin film, and transmits the green spectral rays stopped by the orange-yellow. In this case, therefore, the thin film of paint which alone affects the light is not a mixture of blue and its complementary orange yellow, but only a mixture of blue and pale yellow

In the case of Maxwell's colour discs you get a grey if the blue and yellow are complementary, or a green or red if they are not, just as in the case of mixtures of transparent pigments. Complementary pigments are simply those which between them absorb all spectral rays, thus blue absorbs red, yellow, and some green, and the complementary orange yellow absorbs violet, blue, and some green A mixture of these pigments on the palette—if transparent enough—or on the Maxwell's disc absorbs, therefore, the light which falls upon it from all parts of the spectrum in about equal proportions If examined by the spectroscope the mixture of pigments and the rotating disc both give a dim, unbroken spectrum identical with that of white paper held in half light In our study of vision we have to deal with the stimulus—spectral rays—and the resulting sensations Inasmuch as the stimulus—the light of a dim, unbroken spectrum—is the same whether the eye looks at a mixture of blue and orange yellow on a palette, at a Maxwell's disc, or again at a piece of white paper held in half light, the resulting sensation must in all cases be the same—we call it grey or white In the case of the rotating Maxwell's disc experiment we are not dealing with the fusion of blue and orange-yellow sensations, but the adding together of two halves of the spectrum to make a whole one Once understood, the physiologist will discard the experiment altogether, as it has no bearing upon colour vision

The work of Sprengel, Darwin, and especially of Sir John Lubbock, shows that the colour sense has gradually been evolved by the coloured environment of the species We may infer that in the ancestral condition in which light was distinguished from darkness, but blue was undistinguishable say from red, all visual stimuli were felt as white or various shades of grey The greater the amount of spectral light the nearer the sensation approached white This, if accepted, explains why the outer and less used parts of the retina are colour blind in the human eye at the present day, and further explains why a minimal stimulus from a coloured object gives rise to a sensation grey Just as we may smell something, but require to "sniff," in order to make out what it is, so the coloured object held far away may give rise only to the primitive sensation grey, and has to be brought nearer in order that its colour quality can be felt

We may explain the fact that an artificial mixture of spectral green and red gives rise to the sensation yellow by the fact that all coloured objects which send to the eye red and green rays also send the intermediate yellow, these objects give rise to the sensation yellow, and we call them by that name Inasmuch as this association of red and green rays has in the evolution of the eye always combined with yellow rays to produce the sensation yellow, we can explain, as an instance of association, the fact that artificially combined red and green rays produce a yellow sensation

When, say, red and blue green spectral rays are artificially combined, they produce a grey sensation, and this we can explain by the fact that no fully coloured natural object sends to the eye such a combination, which combination, therefore, played no part in the evolution of the colour sense, and it produces merely a primitive sensation of simple brightness—white or grey

That a coloured object brightly illuminated appears white follows the law of maximal stimulation, for in this case the object absorbs so slight a proportion of the light from any one part of the spectrum that that part gives rise to its maximal effect, and the rest of the spectrum can do no more In this case, therefore, the eye is affected equally (maximally) by all parts of the spectrum, and we have of course the sensation of white.

The above view is an attempt to explain some of the facts of vision by showing that they are on all fours with other facts known to the physiologist This seems to the author a more scientific method than the one adopted by Young and Helmholtz, who "conceive" a visual apparatus, and endow it with such properties as will, in their opinion, account for the facts of visual sensation.

1 If we assume the E.M F of our Clark cells to be the same as that of the Cavendish standard (and we are inclined to think we have over-estimated the difference), we get J = 4 1930 × 10^7

2 The value obtained by us in 1891 = (4 192 +) × 10^7

3 Rowland obtained the mean value of Joule's determinations by assigning values to different experiments, and the above comparison refers to the numbers thus obtained. If, however, we attach equal weight to all Joule's results, as reduced by Rowland, the mean *exceeds* our value by 1 in 4280, assuming our expression for the temperature *coefficient* of the specific heat of water.

Chemical Society, February 16.—Prof. A. Crum Brown, F.R.S., President, in the chair.—It was announced that the following changes in the Council were proposed by the Council for the ensuing year:—President, Prof. H. E. Armstrong, vice Prof. Crum Brown. Vice-Presidents: Dr. E. Atkinson and Mr. C. O'Sullivan, vice Prof. Hartley and Mr. Warington. Secretary, Prof. Dunstan, vice Prof. Armstrong. Ordinary Members of the Council: Messrs. C. F. Cross, Bernard Dyer, Lazarus Fletcher, and W. A. Shenstone, vice Mr. H. Bassett, Prof. Ferguson, Mr. J. Heron, and Mr. S. U. Pickering.—The following papers were read:—Note on the preparation of platinous chloride, and on the interaction of chlorine and mercury, by W. A. Shenstone and C. R. Beck. The authors find that very pure specimens of chlorine may be prepared by igniting platinous chloride obtained by heating hydrogen platinichloride in a current of dry hydrogen chloride. On passing the dry gas for fifteen hours over the platinichloride at the boiling point of mercury and igniting the residue *in vacuo*, chlorine was obtained which contained 99.84 per cent. of the gas. A portion of the platinous chloride obtained in this experiment was heated at 500° in a current of dry hydrogen chloride during many hours; on then igniting the residue, chlorine was evolved which when treated with mercury only left a residue of 0.06 per cent. unabsorbed. The platinous chloride made by the above method probably contain a little platinum, but as a source of chlorine, it seems to be superior to the product of more familiar processes. The second sample of chlorine mentioned above acted very sluggishly on mercury; this fact, considered in connection with the great purity of the gas, supports the authors' view that the activity of chlorine towards mercury is probably due to the presence of impurity in the former.—The action of phosphoric anhydride on fatty acids. Part III., by F. S. Kipping. In the present paper the author shows that caprylone $(C_7H_{15})_2CO$, nonylone $(C_8H_{17})_2CO$, and myristone $(C_{13}H_{27})_2CO$, can be readily prepared from the corresponding fatty acids by the action of phosphoric anhydride; a number of derivatives of these ketones are described. Mixed ketones of the general formula R.CO.R′ are produced when a mixture of two fatty acids is treated with phosphoric anhydride at a moderately high temperature; the mixed ketone is, however, accompanied by two simple ketones. Treatment with phosphoric anhydride would seem to be one of the simplest and most rapid methods by which the ketone $(C_nH_{2n+1})_2CO$ can be prepared from a fatty acid $C_nH_{2n}O_2$.—Regularities in the melting points of certain paraffinoid compounds of similar constitution, by F. S. Kipping. The author has prepared and characterised a number of hydroximes, secondary alcohols and ethereal salts derived from the fatty ketones $(C_nH_{2n+1})_2CO$ and draws attention to certain regularities observed on comparing the melting points of these compounds. The melting points of all ketones of the general formula $C_nH_{2n}O$ cannot be calculated by means of the formula given by Mills (*Phil. Mag.* 1884), inasmuch as isomeric ketones frequently melt at different temperatures.—Some relations between constitution and physical constants in the case of benzenoid amines, by W. R. Hodgkinson and L. Limpach. A study of the formyl and acetyl derivatives of certain homologues of aniline shows, (1) that the entry of alkyl groups into the nucleus affects the melting and boiling points in a regular manner; (2) that the conversion of formyl into acetyl also involves an alteration in physical properties in extent the same as that produced by introducing CH_2 into the nucleus in an ortho- or para-position relatively to the amido-group, and (3) that the same (or any?) alkyl group entering the nucleus in the meta positions has no effect on melting or boiling point. Several numerical regularities are also apparent.—Electrolysis of sodic ethylic camphorate, by J. Walker. On electrolysis, sodium ethyl camphorate yields the ethyl salts of two new acids, viz. campholytic acid, $C_8H_{13}.COOH$, and camphotetic acid, $C_{16}H_{28}(COOH)_2$. The first of these is a monobasic, unsaturated acid boiling at 240–242°. It is lævo-rotatory, but gives a dextro-rotatory ethyl salt. Camphotetic acid is a colourless crystalline solid, melting at 132°; it behaves as a saturated, bibasic acid and forms well-characterised salts. Judging from the nature of the electrolysis and the behaviour of campholytic acid towards bromine, camphoric acid should contain the group

$$\begin{array}{l} \quad | \\ \mathrm{HC.COOH} \\ \quad | \\ \mathrm{-C \;\; COOH} \\ \quad | \end{array}$$

—The hydrates of hydrogen chloride, by S. U. Pickering. Determinations of the densities of aqueous solutions of hydrogen chloride show a strongly marked break indicative of the presence of a trihydrate. The author has obtained this hydrate in the solid state by making a series of freezing point determinations; it forms large, transparent crystals melting at −24°.9. The densities also indicate the existence of a change of curvature at a point corresponding to a hexhydrate; the freezing-point determinations afford no evidence for or against the existence of this substance, but the presence of a decahydrate was indicated.—A new base from *Corydalis cava*, by J. A. Dobbie and A. Lauder. By exhausting crude corydaline with hot water the authors have isolated a new alkaloid of the composition $C_{19}H_{25}NO_4$, which they term corytuberine; this alkaloid contains only two methoxy-groups, whilst corydaline contains four. A number of its salts are described. The authors also give some notes on yet another alkaloid, which they consider to be distinct from all the bases of *Corydalis cava* hitherto described.

February 20.—Lord Playfair, F.R.S., Vice-President, in the chair.—This being the anniversary of the death of Hermann Kopp, Prof. T. E. Thorpe delivered a memorial lecture entitled "The Life Work of Hermann Kopp."

PARIS

Academy of Sciences, March 6.—M. Lœwy in the chair.—On a partial differential equation, by Émile Picard.—On the spectro-photographic method which makes it possible to obtain photographs of the chromosphere, faculæ, protuberances, &c., by M. J. Janssen. This method was outlined by M. Janssen as early as 1869, at the Exeter meeting of the British Association.—Analysis of the ashes of the diamond, by M. Henri Moissan. All the specimens of the carbonado and Cape diamond analysed contained iron, as shown by the potassium sulphocyanide reaction. This metal formed the larger portion of the ashes. Silicium also occurred regularly, and calcium very frequently. It will be remembered that this alkaline earthy metal was found by M. Daubree in native iron from Ovifak.—On some new properties of the diamond, by M. Henri Moissan (see Notes).—The pancreas and the nervous centres controlling the glycemic function, by MM. A. Chauveau and M. Kaufmann. The inhibitory action exerted by the pancreas on the glycogenic function of the liver appears to be dependent upon an excito-secretory centre controlling the cells performing the internal secretion of the pancreas. This centre is situated in the encephalic portion of the spinal cord, and the inhibitory impulse acts through this centre upon an excito-secretory centre controlling the glycogenic activity of the liver. The removal of the pancreas eliminates this control, and renders an excessive activity of the liver more serious.—The fixation of torrents and the planting of the mountains, by M. Chambrelent. It has been calculated that in the last forty years France has suffered losses amounting to 700 million francs due to inundations in places where the mountains were not wooded sufficiently to check the ravages of mountain torrents after heavy rain. The Chamber has recently voted a sum of 2,600,000 fres. for the planting of the mountains, and it is hoped that the work will be completed in twelve or fifteen years.—On the cause of the variations of terrestrial latitude, by M. Hugo Gylden.—On some new derivatives of phenolphtaleïn and fluoresceïn, by MM. A. Haller and A. Guyot.—On the diameters of Jupiter's satellites, by M. J. J. Landerer.—On a class of dynamical problems, by M. P. Staeckel.—On surfaces whose principal planes are equidistant from a fixed point, by M. Guichard.—On a theorem of M. Stieltjes, by M. Cahen.—On a partial differential equation of the second order, by M. J. Weingarten.—On the calculation of stability of ships, by M. E. Guyou.—On electric waves in wires, and electric force in the vicinity of a conductor, by M. Birkeland.—Oscillographs, new apparatus for the study of slow electric oscillations, by M. A. Blondel.—Photographic reproduction of gratings and micrometers engraved on glass, by M. Izarn. Ammonium bichromate in gelatine gives better results than either collodion or silver salts in gelatine. Copies of microscopic divided scales and gratings were obtained easily and with certainty, and reflection gratings were produced by employing silvered instead of plane glass.—Concerning the direct-reading stereo-collimator of M. de Place, by M. R. Arnoux.—On the industrial preparation of aluminium, by M. A. Ditte. The alkaline aluminates are decomposed by water, and even in the presence of an excess of alkali the introduction of a few crystals of aluminium hydrate into the solution suffices to prevent the establishment of equili-

brium and to effect the decomposition of the aluminate, the rapidity of the reaction being increased by well stirring In the industrial process of obtaining aluminium from bauxite, these crystals are provided by adding to the sodium aluminate a little of the deposit obtained by treating it with a current of carbon dioxide in the cold, a deposit which consists of crystallised aluminium hydrate. The gelatinous hydrate has no such effect The alumina precipitated is very pure Substances such as silica and phosphoric acid, dissolved out of the bauxite by the caustic soda employed, remain in solution.—On the isomerism of the amido-benzoic acids, by M Oechsner de Coninck.—On the dimorphism of the chloroplatinate of dimethylamine, by M Le Bel —On inuline and two new proximate bodies—pseudo-inuline and inulenine, by M C Tanret —Absorbing action of cotton on dilute solutions of sublimate, by M Léo Vignon —Remarkable resistance of animals of the genus *Capra* against the effects of morphine, by M L Guinard —Alterations of molecular tissue in the barbel due to the presence of myxosporidia and microbes, by M P Thélohan —On the maxillary apparatus of the Eunicidæ, by M Jules Bonnier.—On the perfume of orchids, by M Eugène Mesnard —Experimental researches on the mole and on the treatment of this disease, by M Julien Constantin —A disease of the endive, by M Prillieux, remarks by M Arm Gautier —On the morphology of the cellular nucleus in the Spyrogyras and the resulting phenomena in this plant, by M Ch Decagny —Discovery of *Mastodon Borsoni* at Rousillon, by M A Donnezan —On the use of soluble cartridges in oceanographic measurements and experiments, by M J. Thoulet —Temperatures observed in the winter of 1789 at Montbéllard, by M Contejean

BERLIN.

Physical Society, January 20 —Prof Kundt, President, in the chair —Dr Haentzsch spoke on the potential equation, gave an historical account of researches bearing on it, and added a communication on the results of his own investigations Prof Planck explained the arrangement and principle of a truly-tuned harmonium, built on the system of C Eitz, and bequeathed to the Physical Institute The instrument includes four and a half octaves, and possesses special notes, arranged in several rows and distinguished by four different colours, for the fifths, the major and minor thirds, and the major and minor sixths. The pure intonation of the harmonium enables it to be used with far greater success than one which is "tempered," for demonstrating that our ear accommodates itself to concords which are not quite pure, and is influenced in its discrimination of concords by the recollection of tones heard previously The instrument is not suited for concert purposes

Physiological Society, February 3 —Prof du Bois Reymond, President, in the chair —Prof Gad opened a discussion on the communication made by Prof Behring at the last meeting of the Society (see NATURE, vol xlvii p 336) The discussion turned chiefly on the applicability of the results of Prof Behring's experiments to the treatment of tetanus in man Dr Wernicke exhibited diphtheritic cultures which had been kept for more than a year, and still developed rapidly in either agar, gelatine, or broth He then demonstrated on dissected guinea-pigs the more important symptoms of diphtheritic infection, viz. œdema at the place of inoculation, hyperæmia of the liver, kidneys, and adrenals, serous exudations in the abdomen and thorax He next exhibited some guinea-pigs which, after inoculation with the bacilli of diphtheria, had been treated with blood-serum from other animals immune to diphtheria and had been thereby cured It was found that the longer the interval which elapsed after inoculation before the curative serum was administered, the greater was the dose of the serum required to effect a cure He finally reported on experiments on dogs in which immunity and recovery after inoculation had been similarly attained.

Meteorological Society, February 7 —Prof. von Bezold, President, in the chair.—Dr Schubert gave an account of recent researches on the influence of forests on the temperature and humidity of the air, with special reference to certain forests in Austria So far only the experiments made in Podolia in a leafy forest on level ground have led to uniformly positive results From these it appears that the forest lowers the mean temperature of the air, but only in so far that the temperature at 8 p m. is much lower than that existing in the open country, that at 2 p.m. it is higher than in the open, and that the daily amplitude of variation is greater in the forest. The speaker had however found, from a careful perusal of the existing data, and from comparative determinations made in the forests near Eberswalde, that the results so far obtained are markedly affected by radiation The true temperatures of the air inside and outside the forest have not yet been measured, and for this purpose it would be necessary to use an aspiration-thermometer Determinations of humidity are similarly adversely affected by wind and by evaporation due to air-currents. In this case accurate results would be obtained by means of an aspiration psychrometer. Prof Sprung communicated an observation he had made at the Potsdam meteorological institute on the recent coldest day in January While endeavouring to find the most suitable position for a thermometer, he observed, while using similar aspiration thermometers, the following simultaneous temperatures at four different places, viz. -23°, -23°, -18°, and -17° The four places were (1) in an adjoining meadow two metres above the ground; (2) at the north side of the observatory two metres above the ground, (3) two metres above the platform of the tower, and (4) at the cage of the anemometer seven metres above the platform Hence the temperature at the comparatively slight elevation of the anemometer was 6° higher than at the ground, whereas usually the same four thermometers showed a slight fall of temperature at the greater elevation

BOOKS RECEIVED

L'Art de Chiffrer et Déchiffrer les Dépêches Secretes Marquis de Viaris (Paris, Gauthier Villars).—Traité Pratique de Calorimétrie Chimique M Berthelot (Paris, Gauthier Villars).—The Poets and Nature P Robinson (Chatto and Windus).—The Evolution of Decorative Art H Balfour (Percival).—Discussion of the Precision of Measurements S W Holman (K Paul)—Report of Observations of Injurious Insects and Common Farm Pests during the Year 189-. E A. Ormerod (Simpkin).—Some Lectures by the late Sir G E Paget, edited from MSS, with a Memoir by C E Paget (Cambridge, Macmillan and Bowes).—Catalogue of the British Echinoderms in the British Museum (Natural History) F Jeffrey Bell (London).—Lehrbuch der Allgemeinen Chemie, 2 vols Dr O Ostwald (Leipzig, Engelmann)—The Mechanics of the Earth's Atmosphere C. Abbe (Washington)—Das Horizontalpendel Dr E von Rebeur Paschwitz (Halle).—A Manual of Ethics J S Mackenzie (Clive) —Notes on Astronomy S P Johnston edited by J Lowe (J Heywood) —L Aquarium d'Eau Douce H Coupin (Paris, J B Baillière).—Les Lichens A. Acloque (Paris, J B Baillière)—Éléments de Paléontologie, première partie F Bernard (Paris, J B Baillière)—Der Nord Ostsee Kanal C Beseke (Kiel, Lipsius and Tischer).—Catalogue of American Localities of Minerals Prof E S Dana (Gay and Bird).

CONTENTS.

THURSDAY, MARCH 23, 1893

COLLIERS AND COLLIERY EXPLOSIONS

Coal Pits and Pitmen A Short History of the Coal Trade, and the Legislation affecting it By R Nelson Boyd, M Inst C E (London Whittaker and Co)

AS the author remarks in his preface, his present work is a re-cast of a book published for him in 1879 by W H Allen and Co, under the title of "Coal Mines' Inspection" A casual examination of both books shows that they are alike in their main features, only, the latter work has been extended so as to include some of the events of later years The subject is divided into twelve chapters, to which are added four short appendices and a good index The text extends to 239 pages 8vo of good readable print, and there are a few good illustrations of ancient mechanical arrangements, including the steel mill

Mr. Boyd begins by giving a very short historical account of the situation before Parliament began to interfere in the relations between masters and men He then describes the circumstances which led to the appointment of successive Royal Commissions, charged to inquire into various matters relating to mines and miners, and he sketches briefly the leading features of the reports presented by these Commissions, together with the chief points of interest contained in the legislative enactments which were founded upon some of them Our author also pauses from time to time to recount in considerable detail the events of more than passing interest, such as explosions, inundations, and other accidents which happened during the period with which he is dealing, and lastly, in his appendices, he gives the titles of the Acts of Parliament affecting coal mines and miners, both English and Scotch, a list of serious colliery explosions previous to and since 1850, and a table showing the production of coal at different times, commencing in 1660, and brought down to 1891

Among other more or less important provisions of the Acts of Parliament our author gives prominence to — The exclusion of women from mines, the appointment of Government inspectors, the limitations of the ages at which boys can be employed, the restrictions under which explosives may be used, the requirement that each mine should have two distinct shafts, that each mine manager must have a certificate similar to that of a sea captain, that payment must be made by weight and not by measure, the conditions under which safety lamps are to be used, and the method of dealing with coal-dust when it is present

He also reviews such questions as the payment of royalties and wayleaves to landlords, the employers' liability, the wasteful consumption of fuel, the duration of the coal supplies, and old-age pensions to miners

Contrasting the present with the past he says —"The workmen of the present day have attained a distinct social position, have representation in the House of Commons, and trade unions, societies, and powerful combinations," whereas formerly the Scotch colliers were *adscriptæ glebæ*, that is, were bought and sold with the land an Act of the Scotch Parliament of 1660 prohibited them from leaving their employment without a written attestation from their masters under pain of punishment in their bodies, and any person employing them was ordered to return them within twenty-four hours or pay a fine of one hundred pounds Scots The colliers of the North of England were little better, being hired by the year under a system of binding or bonding, those of the Bristol coal-field were described by contemporary writers as being as brutal and ignorant as savages. Colliers lived apart from the rest of the community, were looked down upon with contempt by their fellow-men, and diverted themselves with bull-baiting, drinking, and debauchery

The state of serfdom was removed by various Acts of Parliament passed during the latter half of last century, apparently more with the object of increasing the numbers of the colliers by drawing other classes of labourers into the mines than from any specially humanitarian motives But at length a day dawned when higher principles began to prevail From 1842, when Lord Ashley's Act was passed for the exclusion of women from the mines, onwards to 1887, one Act was passed after another, each having the same object in view, namely, the amelioration of the lot of the miner

The frequent occurrence of disastrous colliery explosions and the great destruction of life and property which accompanied them, had done more than anything else to draw the attention of the public to a consideration of mining affairs, and had likewise been the principal incentive to the appointment of Royal Commissions and to the passing of Acts of Parliament to regulate the supervision and the working of mines

Notwithstanding all that had been done previously, more lives were lost in explosions during the five years ending 1870 than during any preceding five years, the aggregate number lost in fifteen explosions, each of which involved the loss of ten lives and upwards, having amounted to 923

The Coal Mines' Regulation Act of 1872 was drawn up with great care by Mr Bruce (now Lord Aberdare), the Home Secretary It embraced the experience of the Inspectors of Mines, as well as the combined wisdom of mine owners, engineers, managers of mines, and delegates of the colliers But, firedamp having been hitherto regarded as the sole cause of colliery explosions, the stringent provisions of that Act were directed exclusively towards the detection and removal of that element of danger

In 1845 Messrs. Lyell and Faraday, who had examined the scene of the Haswell colliery explosion, which they attributed to large accumulations of firedamp in the empty spaces (goaves) from which pillars had been removed, remarked that firedamp had not been its only fuel, but that doubtless the coal-dust which was raised and swept along *by the firedamp flame* would be decomposed by the heat of that flame, and would therefore add to the force of the explosion.

Between the years 1860 and 1875 several French mining engineers were impressed with the idea that coal-dust had played a part in certain explosions which took place in France Some experiments were made by a committee of the Société de l'Industrie Minérale, and by M

Vital, one of the Ingénieurs des Mines, with the object of ascertaining the likelihood or otherwise of this hypothesis, but no definite conclusions were arrived at

In December, 1875, the present writer examined into all the circumstances attending a colliery explosion in South Wales, and gave a minute description of it before a coroner's jury He insisted that coal-dust had been the principal agent in that explosion, and that firedamp had only played a subordinate part At the same time he referred to the results of experiments he had made which showed conclusively that when fine dry coal-dust is added to a mixture of air and firedamp, in which the firedamp is present in so small a proportion as to escape detection by the means employed for this purpose in mines, the mixture is inflammable at ordinary pressure and temperature, and when ignited burns like a jet of inflammable gas In March, 1876, he read a paper before the Royal Society, in which he described these experiments, as well as the apparatus with which they had been carried out In this paper, also, he claimed that when an explosion is once begun in a dry and dusty mine it becomes self-propagating, and, provided the continuity of the deposit of coal-dust is unbroken, it extends to the utmost limits of the workings This became known afterwards as the "Coal-dust Theory of Great Colliery Explosions"

In May, 1876, Mr Hall, one of the Inspectors of Mines, read his first paper on the subject before a meeting of the North of England Institute of Mining and Mechanical Engineers held in London

During the year 1878 the present writer published a series of papers on "Coal-dust Explosions" in "Iron", and while they were appearing Messrs Marrecco and Morrison read their first paper on the subject

Numerous societies of mining men, and individuals more or less connected with mining, now began to take an interest in the subject, and to make experiments with coal-dust About this time, also, Commissions were appointed by the Governments of England (Royal Commission on Accidents in Mines 1879), France (Commission du Grisou), Prussia and Austria, to inquire into the causes of mining accidents, and amongst other things to investigate the probable influence of coal-dust in colliery explosions.

This sudden activity was no doubt quickened by the events of the ten years ending with 1880, during which the loss of life from explosions was twice as great as it had been during any previous decade. Taking into account only those explosions in which ten lives and upwards were lost, we find that there were thirty-five explosions, involving the lives of 2014 persons, of which 1411 were attributable to the second half of the decade

In 1880 Prof (now Sir Frederick) Abel, one of the English Commissioners, was instructed by the Home Secretary to investigate and make a special report upon the Seaham Colliery explosion (September 8, 1880) During the course of these investigations Abel repeated our experiments of 1875-76 with a similar apparatus with practically the same results as far as coal-dust is concerned, but he claimed in addition to have discovered that any very finely divided incombustible dust would render a mixture of air with 3 or 4 per cent of firedamp inflammable. His apparatus was not, however, provided with any special means of mixing the gas and air such as had been used in our own apparatus, of which it was otherwise a copy

The German Commissioners erected and made experiments with an apparatus similar to one that we had described to the Royal Society in 1881, but on a somewhat larger scale, and they obtained similar results Unfortunately, however, they passed away from the main question, viz whether an explosion that *has taken place* in a dry and dusty mine under the circumstances that would have been formerly described as mysterious, can be attributed to the influence of the coal-dust in the supposed absence of firedamp?

The French Commissioners arrived at conclusions adverse to the coal-dust theory They made no special experiments with coal-dust on an important scale and they did not, so far as can be gathered from their reports, examine the workings of any mine immediately after an explosion

The Austrian Commissioners arrived at the conclusion which we had previously stated in this country, namely, that the relative fineness of a dust has far more to do with its relative inflammability than its chemical composition

The English Commissioners expressed an oracular opinion They denied on the one hand that coal-dust could be the principal agent in great colliery explosions, for, "If that were the case," said they, "an explosion would happen every day, nay every hour" But, on the other hand, they endeavoured to point out that coal-dust may be an element of the gravest danger under certain circumstances which they proceeded to define in a very precise manner The Act of 1887 embodies their recommendations regarding safety lamps, explosives, and coal-dust

From the end of 1875 onwards attention had been more and more directed to the coal-dust question It had been observed that a great explosion never by any chance took place in a damp or wet mine, that when such an explosion took place in a dry and dusty mine, its progress was always arrested by dampness or wetness or by the absence of coal-dust, that it always passed through the dry intake airways, which contain pure air, and comparatively clean coal-dust, that it frequently avoided the return airways, which contain all the firedamp produced in the workings, but impure coal-dust or only stone-dust, and, lastly, that it spread into all the districts of the workings ventilated by separate and distinct intake and return airways, quite irrespective of the force or direction of the ventilating currents, and dependent only upon the one simple but indispensable condition that the train of dry coal-dust continued unbroken, or was interrupted only for short distances here and there. These facts were proved to demonstration by the researches of a number of independent observers in the mines themselves, immediately after the occurrence of explosions. In vain have the opponents of the coal-dust theory, who were at one time very numerous, urged that the intake airways might have contained firedamp, that the coal-dust cloud raised and ignited by a local disturbance, such as the firing of a blasting shot, probably acted as a connecting link which carried the flame from one accumulation of firedamp to another, that if coal-dust was as dangerous as it was represented to be, an explosion would take place

every day, nay, every hour, that certain kinds of coal-dust were perhaps less inflammable than others, and so on

Comparatively few have had the advantage of carefully studying the coal-dust flame as well as the opportunity of investigating the minutest details of a series of great colliery explosions in the mines, immediately after their occurrence The foregoing arguments are therefore perhaps to some extent excusable, but they are none the less the outcome of the imagination of their authors They are being pressed more and more feebly as time goes on, and they are likely, we think, before many years have passed, to vanish as absolutely as the so-called "outburst of gas" theory which for more than a generation was invariably quoted as the only possible means of accounting for the kind of explosions to which we have been drawing attention.

The late Home Secretary, Mr Matthews, was so much impressed by the occurrence of great explosions one after the other in dry and dusty mines, that he appointed a Royal Commission on Coal-Dust in 1890 That Commission has not yet issued its report, but the volume of evidence taken before it, which has been lately published, shows to what small proportions the opposition has shrunk since the theory was first started It is also satisfactory to observe that the number of lives lost in great explosions during the last ten years is only about one half of the number lost during the previous ten years

W G

REVERIES OF A NATURALIST

Idle Days in Patagonia By W H Hudson, C M Z S, Author of "The Naturalist in La Plata" (London Chapman and Hall, 1893)

THE title of this book well describes its contents, but Mr Hudson has established so high a standard by his previous work that the present volume has something of the character of an anti-climax In literary style, in picturesque description, and in suggestive ideas and reflections there is no falling off, but we miss the wealth of original observation and ingenious speculation which made "The Naturalist in La Plata" a masterpiece

Mr Hudson was wrecked on the shores of Patagonia, and had a weary tramp over the desert, of some thirty miles, to reach the settlement on the Rio Negro There, and at some farms higher up the valley, he appears to have spent a year or more, doing nothing but wandering about on foot or on horseback, observing the habits and peculiarities of the scanty fauna and flora, noting the varied aspects of nature, and apparently thoroughly enjoying day after day of dreamy idleness He spent some months at a house about seventy miles up the valley, which was here about five miles wide, and every morning he rode away to the terrace or plateau, covered with grey thorny scrub, and there found himself as completely alone as if he were five hundred instead of only five miles from civilisation. He says —

"Not once, nor twice, nor thrice, but day after day I returned to this solitude, going to it in the morning as if to attend a festival, and leaving it only when hunger and thirst and the westering sun compelled me And yet I had no object in going—no motive which could be put into words, for although I carried a gun, there was nothing to shoot—the shooting was all left behind in the valley Sometimes a dolichotis, starting up at my approach, flashed for one moment on my sight, to vanish the next moment in the continuous thicket, or a covey of tinamous sprang rocket-like into the air, and fled away with long wailing notes and loud whirr of wings, or, on some distant hillside a bright patch of yellow, of a deer that was watching me, appeared and remained motionless for two or three minutes But the animals were few, and sometimes I would pass an entire day without seeing one mammal, and perhaps not more than a dozen birds of any size"

There was nothing beautiful or even pleasing to be seen in this dreary monotonous solitude, yet he felt a great delight and satisfaction in it, which he imputes to the ancestral savage nature that still exists in all of us, though repressed and overlaid by civilisation and society

"It was elation of this kind, the feeling experienced on going back to a mental condition we have outgrown, which I had in the Patagonian solitude, for I had undoubtedly *gone back*, and that state of intense watchfulness, or alertness rather, with suspension of the higher intellectual faculties, represented the mental state of the pure savage"

In the second chapter—"How I became an Idler"—we are told of a still more disagreeable adventure than the shipwreck Mr Hudson was going with a friend to a farm eighty miles up the valley On the way they stayed a night at a deserted hut, and here he had the misfortune accidentally to discharge a revolver bullet into his knee, rendering it necessary for him to return to the settlement to be cured, perhaps to save his life His friend tied up the wound as well as he could, and left him to get a cart from the nearest house a good distance off He was absent a whole day, Mr Hudson lying on his back on the ground all the time. When his companion at length returned with the cart, and lifted him up to put him into it, a large and very poisonous snake moved from under his cloak, where it had been lying close to his feet for many hours It glided away into a hole under the wall, and Mr Hudson rejoiced "that the secret deadly creature, after lying all night with me, warming its chilly blood with my warmth, went back unbruised to its den"

This accident kept the author for some months in bed, and for other months a convalescent unable to walk far, and thus the finest summer weather was wasted, and he acquired those habits of the country and the people that made him an idler, and prevented him from learning as much of the animal and vegetable life of the country as, under more favourable circumstances, he might have done Yet he gives us many interesting facts and discussions, and the chapter on "The War with Nature" is one of these. This war begins when man introduces domestic cattle, cultivates the soil, and destroys the larger wild animals for food or sport In doing this he provides food of an attractive kind for many wild creatures, and the war begins Pumas devour his cattle, locusts destroy his grass or crops, coots, ducks, geese, or pigeons devour the grain as soon as sown, or feed upon the young shoots, or upon the ripe wheat ready for the harvest; and thus the farmer is kept in a constant state of activity and watchfulness, which really gives him a beneficial excitement in what would otherwise be a most

monotonous and unattractive existence. In one of his glowing passages Mr Hudson thus describes and personifies the war between nature and man

"He scatters the seed, and when he looks for the green heads to appear, the earth opens, and lo! an army of long-faced yellow grasshoppers come forth! She too, walking invisible at his side, had scattered her miraculous seed along with his He will not be beaten by her, he slays her striped and spotted creatures, he dries up her marshes, he consumes her forests and prairies with fire, and her wild things perish in myriads, he covers her plains with herds of cattle, and waving fields of corn, and orchards of fruit-bearing trees She hides her bitter wrath in her heart, secretly she goes out at dawn of day and blows her trumpet on the hills summoning her innumerable children to her aid Nor are they slow to hear From north and south, from east and west, they come in armies of creeping things, and in clouds that darken the air Mice and crickets swarm in the fields, a thousand insolent birds pull his scarecrows to pieces, and carry off the straw stuffing to build their nests, every green thing is devoured, the trees, stripped of their bark stand like great white skeletons in the bare desolate fields, cracked and scorched by the pitiless sun When he is in despair deliverance comes, famine falls on the mighty host of his enemies, they devour each other and perish utterly Still he lives to lament his loss, to strive still unsubdued and resolute. And she, too, is unsubdued, she has found a new weapon it will take him long to wrest from her hands Out of the many little humble plants she fashions the mighty noxious weeds, they spring up in his footsteps, following him everywhere, and possess his fields like parasites, sucking up their moisture and killing their fertility Everywhere as if by a miracle, is spread the mantle of rich, green, noisome leaves, and the corn is smothered in beautiful flowers that yield only bitter seed and poison fruit With her beloved weeds she will wear out his spirit and break his heart, she will sit still at a distance while he grows weary of the hopeless struggle, and at last, when he is ready to faint, she will go forth once more, and blow her trumpet on the hills and call her innumerable children to fall on him and destroy him utterly"

This, the author tells us, is no fancy picture, but one painted from nature in true colours If so it is not encouraging for emigrants; but then, the climate is superb, and it is a proverb that "once in a hundred years a man dies in Patagonia" Then, again, the bird music is unsurpassed, there are numerous exquisite songsters, and of one of them—the mocking bird, he declares that the song is so varied and beautiful that all the music of our song-thrush might be taken out of it and not be much missed. Azara declared that there were as many and as good songsters in Paraguay and La Plata as in Europe, and Mr Hudson agrees with him The reason why Darwin and other travellers thought otherwise is, because most of the South American songsters are shy wood-birds which rarely approach man's dwellings, and are therefore only heard by those who seek them, whereas in Europe they are mostly species which haunt gardens and orchards, and cultivated fields, and are thus more or less familiar to every one

In a chapter on "Sight in Savages" it is maintained that they have no superiority in this respect to civilised man, and that what often seems like better sight is merely trained observation of objects which it is essential for them to know. There is an amusing story of a middle-aged Gaucho, who laughed and jeered at an Englishman for wearing spectacles, and would not believe that bits of glass over his eyes could possibly make him see better The gentleman persuaded the man to try them, and they happened exactly to suit his sight, which had gradually grown imperfect without his knowing it He stared round, utterly amazed, and then shouted.—"Angels of heaven, what is this I see! What makes the trees so green—they were never so green before! I can count their leaves! And the cart over there—why it is red as blood" And he went up to it to be sure it had not been fresh painted There is also a chapter—"Concerning Eyes"—dealing with their characteristic colours, their scintillation under excitement, and the uses of these peculiarities, a subject to which Mr. Hudson has given much attention Many old Indian burial places and village sites were found, with abundance of arrow-heads, flint knives, scrapers, mortars and pestles, stone anvils, pottery, and other objects There were two kinds of arrow-heads, some large and very rude, others smaller and exquisitely finished, the former found mostly on the plateau, the latter in the valley One of the village sites, where the greatest number of objects was found, had been buried seven or eight feet, and was exposed by heavy rains, which had washed away great masses of gravel and sand Many of the smaller arrow-heads were of crystal, agate, green, yellow, or horn-coloured flint, and were perfect gems of colour and workmanship, and these were all found at one spot Unfortunately, most of the finest specimens, which had been packed separately for security, were lost on his homeward journey—"a severe blow," Mr Hudson says, "which hurt me more than the wound I had received on the knee"

Although this volume cannot have the same absorbing interest for the naturalist as the author's previous work, it is yet full of suggestive observations and reflections, and gives us a vivid picture of both animate and inanimate nature in one of the least known portions of the southern hemisphere The volume is nicely got up, and is illustrated with a number of landscapes and figures of men and animals in the same style as in the author's former work

ALFRED R WALLACE

OUR BOOK SHELF

Ueber das Verhalten des Pollens und die Befruchtungsvorgange bei den Gymnospermen Von Eduard Strasburger. (Jena: Gustav Fischer, 1892)

THIS forms the fourth part of Prof Strasburger's "Histologische Beitrage," and it is largely taken up with an examination of segmentation in pollen grains of the gymnosperms, and the contents of, and processes in, the pollen-tubes Recent discoveries had led Strasburger to doubt the correctness of his former interpretation of the contents of the pollen tubes, and his further researches have "confirmed in a surprising manner" the results obtained by Belajeff in his paper on *Taxus baccata*, entitled "Zur Lehre von den Pollenschläuchen der Gymnospermen" Strasburger is also essentially in accord with Belajeff's generalisations therefrom Two double plates illustrate division in the pollen-grain, the development of the pollen-tube, and the further processes of fertilisation in various gymnosperms, including *Taxus*, *Pinus*, *Ginkgo*, and *Welwitschia*. An unusual condition is shown of cell-division in a pollen-grain of *Ginkgo* Usually two or three "prothallium cells" are formed, and in part disappear before the protrusion of the pollen tube

and the division of the "generative cell", but occasionally they persist somewhat longer, and Strasburger figures a pollen-grain in which the three prothallium cells are intact, and the first of them has a partition at right-angles to the walls of the other cells In this work Strasburger also gives the results of some experiments on the colour-reactions of the male and female nuclei Rosen discovered that, as in animals, the male nucleus of phanerogams is kyanophilous and the female nucleus erythrophilous Strasburger found that the small nuclei of the cells formed in the pollen grains of gymnosperms were kyanophilous, whether the cells were vegetative or destined for generation, but the nucleus of the pollen-tube was more or less decidedly erythrophilous The second and larger portion of this "Beitrag" is devoted to swarmspores, gametes, vegetable spermatozoids, and the nature of fertilisation W B H

Autres Mondes By Amédée Guillemin (Paris Georges Carré, 1892)

WHETHER the author of this small volume thought that the sequence of the subjects dealt with was really quite unimportant, or whether no order at all was intended, puzzled me considerably when glancing through these pages for the first time To be suddenly led off without a word of warning into "L'infini dans le temps et dans l'espace," and then to be as suddenly pulled back again to a second chapter dealing with Sirius seems rather a large oscillation to commence with The same remarks might apply to the next chapters, for they treat consecutively of "The Cluster in Hercules," "Structure of the Visible Universe," "Movement in the Universe," and "The Nebula of Orion," followed up by chapters on "The Age of Stars," and "The End of the Solar System"

That the work is written by M Guillemin is quite sufficient guarantee that strict accuracy is throughout adhered to The book is one that can be picked up at odd moments and a chapter or two read with delight The illustrations are excellent copies of lunar and stellar photographs taken by the brothers Henry at the Paris Observatory W J L

Some Lectures by the late Sir George E Paget, K C B, F R S Edited, with Memoir, by Charles E Paget (Cambridge Macmillan and Bowes, 1893)

THIS volume will be cordially welcomed by the late Sir George Paget's friends, and members of the medical profession, whether they knew him personally or not, will find in it much that cannot fail to interest them The lectures deal with three subjects—the ætiology of typhoid fever, alcohol as a cause of disease, and mental causes of bodily disease In dealing with each of these topics, the author presents the results of prolonged and most careful observation, and it is impossible not to admire the directness, lucidity, and vigour with which his facts and conclusions are set forth The memoir, by the editor, is a short and attractive record of Sir George Paget's distinguished career, and its value is increased by the fact that it is accompanied by an excellent portrait

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications*]

Origin of Lake Basins

WE may all thank Mr. Alfred Wallace for putting together so concisely the main arguments on which the glacial theory of the origin of all lake basins has had a wide acceptance My time is just now so occupied with "earth movements" of another kind that I am unable to marshal all the arguments on the other side. But I shall try to put the main points as clearly as I can

I accept Mr Wallace's correction of the word "grinding" as the best word to describe the action of glaciers. It is better than either "digging up" or "scooping" Many men who account for marine gravels on such places as Moel Trefan mountain-top by the action of glaciers, *must* conceive of glaciers as capable of digging out and lifting up But I agree with Mr Wallace that "grinding" down is the best expression for true glacier action This is the *mode* of action, but what of the *cause* of the motion which effects the grinding? Are we agreed on this? Mr Wallace does not explain his view on this point. I hold that the only cause of true glacier action is gravitation, and that masses of ice will not move at all, or exert any grinding action, except when impelled by gravity down gradients more or less steep Even if they do mount up some slopes, it is only when they are violently pushed by other masses moving down slopes from behind them If this be true, then glaciers will not tend to dig holes out of the flat bottoms of valleys Mr Wallace says they will, if they are exceptionally thick This is very doubtful and still more is it doubtful that they can dig holes of a very peculiar character, such as is now proved to be the character of Como and other lakes, with steep and sharp outlines, or with barriers left untouched One single fact of this kind, if well ascertained, is quite enough to upset a great theory, because it may be sufficient to prove that at least *some* lake basins *cannot* have been made by glaciers. And if some have not, it is not certain that any have been made by glaciers alone

The constant association of lake basins with glaciated countries is Mr Wallace's grand argument But it is explicable in the theory of earth movements quite as easily as on the theory of glacial action Glaciated countries are generally hilly, or mountainous If Mr Wallace believes that all hills and valleys are due to superficial *sculpturing alone*, of course his argument is facilitated But if hills and valleys are even in any measure due to earth movements—crumplings of the surface—then the formation of lake basins is an inevitable necessity Every hollow must become a lake basin which has no natural outlet except at a higher level than at its own bottom Yet if there be such a thing as earth movements at all, it is in the highest degree improbable that they should have failed in numerous cases to occasion hollows in which water would accumulate

Mr Wallace's unbelief that any earth movements have taken place so lately in geological time as the glacial age—say 100,000 years ago—is a declaration that does indeed astonish me I can understand great doubt and difficulty as to the extent of these movements But that they have taken place to some extent very lately indeed is, in my opinion, demonstrable in the country in which I now write There is one old sea beach on the Island of Jura where the stones as left by the surf are as bare of vegetation and as unaltered in forms which show surf action, as if the ocean had beat upon it last year. And this sea beach extends for miles at elevations varying from 120 to (I believe) 160 feet If I am not mistaken, recent surveys of the great Canadian and American lakes have proved that they lie in hollows of crumpled and distorted land surfaces The whole of Mr Wallace's theory on this subject seems to me to be out of date The distribution of boulders in the Highlands can, in my opinion, be accounted for in no other way than the transport of masses of stone on floating ice But putting aside altogether this larger question, if a "great submergence," as one of the latest events in the glacial epoch, smaller elevations of the land are among the most certain of geological facts But if so, we have lake-basins in all hilly countries easily explained Very often the elevation of land to a very small extent indeed, if unequal, as it is sure to be more or less, would immediately cause lakes wherever a pre existing valley had its lower end more tilted than its upper end The 120 feet which is represented on the coast of Jura in this county is an elevation which would fill half of our glens all over the county with lakes unless it was an elevation perfectly equal along the whole of pre-existing contours The co existence of lake basins with hilly and glaciated countries, therefore, admits of an easy explanation without attributing to ice a kind of action which has never been proved to exist at all Hilly countries are *crumpled* countries, and slight increases or decreases of the same action must of necessity produce lakes.

Glaciers have, however, without doubt caused lakes in cases where they have dammed up the mouth of glens with detrital matter The enormous masses of such matter which dam up the waters of the northern Italian lakes are most impressive But it does not follow that the glaciers which left those great masses also scooped out the deep bed and rocky walls of the Lake of Como

My own belief is that the great recency of large earth movements is one of the facts of geological science which has yet to be accepted, and that the slowness with which it has made progress, or has even been overborne, is entirely due to very natural preconceptions and general assumptions about the stability of the earth surfaces, such as those which find expression in Mr Wallace's very interesting and significant paper ARGYLL

Inveraray, Argyllshire, March 11

P.S —Recent calculations in America seem to bring down the possible date of the close of the glacial epoch there to little more than 10,000 years

The Cause of the Sexual Differences of Colour in Eclectus

MR. F E BEDDARD says in his suggestive work on "Animal Coloration" (1892, p 3) —

"Sometimes differently coloured animals have in reality the same skin pigments The attention of the reader will be directed in a later chapter to the remarkable difference in colour between the males and females of certain parrots In *Eclectus polychlorus* this sexual dimorphism is extremely marked It would be an exceedingly anomalous fact if the same species of bird were to possess different pigments in the two sexes, and as a matter of fact it is not so in this parrot, different in colour though the two sexes are The same pigments are present, *but the structure of the feathers is different, and thus the resulting colour as seen by the eye is different*"

The last sentence (the italics are mine) is not consistent with late Dr Krukenberg's investigations on the colours of feathers The case is not one of structural difference in the feathers, for the differences in colour between male and female of *Eclectus* are occasioned by the presence or absence of the pigment itself The green colour of the male results from a yellow pigment (*psittacofulvin*) lying over a blackish brown one (*fuscin*), but the blue colour of the female (*E linnei*, auct.) simply results from the absence of the yellow pigment The dark pigment (*fuscin*) is present and the incident rays of light are reflected from it, passing through a zone without pigment, which zone absorbs the rays of the red extremity of the spectrum Here the same conditions occur which effect the blue colour of the sky The blue is an optical colour, as is the green, but a different structure of the feathers does not come into question The red colour both in male and female is effected by a red pigment, which is the same in both sexes, the differences in shade (as also the violet in *E grandis*, *e g*) depend on the quantity of this colouring substance and in the absence or presence in different quantities of the underlying *fuscin* The pigment of the yellow feathers in the female of *E. grandis* is the same as the yellow pigment in the green males. Dr. Krukenberg supposes that these different pigments are derived from one and the same ground substance, a supposition which appears to be very plausible

Why the yellow pigment of the male is not developed in the blue parts of the female we do not know, nor why the different pigments in *Eclectus* are disposed just as they are, since we are in general quite ignorant about the causes of the disposition of colours in bird feathers, but in the case under discussion a "different structure" of the feathers would not give as sufficient an explanation of the facts as does the above Touching the *causa movens* of the different colours in the sexes of *Eclectus*, we can only say that it is sexuality, but this, of course, is no mechanical explanation, *i.e* no true explanation at all We can only say that in most birds the male offers an *overplus* of colour as compared with the female, which *overplus* no doubt has a relation to the more vigorous biological processes or superabundant vitality in the male during certain periods, and this also holds good in *Eclectus*, as we see that the female wants the yellow pigment which the male possesses. But we must bear in mind that in *Eclectus* the young ones from the egg display already these sexual differences of colour, a fact which is as remarkable as it is rare.

For reference see C Fr W. Krukenberg, "Die Farbstoffe der Federn," four papers in *Vergl phys Studien*, 1881 sq, and my papers, *Mitth orn Ver Vienna*, 1881, p 83, and *Sits ber Akad Wiss Berlin*, 1882, p 517 sq

Dresden, March 8 A B MEYER

Blind Animals in Caves

MR CUNNINGHAM'S notion as to what constitutes "a fact" would appear from his letter published in your issue of March 9 to be peculiar It is of course only through inadvertence that he declares a mere supposition to be a fact, and states that I have "overlooked" it His words are "he (Prof Lankester) has overlooked the fact that blind cave animals are born or hatched at the present day with well developed eyes" Further on he proceeds to state that no such fact is known or recorded, but that he is "quite confident" that the young of blind cave-animals have well developed eyes

I am quite aware that an important test of the truth of my theory of the origin of blind cave animals would be found in the details of their embryonic development, but cannot think that Mr Cunningham is justified either in his confidence as to the result of a hitherto unattempted embryological research or in asserting what is at variance with his own subsequent avowal, viz that there are facts ascertained as to the condition in which blind cave animals are born, which I have ignored

E RAY LANKESTER

Lunar "Volcanoes" and Lava Lakes

I HAVE waited some time to see what replies might be made to Mr J B Hannay's suggestion, that lunar walled plains may have been due to tides in the molten nucleus during crust formation (NATURE, vol xlvii p. 7)

There seem to be at least two objections to the "volcanic" theory of lunar surfacing First, that there must have been during the earlier, and indeed later, stages of it a vast gaseous and vaporous envelope, which, as secular temperature slowly declined, would be condensed to form seas, giving rise to a long era of erosion, and extensive denudation, and formation of sedimentary strata, as on our earth There are no traces of this on our moon, the surfacing of which is conspicuously destitute of evidences of drainage phenomena Secondly, there is an entire absence of distinct local colour in the detail, which should be easily seen in volcanic deposits unencumbered by vegetation and weathering

I leave it to geologists and physicists to say if they think it at all likely or possible for any globe like our moon to pass from the semi-incandescent, lava-crusted stage, with huge vaporous envelope, to the cold, airless, and waterless condition of our satellite without passing through a very prolonged era of erosion, which, as in our case, would obliterate all traces of the former era.

Judging by our vast series of stratified rocks, we are led to conclude that an exceedingly long temperate era of erosion must, in the very nature of things, supervene on the heated lava stage in all planetary development, quite obliterating the relics of the volcanic era and relaying a sedimentary surfacing

Taking up the second objection, *in re* the marked absence of colour, I would point out the abnormal brightness, or even brilliancy, of the lunar cliffs and steep inclines all over the surface It is precisely at such places that astronomers expect to see the nature of the surface and degradation due to the effect of gravitation, *i e* where (exposed to unmitigated solar heat in the day, and a cold probably below − 100° C. at night) the cliff-falls would be most frequent, and the true colour of the strata most visible

Proctor in his "Moon" (pp. 301-2) says.—"In each lunation the moon's surface undergoes changes of temperature which should suffice to disintegrate large portions of her surface, and, with time, to crumble her loftiest mountains into shapeless heaps In the long lunar night of fourteen days a cold far exceeding the intensest ever produced in terrestrial experiments must exist over the whole unilluminated hemisphere"

Neison, on page 113 of his "Moon," also says.—"That physical changes of various characters must be still occurring upon the moon is rendered certain by . . the alternate heating and cooling of the lunar strata; from the nature of the expansion and contraction thus brought into play must, through numerous fractures of the resulting general disintegration, gradually ruin all the lunar formations." Thus "considerable changes must

slowly be effected in the condition of the surface through earth-falls and landslips" . "until all the more striking and abrupt irregularities have disappeared from their action"

Now it is precisely at cliff faces and steep slopes that we should best see the real colour, if any, of the superficial strata, and what do we find? Wherever we turn, from pole to pole, there is an entire absence of colour, they are white and at times as brilliant as "new fallen snow" If we scan the vast cliffs of the "Apennines," say at sunset, for hundreds of miles, rising to 8000 or 10,000 feet, with peaks up to 20,000, they are white, seen in sunshine

If we examine the cliffs of the Sinus Iridium highlands, the huge array round Mare Crisium, or indeed anywhere else, it is the same, and without a doubt it demonstrates to us that the outer strata on the moon are of *the same white material all over the globe* Precisely where degradation is most certain, and where the true colour of the strata would be distinctly visible, there we find the most extraordinary and invariable whiteness for a thickness of at least two or three miles

A remarkable feature of the case is that, as a rule, all cliffs are much whiter than the general surface around them In the raised ramparts of craters and walled plains, it is well known that the outer, and more gradual slopes, are invariably darker than the steep inner cliffs facing the enclosure In Aristarchus, Theophilus, and such like rings, at sunrise, this is very conspicuous, especially in photographs, and it is not easy to account for this peculiar feature (evidently the result of disintegration and removal of the surface by gravitation) except by the supposition that the outer surface all over (and excepting rays and nimbi) is snow stained by meteoric dust "It is well known that the fall of meteoric dust on our earth is very considerable, and estimated by Dr Kleiberg, of St Petersburg, at about 11,435 tons per annum It has been found on all our ocean bottoms, and on our polar snows, where it is soon overlaid or removed by winds On the moon, however (where there is no wind and now no snowfall), it could accumulate for many thousands of years, at least on levels, and so stain them very perceptibly"

Undoubtedly we see the true colour of the surface layers at the cliff faces, but unless the outer surface were stained in some way their bright *contrast* would be impossible

Hence I take it that the outer layer of the surface all over, for at least one or two miles in thickness, is formed of snow, stained outside by a deposit of meteoric dust, the accumulation of many thousands of years, the removal of which, by gravitation, at cliffs causes their brightness, and this would explain the perennial enigma of where all the water has gone

At low temperature neither ice nor snow vaporise, even *in vacuo*, and also that at low temperature ice is a non-viscous solid (like glass) has been experimentally demonstrated by Mr T Andrews, F R S, and the results laid before the Royal Society (see NATURE, vol xlii. p 214) The prevailing whiteness, therefore, of the lunar cliffs and steep inclines would seem to be a powerful argument against a "volcanic" surfacing to our satellite, and a good one in favour of glaciation

The question of maximum surface temperature under fourteen days' solar heat has undergone a startling change since Lord Rosse's classical experiment The possibility of snow existing on the moon is now admitted by leading astronomers, since the researches of Profs. S P Langley and F W Very, of the Allegheny Observatory, have demonstrated that the maximum may be so low that the *mean* temperature may possibly be below -100°C

The old volcanic "selenology" is dying, there is no hope of any more *progress* in it (and that is the great sign of life in all branches of science nowadays), it is fossilised That a "new selenology" is badly wanted is pretty obvious to all who look into the question. The surfacing of our own satellite, one of the most conspicuous and easily seen objects in the heavens, is still the standing enigma S E PEAL

Sibsagar, Asam, February 8

THE CROONIAN LECTURE

MUCH interest has been excited not only among men of science but among the general public by Prof. Virchow's visit to England. From the moment when it was announced that he had agreed to deliver the Croonian Lecture, it was universally felt that it would not do to lose so good an opportunity of doing honour to an illustrious investigator Prof Virchow is known, of course, chiefly as a pathologist. He is the founder of the science of pathology in the sense in which it is now everywhere understood and taught, and it would be difficult to form too high an estimate of the value of this part of his labours But Prof Virchow is one of those men of genius who never find in any one department of research a sufficient outlet for their energies In archæology, anthropology, and ethnology he has been for many years one of the foremost workers of the age, and he has brilliantly represented science in the political life of Prussia and the German Empire and in the municipal life of Berlin As a teacher in the Berlin University, of which he is now Rector Magnificus, he has done much to foster a genuinely scientific spirit among the pupils who have flocked to his class-room, and as a writer he has command of so pure and attractive a style that he has been able to exercise a wholesome and stimulating influence on the intellectual life even of classes to whom science does not usually make a very strong appeal Altogether, Prof Virchow's career is one of which Germany has good reason to be proud In him she possesses one of those rare and potent thinkers who touch no subject without giving it fresh significance, and who have the secret of awakening in other minds something of their own enthusiasm, independence, and vigour

There was so great a demand for tickets that arrangements had to be made for the delivery of the Croonian Lecture in the theatre of the University of London, and here—on Thursday, March 16—a crowded audience listened with the deepest interest to what Prof Virchow had to say about the great subject in the development of which his researches have marked so splendid an era In the evening a public dinner was given in his honour at the Hôtel Métropole Lord Kelvin presided, while the Presidents of the Royal Colleges of Physicians and Surgeons acted as vice-chairmen In proposing the toast of the evening, Lord Kelvin said he was one of those who had listened with rapt attention that day to the lecture delivered by Prof. Virchow The mystery he dealt with remained a mystery, but they were conscious of no feeling of disappointment Though it was not for any man to tell them what life was, they had been brought nearer than ever to the solution of that fascinating problem by the researches of Prof Virchow Mr Huxley, Sir James Paget, and Sir Andrew Clark also spoke of Prof Virchow's magnificent discoveries. Prof Virchow, in responding to the toast, expressed the pleasure he felt in being welcomed by "so large and so illustrious an assembly of the learned men of England" "Abroad," he said, "he had never seen anything like it" English men of science do not often indulge in demonstrations of this kind, and it is satisfactory to know that when they do try to show what they think of a great investigator their achievement does not fall short of anything done with a like intention in Paris or Berlin

This week Prof Virchow has been in Cambridge, where he has been received with as much enthusiasm as in London On Tuesday the University marked its sense of the importance of his labours by conferring on him the honorary degree of Doctor in Science The following is the speech delivered by the Public Orator, Dr Sandys, in presenting Prof Virchow for the degree —

Dignissime domine, domine Procancellarie, et tota Academia —

Universitatis Berolinensis Rector Magnificus, vir non modo de medicina et salute publica, sed etiam de anthropologia, de ethnologia, de archaeologia praeclare meritus, vir et sexagesimo

et septuagesimo exacto aetatis anno honoribus amplissimis cumulatus, satis magnum hodie praebet dicendi argumentum Ipse laude nostra maior, laudes tamen suas (qua est modestia) invitus audiet, atqui laudes illas non verba nostra qualiacumque, sed ipsius opera insignia, ipsius discipuli illustres, ipsius denique orationes disertissimae, etiam ipso invito, satis clare loquuntur

Legistis fortasse orationem illam in qua, Rectoris munus nuper auspicatus, studiorum Academicorum orbe universo lustrato, partium liberalium dux et signifer olim insignis dixit veram Academiae libertatem esse libertatem docendi, libertatem discendi, ostenditque, qua potissimum mentis disciplina iuventus Academica discendi amore vere liberali imbui posse videretur Legistis certe, fortasse etiam audivistis, orationem alteram in qua nuperrime inter scientias biologicas locum pathologiae proprium vindicavit, et, studiorum suorum origines repetens, non modo HARVEII nostri merita immortalia denuo commemoravit, sed etiam GLISSONII nostri gloriam prope intermortuam ab integro renovavit HARVEII quidem in doctrina, *omne vivum ex ovo* nasci, lacunam magnam relictam esse constat, laetamur lacunam tantam ab eo magna ex parte esse expletam qui primus omnium re vera probavit *omnem cellulam e cellula* generari

Ergo rerum naturae investigator tantus, tot illustrium praeser tim medicorum in Academia, titulo nostro honorifico iure optimo decoratur Etenim ubicumque florent medicinae studia cum rerum naturae observatione exquisita feliciter coniuncta, talium virorum nomina in honore maximo non immerito habentur Talium certe virorum per labores verba illa vetera vera facta sunt, quae Salutis in templo supra portam inscripta esse debent — *sine rerum naturae cognitione trunca et debilis est medicina*

Duco ad vos Regiae Societatis Londinensis unum e sociis extraneis, virum gentis Teutonicae inter decora numeratum, RUDOLFUM VIRCHOW

The following is Prof Virchow's Croonian Lecture —

It is now nearly ten years since this illustrious Society conferred on me the unexpected honour of electing me one of its Foreign Members Not this only, but last autumn it held me worthy of a further honour, in awarding me the Copley medal —a sign of the highest recognition of my work, the significance of which far exceeds the distinctions which the changing favour of political powers is accustomed to bestow Nevertheless, deeply as I appreciated this mark of its constant and increasing esteem, still I was not in a position to offer my thanks personally to the society Numerous duties, official and private, the weight of which has increased with each year, compelled me to continuous work at home, and even during the vacations the freedom of my movements has been for some time past restricted by international engagements, which yearly become more numerous and more pressing

With great indulgence, which I fully know how to appreciate, the Council has allowed me to postpone the date of my appearance in your midst Hence, you see me only to-day among you, and I may tell you in person how very grateful I am to this Society, and how great an incentive to new efforts your recognition has become to me

Who of us is not in need of friendly encouragement in the changing events of life? True! happiness is not based on the appreciation of others, but on the consciousness of one's own honest labour How otherwise should we hold our ground in the midst of the turmoil of the day? How should we preserve the hope of progress and of final victory against the attacks of opponents and the insults which are spared to no one who appears before the public? He who during a long and busy life is exposed to public opinion, certainly learns to bear unjust criticism with equanimity, but this comes only through the confidence that our cause is the best, and that some day it must triumph Such is our hope in our wrestlings for progress in science and art Such is our hope in our struggles for civil and religious liberty, and in this hope we gradually become hardened against malicious attacks It is a kind of immunisation which, I acknowledge, has also great drawbacks, for this hardening against unjust attacks leads very easily to a similar indifference towards just attacks, and, owing to the tendency to contradiction rooted in the nature of human thought, it finally leads also to indifference to praise and recognition One withdraws again and again into oneself discontented with the world and with oneself also, but who can so completely retire within himself that the consciousness of the insufficiency of human thought, and that the criticisms of opponents are justified, cannot break through the crust of even the most hardened self consciousness? Happy is he who has courage enough to keep up or regain his connections with other men, and to take part in the common work! Thrice happy he who does not lack in this work the flattering commendation of esteemed colleagues!

Such were the thoughts which filled my mind, as, looking forward to the present occasion, I reviewed my own life and the history of science, or, to use another expression, the fortunes of our predecessors How often have I found myself in a state of despondency, with a feeling of depression! And the history of science—what long periods of stagnation and numerous interruptions has it not experienced owing to the victory of erroneous doctrines! What has saved me is the habit of work, which has not forsaken me even in the days of outward misfortune—that habit of scientific work which has always appeared to me as a recreation, even after wearying and useless efforts in political, social, and religious matters

That which has saved science is identically the same, it only appears to be different, because the co operation of many is necessary to secure the advance of science, hence, the exalting and consoling thought that one nation after the other comes to the front to take its share in the work When the star of science becomes dim in one nation, it rises sooner or later to yet brighter glory in another, and thus one nation after another becomes the teacher of the world

No science, more often than medicine, has gone through these waxings and wanings of brilliancy, for medicine alone, of all the sciences, has, for more than 2000 years, found ever new homes in the course of a progress which, though often disturbed, has never been wholly arrested

It would lead us too far to illustrate this with examples drawn from the entire past It is enough for my present purpose to take the outlines of modern medicine as the object of our consideration Such a sketch, cursory as it must be, ought at the same time to throw some light on the intellectual relations of both nations, English and German, for these have taken a prominent part in establishing the principles of modern medicine

The downfall of the old medicine, the so called humoral pathology was brought about in the beginning of the 16th century We, in Germany, are inclined to attribute to our nation a decisive *rôle* in this memorable struggle

It was a man of our race, Andreas Vesalius, or from Wesel, who transformed anatomy into an exact science, and who thus, at one stroke, created for medicine a solid foundation, which it has retained ever since and, let us hope, will never again lose

But the principal blow to the old medicine was struck by his somewhat elder contemporary Paracelsus, that charlatan, yet gifted physician, who removed from among the beliefs of mankind the doctrine of the four humores, which, *quasi*-chemical in its construction, formed the basis of the old pathology. Strangely enough he accomplished this with weapons borrowed from the armoury of the Arabs, the successors of the Greeks, and the chief representatives of the mediæval humoral pathology. From them, also, he borrowed alchemy, and, at the same time, the fantastic spiritualism of the East, which found a clear expression in his doctrine of the "Archæus," as the determining force in all living beings

In this way, the new medicine, at its very birth, absorbed the germs of that ruinous contradiction, which, even up to this present century, has kept up the embittered strife of the schools

To Vesalius is due the exact tendency, which starts from the observation of actual conditions, and which, without going further, we may call the anatomical

Paracelsus, who pronounced the anatomy of the dead body to be useless, and sought for the basis of life as the highest goal of knowledge, demanded "contemplation" before all else; and, just as he himself arrived in this way at the metaphysical construction of the archæi, so he unchained among his followers a wild and absolutely fruitless mysticism

Nevertheless there lay hidden in that "contemplation" of his a healthy kernel, which would not allow the intellectual activity which it had stirred up to come to rest. It was the idea of *life* which formed the ultimate problem for all future research Strangely enough, this idea, which always existed in the popular mind, and which is in an unmistakable form present even amongst primitive nations, had been driven far into the background in scholastic medicine Ever since the time of Hippocrates it had been the custom to use, instead

of life, the obscure expression φύσις, *natura*, but in vain does one seek for a more exact definition of the term. To Paracelsus nature was living, and the basis of his life was that very "archæus," a force differing from matter, and separable from it, or, as he himself expressed it, in the sense of the Arabs, a spirit, "spiritus." In the compound organism of man, the mikrokosmos, each part, according to him, had its own "archæus," but the whole was ruled by the "archæus maximus," the "spiritus rector." From this premiss has proceeded the long succession of vitalistic schools, which, in ever changing forms, and with ever new nomenclature, introduced into the notions of physicians this idea of a fundamental principle of life.

If the sagacious Georg Ernest Stahl, whose services to the development of chemistry are now acknowledged everywhere, substituted the soul for the "spiritus rector," and so created a system of animism, the last vestiges of which have disappeared from the school of Montpellier within our own time only, so also in turn did the pure vitalists build up on the dogma of specific dynamic energies, maintained so stoutly by the physicists, that notion of the vital force, the half spiritualistic and half physical character of which has contributed so much, even in our day, to puzzle and mislead men's minds.

The doctrine of the vital force found its strongest support in the "Natur philosophie," especially in that which, on German ground, soon obtained universal sovereignty.

This summary exposition of mine has greatly anticipated the historical progress of the evolution of medicine. It is now time to pay proper homage to the great investigator who made the more exact method the ruling one, and at the same time to award to this country, which brought him forth, its important share in determining the new direction of our science.

Nearly 100 years had passed since Vesalius and Paracelsus had begun their work when William Harvey published his "Exercitatio anatomica de motu cordis et sanguinis in animalibus." Here, for the first time, the anatomical examination of living parts was carried through, in an exemplary way, according to experimental methods. All the objections that anatomy concerned itself with dead parts only were thus at once set aside; living action became the object of immediate observation, and this was done on one of the most important organs, one absolutely necessary to life, the varying activity of which constantly calls for the attention of the practical physician. Not only so, however, but a new mode of observation—the experimental method—was thus brought into use for research; a method through which a new branch of medical science, physiology, has been laboriously built up.

The influence of this one wonderful discovery of Harvey's on the ideas of men of his time, and of his successors, was memorable.

Among the men of his time the last support of Galenism disappeared with the proof of circulation; among his successors the comprehension of the causation of local processes dawned for the first time. Very ancient and highly difficult problems, such as inflammation, could now be attacked; a goodly piece of life also became intelligible, since one of the vital organs themselves could now be subjected to experiment, and, to the astonishment of all, the action of this organ showed itself to be an absolutely mechanical one. The revulsion of thought was so complete that it has become since a difficulty hardly to be overcome to enter even in imagination into the ideas of the older physicians, to whom the circulation of the blood was unknown.

Nevertheless, in spite of such striking results, the craving of man for more complete understanding remained unsatisfied. One saw the action of the living heart, but how did it live? What was this life, the action of which one saw before one? In the heart itself the essence of life could not be recognised.

Harvey turned his attention to another object; he tried to observe the very beginnings of life in the incubated egg of the fowl and in the embryos of mammalian animals. He thereby soon arrived at the question of the significance of the egg in general, and enunciated the celebrated dictum, "Omne vivum ex ovo." Owing to the more extensive researches of modern investigators, this dictum, as is well known, proved too narrow for the whole animal kingdom, and is no longer exact when applied to plant life. Its validity for the higher animals, on the other hand, cannot be questioned, and it has formed one of the firm standpoints on which researches on sexuality and on the propagation of life have been based. But Harvey, on account of the deficiency of his optical instruments, was unable to see that which he was labouring to discover, namely, the process of organisation as such, just as he had been unable in former times to see the continuity of the capillary flow. This imperfection lasted for a long time afterwards; and thus it happened that even Albrecht von Haller and John Hunter considered the formation of the area vasculosa in the incubated egg of the fowl as the commencement of organisation, and indeed, as the type of organisation itself.

I will return to this point later on; but for the present I should like first to draw your attention to a man whose importance for the further development of the doctrine of life has always appeared to me to have been uncommonly great and highly significant, but who, nevertheless, has sunk into unmerited oblivion, not only among posterity in general, but also, I think I may be allowed to say, even in the memory of his countrymen. I mean Francis Glisson, who was a contemporary of Harvey, and whose works appeared almost simultaneously with those of his more celebrated colleague; but the brilliancy of Harvey's discoveries was so great that the light which shone from Glisson's work-table almost disappeared. I rejoice that on so auspicious an occasion I may recall the memory of the modest investigator, and may offer him the tribute of gratitude which science has to award him.

When, thirty five years ago, I published my little essay on "Irritation and Irritability" (*Archiv fur Pathologische Anatomie und Physiologie*, 1858, vol. xiv. p. 1), I did not know much more about Glisson than what every student of medicine learns, namely, that there is in the liver a "capsula communis Glissonii," and what was even less known, that this anatomist had written a small work on "Rachitis," which, indeed, was the first of its kind. In my own paper on this disease (*ibid.* 1853, vol. v. p. 410) I had tried to demonstrate the circumspection and accuracy which are noticeable in this book, and which make it a typical model for all collective investigations; but even at that time I overlooked the fact that this was only the smallest merit of this wonderful man. It was only in the further course of my studies on the history of the doctrine of irritation and irritability that I made the discovery, an astonishing one to me, that the idea of irritability did not, as is generally thought, originate with Haller, but that the father of modern physiology, and the Leyden school in which he had been brought up, had borrowed this idea from Glisson. I then stumbled on a series of almost forgotten publications of this original scholar, especially his "Tractatus de natura substantiæ energeticæ seu de vita naturæ ejusque tribus primis facultatibus, perceptiva, appetitiva et motiva," which appeared in London in 1672, and in which the ideas were further worked out, the outlines of which had already been brought forward in his "Anatomia hepatis," published in 1654. In this work (p. 400) the newly-coined word "irritabilitas" appears, so far as I can find out, for the first time in literature. It may be noticed, by the way, that the expression "irritatio" is much older. I find it already in Celsus, but with an exclusively pathological signification. It appears, also, occasionally in later writers, and to this day it has not, speaking accurately, lost this original signification. It is otherwise with Glisson; to him, irritability is a physiological property, and irritation merely a process of life dependent on the natural faculties of living matter.

Thus he was led, through a process of "contemplation," to maintain the existence of the "biarchia," the "principium vitæ," or the "biusia," the "vita substantialis vel vitæ substantia." And in order to allow of no misunderstanding as to the scource of his "contemplation," he adds distinctly that this is the "archæus," of Van Helmont—the "vis plastica" of plants and animals.

In the further course of his philosophical discussions, he nevertheless is led into the same by-path, which has misled, even in the most recent times, so many learned men and even excellent observers. This is the by-path of unlimited generalisation. The human mind is only too prone to render intelligible what is unintelligible in particular phenomena, by generalising them. Just as even in recent times an attempt has been made to render consciousness intelligible by representing it merely as a general property of matter; so Glisson thought he might attribute to the active principle ("principium energeticum") which according to him is contained in all matter the three faculties of living matter which he considered as fundamental, namely, the facultas perceptiva, appetitiva et motiva. All matter was sensitive, was thus stimulated to develop impulses, and moved itself as a consequence of these impulses.

It is not necessary for the purpose of our present inquiry to carry these quotations further, since they are quite, in the Paracelsian sense, contemplative in their nature, and especially as, in their generalisation, they do not appear to be important for the history of advancing knowledge

That which is full of significance for us is concerned with actual life only, in the narrower sense of analytic science It was not the "principium energeticum" set up by Glisson, which stimulated his successors again to take up the thread of his observations, but rather this process of irritation described by him, and the fundamental faculties of living matter on which it depended In this way he has really led up to a more exact study of the actions of life and the properties of living matter

Unfortunately, there intervened a mistaken conception, which led his followers again into a series of most serious errors Glisson, following on this point also the example of Van Helmont, was convinced that nerves contracted when irritated He joined to this the idea that, through the contraction of the nerves, or even of the brain, the fluid contained in them was propelled towards the periphery

This notion, shared by Willis and many other physicians of that time, furnishes the reason why irritability was identified with contractility Even the great master Hermann Boerhaave, and after him his pupil Gaubius, the first special writer on general pathology, considered sensation and motion as common properties of, at all events, all the solid parts of the body The former thought it proved that hardly a single particle of the body existed which was not sensitive and did not move, and thus it becomes comprehensible how Haller himself carried this idea that irritability had the same significance as contractility from his school days in Leyden to his professorship in Gottingen It was in this sense that he understood the irritability of the muscles, and in the same sense he denied this property to the nerves

This dispute about the irritability of muscles has continued far into the present century, its long duration becomes intelligible only when we bear in mind that, without the most exact knowledge of its historical development, even the very statement of the question is liable to be misunderstood

As a matter of fact, so far as we know, the nerves are not contractile, like the muscles, on the other hand, the muscles are not only contractile, but are also irritable Irritability and contractility are not identical, even when they occur in the same part The nerve current, on the other hand, cannot be compared with the blood stream, it does not consist in the movement of a fluid, but is of electrical nature, and hence there is no need for its production of a contraction of the nerve-tubes

It was also an erroneous conclusion that every irritated part contracted Instead of contraction, secretion, or, under certain circumstances, a more vigorous nutrition, may occur as the final result of irritation Hence we use a more comprehensive term in order to express this final result, and call all forms of it "actions" While Glisson defined all "actio propria sic dicta" as "motus activus," we distinguish different kinds according to the nature of the effects, or, expressed otherwise, according to the direction of the activity (nutrition, formation, and function) but we agree with the above thinker in the opinion that no vital energy is ever set free without stimulus that, therefore, every action is of an irritative nature. In this irritation, according to my idea, consists the "principium dividendi," according to which we must distinguish between active and passive processes of life, and in this way we gain also a basis for the fundamental division of pathological elementary processes. How much work has been necessary in order to render this conception possible! And how great, even now, is the number of our colleagues who have not fully accepted it! The reason for this difficulty is twofold.

Most of the vital actions of life, whenever they manifest themselves by visible events, are of a compound nature As a rule very various, at times wholly unlike parts, each with its specific energy, combine to produce them Not unfrequently it thereby happens that in the visible sum of final effects one part behaves in an active the other in a passive manner. It is only the most minute analysis of the phenomenon, tracing it right back to the elementary parts, which allows the total result to be resolved into its components, such an analysis cannot, for the most part, be expressed in current language, except at great length. No language in the world is rich enough to possess special expressions for each such combination Only too often we help ourselves out of the difficulty by regarding the compound phenomenon as a simple one, and by expressing its character according to some chief trait, which stands out in a commanding manner from the general picture This is the practical difficulty

With it, however, a theoretical difficulty is very often combined The human mind, owing to a natural impulse, seeks in the phenomena indications of their determining cause The more complex the phenomenon the more busy is the imagination, in order to convert it into a simple one, and to find a unitarian cause for it So has it happened in respect to life, so in respect to disease The course of thought followed by Glisson is opposed to such an explanation He had no scruple in dividing the unit of life into a large number of individual lives Although the knowledge we now possess of the arrangements of the body was absolutely foreign to him, yet he arrived quite logically at the "vita propria," the proper elementary life, of the several parts To be sure, this expression, as far as I can see, is not to be found in his works, and occurs first in those of Gaubius, but Glisson says distinctly ("Anatomia hepatis," "Ad lectorem," N 17) "Quod vivit per se vivit vitam a nulla creatura præter se ipsum dependentem Hoc enim verba vivere per se sonant"

The unitarian efforts of the following period relentlessly passed over the tendency of which I have just spoken Some returned to the old Mosaic dictum, "the life of the body is in his blood"; others gave the nervous system, and the brain especially, the first place in their consideration Thus once more was renewed the old struggle, which for thousands of years had divided the schools of medicine into humoral and solidar pathology Even when we ourselves entered on scientific work, hæmato pathologists stood in hostile attitude to neuro-pathologists

In England, humoral pathology found a strong support in the great and legitimate authority of John Hunter Although this distinguished practitioner never shared the one sidedness of the later pathologists, but rather attributed to the solid parts the living principle the existence of which he assumed, yet, in his investigations, the blood took precedence over all other parts as the chief vehicle of life

One must, however, recall to mind that Hunter laid special stress on the fact that life and organisation are not bound to each other, since animal substances which are not organised can possess life He started, as has already been noticed, from the erroneous conception that eggs are not organised, and that it was not till after incubation that the first act of organisation, namely, the formation of vessels, took place He considered his "diffuse matter" ("materia vitæ diffusa") as the actual carrier of life, and this was to be met with not only in the solid parts, but in the blood also This matter, according to him, existed in the brain in a remarkable degree of concentration, but its presence was quite independent of all nervous structures, as is shown by the example of the lower animals which possess no nerves In the posthumous writings of Hunter, which Owen has collected, the very striking expression "simple life" is met with, a state most clearly to be recognised in plants and the lowest animals This simple life was in Hunter's view the ultimate source of all living actions, pathological as well as physiological

Hunter was out and out a vitalist, but his materialistic vitalism, so to speak, differed *toto cœlo* from the dynamic vitalism of the German schools If living matter existed independently of all organisation, such living matter was beyond the scope of anatomical investigation, but, on the other hand, if it were present in non organised parts, such as an egg, it was in itself the ultimate source of the organisation which subsequently makes its appearance in these parts It must, therefore, to adopt a later mode of expression, be of a plastic nature. Here Hunter's notion fell in with that of the plastic lymph, as developed by Hewson, and it was only logical that Schultzenstein applied it to the blood at last, and designated as "plasma" the material of life present in the blood In this way the formative and nutritive matter necessary to physiological life as well as the plastic exudations occurring in diseased conditions could be attributed to the same material—a highly satisfactory result in appearance, and one providing a most convenient basis for interpretations. The exponents of this notion had no scruples in going one step further, and in providing this material of life with a technical name. They called it "fibrin." Evidently this did not quite correspond with Hunter's ideas, for we know of no such matter, either in the egg or in the plants or the lower animals, as that to which he attributed simple life, but the necessities of pathology

overcame all such scruples, and the plastic exudations were received as undoubted evidence that fibrin possessed the power of becoming organised They formed, in the *crasis* doctrine of the Vienna school, the bright spot of this newest kind of hæmato-pathology

Wherever fibrin failed, blastemata were brought to the fore Ever since Schwann had given the name of cytoblastema to the organising material of the egg, the way had been open for assuming in other places the existence of material with this ambiguous name

But of course through these steps the one simple matter of life predicated by Hunter was replaced by many "matters of life," and thus the entire advantage gained by the exposition of a unitary theory of life was at once lost

Even when, finally, the cell-contents were designated as protoplasm, and thus the one requisite of Hunter, namely, that the material of life must also be contained in the individual parts, appeared to be fulfilled, yet no single specific material was thereby arrived at No one dreamed of regarding protoplasm as fibrin, and least of all did any one consider it a simple chemical body

By the conception of the blastema, however, there had been reawakened a thought which had occupied the minds of man from the earliest times If a plastic matter capable of being organised really existed in the body, then the organisation of the same must present the first reliable example of epigenesis The problem of the "generatio æquivoca," which had been fought over for so long a time, now appeared to be solved What Harvey had taught concerning the continuous descent from the egg became temporarily obliterated, when the theory of descent through exudation made its appearance Several generations of young medical men have been educated in this belief I myself remember my "epigenetic" youth, with no little regret, and I have had hard work to force my way through to the recognition of the sober truth

Meanwhile, the attention of other bodies of inquirers had been directed to the tissues of the body Among these, in view of their importance, the nervous tissues, and especially the mass of nervous tissues in the brain and spinal cord, rank highest

Hunter also had acknowledged the importance of the brain, and hence called it the "materia vitæ coacervata" It was easily seen that it contained no fibrin, but experimental research showed also that neither the brain nor the spinal cord was of the same value throughout all its parts The more accurate the experiments the smaller became the region which, in the strictest sense, is the vital part, until Flourens limited it to one single spot, the knot of life ("nœud vital") Was the unity of life found in this way? By no means The brain is no more and no less vital than the heart, for life is present in the egg long before the brain and heart are formed, and all plants, together with an immense number of animals, possess neither the one nor the other. In the highly compound organism of man, the brain and spinal cord have a certain determining action on other parts necessary to life Their disturbance may immediately be followed by the disturbance of other vital organs, and sudden death may ensue

But the collective death of a compound animal no more implies the immediate local death of all its special parts than the local death of some of the latter is incompatible with the continued collective life of the animal As has been well said, at the death of a compound organism there is a "primum moriens," one part which first ceases to live, then follow, at long intervals sometimes, the other organs, one after the other, up to the "ultimum moriens" Hours and days may pass between the total death of the individual and the local death of the parts The fewer nerves a part contains the more slowly usually does it die, I therefore consider the process of dying in the compound organism as the best illustration of the individual life of the several constituent parts, which is in its turn the first axioma necessary for the study and for the understanding of life.

A long time, however, elapsed before it was possible to return to this starting point, and to obtain a considerable number of supporters for the doctrine of the "vita propria" The attention of many observers was drawn to a totally different side of the question In the last decade of the past century, about the same time that John Hunter, starting from careful anatomical investigations and exact observations of surgical practice, worked out his idea of the material of life, a new system of medicine was founded in Scotland, the so-called Brownian system, which was based on quite different premisses Brown also was a vitalist, he, too, constructed, not merely a pathological and therapeutic system of vitalism, but a physiological one, though this doctrine was dynamic in its character There is but little to be noticed therein of the material anatomical foundation of exact medicine It is concerned principally with contemplations of the forces of the living organism One can understand to some extent how this happened, if one keeps in view the history of the development of this extraordinary personality, I cannot go into this here, but anyhow the remarkable fact remains that the two contemporaries, Brown and Hunter, worked near each other without its appearing from their writings that they were acquainted with one another Brown struck out his own line, and stuck to it, without troubling himself about the rest of the medical world And yet even his first work "Elementa Medicinæ,' had the effect of an earthquake, the whole European continent was shaken by it, and even the physicians of the recently opened New World bent under the yoke of revolutionary ideas, and in a few years the aspect of the whole field of medicine was entirely changed True! the triumph was but short, the Brownian system disappeared as it had come, a meteor in the starry heaven of science There would be no reason to go into it more fully, had not the impulse which he had given instigated other men, and be permanently applied by them to the true service of science This impulse was founded on the fact that irritability, or, as Brown called it, "incitability," was thus reinstated as the starting point of the theory, but, along with this, the stimuli which set living substances in action, the "potestates incitantes," were brought to the fore In so far that stimuli produce a state of irritation ("incitatio"), or, as Brown called it later, excitement, they came to be viewed not only as the cause of health and disease, but even of life itself, for excitement, so he said, is the true cause of life But, as excitement stands in a certain relation to the strength of the stimulus, a state of good health was only possible with a normal degree of stimulus, whilst an excess or a lack of stimulus brought diseased conditions in its wake Of course excitement is dependent also on irritability, with a certain quantity of which, in the form of energy, every living being is endowed at the beginning of its life

The division of diseases, according to the amount of vital force visible in them, into sthenic and asthenic, has never been abandoned since, though acknowledged perhaps in a less precise manner, it has sometimes been brought more prominently forward, and sometimes thrown into the background In Germany, Schonlein was the one of all others who took this doctrine as the foundation of his opinion on special cases of disease, and for his choice of treatment

But the application of the Brownian principles to physiology has been of far greater importance If life itself were dependent on external stimuli, the notion of the spontaneity of vital actions, a notion still in force, must lose all significance Certain stimuli would in that case prove to be necessary conditions of vital activity, without which life could at best be carried on in a latent form only Certainly even for this latent life the question remained open How does it come to pass, and in what does it practically consist? Brown avoided this ticklish question, not without great skill, by drawing the whole attention to active life and to the stimuli which call forth action To speak openly, science has since then deflected little, or not at all, from this guiding notion. Even now, we cannot say what latent life is We simply know that through external stimuli it may be converted into active life, and hence irritability is considered by us as the surest sign of life, not of course of the general life of all matter in the sense of Glisson, but of the real and individual life of special living organisms. Brown remarked, with reason, that through irritability the living substance is differentiated from the same substance in its dead condition, or from any other lifeless matter Nevertheless, neither irritability nor incitability, neither irritation nor incitation, explains the essence of the living substance, and therefore neither explains the essence of life

In Germany the physiologists especially took up this question Among the first was Alexander von Humboldt, who in his various writings, especially in his celebrated treatise on the irritated muscle and nerve fibre, entered into the question In the end he held fast to the assumption of a vital force The majority of pathologists and physicians followed in his footsteps, and long and fierce controversies were necessary before, nearly half a century later, the belief in a vital force was destroyed When du Bois-Reymond had demonstrated the electrical current

in muscle and nerve in all its characters, and, at the end of his work, had also disclosed the inadmissibility of vital force, then the venerable Humboldt formally and expressly renounced the dream of his youth, with the masterly submission of the true naturalist to the recognised natural law

The hypotheses of a particular force of life had, however, in regard to Brown's theory neither a positive nor a negative value. Johannes Müller rescued for general physiology, in which it has ever since kept its place, that which was valuable in Brown's system, the doctrine of the integrating life stimuli The occasional stimuli which produce disease have found their place in etiology, their significance has become more and more sharply defined, the more accurately we have learnt to distinguish between the causes and the essences of disease, a distinction which became more difficult as the "causæ vivæ" of diseases became known in ever increasing numbers And now a new task has arisen, namely, to draw into our sphere of observation the life of the causative agents themselves

The way in which pathology has tried to approach the desired goal, to fathom the living substance in its diseased conditions, has led us a great step forward Pathological anatomy, especially, has opened this road The more numerous its observations, and the more it penetrated into the details of the lesions, the smaller became the field of so called general diseases The first steps of mediæval anatomists had the effect of drawing the attention to local diseases In the first and longest period, which one may define as that of Regionism, the pathological anatomists sought the cause of disease in one of the larger regions or cavities of the body—in the head, chest, or abdomen In the second period, ushered in by the immortal work of Morgagni, shortly before the time of which I last spoke—the time of Brown and Hunter—they endeavoured to find in a certain region the actual organ which might be considered as the seat of disease. On this foundation arose the Parisian school of Organicism, which, until late in this century, held a dominant position in pathology In this school, already, they recognised that not the organ, nor even a portion of it, could be the ultimate object of research Xavier Bichat divided the organs into tissues, and showed that in the same organ sometimes one and sometimes another tissue might be the seat of disease

From that time forward the eye of the pathological anatomist was directed chiefly to the changes in the tissues, but it soon became apparent that even the tissues are not simple substances. Since the third decade of this century, the microscope has disclosed the existence of cells, first in plants, and very soon afterwards in animals. Only living beings contain cells, and vegetable and animal cells show so much similarity of structure that one can demonstrate in them the actual product of organisation This conviction has become general, since through our embryologists, especially through Schwann, proof has been afforded that the construction of embryonic tissues was derived from cells also in the highest animals and in man himself

In the fourth decade of this century the science of pathological anatomy had already begun to be directed towards cells. These researches very soon struck on great difficulties Many tissues, even in their developed state, appeared to contain neither cells nor their equivalents, nevertheless, I have been able to demonstrate their existence in those tissues in which their presence appeared to be most doubtful, viz in bone and connective tissues At the present time we are so far advanced as to be able to say that every living tissue contains cellular elements. We go a step further even, for we require that no tissue should be called living in which the constant occurrence of cells cannot be shown

A still greater difficulty then appeared, namely, to discover in what way new cells originated. The answer to this question had been very heavily prejudiced by the so called cell-theory of Schwann. Inasmuch as this very trustworthy investigator asserted that new cells originated from unformed matter, from "cyto-blastema," there was opened up a wide road to the old doctrine of the "generatio æquivoca," which afforded all partisans of plastic materials an easy way of reviving their dogma The discovery of cells of connective and allied tissues gave me the first possibility of finding a cellular matrix for many new growths. One observation followed another, and I was soon in a position to give utterance to the dictum, "Omnis cellula a cellula."

And so at last the great gap was closed which Harvey's ovistic theory had left in the history of new growth, or, to speak more generally, in the history of animal organisation. The begetting of a new cell from a previous cell supplements the reproduction of one individual from another, of the child from the mother The law of the continuity of animal development is therefore identical with the law of heredity, and this I now was able to apply to the whole field of pathological new formation I blocked for ever the last loophole of the opponents, the doctrine of specific pathological cells, by showing that even diseased life produced no cells for which types and ancestors were not forthcoming in normal life

These are the fundamental principles of cellular pathology In proportion as they have become more certain, and more generally recognised, they have in turn become the basis of physiological thought The cell is not only the seat and vehicle of disease, but also the seat and carrier of individual life; in it resides the "vita propria" It possesses the property of irritability, and the changes in its substance, provided these do not destroy life, produce local disease

Disease presupposes life, should the cell die, its disease also comes to an end Certainly, as a consequence, the neighbouring and even far distant cells may become diseased, but as regards the cell itself the susceptibility to disease is extinguished with life

Since the cellular constitution of plants and animals has been proved, and since cells have become recognised as the essentially living elements, the new science of biology has sprung up It has not brought us the solution of the ultimate riddle of life, but it has provided concrete, material, anatomical objects for investigation, the structures and active and passive properties of which we can analyse It has put an end to the wild confusion of fantastic and arbitrary notions such as I have just mentioned, it has placed in a strong light the immeasurable importance of anatomy, even in the most delicate conditions of the body, and lastly, it has made us aware of the close similarity of life in the highest and lowest organisms, and has thus afforded us invaluable means for comparative investigation

Pathology has also its place, and one certainly not without honour, in this science of biology, for to pathology we are indebted for the knowledge that the opposition between healthy and diseased life is not to be sought in a fundamental difference of the two lives, not in an alteration of the essence, but only in an alteration of the conditions.

Pathology has been released from the anomalous and isolated position which it had occupied for thousands of years By applying its revelations not only to diseases of man, but also to those of animals, even the smallest and lowest, and to those of plants, it in the best manner helps to strengthen biological knowledge, and to narrow still more that region of the unknown which still surrounds the intimate structure of living matter. It is no longer merely applied physiology, it has become physiology itself

Nothing has more contributed thereto than the constant scientific union which has endured for more than 300 years between English and German investigators, and to which we to-day add yet another link May this union never be broken!

APPLIED NATURAL HISTORY

THE so called experimental sciences—chemistry and physics—in their various branches, have hitherto been more extensively "applied" to the service of man, than the observational sciences of botany and zoology

The various industries in which civilised man has naturally become engaged have induced a scientific study of the fundamental principles, and an eager search for such information as can lead, with the assistance of art, to a further advance towards the goal of perfection.

It is true, however, that the practice of medicine has much dependence on the science of botany

Zoology, on the other hand, has never been considered as possessed of qualities serviceable to any bread-winning occupation, and although included, like botany, in all ordinary courses of medical study, has not until recently been considered of importance for the advancement of any industry.

Now, when the nineteenth century is in its last decade, we in this country are beginning to realise that a knowledge of the life-histories and habits of sea-fishes and

other food-products of the deep is of paramount importance in regulating and bettering the fisheries around our coasts.

A few years ago the scientific aspects of this industry received but scant attention. Many outcries have indeed been always heard as to injurious methods of fishing, the wilful destruction of fish suitable for food, and the general depletion of certain fisheries, but in spite of Royal Commissions and Courts of Inquiry, we have been slow to grasp the truth that for want of proper knowledge with which to control our laws and regulations we have been timidly procrastinating, and allowing our chance of ready resuscitation to diminish. We have about 400,000 men dependent on our fisheries, and yet are at the present day lagging behind other and younger countries in our State Aid. In Scotland the proportion between fishermen and the rest of the population is 1 in every 76, in Ireland 1 in every 216, in England and Wales 1 in every 612. In a recent report of the Board of Trade it is also stated that "the sea fisheries of the United Kingdom appear to be of greater value than those of any other country in which fishery records are kept." The value of the fish landed annually in the United Kingdom is about six million pounds, and yet a large proportion of our fishermen eke out a miserable existence, and see the industry in which they are engaged becoming more and more unremunerative every year. In Scotland, where most is done for our fisheries, there is a Government Board where appeal can at all times be made by any persons desiring alterations in the existing state of circumstances. A Board which not only collects all statistics, but which has power and capabilities to inquire into all methods of fishing, whether from a biological or commercial standpoint, as well as to construct by-laws if necessary. In England the absence of such a body is much felt. Conference after conference is held, but although promoted under the most favourable auspices, the resolutions agreed upon can hardly be made to impress the House of Commons, because of this want of a proper channel. It would be quite out of place in an article such as the present to speculate as to the constitution of a Fishery Board for England, but without any doubt it should have not only a representative of biology, but a small staff of investigators.

The unfortunate antithesis which at present exists between so-called practical people and men of science results largely from the unknown altitude from which the latter choose somewhat exclusively to illuminate the world. Without desiring in any way to discount the pursuit of knowledge for its own sake, it seems apparent that the benefits to be derived for our fisheries are not to be obtained from the lovers of pure science, but rather from those who, having had the proper scientific training, are willing to occupy a position in which they will be intimately acquainted with the requirements of practice as their object, and yet be able to focus the theoretic rays of the specialists on the different sections of their work.

The history of the various Royal Commissions has thrown considerable light on the particular nature of the information needed. It has also shown how widely the investigations yet to be carried on must extend.

Take, for example, the old vexed question of beam-trawling in Scotland. Fishermen practising the time-honoured art of long-lineing appeared as witnesses before the Commission of 1883, and being keenly antagonistic to the trawler, described how this species of robber descended upon their old haunts, scraped and harrowed the bottom to the utter destruction of all spawn and fry, scooped up tons of fish (which should have lived to have been caught by hook and line in the proper manner), and glutted the market with what was quite unfit for human food.

It is often extremely difficult to separate political interests from fishery reports, but the fact remains that evidence of this kind, being inserted in the public press, led to much misunderstanding, and inclined people to support the line fishermen at the expense of the trawler. But the late Lord Dalhousie, as chairman of the Commission, was fortunate in having as one of his colleagues a naturalist who had for many years given special attention to fisheries. The statements, therefore, as to destruction of spawn and young fish were tried and found wanting. The evidence as to the natural history of fishes being most wild and conjectural, though given by men who had spent their lives at sea and were masters of their craft, was met by scientific accuracy and fell to the ground. We find in the official report of the Commission, published in 1886, very decided statements indicating that in the opinion of the Commissioners the injury done by the use of the beam-trawl is insignificant.

Much information has now been gained as to the eggs and embryology of sea fishes, and important observations published on such matters; for instance, as to the proportional numbers and sizes of the sexes, and the sizes at which the various food fishes become sexually mature.

Observations made on the last-named inquiry show that on different coasts where the conditions of life vary as to temperature, food, or ocean currents, the sizes at which any individual members of a species of fish spawn are distinctly different, and that the rate of growth is different. This is a matter of some importance to those who would prevent capture of fish till after some progeny has been allowed to remain. Fulton's experiments on the proportional numbers of the sexes show that out of 12,666 fish of twenty-one species examined, 3,858 were males and 8,808 were females—a ratio of 228 females to 100 males.

The flounder and the brill were, however, found to be exceptions, while the greatest inequality was found in the case of the long rough dab (*Hippoglossoides limandoides*), where the ratio was 842 females to 100 males, or nearly seventeen females to every two males. As regards the proportional size, the observations show that "Among all the flat fishes without exception, the female is longer than the male, the ratio varying with the species."

Mr. Holt, who has worked most extensively at the sexual maturation of fishes, in order to determine if possible a method of protecting fishes which have never spawned, discards the male sex altogether, and considers only the sizes of the females, since the males, being both smaller and less numerous, would be more highly protected than the females by any measures drawn up with a view to prohibiting the capture or sale of flat fishes under certain sizes. Others who have worked at the same subject pursue the same course.

These inquiries have been instituted not for their own sakes, but because, from studying the fisheries of the country, it has become obvious that knowledge of this kind is essential. The constant clamour kept up by fishermen who daily see their returns becoming smaller does not reach the ears of those who are busily occupied in commerce, or in science; it is appreciated only when special attention is paid to the history and present condition of some of the most important areas. Take the great industry of the Dogger Banks, which for other reasons has come before the notice of the public of late years. In 1828 the North Sea was practically an unknown fishing region. Boats of no very great size were in that year just beginning operations from Harwich. Before this date trawling was confined to the south coast, having commenced at Brixham about the year 1764. The Dogger Bank was found to be teeming with fish, there was plenty for every one, and an almost endless scope for fresh ventures. The "Silver Pits" were discovered in 1837, the name being significant of the value to the discoverer and his followers. So things went on, more and larger boats were built, heavier gear used, boats banded

together in fleets, and remained out on the grounds for weeks at a time, steam was introduced, and the east-side of the North Sea visited It was a "roaring trade," and many were made wealthy by it Now things are changed, and every one cries out that the balance has been overturned, that the fish are being caught faster than the stock is being kept up this, in spite of what was once said as to the amount of fish which could be taken from one acre of sea-bottom It is possible to fix close times during which salmon and trout must not be taken from certain rivers, and to hatch fry which will remain in the one district It is another matter to apply close seasons, or fix standard sizes for areas of the open sea From what we know of life at the sea-bottom it is pretty certain that if one of the conditions necessary for keeping up a true balance of nature is removed or greatly lessened, the proportional arrangement of the remaining fauna is also interfered with, for since marine animals prey largely upon each other it follows that if one class of devourers is removed, the devoured become more numerous, which again seriously affects other classes

For this reason an over-fished oyster or mussel bed if left to itself, or not properly regulated, will probably never regain its former condition, a fact brought out with great clearness in the course of the evidence taken before Lord Balfour of Burleigh, at the Board of Trade Conference last June With free swimming round fish the condition is somewhat analogous, although more knowledge is required concerning their migratory movements If the natural balance is interfered with, the result, although at first it may be only to increase certain other forms which are also of advantage to man, will eventually appear when useless or unprofitable fishes remain in the majority, or when the appearance of a once common and useful species is no longer present in the market

If human interference can so alter the marketable productivity of the sea, and materially lessen the incomes of a large portion of a nation, surely it becomes a duty to study the application of such sciences as deal directly with the animals concerned If by continual fishing the only available grounds became depleted, it is by a thorough study of the actual cause and effect, and the application of the principles of natural history involved, that the only true remedy is to be found

W L CALDERWOOD

THE SOUTH KENSINGTON LABORATORIES AND RAILWAY

THE friends of science throughout the country may be congratulated upon the fact that work in the laboratories of the Royal College of Science and of the City and Guilds Institute is not to be rendered impossible by the building of a railway along Exhibition Road Sir John Kennaway, the chairman, and the members of the House of Commons Committee deserve the best thanks of the community for their unanimous rejection of the scheme even if only partly on scientific grounds When the evidence given before the committee comes to be published there will be some curious reading Lord Kelvin, the President of the Royal Society, informed the committee of what was at stake, and gave his opinion as to the question both of mechanical and electrical disturbance The paid "scientific experts" in their pleading on the side of the company promoters may be said to have almost eclipsed the usual "emphasis" of statement We may refer to this evidence later, but in the meantime the following quotation from a leader in the *Times* indicates the general opinion as to the importance of the result which has been achieved —

"What makes the history of this Bill novel and interesting is the second line of attack adopted by its opponents. On either side of Exhibition Road stand two of the most important scientific institutions in London. One of these—the Royal College of Science—is supported by the State; the other was founded by the City and Guilds of London for the promotion of advanced technical education The former of these institutions, and the great collection of scientific instruments which is being formed at South Kensington, make an organised whole This collection, which includes the earlier and the latest instruments, is invaluable both historically and practically, and is in close proximity to the lecture-halls and laboratories where use can be made of the instruments The collection and the laboratories are used not only by many other students, but by the large number of national scholars and exhibitioners who, after the annual May examination of the Science and Art Department, are brought up from all parts of the country, chiefly at the public expense These students, and the deserving lads who work at the City and Guilds Institute, form an important element in the situation; for to them the advent of an electrical railway was a serious peril It was shown, and admitted, that the magnetic disturbances in the neighbourhood of the South London Railway are so great that no accurate magnetic work can be done within some hundreds of yards of it Now the proposed Paddington and Clapham Railway would run, not some hundreds of yards from the South Kensington laboratories, but within forty feet of some of them, and there was a genuine fear on the part of the Professors that at such small distances it would be impossible not only to accurately neutralise the conflicting forces, but to prevent the astronomical instruments being affected by the earth-tremors caused by the passage of trains This view was urged by Lord Kelvin, perhaps the greatest living authority on such matters, and by Profs Norman Lockyer, Ayrton, Rucker, and Boys, and after a contest which lasted three days their view prevailed, and the committee found the preamble of the Bill 'Not proved' The men of science are to be congratulated on the result A year or more ago they successfully defended their South Kensington preserve against the invasion of Art; and it would be pitiful indeed if Science were now to be put in jeopardy by a practical application of herself It appears that electricity cannot be studied in the neighbourhood of an electric railway, naturally, then, we cannot have an electric railway close to the great central institution where electrical science is taught at the public expense"

NOTES

THE annual general meeting of the Institution of Naval Architects is being held this week in the rooms of the Society of Arts, which have been lent for the purpose The proceedings began yesterday (Wednesday) morning, and will conclude to-morrow evening. The meeting is one of more than usual importance in the history of the Institution from the fact that the president, the Earl of Ravensworth, is resigning the position which he has so well filled for a period of fourteen years Lord Ravensworth is the second president the Institution had had, he having succeeded to the chair on the death of Lord Hampton, who first occupied the position The new president is Lord Brassey, whose great interest in all maritime questions well qualifies him for the post Lord Ravensworth will not sever his connection with the Institution, as he will accept the position of a vice-president The following is the programme of the present meeting —Wednesday, March 22.—Morning meeting, at twelve o'clock. Annual report of Council, address by the president (the Earl of Ravensworth); on the present position of the cruiser in warfare, by Rear-Admiral S. Long, on approximate curves of stability, by W Hok. Thursday, March 23 —Morning meeting, at twelve o'clock Some considerations relating to the strength of bulkheads, by Dr F. Elgar, on the measurement of wake currents, by George A Calvert; on the new Afonasieff's formulæ for solving approximately various problems connected with the propulsion of ships, by Captain E. E Goulaeff Evening meeting, at seven o'clock. Some experiments on the transmission of heat through tube plates, by A. J. Durston, some notes on the testing of boilers, by J. T Milton. Friday, March 24.—Morning meeting, at twelve o'clock: On an apparatus for measuring and registering the vibrations of steamers, by Herr E. Otto Schlick; on the re

pairs of injuries to the hulls of vessels by collisions, stranding, and explosions, by Captain J Kiddle Evening meeting, at seven o'clock Some experiments with the engines of the s s *Iveagh*, by John Inglis, on the cyclogram, or clock-face diagram, of the sequence of pressures in multi cylinder engines, by F Edwards, presentation of an address from the Institution to the Right Hon the Earl of Ravensworth, on his retirement from the office of president In addition to the above there is a paper by Lord Brassey on merchant ships as cruisers The annual dinner was held at the Holborn Restaurant yesterday evening In summer the Institution will meet at Cardiff

ON Friday a deputation will wait upon Mr Campbell Bannerman to make some representations as to the position of those Woolwich cadets who have taken up science at the entrance examination The existing system at the Royal Military Academy, as we have repeatedly taken occasion to point out, is very unfavourable to cadets of the scientific type, and it is hoped that the approaching interview may lead to the adoption of more reasonable methods Among the members of the deputation will be Sir Henry Roscoe, Sir Henry Howorth, and the head masters of Rugby, Cheltenham, and Clifton

MR. W L CALDERWOOD has resigned the post of director of the Laboratory of the Marine Biological Association at Plymouth He vacates the residence early in April

WE are privately informed of the death, on the 7th instant, of Dr. G Vasey, the chief of the botanical section of the United States Department of Agriculture at Washington He was a native of Yorkshire, we believe, and emigrated to America many years ago. The grasses of North America were his special study, and he published several important works on this family The "Grasses of the Pacific Slope" and the "Grasses of the South-west," fully illustrated, are his latest works, but the former is not yet completed Dr Vasey wrote also on the agricultural value of the grasses of the United States Last year he visited England, and made many friends through his amiable disposition

WE learn with regret, from the daily papers, that the Rev W Woolls, of Burwood, near Sydney, New South Wales, has lately died It is stated that he emigrated from England as long ago as 1831, and he certainly did much to promote science in the country of his adoption Botany was his favourite study, and he made several important contributions to botanical literature, chiefly on the botany of New South Wales He was president of the "Cumberland Mutual Improvement Society," and in that capacity delivered a number of carefully compiled instructive lectures on the vegetable products and resources of the colony, and other branches of botany One of the most interesting of his published lectures is on the progress of botanical discovery in Australia, which is indeed a concise and correct history of the subject It was he who wrote the appreciative reviews of the volumes of Bentham's "Flora Australiensis" that appeared in the *Sydney Morning Herald*, and he himself published separate accounts of the plants of the neighbourhood of Sydney, of the Paramatta district, and of the colony of New South Wales.

THE *Botanisches Centralblatt* announces the death of Dr Karl Prantl, Professor of Botany in the University of Breslau, and director of the Botanic Garden there For some years past Dr Prantl has edited *Hedwigia*, a journal devoted to cryptogamic botany; but it was chiefly as a teacher that he was known. An English edition of his "Lehrbuch der Botanik" was edited by Dr. S. H. Vines in 1880.

THE following are among the lecture arrangements at the Royal Institution after Easter:—Mr. John Macdonell, three lectures on symbolism in ceremonies, customs, and art; Prof Dewar, five lectures on the atmosphere, Mr R Bowdler Sharpe, four lectures on the geographical distribution of birds, Mr James Swinburne, three lectures on some applications of electricity to chemistry (the Tyndall lectures) The Friday evening meetings will be resumed on April 14, when a discourse will be given by Sir William H Flower, on seals, succeeding discourses will probably be given by Prof A B W Kennedy, Prof Francis Gotch, Mr Shelford Bidwell, the Right Hon Lord Kelvin, Mr Alfred Austin, Mr. Beerbohm Tree, Prof Osborne Reynolds, Prof T E Thorpe, and other gentlemen

DR H WOODWARD, F R.S, is the president of the Malacological Society which was founded lately at a meeting held at 67, Chancery Lane The Society will meet at the same place on Friday, April 14, at 8 p m, and again on the second Fridays in May and June, after which there will be no meeting till November

ANY one who may desire to learn all that is best worth knowing about the progress and prospects of technical education should read an admirable lecture on the subject delivered by Sir Philip Magnus last week before the Society of Arts, and printed in the current number of the Society's Journal Sir Philip is of opinion that what is now wanted is the co ordination of our resources and the simplification of our machinery The Technical Instruction Committees, with the help of their able secretaries, are doing good and useful work, although much of it is necessarily impeded by the restrictions of the Acts of Parliament under which they work Between these bodies and the School Boards, Sir Philip urges, there should be earnest cooperation To them, acting together, and strengthened by the representatives of other educational interests, should be ultimately submitted the duty of making that further provision for secondary education, the need of which is generally admitted

A MEETING was held at the First Avenue Hotel on Saturday last for the purpose of forming a Cage-bird Club Dr. Martin, chairman of the Norton Ornithological Society, and vice president of the London Cage-bird Association, occupied the chair, and a paper was read by Mr W H Betts, who explained that the object of the club was the enrolment among its members of ladies and gentlemen who, from the fact that the majority of cage-bird clubs were held at public-houses, were debarred from membership thereof He said the club would endeavour to train novices in the management of cage-birds, would give encouragement and assistance to ornithological societies generally, would circulate literature with the object of improving the moral tone of the cage bird fancy, and would endeavour to prevent cheating at shows and to put an end to brutality On the motion of the Rev W K Suart, president of the Cage-Bird Association, seconded by Mr George Crabb, president of the London and Provincial Ornithological Society, it was determined that the club should be founded Mr Betts was appointed honorary treasurer, and Miss E A Darbyshire honorary secretary

DR JAMES RORIE, writing from Westgreen House, Dundee, sends us the following note on a brilliant meteor —"A very brilliant meteor, or fire-ball, was seen here about 6 23 p m on Saturday evening, the 18th inst. When first observed it was about 70° above the horizon south-south-west from the asylum, and moving in a direction from east south east to west northwest It was visible for about five seconds, and appeared like a large pale blue ball of fire throwing off jets of red-coloured flames, and leaving behind it a pale white silvery streak, marking its course across the sky like a very thin line of vapour, but at the point near the horizon where the meteor disappeared leaving a shining electric blue colour This streak was in all probability composed of dust particles thrown off by the meteor

during the passage in a state of ignition through the atmosphere, as it remained visible for nearly three-quarters of an hour, first as a straight line, and then, evidently caught by the westerly wind, becoming gradually contorted, and, slowly expanding and disappearing, it passed overhead like a long thin twisted cloud of pale blue smoke "

During the latter part of last week the high pressure over France gave way, and several shallow secondary depressions passed across our islands, accompanied by northwesterly winds, snow and hail showers Sharp frosts occurred in places at night, the shade minima varying from 20 to 23°, while the grass temperatures were much lower, the thermometer on Saturday night falling as low as 12° to 16° in the Midland counties and in London, but during the bright intervals of the day-time the maxima reached 50° and upwards Towards the close of the week an anti-cyclone which previously lay off our south west coasts spread over the United Kingdom, and extended eastwards over the continent The weather during the next few days became fine and bright generally, with the exception of fog in the neighbourhood of London and the south east of England The maximum day temperatures exceeded 60° at several stations, but the nights continued exceptionally cold, the ground being thickly coated with hoar frost Such severe frosts as those experienced on several nights during the past week rarely occur so late in the season The *Weekly Weather Report* for the week ending the 18th instant shows that, notwithstanding the very low minimum temperatures, the averages for the week were rather above the mean in England and the south of Ireland Rainfall was considerably in excess of the average in the north of Scotland, but less in all other parts The greatest amount of bright sunshine was recorded in the north-east of England, where there was 52 per cent of the possible amount, the lowest average amount was 18 per cent in the north of Scotland

With the view of enabling masters of vessels to know what weather to expect at sea in the far East, and to choose the best routes, all the observations recorded in the archives of the Hong Kong Observatory made between 0° and 45°, and between Singapore and 180° E Gr are being tabulated, and will serve for the construction of maps, which will ultimately make it possible to issue pilot charts for the China Seas. Dr Doberck invites all persons having old log-books in their possession to send them to him on loan There are log-books of our large lines which, if forwarded to the proper quarters, might help to make passages shorter, pleasanter, and safer.

The Societies forming the Scientific Alliance of New York have held their first joint meeting, the object being to present the needs of science in that city, and the plans and purposes of the Council of the Alliance The addresses delivered on this occasion have now been published as a pamphlet. We may note that the membership of the societies is over 650, and is said to include the names of nearly all persons in New York who are interested in pure science

Columbia College, New York, has received from Mr. Loubat an endowment which is to be used for the encouragement of the study of (1) The history, geography, and numismatics, (2) the archæology, ethnology, and philology of North America. It will permit an award at least every five years alternately in these two groups of subjects This year two prizes of 1000 dollars and 400 dollars will be given for the best works published in English on the subjects in question. The author need not be a citizen of the United States. The works must have been published since January 1, 1888, and must be based on original research. Copies must be sent, not later than June 1 of the present year, to the president of Columbia College, whose secretary will furnish copies of the regulations adopted

Mr Thomas Steel, of Victoria, has been visiting several zoological gardens in Great Britain and America, and in the February number of the *Victorian Naturalist* he gives an interesting account of some of his experiences In the London Zoological Gardens he was naturally attracted especially by animals and birds from Australia. The kangaroos seemed to him to have very small quarters compared with those set apart for kangaroos in the Melbourne gardens. Nevertheless, he thought them "fairly healthy and sleek" Mr Steel was much pleased with a pair of Australian brush turkeys, who were evidently "quite at home in their enclosure" The laughing jackass, however, was the animal which interested him most strongly He had "quite a thrill of pleasure" when he recognised its "well-remembered voice" Of the collection of animals in the Central Park, New York, Mr Steel formed no very high opinion He was much surprised that so mighty a city should be "so far behind in a matter of this kind" Of the "dejected looking lions" in the Central Park he says that they were greatly to be pitied. They were "cooped up in the smallest of cages, with no proper shelter and no exercising yard"

The *Kew Bulletin*, appendix ii 1893, consists of a list of the new garden plants of the year 1892 The list includes not only plants brought into cultivation for the first time during 1892, but the most noteworthy of those which have been reintroduced after being lost from cultivation Other plants included in the list have been in gardens for several years, but either were not described or their names had not been authenticated until recently These annual lists, as the *Bulletin* points out, are indispensable to the maintenance of a correct nomenclature, especially in the smaller botanical establishments in correspondence with Kew, which are, as a rule, only scantily provided with horticultural periodicals The lists also afford information respecting new plants under cultivation at Kew, many of which will be distributed from the Royal Gardens in the regular course of exchange with other botanic establishments

Prof. P H. Schoute and some other Dutch mathematicians have undertaken to edit, under the auspices of the Mathematical Society of Amsterdam, a "Revue Semestrielle des Publications Mathématiques" The first part of the first volume has just been issued by W Versluys, Amsterdam. The "Revue" appears likely to be of service to mathematicians far beyond the limits of Holland

The Smithsonian Institution has published a collection of translations of some of the best recent memoirs issued in European countries on "The Mechanics of the Earth's Atmosphere" The work has been prepared by Mr Cleveland Abbe, who expresses his conviction that "meteorology can be advanced beyond its present stage only by the devotion to it of the highest talent in mathematical and experimental physics

The geological department of Colby University, U S, has published a useful "Summary of Progress in Mineralogy and Petrography in 1892," by W. S Bayley The volume consists of monthly notes contributed to the *American Naturalist*.

Mr Elliot Stock has issued a little volume, by "Medicus," showing how the height and chest measurement may be increased by systematic exercise. The title of the volume is "How to Improve the Physique."

In the current number of the *Comptes Rendus* there are two papers on the use of the electric current in producing high tem-

peratures. In one MM. Moissan and Violle describe two forms of electric furnace which they have used in their experiments. The substance to be heated is contained in a small crucible made of carbon having two holes pierced through its side to allow the carbon rods, between which the arc is formed, to pass. This crucible is surrounded by blocks of lime to reduce the loss of heat on account of radiation. In one form of furnace there is an arrangement by which a piece of graphite, after being heated in the arc, is allowed to fall into a calorimeter, and by this means they have found that a temperature of 3000° can be reached. In the other paper MM. Lagrange and Hoho have investigated the fact, observed by Planté and others, that when you pass a sufficiently strong current through an electrolyte, using as negative electrode a fine wire, and as positive electrode a conductor of considerable surface, a kind of luminous sheath is formed round the negative electrode. The authors find that the heat developed in this sheath is very great, and that by its means a very intense heat can be applied at any point of a body while, on account of the rapidity with which the heat is disengaged, the rest of the body remains cold. As an application of this method they have heated to a bright red the outside of a bar of steel, while the inside remained comparatively cool, then by merely stopping the current the cold liquid has come in contact with the hot steel. In this way they have hardened the outside of bars of steel, while the inside has remained soft and therefore tough.

PROF. L. WEBER, of Kiel, has recently constructed a mercury barometer which can be filled without boiling, and whose vacuum can be freed from residual air at any time in a few seconds. It consists, according to the *Zeitschrift für Instrumentenkunde*, of a vertical tube with two bulbs, one on each side. One of these bulbs ends in a tube to which an indiarubber tube can be attached. The other is connected by a short tube with a capillary constriction. A narrow tube connects the lower end of the bulb with the top of the main tube, thus forming a kind of double barometer. To fill it mercury is poured into the first bulb and allowed to enter the main tube. In doing so it forces the air down through the narrow tube and out by the second bulb. Some mercury also enters the latter by the capillary constriction. On placing the instrument in a vertical position a vacuum is formed at the top of the two communicating tubes, which is slightly longer in the narrow one owing to capillary depression. Barometric readings are then taken in the usual way by means of a scale fixed to the main tube. The vacuum can be tested and easily restored in the following way. The indiarubber tube attached to the first bulb ends in an elastic ball with a small hole in it. This hole is closed by the thumb and the ball is compressed. Mercury is thus forced up the main tube and over into the capillary tube. If there is any residual air it will form a bubble between the two columns, which will on further compression be driven out through the second bulb. On releasing the pressure the vacuum is re-established, and the slight difference of level in the two bulbs is gradually obliterated by the passage of mercury through the capillary contraction. The latter can be replaced by a glass rod with a conically ground end, by means of which the communication between the two bulbs can be temporarily interrupted.

AN interesting communication concerning metallic osmium is contributed to the current number of the *Comptes Rendus* by MM. Joly and Vèzes. Metallic osmium, as usually prepared by the method of Berzelius, which consists in calcining the sulphide in a carbon crucible, takes the form of a powder or a spongy mass of a blue colour. As thus obtained it is rapidly attacked by the oxygen of the air with production of the volatile and dangerously poisonous tetroxide OsO_4, hence the metal constantly exhales a strong odour due to the vapour of the tetroxide. Sainte-Claire Deville and Debray some time ago succeeded in obtaining metallic osmium in the form of beautiful little greyish blue crystals, by passing the vapour of the tetroxide through a strongly heated carbon tube. The density of these crystals, 22.48, was the highest which has been observed for the metal. All the efforts, however, of Sainte Claire Deville and Debray to fuse osmium in the flame of the oxyhydrogen blowpipe were unavailing. If enclosed in a crucible of carbon surrounded by another of lime, the metal simply remained unchanged, but if heated directly in the flame itself it rapidly disappeared, owing to its conversion into the volatile tetroxide, but no trace of fusion was ever observed. It is now shown that osmium does melt at the temperature of a very powerful electric arc, in a manner analogous to ruthenium. It is, of course, essential that special precautions should be taken in order to prevent loss of the extremely expensive metal by oxidation, and consequently volatility, particularly as the volatile product of the oxidation, the tetroxide, is so injurious to the experimenter. The operation was therefore performed in the electric furnace devised by Ducretet and Lejeune, which enabled the metal to be heated in a carbon crucible placed in a closed chamber traversed by a stream of carbon dioxide. Under these conditions when osmium is rapidly raised to the highest temperature of the electric arc it melts without sensible loss by volatilisation. After fusion osmium presents a very brilliant metallic surface of a beautiful blue colour slightly tinged with grey. It breaks with a crystalline fracture, and is distinguished by its remarkable hardness, being harder than both ruthenium and iridium, readily cutting glass and scratching quartz. Moreover, after fusion osmium appears to be no longer attacked by the atmospheric oxygen, its surface remaining bright greyish blue.

THE whole of the refractory metals of the platinum family have now been obtained in the liquid form. Of them all osmium has been found the most refractory, its melting point being considerably higher than that of ruthenium. It resembles the latter metal very much in many of its properties, particularly as regards the ready formation of a volatile tetroxide. It differs entirely, however, from ruthenium in aspect, exhibiting as above described a remarkable blue metallic lustre, while ruthenium is more white than platinum, resembling in fact burnished silver. The six metals of the platinum group would appear to more particularly resemble each other in pairs, ruthenium and osmium having many physical and chemical attributes in common, rhodium and iridium being similarly very nearly allied, and palladium and platinum forming the third pair. In many respects, however, osmium exhibits a peculiar and somewhat isolated character, more akin to that of the metalloidal elements; indeed, so marked is this that Deville and Debray termed it the metalloid of the platinum group, Berzelius compared it to arsenic, and Dumas to tellurium.

NOTES from the Marine Biological Station, Plymouth.—Little change has been observed in the floating fauna since last week. *Sarsia prolifera* and medusæ of *Clytia Johnstoni* have again been taken; and *Obelia* medusæ have been plentiful, although for the most part very small and immature. A few *Polydora* larvæ have been taken. *Evadne Nordmanni*, which at times is abundant in the surface waters, has made its first appearance for the year; the few individuals noticed were carrying embryos in the brood pouch. The Nemertine *Cephalothrix linearis* and the crabs *Portunus depurator* and *holsatus* have begun to breed.

THE additions to the Zoological Society's Gardens during the past week include eleven Orbicular Horned Lizards (*Phrynosoma orbiculare*) from California, presented by Mr. William Chamberlain; a Stanley Parrakeet (*Platycercus icterotis*) from Australia, deposited; a wandering Albatross (*Diomedea exulans*) captured

off Cape Horn, purchased, an Upland Goose (*Bernicla magellanica*) from the Falkland Islands, a Mute Swan (*Cygnus olor*) European, received in exchange; a Mouflon (*Ovis musimon*), four Shaw's Gerbilles (*Gerbillus shawi*), four Barbary Mice (*Mus barbarus*) born in the Gardens

OUR ASTRONOMICAL COLUMN

THE MELBOURNE OBSERVATORY —On September 2 last Mr. Ellery, the Government Astronomer, made his annual report to the Board of Visitors to the Observatory This report shows that with his staff a great amount of work was got through, the following being a brief summary —With the meridian circle 3590 observations for Right Ascensions, and 2233 for N P D were made, these numbers including the observations for the places of the guide stars used in the astrographic operations The great telescope, owing to the demands on the staff for the astrographic work, has not been much in use, the routine work having been dropped altogether It is pleasing to hear that a good start and considerable progress has been made in the part allotted to them in the photographic chart and catalogue of the heavens Up to June 30, 278 plates had been exposed, excluding a great number obtained for purposes of testing adjustments, &c, although Mr Ellery remarks that the weather since May was anything but inviting for such work With the photoheliograph 201 sun pictures were obtained The observations and records relating to terrestrial magnetism, meteorology, and intercolonial weather service, and time distribution have been continued as usual with satisfactory results In the seventh paragraph of the report Mr Ellery informs us of the necessity that has arisen for the reduction of expenditure Mr White, the chief assistant, and Mr Moerlin, the second assistant, were both called upon to retire on September 30, having attained the age of sixty years, both a considerable loss to the observatory, having served there thirty one and thirty years respectively, and Mr Ellery found it necessary to close the observatory workshop, and dispense with the mechanic. In a re organisation of the duties it will be necessary, he says, to put in abeyance observations with the great reflector, reduce meteorological work, including some photographic registration, stop ordinary extra meridian observation, except the most important, reduce publications and issue of weather charts, and generally to limit operations to the most important and urgent kind Such a reduction as this after so many years of smooth working and the loss of two such experienced and efficient officers must fall heavily on Mr Ellery's shoulders, but we are glad to hear that the new scheme is now in working order We hope to hear also that Mr Wallace's services have been retained for the astrographic chart, as Mr Ellery says in a supplementary report that without him this undertaking will have to be dropped

NATAL OBSERVATORY —Just as in his former report, Mr Nevill, the Government Astronomer, is indebted to several ladies for assistance in the observatory, without whose aid he says the numerous astronomical and meteorological computations and reductions could not have been carried out (Report of the Government Astronomer for the year ending June 30, 1892). Again, he urges the necessity of removing the transit to another position, this instrument being so close to the equatorial that only one of them can be used at a time. Besides the usual observations for the comparison of the declinations deduced from observations made at observatories in both hemispheres, by a comparison (Talcott's method) of the zenith distances of northern stars and southern circumpolar stars, the work for determining the latitude of the observatory has been brought to a conclusion and awaits publication. The work, comparing the Greenwich lunar observations from 1851–1888 with the basis of Hansen's Lunar Tables, comprising a discussion of four thousand observations, has been completed, and auxiliary tables, founded on the corrections thus deduced, are now being formed. Several observations of Mars were made to determine the distance of the sun, and these are at present being reduced.

THE BIELIDS OF 1872, 1885, AND 1892.—In "Our Astronomical Column" on p 451 we referred to a note by M Bredichin on the Bielids, in which he said that from observations made last year it seemed very probable that the densest part of this swarm had undergone perturbations, amounting to a recession of the ascending node of nearly 4°, due to the proximity of the planet Jupiter In the current number of *Astronomische Nachrichten*, 3156, he further suggests that the swarm has undergone a separation, perhaps into many parts, an analogous case of such a separation having occurred in the comet 1889 I The force which accomplishes this division he denotes by I at the commencement of separation and assumes that its direction coincides with the line of the radius vector, being positive and negative when directed towards and from the sun Denoting by R the radius of the earth at the time of the meeting with the swarm, and the common radius vector, v the true anomaly of this radius in the original orbit, and v_1 that in the derived orbit, representing the angle between this common radius vector and the tangent to the original orbit by β, and with any one on the derived orbit by β_1, he educed the following values for the elements of the three orbits, where m is the value of the velocity of commencement for one second of time —

	Comet	I	II	III
T	1859 390 G M T	1872 986	1885·983	1892 976
π	109° 50′ 4	108° 55′ 0	108° 45′ 3	108° 59′ 2
Ω	246 1 3	—	—	—
i	12 22 0	—	—	—
log a	0 54950	0 55149	0 54833	0 55050
log e	9 87711	9 87788	9 87668	9 87750
log q	9 94123	9 94087	9 94138	9 94103
U	6 672	6 718	6 645	6 695
log R	—	9 99395	9 99397	9 99426
log r	—	9 94216	9 94156	9 94146
v	—	+ 5° 48′ 0	− 3° 34 0	+ 3° 3′ 0
v_1	—	+ 6 43 4	− 2 28 9	+ 3 54 2
β	—	87 30 5	91 32 0	88 41 4
β_1	—	87 6 5	91 4·2	88 19 3
I	—	− 0 0099	− 0 0116	− 0 0095
m	—	292m	342m	279m

COMET HOLMES (1892 III) —M. Schulhof's ephemeris for this comet gives for the ensuing week —

12h Paris Mean Time

1893	R A (app) h. m s.	Decl. (app) ° ′ ″
March 23	3 8 3 8	+35 47 40
24	9 52 5	50 28
25	11 41 4	53 16
26	13 30 5	56 3
27	15 19 8	35 58 49
28	17 9 3	36 1 34
29	18 58 9	4 10
30	3 20 48 7	36 7 2

PROF HALE'S SOLAR PHOTOGRAPHS.—Among the latest advancements in obtaining photographs of the sun, including simultaneously the chromosphere, faculæ, spots, &c., Prof Hale has distinguished himself especially in this direction With regard to the method which he adopts, M Janssen communicates to the *Comptes Rendus* for March 6 (No 10) a few words. I ask the Academy, he says, "la permission de lui faire remarquer que le principe de cette seconde fente a été très nettement indiqué par nous dans les Communications faites à l'Académie en 1869, et, avec plus de détails, dans une Communication faite au Congrès de l'Association britannique tenu à Exeter la même année"

GEOGRAPHICAL NOTES.

THE recognition accorded to geography in the University of Cambridge is not confined to the lectureship The subject of the English essay proposed for competition this year by members of the University is announced as "The influence exercised upon British literature by the geographical features of the country" Probably "conditions" would convey the meaning better than "features," but apart from such detail, the subject is one likely to turn the attention of competitors to a much neglected matter —the geography of their own country.

THE survey of Greece is being actively carried on by the Austrian Government surveyors, who undertook the work in 1889. The primary triangulation is already completed, and while filling in the topographical details of the provinces of Thessaly and Albania the survey officers will be accompanied

by an Austrian botanist and geologist from whose studies much new information is expected

ONE of the interesting minor results of M Dybowski's recent journey from the Mobangi to the Shari was the discovery that the natives of that part of the Sudan use chloride of potassium instead of chloride of sodium to season their food They carefully select plants which on burning yield an ash containing a minimum of carbonates, and extract their "salt" by boiling water, subsequently filtering and evaporating the solution

DR A GLOY has recently published a very interesting discussion of the population of Schleswig-Holstein, tracing its distribution to the character of the land In order to represent graphically the cause and effect on the same paper, the various agglomerations of people from single cottages to towns of over 2000 inhabitants, are shown by dots of increasing size on a geological map It thus becomes apparent that the population is arranged so that the fertile fenlands and clay ridges which run from north to south are relatively thickly peopled, while the belt of sandy and barren soil separating them has few houses except along its boundaries The type of dwelling in rural villages is also found to vary, showing a clear relation to the former extension of the Slav tribes westward before the time of Teutonic predominance

IN a careful study of the political divisions of the earth, Dr A. Oppel has come to the conclusion that about 1,700,000 square miles are uninhabited or ownerless, about 5,000,000 square miles more without settled government, and the remaining 45,000,000 square miles are occupied by definite states He recognises seventy-five such states, but most of them are of such insignificant superficial extent that the eighteen largest make up 87 per cent of the whole area

FLIES AND DISEASE GERMS

AS we become more intimately acquainted with the nature of pathogenic micro-organisms, the manner in which their distribution takes place also becomes more intelligible For several years past, through researches made by Grassi, Cattani, and Tizzoni, it has been known that flies are capable of disseminating cholera bacteria These authors placed minute quantities of these bacilli on to the bodies of flies and found that after carefully preserving them under a glass shade in diffused daylight for an hour and a half and longer, when introduced into sterile culture media these flies gave rise to typical cholera growths These results have quite recently been confirmed by Simmonds Further experiments on the part played by flies in the propagation of disease germs have been made by Celli, who *fed* flies with the sputum from phthisical patients, also with pure cultivations of the typhoid bacillus, of anthrax, and other organisms The particular microbes experimented with were afterwards demonstrated in the excreta of these flies, partly by microscopic examination and partly by direct inoculation into animals The latter method was especially successful in the case of the anthrax and tubercle bacilli. A paper which has just appeared by Sawtschenko in the *Centralblatt fur Bakteriologie*, vol xii. p 893 ("Die Beziehung der Fliegen zur Verbreitung der Cholera") contains an account of some experiments which the author has made on the fate of cholera bacilli when introduced into flies. The flies used in these investigations were (1) the common small house-fly and (2) a much larger variety, which, from the description given, would seem to answer to our so-called "blue-bottle fly" It was further marked by its rapid flight, its rare occurrence within doors, by feeding on all manner of decaying substances, besides being frequently found on articles of food of all kinds These flies were placed in shallow dishes containing a few drops of broth infected with cholera bacilli, after which they were removed and fed on raw meat or sterile broth In some cases the excrements of cholera patients were substituted for the cholera cultures It would appear very difficult to keep flies alive in captivity, for the healthy as well as those experimented upon died in nearly all cases after twenty-four hours, in only very few instances was it possible to preserve them four days. Not only were the excreta of the flies carefully examined for cholera bacilli, but in many cases the whole contents of the abdominal cavity were removed with all the proper antiseptic precautions, and inoculated into culture tubes This latter practice was adopted in order to satisfactorily dispose of all suggestion of the presence of cholera germs in the excreta being due to their accidental contamination from the feet of the flies themselves In all cases cholera bacilli were found, both in the alimentary tract and in the flies' excreta Moreover, guinea pigs inoculated with cultivations of cholera microbes obtained from the former died quite as rapidly as when inoculated with ordinary cholera cultures, thus showing that their virulence had not been impaired through residence in the fly's body In the intestinal tract of those flies fed with cholera excreta, not only were cholera bacilli found, but also other organisms resembling the vibrio Metschnikowi Gamaleia, and which on inoculation into guinea pigs and pigeons killed them in twenty four hours Similar results were obtained when the vibrio was separated out directly from the cholera excreta and inoculated into these animals Thus in this case also the virulence of the organism had undergone no abatement during its sojourn in the fly's alimentary tract, thus fully confirming similar results with other organisms obtained by Celli Sometimes enormous numbers of cholera bacilli were found in the alimentary tract of flies after seventy two hours, in spite of their having been fed after the first infection with nothing but sterile broth, with the object, if possible, of washing out the bacilli Sawtschenko makes the alarming suggestion that the bacilli may very possibly be able, under suitable conditions of temperature and nourishment, to multiply within the bodies of flies, in which case the latter must not only be regarded as dangerous carriers of infection, but as a hot-bed for the preservation and further multiplication of cholera bacilli

SCIENTIFIC SERIALS

American Journal of Science, March —The specific heat of liquid ammonia, by C Ludeking and J E Starr The liquid ammonia used in the experiments was found to contain 0 3 per cent of moisture, and on spontaneous evaporation to leave only a trace of residue The specific heat was measured by Regnault's method, the liquid being enclosed in a steel tube of 16 122 cc capacity, stoppered by a steel screw The mean value for the specific heat deduced from two series of experiments was 0 8857. —A short cycle in weather, by James P Hall If a diagram is drawn exhibiting the changes of daily mean temperature in New York city for a few months it will be discovered that these fluctuations occur every three or four days, on an average, but that some have much greater amplitude than others In the course of four weeks, perhaps, there will be only two or three conspicuous rises and falls Upon further scrutiny there will be observed a tendency in these more prominent features of the curve to repeat themselves at intervals of about 27 days That these and kindred oscillations in New York city are, in the main, representative of temperature changes over the greater part of the United States becomes evident on comparing temperature curves taken at Utah, St Paul, St Louis, and New York respectively A conspicuous rise of temperature at New York is apt to be a day or two behind that at St Louis, fully two days behind St Paul, and sometimes nearly a week behind Utah Mr Hall attempts to find a relation between this 27-day period and the sun's rotation, which takes place in about the same time —Kilauea in August, 1892, by Frank S Dodge The chief object of interest on the floor of Kilauea was the lava lake of Halema'uma'u, whose surface was found to measure 12 1 acres, which is much larger than any lake in recent years The lake is nearly circular in form, its longest diameter being 860 feet, and the shortest 800 feet The lava was about three feet below the rim on an average Frequent breaks occurred in the rim, from which large flows took place, in some cases covering several acres of the floor One large flow on the night of August 25th covered about one-third of the floor, and raised its level from one to four feet The lake was at times very active, with fountains playing over its surface in every direction, as many as fifteen being counted at one time by a careful observer. Small fountains were always to be seen in some locality, and the whole surface was marked by long irregular seams always in motion —Also papers by Messrs Chamberlin, Darton, Upham, and Winslow, and the Address delivered

before the American Metrological Society, December 30, 1892, by the President, Dr B A Gould

Bulletin de l'Académie Royale de Belgique, No 1, 1893 —On Poisson's law of large numbers, by P Mansion — On the influence of time upon the mode of formation of the meniscus at the temperature of transformation, by P de Heen If a sealed glass tube is partly filled with carbonic acid in the liquid state, and then heated slightly above the critical temperature, the meniscus forming the surface of separation gradually disappears until all the liquid is converted into vapour But for some time after this has taken place the density of the substance above the surface of separation is less than that below, as may be seen by the appearance of a generating line If the tube is withdrawn from the water bath at 33°, the formation of a small cloud is observed in the region where the meniscus disappeared, and the latter is gradually reproduced in the same place The phenomenon is not observed when the tube is inverted, or kept at 33° for 24 hours, thus allowing the two constituents to mix by diffusion —Two experimental verifications relating to crystalline refraction by J Verschaffelt —Crystallographic note on the axinite of Quenast, by A Franck

SOCIETIES AND ACADEMIES

LONDON

Physical Society, February 24 —Prof. A W Rucker, F R S, President, in the chair —Mr Everett, junr, read a paper on a new and handy focometer, by Prof J D Everett, F R S, and exhibited the instrument described The focometer is constructed on the principle of the "Lazy tongs," and so arranged that the distance between the object and screen can be varied whilst the lens is automatically kept midway between the two This gives sharpest definition and the simplest calculation The lazy tongs has eight cells, formed by eighteen bars 13" × ¾" × ¼", and is capable of being extended to about eight feet, or closed up to about one foot Brass pins about ¼" diameter and one and half inches long project upward from each joint in the middle row, and serve as supports for clips carrying the lens, object, and screen The instrument can be used for any lens whose focal length lies between twenty-four inches and one inch or less Details respecting the most appropriate objects and screens, and practical hints about the working of the instrument are given in the paper The question of what accuracy is obtainable is also briefly discussed —Mr A Hilger thought the instrument was too flexible to be used for accurate work — Mr. Blakesley suggested that by using a plane mirror close behind the lens the light would be reflected back, and the length of the focometer could be reduced by one-half —The President thought Prof Everett never intended the instrument to compete, as regards accuracy, with the elaborate and expensive apparatus now used, but nevertheless the focometer was a very valuable one, especially for students' work, and was particularly well adapted to impress upon them the facts relating to conjugate foci —A paper on a hydrodynamical proof of the equations of motion of a perforated solid, with applications to the motion of a fine framework in circulating liquids, by G H Bryan, M.A., was read by Dr C V Burton The object of the paper, which is a mathematical one, is to show how the equations may be deduced directly from the pressure-equation of hydrodynamics, without having recourse to the laborious method of "ignoration" of co ordinates The results are applied to determine the motion of a light framework of wires When the framework has a single aperture it is shown that no force produces motion in its own direction, and no couple produces rotation about its own axis In the case of a fine massless circular ring the direction of whose axis is taken as the axis of x, a constant force along the axis of y produces uniform rotation about the axis of z, and a constant couple about the axis of y produces uniform translation along the axis of z. In conclusion the author states that the results might be made to furnish mechanical explanations of certain physical phenomena. The President said the author had done good service by attacking the difficult problem by elementary methods —Dr. C V Burton made a communication on plane and spherical sound-waves of finite amplitude The first part of the paper refers to plane waves This subject had been considered by Riemann, but Lord Rayleigh had criticised that part of Riemann's work, where it is held that a state of motion is possible in which the fluid is divided into two parts by a surface of discontinuity propagating itself with constant velocity, all the fluid on one side of the surface of discontinuity being in one uniform condition as to density and velocity, and on the other side a second uniform condition in the same respects After quoting Lord Rayleigh's criticisms the author shows that the same objection applies when the velocity and density on either side of the surface may vary continuously in the direction of propagation, and the velocity of propagation of the surface of discontinuity is also allowed to vary In each case the assumed motion violates the condition of energy, and can only exist under that special law of pressure for which progressive waves are of accurately permanent type Inquiry is then made as to what becomes of waves of finite amplitude after discontinuity sets in (which condition must always occur with plane waves), in the course of which it is pointed out that the front of an air disturbance produced by a moving source which starts impulsively, travels faster than the source, even if the velocity of the source exceeds that of feeble sounds A mechanical analogy suggests that a dissipative production of heat takes place when discontinuity occurs In all cases Riemann had assumed that the pressure is a function of density only according to the isothermal or adiabatic law, and thus failed to take account of any heat which may be dissipatively produced Part II of the paper deals with spherical waves, and contains a mathematical investigation into the conditions under which the motion remains continuous or becomes discontinuous The criterion is found in the finitude or infinitude of a certain integral It is shown that if viscosity be neglected, then under any practically possible law of pressure the motion in spherical sound waves always becomes discontinuous. For waves diverging in four dimensions some cases occur in which the motion remains continuous The general question of spherical sound waves of finite amplitude is then treated of, and the paper concludes with a method of finding the differential equation of an infinitesimal spherical disturbance which is superposed on a purely radial steady motion Prof A S Herschel inquired whether the nature of the solution for plane waves of finite amplitude was similar to that for ordinary waves-motion? In the latter case everything depended on the instantaneous impulses, for these alone determined the nature of the wave The President said Mr Boys' experiments on flying bullets might have some bearing on Dr Burton's paper If the conclusions there stated were correct, then the velocity of the air in front of a bullet should be greater than that of the bullet, even if the latter was travelling faster than ordinary sound waves He now asked Mr Boys if his photographs gave any evidence of this Mr Boys said the fact that the photographs showed disturbances in front of the bullet proved that the disturbance travelled faster In one case where a large bullet was moving at a velocity rather greater than that of ordinary sound in the medium, the front of the disturbance was about half an inch in advance of the bullet In another instance where the bullet was smaller and the velocity greater, the distance which the disturbance was in advance of the bullet was somewhat less In all cases, even when the velocity of the bullet was four times that of sound, the character of the effects remained the same Dr Burton replied to the points raised

March 10 —Prof A W Rücker, F R S., President, in the chair —Dr C V Burton read a paper on the applicability of Lagrange's equations of motion to a general class of problems, with special reference to the motion of a perforated solid in a liquid The paper shows that to apply Lagrange's equations it is not always necessary that the configuration of the system should be completely determined by the co ordinates, but that under certain conditions one need not consider whether the whole configuration is determined by the nature of the known co ordinates, nor inquire what is the nature of the ignored co ordinates. The result, which is arrived at by the aid of the "principle of least action," and the investigation given in Thomson and Tait's "Natural Philosophy," second edition, part I § 327, is expressed by the following proposition :—If the kinetic energy of a material system can be expressed as a homogeneous quadratic function of certain generalised velocities $\dot\psi$, $\dot\phi$, . . . only, the co-efficients being functions of ψ, ϕ, . . . only, and if this remains always true so long as the only forces and impulses acting are of types corresponding to ψ, ϕ, . . . , the equations of motion for the co-ordinates ψ, ϕ, . . . may be written down from this expression for the energy in accord

ance with the Lagrangian rule The author then applies the proposition to the case of a perforated solid with liquid irrotationally circulating through the apertures, and shows how it may be extended to any number of perforated solids Incidentally it is mentioned that in equations (10)v and (10)vi (Thomson and Tait, part 1 § 327) the sign of $\partial\nu/\partial\psi$ should be reversed A difficulty which arises in applying the result of § 319, example G, in the same work, to the motion of solids through liquids is also referred to A criticism by Mr A B Basset on Mr. Bryan's recent paper and also on Dr Burton's paper was read by Mr Elder Mr Basset regards the process employed by Mr Bryan in obtaining the equations of motion as a distinctly retrograde step, and thinks the most scientific way of dealing with dynamical problems is to avoid the unnecessary introduction of any unknown reactions The advantages of the theory of the impulse are described by Mr Basset, and the parts which require care when applying the theory to cyclic irrotational motion pointed out Comparisons are then made as regards simplicity, between the different methods of treating the subject which have been used by Mr Bryan, Prof Lamb, and himself With reference to Dr Burton's paper he thinks it will tend to complicate rather than elucidate the subject An account of how Lagrange's original equations had been modified by Hamilton, Routh, and himself is given at some length, and the advantages and power of the mixed transformation, which he had developed are pointed out Prof Henrici said he agreed with Mr Basset in preferring the more general method, but thought the independent treatment of special problems as given by Mr Bryan and Dr Burton, very desirable —Dr Burton in reply said he concurred with Mr Basset on some points, but thought it decidedly advantageous to look at problems from different points of view The investigation he (Dr Burton) had given was applicable to any number of solids, and on the whole simpler than Mr Basset's The President pointed out that no attack had been made on the validity or accuracy of Mr Bryan's or Dr Burton's work As to simplicity of the various methods, different opinions might be expected to exist He himself thought it very desirable that such problems should be approached from different sides —Prof G M Minchin read a paper on the magnetic field of a circular current —A paper on the differental equation of electric flow, by Mr T. H Blakesley, was postponed

Royal Microscopical Society, February 15 —Mr A D Michael, President, in the chair —Mr E. M Nelson exhibited a microscope made by Messrs Watson, to which several novelties had been applied —Mr J W Lovibond read a note on the measurement of direct light by means of the tintometer Mr Nelson said that the wonderful results obtained by the author by means of his instrument were perfectly surprising It was, in fact, equal to discovering differences down to millionths of a tint, having had the pleasure of seeing and using it he soon found that there was a very decided difference in the colour sensation of his own eyes, which until that time he had never suspected It had done such marvels when applied to macroscopic purposes that he did not doubt it would do much also when applied to microscopic studies — Mr G. S Marriott's form of mounting and dissecting stand was exhibited and described by Mr Nelson —Mr T. F Smith read a paper on the use of monochromatic yellow light in photomicrography —Prof F J. Bell read a letter from Dr H. G Piffard bearing on the same subject.—A paper descriptive of two species of rotifers by Mr J Hood was also read by Prof Bell.—Mr Nelson read a paper on the chromatic curves of microscope objectives.—Dr W H. Dallinger said that Mr. Nelson was quite right in pointing out that unless we could devise means for employing the shorter wave-lengths of the spectrum we had approached very near to the limits of visual possibility with the means at present at our disposal. But as to the belief expressed by Mr Nelson that glass such as was used in our objectives was not transparent to the higher violet and ultra violet rays, and to some extent also to the blue, it must be remarked that there could be no doubt but that the figures of the lenses had much to do with this, it led them up to the consideration of the question as to what would be a suitable form and medium for lenses capable of allowing the higher rays to be used There could be little doubt that all who believed in a future advantage in the use of monochromatic light foresaw that there must be lenses specially prepared for its use They all knew now that they had reached the limit of possibility so far as present materials were concerned, for if a lens could be made with a N A of 2 00, there was no liquid medium to use with it, because no medium so employed would be tolerant of living or even organic substances If, therefore, they could by some means use shortened wave lengths, they would have accomplished something extremely useful —The rest of the agenda was postponed in consequence of the lateness of the hour

Entomological Society, March 8 —Capt Elwes, President, in the chair —Herr Pastor Wallengren, of Farhult, bei Hogands Sweden, and Herr Hofrath Dr Carl Brunner Von Wattenwyl, of Vienna, were elected Honorary Fellows of the Society to fill the vacancies in the list of Honorary Fellows caused by the deaths of Prof Hermann C C Burmeister and Dr Carl August Dohrn —Dr D Sharp, F R S, exhibited a fine species of *Enoplotrupes* from Siam, which was believed to be new, and which he thought Mr. Lewis intended to describe under the name of *E principalis* This insect has great power of making a noise, and the female seemed in this respect to surpass the male —Mr W F H. Blandford said he wished to supplement the remarks which he made at the meeting of the Society on February 8 last, on the larva of *Rhynchophorus* He stated that he had since found that only the first seven pairs of abdominal stigmata were rudimentary The posterior pair were well developed and displaced on to the dorsum of their segment, which was thickly chitinised, and bore a deep depression, on the margins of which the spiracles were situated He added that dissection showed that the posterior pair were the principal agents of respiration —Mr W H B Fletcher exhibited a long series of bred *Zygæna lonicerae* and *Z trifolii*, hybrids of the first generation with the following parentage —*Z lonicerae*, male—*Z trifolii*, female, *Z trifolii*, male—*Z lonicerae*, female, also hybrids of the second generation between *Z trifolii*—hybrid, and *Z lonicerae*—hybrid He stated that many of the hybrids were larger than the parent species, and that some hybrids between *Z lonicerae* and *Z filipendulae* were the largest he had ever seen He added that *Zygæna meliloti* would not hybridise with *Z lonicerae*, *Z trifolii* or *Z filipendulae* —Mr F W Frohawk exhibited a bred series of *Vanessa atalanta*, showing the amount of variation in the red band on the fore wings of the female —Capt Elwes exhibited a large number of specimens of *Chrysophanus phlæas* from various places in Europe, Asia, and North America, with the object of showing that the species is scarcely affected by variations of temperature, which was contrary to the opinion expressed by Mr Merrifield in his recent paper on the effects of temperature on colouring Mr McLachlan, F R S, Mr A J. Chitty, Mr Bethune Baker, Mr Tutt, and Mr Barrett, took part in the discussion which ensued —Dr Sharp read a paper entitled "On Stridulating Ants" He said that examination revealed the existence in ants of the most perfect stridulating or sound producing organs yet discovered in insects, which are situated on the 2nd and 3rd segments of the abdomen of certain species He was of opinion that the structures which Sir John Lubbock thought might be stridulating organs in *Lasius flavus* were not really such, but merely a portion of the general sculpture of the surface Dr Sharp said that the sounds produced were of the greatest delicacy, and Mr Goss had been in communication with Mr W H. Preece, F R S., with the view of ascertaining whether the microphone would assist the human ear in the detection of sounds produced by ants. Mr Preece had stated that the microphone did not magnify, but merely reproduced sound, and that the only sounds made by ants which he had been able to detect by means of the instrument were due to the mechanical disturbance produced by the motion of the insects over the microphone. A long discussion ensued, in which the President, Canon Fowler, and Messrs Champion, McLachlan, Goss, Hampson, Barrett, Burns, and Jacoby, took part.—Mr C. J Gahan read a paper entitled "Notes on the Longicornia of Australia and Tasmania, Part I, including a list of the species collected by Mr. J J Walker, R N"

Geological Society, March 8 —W H Hudleston, F R S, President, in the chair —The following communications were read —On the occurrence of boulders and pebbles from the glacial drift in gravels south of the Thames, by Horace W Monckton North of the Thames near London, the glacial drift consists largely of gravel, which is characterised by an abundance of pebbles of red quartzite and boulders of quartz and igneous

rock With the exception of very rare boulders of quartz, the hill and valley gravels of the greater part of Kent, Surrey, and Berkshire are entirely free from these materials The author points out that the river Thames is not, however, the actual southern boundary of the distribution of these glacial drift pebbles and boulders, though the number of localities where they are found in gravels south of that river is few The author describes or mentions several, of which the following are the most important —Tilehurst, Reading, Sonning, Bisham at 351 feet above the sea, Maidenhead, Kingston, Wimbledon, and Dartford Heath —On the plateau-gravel south of Reading, by O A Shrubsole This paper contains observations on the gravel of the Easthampstead Yately plateau The constituent elements of the gravel are described, and the author notes pebbles of non local material near Cæsar's Camp, Easthampstead, on the Finchampstead Ridges, and at Gallows Tree Pit at the summit of the Chobham Ridges plateau He mentions instances of stones from the gravel of the plateau (described in the paper) which may bear marks of human workmanship He furthermore argues that the inclusion of pebbles of non-local origin in the gravels may be due to submergence of the plateau up to a height of at least 400 feet above present sea-level, and cites other facts in support of this suggestion He concludes that the precise age of the gravel can only be more or less of a guess, until the mode of its formation has been definitely ascertained The reading of these papers was followed by a discussion, in which the President, Dr Hicks, Mr J A Brown, Prof J F Blake, Mr W J L Abbott, Mr Herries, Mr Monckton, and Mr Shrubsole took part —A fossiliferous pleistocene deposit at Stone, on the Hampshire Coast, by Clement Reid (Communicated by permission of the Director-General of the Geological Survey) This is practically a supplement to a paper on the pleistocene deposits of the Sussex coast, that appeared in the last volume of the *Quarterly Journal* An equivalent of the mud deposit of Selsey has now been discovered about twenty miles farther west, and from it have been obtained elephant remains, and some mollusca and plants like those found at Selsey Among the plants is a South European maple Some remarks were made on the paper by the President, Dr Hicks, and Mr W. J L Abbott, and the author replied

Zoological Society, March 14 —Sir W H Fowler, F R S , President, in the chair —The Secretary read a report on the additions that had been made to the Society's menagerie during the month of February, 1893, and called attention to two terrapins procured on Okinawa Shima or Great Loochoo Island by Mr P. A Holst, and kindly presented by that gentleman Mr Boulenger had determined these tortoises as being Spengler's terrapin (*Nicoria spengleri*) —Mr O. Thomas exhibited and made remarks on a rare antelope (*Nanotragus livingstonianus*) from Northern Zululand —Dr Forsyth-Major exhibited and made remarks on a tooth of *Orycteropus* from the Upper Miocene of Maragha, Persia, which he referred to *O. gaudryi*, of the Upper Miocene of Samos. Drawings of the remains of the latter were exhibited, as well as a photograph of a femur of a struthious bird from the same deposit in Samos The habitats of *Struthio* and *Orycteropus* were thus shown to have been essentially identical in past times, as in the present Therefore the general conclusions to be drawn from their geographical distribution would apply equally to both —Mr Oldfield Thomas made some suggestions for the more definite use of the word "type" and its compounds, as denoting specimens of a greater or less degree of authenticity —Mr P L Sclater, F R S , pointed out the characters of a new African monkey of the genus *Cercopithecus*; and took the opportunity of giving a list of the species of this genus known to him, altogether 31 in number, together with remarks on their exact localities.—Prof. F Jeffrey Bell read a paper on *Odontaster* and the allied and synonymous genera of the Asteroidea.—Mr A. D. Michael read a paper upon a new species (and genus) of *Acarus* found in Cornwall. The creature in question, which it was proposed to call *Lentungula algivorans*, was found in some quantity on a green alga (*Cladophora fracta*) near the Land's End It was a minute creature belonging to the family Tyroglyphidæ, the remarkable feature about it being that, whereas the two hind pairs of legs were terminated by a hard and powerful single claw (which claw sprang from the end of the tarsus), the two front pairs had the tarsus itself hardened and curved strongly downward, forming clinging and walking-organs, while from the side of the tarsus sprang a long peduncle, flexible in all directions at the will of the creature, and bearing an exceedingly minute claw This apparatus was not used in climbing, but had become wholly tactile Such an arrangement was previously unknown in the Acarina.—Prof. Howes described some abnormal vertebræ of certain Ranidæ (*Rana catesbiana*, *R esculenta*, and *R macrodon*) in which the so called "atlas" possessed transverse processes and trans-atlantal nerves Prof Howes discussed the bearings of these specimens on the morphology of the parts, deducing the argument that the first vertebra of the Amphibia is probably to be regarded as a representative of at least two vertebræ, of which the formative blastema has become merged in the occiput in the Amniota The author also described a stage in the development of the urostyle of *Pelobates*, and showed that, in this Batrachian, there is a provisional inversion in the order of development of the parts of the urostyle and precoccygeal vertebræ He also described a reduced hind limb of *Salamandra maculosa*, in which the reduction and fusion of the parts remaining realised the condition normal for the Urodele limb with numerically reduced digits

Royal Meteorological Society, March 15 —Dr C Theodore Williams, President, in the chair —Mr Shelford Bidwell, F R S , delivered a lecture on some meteorological problems, which was illustrated with numerous photographs and experiments The lecturer said that one of the oldest and still unsolved problems of meteorology relates to the origin of atmospheric electricity Many possible sources have been suggested, among them being the evaporation of water and the friction of dust laden air against the earth's surface Having granted some sufficient source of electrification, Mr. Bidwell said that it is not difficult to account for the ordinary phenomena of thunder storms. Photography has shown that the lightning flash of the artists, formed of a number of perfectly straight lines arranged in a zig zag, has no resemblance to anything in nature The normal or typical flash is like the ordinary spark discharge of an electrical machine, it follows a sinuous course, strikingly similar to that of a river as shown upon a map The several variations from the normal type all have their counterparts in the forms taken by the machine spark under different conditions, and the known properties of these artificial discharges may be assumed to afford some indication as to the nature of the corresponding natural flashes Thus, for example, the ramified or branched flash, from which no doubt the dreaded "fork lightning" derives its name, is probably one of the most harmless forms of discharge. Ever since the time of Franklin it has been customary to employ lightning rods for the protection of important buildings According to Dr Oliver Lodge these are of no use in the case of an "impulsive rush" discharge, which, however, is of comparatively rare occurrence. Lightning conductors, however well constructed, cannot therefore be depended upon to afford perfect immunity from risk. Mr Preece is of opinion that the "impulsive rush," though easily producible in the laboratory, never occurs in nature Mr Bidwell made some remarks as to the duration of a lightning flash and the causes of its proverbial quiver, and suggested an explanation of the characteristic darkness of thunder clouds, and of the large rain-drops which fall during a thunder shower. The lecturer concluded with some observations concerning the probable cause of sunset colours, which he attributed to the presence of minute particles of dust in the air

OXFORD

University Junior Scientific Club, March 1 —The President in the chair —Mr C H. H. Walker exhibited some compounds of the rare metals from the collection of the late Duke of Marlborough, which had been presented to the University by the Duchess.—Among the papers read was one by Dr Leonard Hill on cortical localisation.

March 10 —The President in the chair —Adjourned discussion on Dr. L. E Hill's paper on cortical localisation

CAMBRIDGE.

Philosophical Society, February 27 —Prof. T. McK Hughes, President, in the chair.—The following communications were made to the Society:—On the histology of the blood of rabbits which have been rendered immune to anthrax, by Lim Boon Keng. The research was conducted in the pathological laboratory of the University. The rabbits were rendered

immune to anthrax by inoculation with the lymph and blood of frogs which had been subjected to various treatment. Previous observers had succeeded in conferring immunity with the use of similar substances. The object of the investigation, however, was to ascertain the changes in the character and relative number of the white cells of the blood after protective vaccination and after the introduction of virulent anthrax. From four to several hours after the injection of the vaccine a great increase in the number of the white cells is noticeable; and the most remarkable feature is the augmentation in number of the coarsely granular (eosinophile) corpuscles. The relative proportion in the numbers of the different varieties of cells is therefore altered, so that instead of forming only from 2 to 4 per cent of the total number of white cells, the eosinophile corpuscles now constitute about 10 to 25 per cent. This increase persists only a short time, and on the third day the cells may have returned to a normal condition; and at this stage hyaline cells ingesting granular cells may be detected in numbers in certain localities. Although the blood has thus apparently returned to the normal condition, it is found that the state of eosinophile leucocytosis is rapidly reproduced on the introduction of virulent anthrax. After inoculation with a virulent culture of the microbes, the eosinophile cells appear in great numbers, so that they may form 50 per cent of the white corpuscles, and in one instance an even higher percentage was found. These cells are not only increased in number but are also larger and have larger granules. Similar changes were observed in guinea pigs rendered immune by Dr. Haffkine to the common bacillus. In non-vaccinated rabbits the introduction of anthrax causes profound leucocytosis, but the cells are all very small and the eosinophile corpuscles are only slightly increased in number. General infection occurs in 36 to 48 hours rapidly followed by death.—On numerical variation in digits, in illustration of a principle of symmetry, by Mr. W. Bateson. An account was given of cases of variation in number of digits so occurring that the parts are symmetrical about a new axis in the limb. Of these the phenomena seen in the bones of a number of polydactyle cats were chiefly important. The normal hind foot of the cat has four toes, each bearing a claw retracted by an elastic ligament to a notch on the *external* side of the second phalanx. This circumstance differentiates digits formed as lefts from those formed as rights. As extra digits are added on the internal side of the limb the symmetry changes. The limb being taken as a *right*, the variations seen are as follows: (1) Hallux present, making five digits: index is then *intermediate between right and left*. (2) Six digits present, internal having two phalanges: the three external digits are then normal rights, *the next two are formed as lefts*; the internal, having a non-retractile claw, is indifferent. (3) Six digits present, internal having three fully formed phalanges and retractile claw: the three externals are then normal rights, and *the three internals are formed as left digits*, thus forming two groups in bilateral symmetry about an axis passing between the digits having the relations of index and medius. Several cases of "double hand" in Man form a similar progressive series, and analogous facts in other animals were instanced.

PARIS.

Academy of Sciences, March 13.—M. Lœwy in the chair.—On the true theory of waterspouts and tornadoes, with special reference to that of Lawrence, Massachusetts, by M. H. Faye. The tornado which ravaged the town of Lawrence on July 26, 1891, was observed to descend to the earth and reascend four times during its passage over a tract of country seventeen miles long. After each temporary ascent to the clouds no effect was produced on the land just below. This fact tends to confirm M. Faye's theory, according to which tornadoes, waterspouts, and cyclones have their origin not in hot convection currents from the soil, but in disturbances in the higher strata of the atmosphere. The observed cases of upward suction of heavy objects are explained as effects of the reflection of downward currents by the soil.—On an electric furnace, by MM. Henri Moissan and Jules Violle (see "Notes").—The pancreas and the nervous centres controlling the glycæmic function; experiments tending to exhibit the parts played by each of these agents respectively in the formation of glycose by the liver, by MM. A. Chauveau and M. Kaufmann.—Description of a new species of bilateral Holothuria (*Georisia ornata*), by M. Edm. and Perrier.—On the observation of the shadows of Jupiter's satellites, by M. J. J. Landerer.—On the formulæ for annual aberration, by M. Gaillot.—On the transcendentals defined by the differential equations of the second order, by M. Paul Painlevé.—A theorem of infinitesimal geometry, by M. G. Kœnigs.—New semicircular interference fringes, by M. G. Meslin.—Photography of certain phenomena furnished by combinations of gratings, by M. Izarn. On placing a lens with large radius of curvature upon a grating, broad rings, concentric with the Newton's rings observed at the same time, were seen and fixed photographically by means of a layer of sensitised gelatine poured over the lens. On placing one photographic copy of a grating upon another of the same grating, a series of more or less rectilinear fringes was observed, running on the whole transversely to the rulings. A similar phenomenon is described by Brewster in the *Philosophical Magazine* of 1856.—Photographic properties of cerium salts, by MM. Auguste and Louis Lumière. Cerium gives rise to two principal types of salts, cerous and ceric. The former are very stable, the latter are easily reduced, the organic salts being so easily reduced that they cannot be isolated. The best photographic results were obtained with ceric sulphate and nitrate. Paper was soaked in aqueous solutions of these salts and exposed to light under a transparency obtained from a negative. Where the light penetrated, the ceric salt was reduced and the paper changed colour. The image was developed by treating with some carbon compound of the aromatic series, forming an insoluble pigment with the unreduced ceric salt, and fixed by washing. In an acid solution the prints turned grey with phenol, green with aniline salts and orthotoluidine, brown with amidobenzoic acid, &c. The ceric salts are considerably more sensitive than the corresponding ferric and manganic salts.—Intense and rapid heating process by means of the electric current, by MM. Lagrange and Hoho. A bar of steel 1 cm. thick formed one electrode of a strong current passing through an electrolyte. The other electrode had a large surface. The heating was so rapid that, on breaking the current, the liquid suddenly cooling the bar was found to have imparted a brittle structure only to a superficial layer, the rest not having been heated (see also the *Bulletin* of the Belgian Academy).—On metallic osmium, by MM. A. Joly and M. Vèzes (see "Notes").—Researches on thallium; redetermination of its atomic weight, by M. Ch. Lepierre.—On the fluorides of zinc and cadmium, by M. Poulenc.—Quantitative determination of mercury in dilute solutions of sublimate, by M. Léo Vignon.—Alkaline polyphenolic phenates, by M. de Forcrand.—Isomerism of the amido-benzoic acids, by M. Oechsner de Coninck.—Action of carbonic oxide upon reduced hæmatine and upon hæmochromogen, by MM. H. Bertin Sans and J. Moitessier.—The toxic substance which produces tetanus results from the action of a soluble ferment produced by Nicolaier's bacillus, by MM. J. Courmont and H. Doyon.—Action of cold on visceral circulation, by M. E. Wertheimer.—On the affinities of the genus *Oreosoma*, Cuvier, by M. Léon Vaillant.—On a new mineral species from Bamle, Norway, by M. Leopold Michel.—On a chloritoid schist of the Carpathians, by MM. L. Duparc and L. Mrazec.

BERLIN.

Physical Society, February 10.—Prof. du Bois Reymond, President, in the chair.—Dr. Raps exhibited and explained a photographic registration apparatus which he had constructed, primarily for the purpose of obtaining a permanent record of the readings of the voltmeter at central electric stations, but which could also be used for meteorological and physical purposes. The principle of the instrument is as follows. Parallel rays from an incandescent lamp are made to fall on a narrow slit in front of which is the recording needle of the voltmeter or other instrument. The shadow of this needle then causes a white break in the dark image of the slit as cast on to sensitised paper. The paper is moved forward by clockwork, and the hour intervals are simultaneously printed on it by means of a rotating glass disc. The apparatus is arranged so as not to necessitate any dark chamber for its use, or for the manipulation of the sensitised paper. Prof. Kundt exhibited as lantern pictures two photographs of spectra, of which one showed very marked colours from the red to the violet end, and a photograph of some green twigs with red berries on them. The three photographs had been taken by Lippmann in Paris, and sent to Prof. von Helmholtz. Prof. Kundt then gave an account of some experiments carried on in his laboratory on the influence of temperature on electromagnetic rotation of light in iron, cobalt, and nickel. Trustworthy results

could only be obtained with nickel owing to the oxidation of the thin films of iron and cobalt at high temperatures (300°) With nickel a rise of temperature produced at first no change in the rotation, but above 300° a sudden diminution was observed which rapidly became progressively greater, the relationship of the diminution of rotation to the increase of temperature was the same as for the magnetic susceptibility of the metal

February 24 —Prof Schwalbe, President, in the chair —Dr Raps demonstrated his latest and most improved form of automatic gas pump for blood gas analysis Dr Richarz developed, in accordance with the kinetic theory of gases, and under certain assumptions as to the constitution of solid bodies, the formulæ for the law of Dulong and Petit The formulæ furnished an explanation of the divergence from this law which is exhibited by certain elements Dr Gross spoke on the laws of energy, proceeding with his criticism of Clausius's views, stating that he regarded Clausius's second law as unproved, and finally coming to the conclusion that entropy is constant

Physiological Society, February 17 —Prof Zuntz, President, in the chair —Dr von Noorden gave an account of four experiments on nutrition carried out under his direction on men The first established the fact that nitrogenous waste, as in the case of diabetes, even when excess of proteid is given, can be most definitely lessened by the ingestion of large quantities of carbohydrates Fats cannot take the place of carbohydrates in the above The second showed that when carbohydrates are given in increasing quantities over a prolonged period to a person in nitrogenous and calorimetric equilibrium, they lead for the most part to a storage of fat (95 per cent), and to a less extent of proteid (5 per cent) The speaker expressed the opinion that this proteid is laid on in the living cell as a sort of non living reserve proteid The third set of experiments showed that when the food of a fat person is diminished down to the requirements of a seven- to ten-year old child, then any increase of its proteid constituents leads to a storage of proteid with a simultaneously considerable loss of fat Experiments on the respiratory interchange of the person experimented upon showed that the intake of oxygen had been reduced to a minimum and that the respiratory quotient was 0 7 The last set of experiments, made on a gouty patient, showed that with a constant diet, the ratio of intake and output of nitrogen was very variable, at one time a large amount of nitrogen being retained in the body while at another time much more nitrogen was excreted than was given with the food

AMSTERDAM

Royal Academy of Sciences, February 25 —Prof van de Sande Bakhuyzen in the chair —Mr Weber read a paper on the origin of the mammalian hair The author gave a *résumé* of his earlier researches on the scales of mammals, which led him to the hypothesis that the primitive mammals were covered with true scales A weak point in this hypothesis was, that except Manis and the Dasypodidæ, generally the tail alone is scaled The author showed, however, that according to the researches of H. de Meyere, the arrangement of the hairs on scaleless skin of numerous mammals is the same as that in scaled parts Both are placed in alternating groups The author believed that primitive mammals were covered with scales, and that few and small hairs were placed behind them On acquiring a constant temperature the hair coat got denser as a good protection from loss of heat This was the cause of the reduction of the scales, and also mostly of their final loss —Mr Lorentz dealt with the influence of the motion of the earth on the propagation of light in doubly refracting media In the September meeting the author communicated a simple form for the equations which determine the propagation of light in isotropic bodies, moving through the æther with a constant velocity p, the æther itself being supposed to remain at rest It is now shown how these formulæ are to be modified in the case of a crystallised medium, and to what consequences they lead, as to the motion of light, relatively to the ponderable matter The velocity of propagation of a *ray of light* (to be distinguished from that of the waves) is found to be $W = W_0 - \frac{p}{n^2} \cos \theta$, W_0 being the value for the same direction and for $p = o$, θ the angle between the ray and the velocity p, V the velocity of light *in vacuo*, and $n = \frac{V}{W_0}$ The course of reflected and refracted rays may be deduced from Huygens's principle or from the condition that $\int \frac{ds}{W}$ must be a minimum (ds being a linear element) Owing to the above value of W, the motion of the earth will neither affect the course of the rays nor the interference phenomena In this way some experimental results of Ketteler (*Astronomische Undulationstheorie*, pp 151–173, *Pogg Ann* Bd 147), and Mascart (*Ann de l'Ecole normale*, 2e série, t 1 pp 191–196) may be explained —Mr Kamerlingh Onnes gave the results of measurements of Dr Zeeman on the dispersion of Sissingh's magneto-optic difference of phase in Kerr's phenomenon The dispersion is contrary to the theory of Drude —He described further a new entoptical phenomenon found by Dr Zeeman in sighting a split, and communicated the results of the measurements of Dr de Vries on the variation of the ascension of capillary tubes for æther with the temperature from −102°C to the critical temperature 193° 6 The surface work plotted in function of temperature gives a curve turning the convex side to the axis of temperature and ending tangentially to it

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS —An Elementary Treatise on Pure Geometry J W Russell (Clarendon Press) —Comité International des Poids et Mesures, Quinzième Rapport (Paris, Gauthier Villars) —The Intelligence of Animals G W Purnell (Christchurch, N Z, Whitcombe and Tombs) —How to Improve the Physique "Medicus" (Stock) Handbook of Jamaica, 1893 (Stanford).—Modern Meteorology Dr F Waldo (Scott).—Gesammelte Abhandlungen über Pflanzen Physiologie J Sachs, Zweiter Band (Leipzig, Engelmann) —An Elementary Treatise on Modern Pure Geometry R Lachlan (Macmillan) —The Food of Plants A P Laurie (Macmillan) —Elements of Physiography Dr H Dickie (Collins).

PAMPHLETS —Ueber die Bestimmung der Geographischen Länge und Breite und der Drei Elemente des Erdmagnetismus, &c Dr H Fritsche (St Petersburg) —Diseases incident to Workpeople in Chemical and other Industries W Smith (Eyre and Spottiswoode).

SERIALS —Himmel und Erde Marz (Berlin, Paetel) —Revista Internazionale di Scienze Sociali e Discipline Ausiliarie, February (Roma) —Journal of the Chemical Society, March (Gurney and Jackson).—Annales de l'Observatoire de Moscou, deux série, vol 3, liv 1 (Moscou).—Medical Magazine, March (Southwood)—Botanische Jahrbucher, Fünfzehnter Band v Heft (Williams and Norgate).—Transactions of the Wagner Free Institute of Science of Philadelphia, vol 3, part 2 (Philadelphia)

CONTENTS.

THURSDAY, MARCH 30, 1893

ELECTROMAGNETIC WAVES

Electrical Papers. Two vols. By Oliver Heaviside. (London: Macmillan and Co., 1892.)

IN these two volumes the author has collected the papers on electrical subjects which he has from time to time contributed to the *Philosophical Magazine*, the *Philosophical Transactions*, the *Electrician*, and other technical journals. The result is a work of some eleven hundred closely printed octavo pages; that is to say, on a rough estimate, it contains in printed matter about half as much again as Maxwell's two volumes on Electricity and Magnetism, and considerably more than the two volumes of Thomson and Tait. When we add that the author brings into action freely (though with perfect mastery) some of the most elaborate weapons of mathematical physics, and that considerable passages are moreover written in a special condensed notation, it will be evident that the task of the reviewer is no easy one. All that we shall here attempt is to give a general idea of the nature of the book, with some reference to its more original features.

The first few articles are devoted to practical questions, such as duplex telegraphy, signalling with condensers, the best arrangement of Wheatstone's bridge, and so on. These are thoroughly readable, and, apart from their technical value, may be commended to mathematical students as containing interesting concrete applications of electrical theory. The rest of the book is partly a commentary on, and partly a development of, the latter part of Maxwell's treatise, and deals mainly with the propagation of electromagnetic effects in space and time. It is therefore closely connected with the theoretical work of Poynting and J. J. Thomson on the one hand, and with the practical investigations of Hertz and his followers on the other. At the present time there is no great difficulty in following in imagination the propagation of inductive effects from one conductor to another across the intervening space; and that this should be the case is due in no small degree to the labours of our author, for although probably few readers have been found to follow him step by step, yet many have admired the tenacity with which he attacks problem after problem bearing on his subject, and have gathered valuable ideas and suggestions from his exuberant pages.

One of the most noteworthy features in the author's theoretical work is the elimination of the "vector-potential" from Maxwell's equations of the electromagnetic field, with the result that the equations in question are obtained in a "duplex form" in which there is perfect symmetry as regards the parts played by the electric and the magnetic variables respectively, so that the equations are unaltered in form when a reciprocal substitution between the two sets of variables is made. The same simplification has been made independently by Hertz. It is of importance for this reason, that the vector-potential is to a certain extent indeterminate. This was indeed insisted upon by Maxwell himself, but, strange to say, he did not always remember his own warning, with the result that more than one most important passage of his great work is rendered needlessly obscure. Another function which the author seeks (we think rightly) to relegate to the position of a mere mathematical implement, without physical significance beyond the domain of electrostatics, is the electric potential. There is nothing paradoxical in this, for the original definition of this function postulates a state of equilibrium.

The last paper (but one) in the book forms a sort of crown to the whole. It is entitled "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field," and is reprinted from the *Philosophical Transactions* for 1892 (A). Unfortunately this paper is by far the hardest to read. Free use is made of the scalar and vector products of Hamilton, but the author is careful to give us his emphatic opinion that quaternions proper are unsuited to the purposes of mathematical physics. This courageous declaration will, we fear, cause a wicked joy in the hearts of many who have struggled in vain with these refractory symbols. For the special system of mathematical shorthand affected by Mr. Heaviside there is much to be said, but for our own part we should prefer to have papers which profess to give new and important results written in the more homely language of "Mr. Cartesian." Another prominent feature in this memoir is the frequent appeal to the principle of "continuity of energy," but this imposing phrase seems to mean nothing more nor less than Maxwell's negation of action at a distance. The author, indeed, takes care to explain that he does not countenance the notion of "identity of energy" which one prominent physicist has attempted to base on a well-known paper by Poynting. It is now generally recognised that the flux of energy in the electromagnetic field is indeterminate. In his treatment of induction in moving media, a very important but most difficult subject, the author is led to at least one definite conclusion of great interest, viz. the existence of a magnetic force acting on a body moved across the lines of electric induction, just as there is an electric force on a body moved across the lines of magnetic induction. This is in conformity with the duplex character of the fundamental equations already referred to. Finally, we must not omit to notice a somewhat startling proposal for a radical change in the system of electric and magnetic units. In the "rational" system advocated by our author, *one* line of force would emanate from a unit magnetic pole, instead of 4π such lines, so that the force between two poles m, m' at a distance r apart would be $mm'/4\pi r^2$ instead of mm'/r^2 as at present. The existing system is denounced as containing an absurdity of the same nature as if we were to define the unit area to be the area of a circle of unit diameter.

It remains to say a word or two about the style in which the book is written. It is exceedingly fluent, often discursive, and occasionally boisterous, as when the author, introducing the functions called zonal harmonics, remarks that "these are Murphy's *P*'s, *not prates*, but the functions invented by Murphy"; or again, when in his impatience of vector and other potential functions he gives utterance to the wish to "*murder the whole lot*." A more serious matter is that the papers in these volumes often overlap, whilst the frequent cross-

references make it difficult to detach any one from the rest, or to gather the substance of the author's speculations on any one part of his subject In the preface he tells us that he had been urged to publish not a reprint, but a systematic treatise It is, we think, greatly to be regretted that he has not found it possible to take this advice The labour of compression and of proper co-ordination would no doubt have been great, but it would have been amply repaid by the increased currency given to the author's views As it is, we fear that the fate of these weighty volumes will be that students of the stamp which Mr Heaviside would most wish to attract will turn over his pages, picking up a suggestion here and there, will then work out things in their own way, and finally return to the present treatise to ascertain how far their results have been anticipated And this is really matter for regret, for almost every page bears the impress of a vigorous and original mind, and we cannot doubt that the author's speculations would have exercised a considerable influence on the progress of electromagnetic theory, if it had not been for the disadvantageous form under which they are presented H L

THE GREAT SEA-SERPENT

The Great Sea-Serpent An Historical and Critical Treatise With Reports of 187 Appearances (including those of the Appendix), the Suppositions and Suggestions of Scientific and Non-scientific Persons, and the Author's Conclusions With 82 illustrations By A C Oudemans, Jzn Published by the Author, October, 1892 (London Luzac and Co)

IN a large, well-printed volume, Dr A C Oudemans, Jzn, publishes what he is pleased to call "an historical and critical treatise" about the "Great Sea-Serpent," with the reports of 187 appearances, the suppositions and suggestions of scientific and non-scientific persons, and the author's conclusions

It is impossible, however, to treat this laborious work as a scientific treatise, nor will the author, we trust, be vexed with us when we add that it is the very last form of a work that we would have expected from the pen of the learned Director of the Zoological Gardens at the Hague for when one gets by practise to know the utter worthlessness of the descriptions given by even well-educated persons of often the most easily diagnosed forms of life—and surely experience of this nature must often have come across Dr Oudemans's path—one cannot fail to regard as positively hopeless the reconciling of a mass of such crude observations as fill the pages of this book. The very trouble and no doubt anxiety caused by reading over such a pitiful series of records has to some extent affected the author, for he quotes as the motto for his volume the extremely sensible words of a very able biologist, whose chief fault it was not to leave a greater record of his wisdom for posterity, to the effect "That it is always unsafe to deny positively any phenomena that may be wholly or in part inexplicable," meaning thereby to deny a phenomenon because it cannot be explained, and then in the immediately following preface he compares himself to Chladni, who took the trouble to collect all the accounts concerning observations of "meteoric stones," and showed the immense number of *facts* that he had found out about them In this one word fact—*fact*—lies a great world of difference between Chladni's meteoric stones and Oudemans's sea-serpents The meteoric stones could be seen and handled, the sea-serpents "are very shy, and it is not advisable to approach them with a steamboat" "Instantaneous photographs of the animal will alone convince zoologists, while all their reports and pencil drawings will be received with a shrug of the shoulders", this latter sentence, which precedes the preface, makes one shudder at the amount of "reports and pencil drawings" contained in the six hundred following pages

And yet, perhaps, this work is not altogether without its value From the middle of the sixteenth century—when Olaus Magnus wrote about "a very large serpent of a length of upwards of 200 feet and twenty feet in diameter, which lived in rocks and holes near the shore of Bergin" —until this very present hour all sorts and manners of gigantic forms have been reported about by sailors and others, and even pencil drawings of them have been made, and the collecting together and printing of such a series of records forms as strange a chapter of the science known by the people as has ever made its appearance

There is but little necessity of insisting on the need of experience in seeing ere one can describe what is seen, nor on the need of a power of describing what one correctly sees so that the description may be applicable, nor need one wonder that such powers of seeing and describing were not to be found united in the many seagoing worthies whose extraordinary narratives crowd the pages of this volume But what are we to say about the capacity for belief to be found in the compiler of this work, who concludes his task by naming a form he has never seen, *Megophias megophias* (Raf) Oud, and further thinks that a Phylogenetic table, which he gives, "will in a practical manner show the rank which, in my opinion, sea-serpents occupy in the system of nature"?

This volume contains an account of the "literature" on the subject of sea-serpents, a detailed record of the various accounts and reports concerning observations of sea serpents chronologically arranged and thoroughly discussed, and criticisms on the papers written on the same subject, next the various explanations hitherto given, and lastly the author's own conclusions—these he divides into "fables, fictions, exaggerations and errors," and what he is pleased to call "facts" Among the fictions he regards the belief that the sea-serpent "casts its skin, as common snakes do, and that it is born on land", among the exaggerations that it has "a tail fully a hundred and fifty feet in length"! among the errors "that there are *two* species of sea-serpents, or that there are several species of them all belonging to the same genus", or that "it ever takes [mistakes] a boat for one of the other sex."

As to the *facts*, which may be—it is well to note—"*inferred from what is reported*," we find enumerated among them the external characters of the sea-serpent, its dimensions, form, and skin Of its internal characters "it is not astonishing that we don't know much," yet it is clear "that if the animal opens its mouth there

is an opportunity to learn something about its teeth, tongue, &c," and so we get a series of "inferred" facts about them. We have further details of its colours, sexual differences, a very full account of its "physiological characters," some of its "psychical characters," concluding with its enemies, its repose, its sleep, and its death

Enough has been written to prove that this volume is not without a certain amount of interest We have found it a rather troublesome task to read it through, but to open its pages at random one is sure to be arrested by some startling phase of belief or by some marvellous narration, and the first half of the book very certainly deserves to be described as a conscientious compilation It is written in most excellent English

PUBLIC HEALTH

A Treatise on Public Health and its Applications in Different European Countries By Albert Palmberg, M D, Medical Officer of Health for the County of Helsingfors in Finland Translated from the French edition, and the section on England edited by Arthur Newsholme, M D (Lond), D P H, Medical Officer of Health for Brighton (London Swan Sonnenschein and Co, 1893)

ALTHOUGH scarcely more than a year has elapsed since the issue of the Swedish edition of this work, translations of it have already appeared in French, English, and Spanish A book which within so short an interval has attained to such a pitch of popularity may be admitted to have practically established its claim to rank amongst the important contributions towards the literature of the subject with which it is concerned Extensive indeed as is the ground travelled over by the author, yet so ably has the material been handled, that we feel it to be a matter for regret that the writer was unable to deal with the hygienic administration of all, instead of a portion only, of the important European countries The sanitary administrations of England, Scotland, France, Germany, Austria, Sweden, and Finland are detailed, but the description of the Public Health service of Russia, Denmark, Norway, Holland, and Italy is omitted Not having visited these countries, and studied the subject by a personal inquiry on the spot, Dr Palmberg very wisely preferred not to deal with them at all, rather than run the risk of making inexact statements concerning them

In treating of the various countries, the plan which the writer has followed has been first to give a brief summary of the sanitary laws in force, and then to describe in detail the methods adopted in the capital towns for carrying out these regulations Of all countries England claims the largest share of attention, Dr Palmberg assigning to her the chief place amongst the nations for the excellence of her Public Health administration, and the care with which all matters connected with hygiene are attended to The chapter on England contains a good *résumé* of our principal sanitary laws, together with a summary of the model bye-laws of the Local Government Board. The description of sanitary apparatus is excellent, the text being plentifully supplied with illustrations Notwithstanding the limited space which is allotted to each country, the author is nevertheless able to introduce a mass of detail relating to practical sanitation which we believe would be looked for in vain even in our standard text-books on hygiene We may instance as examples of this the paragraphs on the scavenging of London, and the disposal of rubbish and street refuse, the description of the preventive measures adopted in this country for the limitation of the spread of infectious disease, together with an account of the ambulance service and hospital ships, the explanation of the methods adopted for the ventilation of some of our important public buildings, the excellent *résumé* of school hygiene, for which we have no doubt the author is deeply indebted to Dr Newsholme, and the summary on industrial hygiene, although the author is rather inclined to repeat many of his remarks under this head when describing "the sanitary provisions as to industries" Dr. Palmberg's admiration of English sanitation is pronounced, and in commenting on our appreciation of the beneficent results of good ventilation, we find him giving vent to the quaint statement that "even in cold weather the windows of high houses are opened, children and adults without fear of chill breathing the pure air"!

France, the author informs us, has no general sanitary law, most of the sanitary regulations in force consisting of ministerial decrees, orders of prefects and councils of health Corresponding to this laxity of sanitary control, the great sanitary improvements which have been from time to time introduced have not been followed in Paris by a continuous fall in mortality, as in the case of the other European capitals As the author very rightly remarks, the time is past when it can be supposed that good sense and administrative capacity merely suffice for the regulation of the Public Health The drainage of Paris is exhaustively treated, the sewerage of the town being dealt with in detail, the writer in the course of his description pointing out that the system in use is objectionable, inasmuch as it allows deposits of sand to occur, and necessitates the maintenance of an army of 850 men to keep the sewers clear, the workers themselves at the same time having a relative mortality from typhoid fever twice as great as that for all Paris Moreover, owing to the friction of the enormous deposits of sand in the sewers the wear and tear on the latter are great, and compel frequent repairs.

The sanitation of Germany and Austria is dealt with in the same thorough spirit as pervades the rest of the book and calls for no special remark

In the description of the general regulations in force in Sweden relating to hygiene in towns, we think, however, that these laws might with advantage have been more systematised, much after the plan that the writer has adopted in dealing with Finland

The translation is remarkably well done, and with one exception is quite free from the sort of mistake usually met with in English editions of foreign works The instance we refer to occurs on page 380, where the author, in describing the forms of stove ordinarily employed in Germany, makes use of the following words --"Although the construction differs from that of the English ventilating stoves *made by Douglas Galton* and Boyle and Son"

Dr. Palmberg's book is undoubtedly a valuable one, and should prove of the utmost utility to all interested in

sanitary science By placing in our hands a description of the Public Health systems in vogue amongst continental nations, it allows us the opportunity of comparing them with our own, and correcting our shortcomings by their experiences Notably should this be the case in our methods of food inspection H BROCK

OUR BOOK SHELF.

The English Flower Garden Style, Position, and Arrangement, followed by a Description of all the best Plants for it, their Culture and Arrangement By W Robinson Third Edition (London · John Murray, 1893)

THIS quite recently published new edition of this most charming and useful book has been so completely altered as to be at first sight scarcely recognisable, and we are glad to record that all these alterations have been improvements, the result of a determination on the author's part never to give up the effort of making it better. In the present edition the old plates, many of which contained but feeble portraits of plant life, have been broken up, and in their places we find delightful pictures of some of our best loved flowering shrubs and plants, at one time represented as growing over walls or cottage porch, or again by the lake or riverside All of these are perhaps not equal in execution, but it has seldom happened to us to see so large a number of illustrations with so few that are below a high standard Such delightful woodcuts as those of the double flowering hollyhock, the Alpine pink, or of *Rodgersia podophylla* brighten up the pages and add much of interest to this book So familiar is this volume to most lovers of plants, of which the fact of three editions within ten years is a satisfactory proof, that it seems almost needless to explain that the first portion of it is devoted to a series of chapters on such subjects as design and position of a garden, on the wild garden, the Alpine garden, on spring, summer, and autumn flowers, and we note even on "Pergolas," the illustration of this latter being from Venice Alas! in these northern countries our sunshine scarcely ever needs a shade The whole of the first portion of the book is rewritten, and many new illustrations are given, such as the "primrose garden in a small clearing of a birch wood" in Surrey, the group of "Solomon's seal at the foot of a wall," and others too numerous to mention

The second and much larger portion is devoted to a list, arranged in alphabetical order, of all those plants that have been grown successfully in the gardens of Great Britain and Ireland, and of some few that may be expected to grow there Like the rest of the volume, this part too has been very thoroughly revised and brought up to date To every one in the possession of a garden, or having the care of one, we would say study this "English Flower Garden," for you cannot do so without profit

Logarithmic Tables By Prof George William Jones. (London · Macmillan and Co, 1893.)

THIS book of tables, which we notice has reached its fourth edition, will be found to serve the purpose for many computations which require an accuracy extending only to four or five places of decimals The tables throughout seem to be well arranged, and the figures neatly printed, thus fulfilling two important requirements from the computer's standpoint. In addition to five-place logarithms there is a table to four-places, together with four-place trigonometric functions, a table of useful constants, and an addition-subtraction table Among others we may mention a five place table of natural sines, &c., with a six-place table of their logarithms, prime and composite numbers, squares, cubes, square roots, &c, Bessel's coefficients for interpolation to the fifth differences, binomial coefficients for interpolation, also for fifth differences, and lastly a useful table of the errors of observations, from which we can at a glance determine the ordinates of the probability curve, values of probability integrals, &c An explanation, preceding the tables themselves, shows how they may be advantageously used, and the author offers the reward of "a dollar" for the first notice of a mistake "to promote the detection of errors"

Catalogue of the British Echinoderms in the British Museum (Natural History). By F Jeffrey Bell, M A (London. Printed by Order of the Trustees)

DURING recent years many additions have been made to the collection of echinoderms in the British Museum; and, as Dr Gunther explains in his preface to the present volume, much time and labour have been given to the study and arrangement of these additions. It seemed expedient, he says, to prepare, together with the nominal list of the specimens, a complete account of the species hitherto found in British seas All students of the subject will congratulate themselves on the fact that this decision was arrived at, for the result is that they are now provided with a handbook which will enable them to identify, without much difficulty, any specimens that may come in their way Mr Bell, in beginning the preparation of so full a catalogue, had before him a task of no small difficulty, and in the manner in which he has discharged it he has displayed great patience, insight, and knowledge A number of well-printed plates add largely to the value of the work

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications*]

The Hatching of a Peripatus Egg.

IN NATURE, vol xliv p. 468, I briefly described some eggs of the larger Victorian *Peripatus*, which were laid by specimens kept alive by me in the winter (Australian) of 1891. At that time, following previous authority, I identified the species which laid the eggs as *P leuckartii* It appears now, however, that the real *P leuckartii*—at any rate, in New South Wales—is undoubtedly viviparous, and our oviparous Victorian species is, therefore, probably distinct (It may be remembered that in NATURE, vol xxxix p 366, I suggested this probable distinction on account of the remarkable pattern of the skin usually exhibited by the fifteen legged Victorian form) Further particulars on this subject are given in my "Further Notes on the oviparity of the larger Victorian Peripatus, generally known as *P leuckartii*,"[1] and in the literature cited therein In that paper I described two embryos, removed from eggs which had been laid for about three and eight months respectively In the latter case I showed that the embryo was possessed of the full number of appendages, and was in all respects a perfect young *Peripatus*, differing externally from the adult only in the smaller size and less deeply pigmented skin On the strength of these observations I claimed to have definitely proved that the larger Victorian *Peripatus* at any rate sometimes lays eggs, and that these eggs are capable of undergoing development outside the body until perfect young animals are produced. I am now able to add some further information

For some time only one egg (belonging to the original lot, for none have since been obtained) remained in the hatching box The shell of this egg had changed to a dark brownish colour, and latterly an embryo had been visible through the shell, coiled up inside. The egg was lying on a small piece of rotten wood, which rested on the glass floor of the hatching box. On

[1] "Proceedings of the Royal Society of Victoria," vol v p 27, also *Annals and Magazine of Natural History*, 1892

January 3, 1893, not having opened the box for some days, I made an examination The egg was in its former position, so far as I could tell, but the shell was split on one side and the young *Peripatus* had escaped This young *Peripatus* was found lying dead on the glass floor of the hatching box, 25 mm distant from the shell It must have crawled off the rotten wood and along the glass to the position in which it was found It was only about 5 mm in length, so that, even assuming that it moved in a perfectly straight line, it must have crawled for a distance five times its own length To the naked eye the young animal appeared of a pale greenish colour It could not have been dead for very many days, but decomposition had already set in, and the animal was stuck to the glass on which it lay It was impossible to remove it without considerable injury, but I ultimately succeeded in mounting it in Canada balsam, and it is impossible, even in its present condition, to doubt that it really is a young *Peripatus*, for the characteristic jaws and claws are well shown I also mounted the ruptured egg shell, and found that the characteristic sculpturing on the outside was still clearly visible

This egg, then, hatched out after being laid for about seventeen months (from about July 1891 to about the end of December 1892) I cannot believe that under natural conditions the embryos take so long to develop At any rate it now appears certain that the larger Victorian *Peripatus* lays eggs which may hatch after a lapse of a year and five months

ARTHUR DENDY

The University of Melbourne, February

A Simple Rule for finding the Day of the Week corresponding to any given Day of the Month and Year

A RULE was lately mentioned to me by a friend for finding, almost by inspection, the day of the week for any given year and day of any month in that year, during the present century The basis of the rule is so obvious, when once the rule is stated, as to require no demonstration, but it struck me as so ingenious as to be worth while communicating it to you in case you deemed it worthy of insertion I also append a very easy method of extending the rule to any date subsequent to the introduction of the Julian intercalation either in the past or future, except indeed for the eighteenth century, in which the introduction of the new style requires a special treatment

The nineteenth century rule above alluded to is this Each of the 12 months has its special numerical constant, thus:

Jan.	Feb	Mar	Ap	May	June	July	Aug	Sept	Oct	Nov	Dec
3	6	6	2	5	0	2	3	1	3	6	1

Write down four columns thus

A | B | C | D

Under A enter day of month, under B constant for that month, under C year of century, under D greatest multiple of 4 in the year of century

Add together the numbers under these heads, divide by 7, and the remainder is day of week, except that in Leap Year 1 must be subtracted for any day before February 29

Example.—June 18, 1815 (Battle of Waterloo) —

A	B	C	D	Sum		Remr	
18	0	15	3	36	$\frac{36}{7}$	1	Sunday

February 1, 1892 —

A	B	C	D	Sum		Remr	
1	6	92	23	122	$\frac{122}{7}$	3	Sunday

Subtract 1 for Leap Year before February 29 *Ans* —3 − 1 = 2 or Monday

December 25, 1892 —

A	B	C	D	Sum		Remr	
25	1	92	23	141	$\frac{141}{7}$	1	Sunday

To extend the rule to any future century, we have only to alter the monthly constants, adding 5 to each for each added century after the present, and 1 for each century, an exact multiple of 4, in the interval.

Thus for the thirty-first century Number of added centuries is 12, and there are 3 centuries, succeeding multiples of 4 (twenty-first, twenty fifth, and twenty-ninth). Therefore add 5 × 12 + 3 = 63, or omitting multiples of 7, add 0

Hence, constants for thirty-first century are the same for the present century

New Year's Day, 3001,

A	B	C	D	Sum	Remr	
1	3	1	0	5	5	Thursday

For centuries anterior to the eighteenth we must first of all find by special method what the monthly constants would have been throughout the eighteenth century without the change of style, and then subtract 6 for each century short of the eighteenth

It may easily be seen that the constants throughout the eighteenth century would have been without change of style

Jan	Feb	Mar.	Ap.	May	June	July	Aug	Sept.	Oct	Nov	Dec
2	5	5	1	3	6	1	4	0	2	5	0

For the eleventh century subtract 7 × 6 or 42, *i e* since this is multiple of 7 subtract 0, and we get the same repeated

For the seventeenth subtract 6, and remember that when the result is negative we must replace it by the defect of the corresponding positive number from 7, and we get

3	6	6	2	4	0	2	5	1	2	5	1

Example —Battle of Hastings, Oct. 14, 1066

A	B	C	D	Sum	Remr	
14	2	66	16	98	0	Saturday

Execution of Charles I, Jan 30, 1649,

A	B	C	D		Sum		Remr	
30	3	49	12	=	94	$\frac{94}{7}$	3	Tuesday

H W W

"Roche's Limit."

WITH reference to Prof G H Darwin's notes (NATURE, March 16, p 460) on the investigations of M Roche as to the smallest distance from its primary at which a satellite can exist, does not the distance given—viz 2 44 times the radius of the primary—refer to the case of the satellite having the same density as its primary? In Note 3 Prof Darwin warns the reader that Roche's limit depends, to some extent, on the density of the planet Suppose the density of the planet to remain the same while that of the satellite is taken at double In this case the tidal or differential influence of the planet on the two halves of the satellite will have doubled, while the gravitational attraction of the two halves of the satellite on each other will have become fourfold, and generally, the power of the planet to pull the satellite asunder will be inversely as the density of the satellite, and directly as the density of the planet

An alteration of the size of the satellite does not much affect the question, because both forces are thereby equally altered, so long as the satellite is very small in comparison with its distance from the planet

Seeing that the tidal or differential influence of a planet on its satellite is inversely as the cube of their distance apart, perhaps it would be correct—as far as gravitational influence alone is concerned—to state the limit at which a satellite can exist as being equal to $2{\cdot}44\ R \times \left(\frac{D}{d}\right)^{\frac{1}{3}}$

where R = the radius of the planet,
D = the density of the planet,
d = the density of the satellite

As an interesting case of the same problem from a different point of view, suppose two very small equal spheres in contact, and a third much larger sphere placed in line with their centres, all three having the same density, then, when the distance of the point of contact of the small spheres from the centre of the large one is 2 52 times the radius of the large one, the attraction of the two small spheres for each other just balances the differential influence of the large one tending to draw them asunder The effects of variation in density and size being the same in this case as in the former.

It would probably be interesting to many of your readers to have Prof Darwin's views as to whether it is a reasonable supposition that a small satellite, such as Jupiter's fifth, is likely to have the same density as Jupiter, and whether the meteorites forming Saturn's ring are likely to be of so small density as

Saturn, as it would appear that without making some such supposition, no definite limit can be fixed

Applying this supposition to the sun, with reference to meteoric swarms, we have 2 44 times the sun's radius, taken at 433,000 miles, or 1,056,520 miles as the distance at which the sun would prevent the meteors coalescing to form a planet In Note 3 Prof Darwin states this at one tenth of the earth's distance from the sun, probably by inadvertence G. R

The Ordnance Survey and Geological Faults

In view of the re-survey of the United Kingdom, it seems to me that if the officers of the Survey were directed to take special notice of the levels of the former survey on both sides of great geological faults, and to compare these levels now so as to ascertain if any appreciable relative change had taken place during the forty or fifty years since the first survey, valuable information as to the motion of these faults, if any, might be obtained

This idea is mainly suggested to me by the fact that in this neighbourhood a great fault intersects the Old Red Sandstone close to its contact with the Highland schists, it has been traced from Stonehaven on the east coast to Loch Lomond on the west, and seems to give remarkable evidence of being, at least to a certain extent, in motion The village of Comrie, famous for its "earthquakes," is situated on this fault, and the "earthquakes" are as lively as ever In the valley of Strathmore farmhouses placed in the proximity of this great dislocation are, or were, celebrated for being "haunted," on account of the noises and tremors by which the inhabitants are from time to time alarmed

Most, if not all, British "earthquakes" have been, I think, wisely attributed to similar causes

Of course fifty years is a very minute part of the history of one of these old faults, but if the data of the Ordnance Survey be so accurate as is usually supposed, some trace of shifting might possibly be discovered if the necessary observations were made

Newport, Fife, March 18 Jas Durham

The Discovery of the Potential

Mr E J Routh has lately published a most valuable "Treatise on Analytical Statics" I quote from the second volume, p 17, the following note —

"The earliest use of the function now called the potential, is due to Legendre in 1784, who refers to it when discussing the attraction of a solid of revolution. Legendre, however, expressly ascribes the introduction of the function to Laplace, and quotes from him the theorem connecting the components of attraction with the differential coefficients of the function The name, Potential, was first used by Green," etc

From this note it appears that the discovery of the potential must be attributed to Laplace This is a wrong opinion, and some fifteen years ago Baltzer proved that the introduction of the function is due to Lagrange ("Zur Geschichte des Potentials," in *Journal fur die reine und angewandte Mathematik*, vol lxxxvi. p. 213, 1878) Some historical documents in favour of Lagrange's priority have been found, by the writer of these lines, in Todhunter's "History of the Mathematical Theories of Attraction and the Figure of the Earth," and collected in a note at the end of vol i of his work, "Il Problema Meccanico della Figura della Terra" (Torino, 1880), where a full account of the early history of the potential is given, with numerous bibliographical indications Ottavio Zanotti Bianco

Private Docent in the University of Turin,
March 21

The historical note on p. 17 of my "Statics" is chiefly founded on the statements in Todhunter's "History," and in Thomson and Tait's "Natural Philosophy" The references to these two writers are given in the note Both Dr. Todhunter and Lord Kelvin ascribe the introduction of the function for gravitation to Laplace, and assert that the name of "Potential" was first given to it by Green. My own reading, though not so extensive as theirs, had not led me to form any different opinion. In Nichol's "Cyclopædia of the Physical Sciences" the first introduction is given as due chiefly to Legendre, Lagrange, Laplace, and Poisson. In Chambers's "Cyclopædia" Laplace's name alone is mentioned. Baltzer, as cited by Mr. Bianco, mentions the use of the function by Lagrange in the *Mém. de Berlin*, 1777 This is earlier than the memoir of Legendre, but as Legendre assigns the introduction of the function to Laplace, it is difficult to compare the dates I am at present unable to refer either to the memoir of Lagrange or to the treatise of Mr Bianco

E J Routh

Van't Hoff's "Stereochemistry"

The review of the above by "F R J" in Nature, p. 436, raises some important points in connection with this peculiarly fascinating branch of chemical science In referring to the recent ingenious and attractive theory of P A Guye, that the numerical value of optical activity is dependent upon the relative masses of the four groups attached to the asymmetric carbon atom, and which carries with it the corollary that if two of these four groups are of equal mass the rotatory power will cease, your reviewer states that Guye "was unable to verify this view in all strictness" I think, however, that he hardly emphasises sufficiently that this important corollary has in every case, when put to the test of direct experiment, broken down As far as I am aware, there is not a single instance of an asymmetric carbon atom attached to four groups *qualitatively distinct*, being found optically inactive in consequence of two of those groups being *quantitatively equal in mass* Indeed some such substances are not merely active but powerfully so The reviewer considers that this inadequacy of Guye's theory is palliated by the alleged fact that the amount of rotatory power of the esters of an active acid is determined by the weight of the alkyl-group This point, which is one of the cardinal pillars of Guye's theory, I have recently put to the test of actual experiment, by measuring the rotatory power of a number of the esters of active glyceric acid, which have been prepared by Mr J MacGregor and myself In this investigation we found the most extraordinary verification of Guye's theory, as far as the optical properties of the normal series of methyl, ethyl, and propyl glycerates were concerned, with the appearance of isomerism, however, this regularity ceases, thus the isopropyl glycerate has a markedly lower rotation than the normal one, whilst the normal and secondary butyl compounds have a lower rotation than the isobutyl ester Nor are these differences consistently explicable by taking into consideration the interatomic distances, as measured by atomic volume, for the molecular volume of the normal propyl glycerate with its greater rotation is less than that of the isopropyl compound with its smaller rotation, whilst the molecular volumes of the isobutyl and secondary butyl glycerates are almost exactly equal, although the rotation of the former is much greater than that of the latter

The reviewer, in referring to the rotation exhibited by the salts of active acids, states that in the case of tartaric acid all the salts "display in solution the same rotatory power, irrespective of the atomic weight of the metal," and is apparently satisfied that "the clue to this anomaly is furnished by the electrolytic theory of Arrhenius," according to which "it is the ion $CO_2(CHOH)_2CO_2$ which is alone responsible for the rotation." The reviewer has in this endorsed the method of special pleading adopted by the advocates of this theory, in which the metallic tartrates have been summoned as witnesses, whilst only the testimony of those favourable to the theory has been admitted Thus one of the commonest of the metallic salts of tartaric acid—tartar emetic—has a rotation which differs entirely from that of the other tartrates, and thus conclusively negatives the dogma that the rotation of the solutions of metallic salts is independent of the particular metal which has replaced the hydrogen of the acid. Fresh light has been thrown on this point in the course of an investigation, which I have recently carried out with Mr Appleyard on the rotatory power of the metallic salts of active glyceric acid, and which has shown that the specific rotatory power of the glyceric acid has one value when deduced from the rotations of its alkaline salts (lithium, ammonium, sodium, and potassium), another value when deduced from the salts of the alkaline earths (calcium, strontium, and barium), and a third from the salts of the magnesium group of metals (magnesium, zinc, and cadmium) Now it so happens that almost the only salts of tartaric acid which have had their rotation determined are those of the alkaline metals, which also in the case of glyceric acid yield practically the same rotation Hence if only the rotations of the alkaline glycerates had been determined, the same erroneous conclusion would have been arrived at concerning the rotation of glyceric acid Whatever may be the ultimate interpretation put upon these new results, and I prefer for the present to ab-

stain from any generalisations, it is obvious that the notion of the rotatory power of saline solutions being independent of the particular metal present in the salt is altogether untenable

PERCY F FRANKLAND

University College, Dundee, March 11

THE notice referred to by Prof Percy F Frankland was written, and the proof returned to the printer, before the end of last year Since then two researches have been published —by Purdle and Walker, and by Frankland and Appleyard—in which facts are adduced, apparently irreconcilable with Guye's theory Had these facts been at my disposal I should doubtless have expressed myself more guardedly

Prof Frankland says "As far as I am aware, there is not a single instance of an asymmetric carbon atom attached to four groups *qualitatively distinct*, being found optically inactive in consequence of two of those groups being *quantitatively equal in mass*," and he complains that I have hardly emphasised this sufficiently My reason was, that I was not altogether convinced of the fact, as may be seen from the following passage, which I transcribe, and which originally formed a footnote to the notice in question —

"The present reviewer ventures to suggest that cases such as are sought by Guye are to be found in those compounds in which two of the four different groups attached to an asymmetric carbon atom are themselves asymmetric carbon atoms of equal and opposite enantiomorphism Such compounds would exist in two distinct forms, but as the two opposite enantiomorphic groups would be of equal mass and would be situated at equal distances from the central asymmetric carbon atom to which they are attached (inasmuch as the two opposite enantiomorphic modifications of a compound always have the same molecular volume), the conditions necessary for optical inactivity according to Guye's theory would be fulfilled, and neither of the two forms ought to cause rotation of the polarised ray Such a case has already been observed in the two inactive, non-racemic trihydroxyglutaric acids described by Emil Fischer (*Ber der deutsch chem Ges* 24, p 4214), although it does not appear to have been hitherto interpreted from this point of view"

I afterwards suppressed this footnote, partly because it seemed to me out of place in such a notice, and partly because the optical activity of the two trihydroxyglutaric acids could be accounted for in another way namely, by the fact that, as pointed out by E Fischer, the mirror images of their molecules are congruent with the molecules themselves But the passage will show why I was indisposed to enter a proved negative against Guye's theory.

As regards the charge of "endorsing special pleading" in the interests of the electrolytic theory of Arrhenius by suppressing the fact that tartar emetic has, in solution, a different rotation from the other metallic tartrates, I may say at once that I was ignorant of this fact I am not a specialist on the subject of the optical properties of organic compounds, and I merely summarised, doubtless uncritically, the account of Oudemans' law given in van't Hoff's book Indeed, the brief notice, as its wording everywhere indicated, was a summary rather than a criticism

I take this opportunity of rectifying an omission At the time of writing the notice I was not aware that Prof Crum Brown had, independently of M Guye, put forward, in the Proceedings of the Royal Society of Edinburgh, views on the influence of the various substituting radicles in modifying the optical rotation of organic compounds

F R JAPP

University of Aberdeen, March 18

Standard Barometry

THE question of absolute accuracy in barometer readings is one of great importance to meteorologists; but there has been so much uncertainty shown by the accumulated facts relating to the subject, that I think that no one who has carefully studied the matter has felt fully satisfied that strictly comparable international standards had been obtained An uncertainty of at least 0·1 mm. was indicated by the various international comparisons of normal barometers which have been carefully made and discussed during the past ten years. I think that at last a definite conclusion has been reached, and that the very recent results published in paper No. 4, Band xvi of the *Repertorium für Meteorologie* will be accepted as proving that at St. Petersburg at least normal readings are obtained

About twenty-five years ago Director Wild, of the Central Physical Observatory at St Petersburg, established the first normal barometer of the *modern* form, and as much as twenty years ago he claimed to have obtained practically normal readings Moreover, he urged that the transfer of these normal readings from place to place by means of portable barometers was impossible within the desired limits of accuracy, and that each country ought to have its own thoroughly investigated normal barometer This last has been proved by the results obtained by various investigators, and now Prof Wild offers the proof of the accuracy of his normal barometer in the paper just referred to, which bears the title "Die normal-barometer des Physikalischen Central Observatoriums zu St Petersburg"

This paper was presented to the Academy of Sciences on November 4, 1892, and in it Wild gives the results of the intercomparison of three local normal barometers

Normal barometer No I was mounted at St Petersburg in 1870, and was fully described in Band iii of the *Repert f Meteor*

A second normal barometer was mounted at Pawlowsk (about twenty miles from St Petersburg) in 1887, and a third normal was mounted at St Petersburg in 1891, and is known as normal No II

In 1887 and 1888 Wild found that the St Petersburg normal I and the Pawlowsk normal did not differ by more than 0 01 mm

In 1892 the St Petersburg normals I and II were found to agree within the limit of error of observation (less than 0 01 mm)

In 1892 the St Petersburg Normal II was dismounted, taken to Pawlowsk, and there compared with the Pawlowsk normal, and the two were found to differ by only 0 01 or 0 02 mm, that is 004 or 008 inch It must be added that these comparisons have all been checked by means of comparisons with portable barometers of the highest class

The paper by Prof Wild is accompanied by illustrations of these various normal barometers The St Petersburg normal has recently undergone some alterations, and these are also fully described Altogether this is perhaps the most important contribution to the subject that has appeared since Prof Wild's famous memoir of 1873, for we can now rest assured that farther refinement is not required by any practical demands.

It seems to me that now that we are sure of the accuracy of Wild's normal, it is more necessary than ever that we should know with greater certainty its relation to the principal standards of Europe I desire, therefore, to propose a plan by which a series of comparisons can be carried out for a few places at a very slight expense, and with as much accuracy as portable instruments will permit In 1883 it became my duty to transport to America, from Hamburg three of the Wild-Fuess portable barometers of the highest grade; and it was of great importance to take every possible precaution against their being injured or their condition altered in any way so as to affect their readings I devised a mounting on shipboard which was very satisfactory, and gave me no cause for uneasiness regarding the barometers, even in stormy weather So many barometers are sent out from England to almost every country that I strongly urge the use of a similar arrangement in all cases where it is desirable to retain an assigned barometer correction

The accompanying sketch shows my manner of mounting the barometers Two small strips of wood, AA, are screwed to the woodwork running lengthwise of the vessel They are placed about two feet apart, and are inclined at an angle of perhaps 45°. Small leather straps, say 15 inches long, are fastened to these strips by single screws as shown at BB A rather soft stuffed flat cushion or pillow is now placed against the woodwork (wall) as shown at C. The box containing the barometer is now pressed against the cushion and the two extremities are placed within the grasp of the straps BB These last are buckled and drawn tight enough to hold the barometer box firmly against the cushion C The barometer is thus held in such a manner that no ordinary jarring can cause any damage to it, as there is no direct contact with a rigid surface, since the pillow prevents it from touching the wooden strips, and the soft yielding straps have a spring-like effect

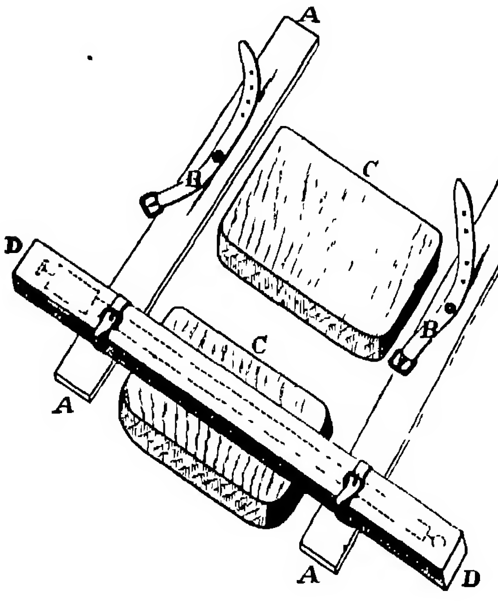
The lower part of the sketch shows the barometer box DD in position, with the barometer shown within it Of course the cistern is held uppermost. On account of the jarring motion of the ship's screw in rough weather, it is desirable to locate the barometers well amidship, and also have the cistern of the baro-

meter directed towards the stern Barometers can be placed in this manner on ship board by the maker, and can be left to themselves for any length of time If the person to whom they are consigned is notified of their subsequent arrival at port, he can take them from their hangings on the ship in the best possible condition Of course this presupposes an arrangement with the officers of the vessel, such that the instruments shall be let entirely alone from the time they are mounted by the consignor until they are received by the consignee

I think this method of carrying instruments can be very usefully applied in improving our knowledge of the relation of international barometric standards, and at a minimum expense, and I will give a brief outline of a convenient way for accomplishing it The Deutsche Seewarte at Hamburg, and the Kew Observatory at Richmond (through the London Meteorological Office), are in the best positions for supervising this work, and I venture to express the hope that the matter will be seriously considered

I will outline the work when carried on from London

Let two barometers of the best construction, say an Adie Fortin and a Wild Fuess control barometer, be compared with the Kew normal during a period of a week or more, or long enough to experience considerable variation in the barometer



height Then let the two barometers be mounted on one of the London Hamburg steamships, in the manner which I have described, and sent to Hamburg, where an employee of the Deutsche Seewarte could be despatched to take down the instruments and carry them to the Seewarte for comparison with the normal barometer Then the barometers could be taken by a messenger to Lubeck, at an expense of a few shillings, and mounted on a St Petersburg steamer, which would carry them almost to the door of the Central Physical Observatory, where they could be again taken in charge by a meteorologist, compared for a few days, and then again be mounted on another steamer bound for one of the Scandinavian ports where there is a standard barometer, and finally returned to London by one of the numerous regular steamships At an expense of a couple of pounds the barometer could be sent from St Petersburg (or Scandinavia) back to Hamburg *viâ* Stettin and Berlin; thus allowing Berlin to enter into the series. The barometers would probably have to be sent by a messenger from Berlin to Hamburg, thus entailing the just mentioned expense A second comparison at Hamburg would be desirable, and then the barometers could be returned to London by sea, and again compared at Kew

Similarly, barometers could be sent to New York for comparison with the sub-standard, by Adie, at the Maritime Exchange; although probably the United States Weather Bureau would assume the expense of the three pounds necessary to carry the instruments to Washington for comparison with the normal there, and then return them to New York and put them on shipboard to be returned to London.

The standard barometers of Australia, India, Brazil, and other countries accessible by sea can be reached from London (or Hamburg) in the same way, and the comparison instruments can be returned to their starting point for additional verification

My own experience in the transportation of barometers assures me that ship captains would gladly give their hearty co operation to a work of this kind, and there would be no charges for carrying the instruments even half round the world and back again.

In offering this suggestion it is not necessary for me to give the details for the complete organisation of such a scheme, but it may be remarked that if it should be undertaken, the personal experience of those who have been over the ground should be utilised in making plans A single instance will serve to show why this is advisable Some years ago I carried two barometers from Hamburg to London by sea I took the German line of steamers and found myself anchored in the middle of the Thames, and had to get ashore as best I could I greatly feared that I should never get the barometers ashore in a whole condition, as there was necessitated a great deal of scrambling over lighters, &c, and embarkation in an unsteady row boat in order to make a landing Had I taken the English steamer, all this worry would have been saved Other similar instances occurred which could have been avoided by one personally familiar with the routes to be travelled

FRANK WALDO

Princeton, New Jersey, February 20

Motion of a Solid Body in a Viscous Liquid

THERE is perhaps no branch of mathematical physics which has made greater progress during the last thirty five years than hydrodynamics During this period numerous important investigations have been published upon the motion of solid bodies in a *frictionless* liquid, upon the theory of discontinuous motion, upon the theory of vortex motion and vortex rings, upon the motion of a liquid ellipsoid under the influence of its own attraction, and upon waves and tides These investigations constitute an enormous increase in the knowledge possessed by the present generation compared with that of its predecessors, they have to a considerable extent exhausted the field of research in the theory of the motion of *frictionless* liquids, but notwithstanding the importance of the results, the elegance of the methods by which many of them have been obtained, and the skill by which the mathematical difficulties have been surmounted, all the investigations referred to possess the defect of not accurately representing the motion of liquids as they occur in nature

The reason of this discrepancy between theory and observation is that the ideal substance, which is called a *frictionless* liquid, has no actual existence, for all liquids which occur in nature are *viscous* The viscosity of the mobile liquids, such as water, alcohol, &c., is a small quantity, being in the case of water equal to a tangential stress of about 014 dynes per square centimetre, whilst in the case of the sticky and greasy liquids, such as treacle and oil, it is much greater The viscosity of olive oil is about 3 25 dynes per square centimetre, and is therefore about 232 times as great as that of water

The mathematical theory of the motion of viscous liquids was elaborated as long ago as 1845 by Sir G Stokes, in a paper in which he showed that the effect of viscosity might be represented by certain additional terms in the equations of motion of a frictionless liquid, which contain as a factor a new physical quantity called the viscosity. In a subsequent paper, published in 1850, he applied the above theory to calculate the diminution of the amplitude of the small oscillations of a sphere surrounded by water; and by means of experiments in which this quantity was observed, he calculated the numerical value of the viscosity of water, and found that it was in close agreement with the value found by Poiseuille from experiments on the flow of liquids through capillary tubes. An investigation of a similar character was undertaken by von Helmholtz and Piotrowski about 1863, in which the sphere was suspended by a torsion fibre, and made to perform small torsional oscillations about a diameter.

Almost all calculations relating to small oscillations proceed upon the basis that the squares and products of quantities, upon which the disturbed motion depends, may be neglected. This introduces a great simplification into the work, and enables a variety of problems, which would otherwise be exceedingly intractable,

to be solved by fairly simple methods There is, however, another class of problems of great practical importance, in which it is not allowable to neglect these quadratic terms, and towards the solution of such problems theory has as yet made little progress

When a sphere is constrained to move along a horizontal straight line, but is otherwise free, it is well known that if the surrounding liquid is supposed to be frictionless, its only effect is to increase the inertia of the sphere by half the mass of the liquid displaced The sphere accordingly requires a larger impulsive force to start it than if the liquid were absent, but when once started it continues to move with its velocity of projection. But when the sphere is surrounded by an *actual* liquid, its velocity gradually diminishes until it ultimately comes to rest, and this fact shows very forcibly the necessity of taking the viscosity of the liquid into account in problems of this character I obtained a few years ago a mathematical solution, which shows that this effect must necessarily be produced by a *viscous* liquid, but the solution is an imperfect one, as mathematical difficulties compelled me to disregard the quadratic terms

It is always a great advantage when the solution of a mathematical problem can be made to depend upon a *single* function which satisfies a partial differential equation and certain boundary conditions This is always the case when a solid of revolution moves along its axis in a viscous liquid which is initially at rest, or has an independent motion which is symmetrical with respect to the axis In this particular class of problems, the motion can be expressed by means of Stokes's current function in the following manner —Let z be measured along, and r perpendicularly to the fixed straight line with which the axis coincides during the motion, let w and u be the velocities of the liquid in these directions; then —

$$u = -\frac{1}{r}\frac{d\psi}{dz}, \quad w = \frac{1}{r}\frac{d\psi}{dr},$$

$$\left(\nu D - \frac{d}{dt} - u\frac{d}{dr} - w\frac{d}{dz} + \frac{2u}{r}\right)D\psi = 0,$$

where

$$D = \frac{d^2}{dz^2} + \frac{d^2}{dr^2} - \frac{1}{r}\frac{d}{dr},$$

and ν is the kinematic coefficient of viscosity

So far as I am aware, no serious attempt has been made to obtain a solution of this equation in a suitable form, even when the solid is a sphere. The equation is well worthy of the attentive consideration of mathematicians, and although it is an intractable one, it must be recollected that a general solution is not required, but only a particular one which is suitable in the case of a sphere It will be quite time enough to consider the possibility of obtaining solutions of a more general character, when the appropriate one in the case of a sphere has been discovered It is also important to recollect that in most problems which are of practical interest, ν is a small quantity (about 014 in C G S. units for water), and consequently an approximate solution in which ν is supposed to be small would meet the exigences of the case.

When a solid body is moving through a liquid, one of the boundary conditions is that the normal velocity of the solid must be equal to the component along the normal of the velocity of the liquid in contact with it If the liquid is frictionless, this condition is the only one which has to be satisfied; but when the liquid is viscous, a further question arises as to the law which expresses the effect of the tangential stress exerted by the liquid upon the solid When the motion is very slow (as in the case of problems relating to small oscillations) the experimental evidence is in favour of the hypothesis of *no slipping*, but when the velocity is considerable, the experimental evidence is not so satisfactory. The partial slipping which takes place under these circumstances must depend partly upon the nature of the liquid, and partly upon that of the surface in contact with it, and the tangential stress to which it gives rise is probably approximately proportional to the square of the relative velocity.

When the motion is symmetrical with respect to an axis, the stresses due to viscosity can be calculated as soon as the value of ψ is known, the resistance which the liquid exerts on the solid can be found, and the equation of motion written down and integrated. This process is, however, an exceedingly tedious one; but it can always be dispensed with in the case of a single solid by employing the principle of momentum When the motion is not symmetrical with respect to an axis, it cannot be expressed in terms of ψ, but if the velocities of the liquid can be found from the hydrodynamical equations, the components of the linear and angular momenta of the liquid can be calculated, and by applying the principle of momentum to the compound system composed of the solid and the surrounding liquid, the equations of motion of the former can be obtained Since the momentum of the system is obviously a function of the six co ordinates of the solid, this principle furnishes a sufficient number of equations for the determination of the motion

When there is more than one solid, the principle of momentum is insufficient to determine the motion, but if the velocities of the liquid in the neighbourhood of each solid could be found, the force and couple constituents of the resistance could be calculated, and the equations of motion of each solid written down. Lagrange's equations in their ordinary form cannot be employed, as viscous motion involves a conversion of energy into heat, but problems which can be solved by an indirect method can usually be solved by a direct one, and I feel confident that equations analogous to Lagrange's equations exist, by means of which the motion of a number of solids in a viscous liquid can be found without going through the above-mentioned process A form of Lagrange's equations has already been discovered, which is applicable when the viscous forces depend upon a dissipation function which is expressible as a homogeneous quadratic function of the velocities, and the circumstance that a dissipation function also exists in the hydrodynamical theory, although it is expressed in a different form, furnishes additional grounds for believing in the existence of equations of this character. The discovery of such equations would constitute an important advance in the theory of viscous liquids

A B Basset

SCIENCE IN THE PUBLIC SCHOOLS AND IN THE SCIENTIFIC BRANCHES OF THE ARMY

On Friday last Mr Campbell Bannerman received a deputation on this subject in his room in the House of Commons There were present Sir Henry Roscoe, the Head Master of Rugby School, the Principal of Cheltenham College, the Head Master of Clifton College, Sir B Samuelson, Prof Jelf, and Mr Shenstone Lord Playfair, Sir John Lubbock, and Sir Henry Howorth would also have been present, but they were prevented by other engagements. The following is a brief account of the proceedings —

Sir Henry Roscoe, in introducing the deputation, said that he had introduced a deputation on this subject to Mr Stanhope about five years ago, and that if the suggestions then made had been adopted the present deputation would not have been necessary. After some remarks which showed the injustice of the present system to the more scientific lads, he pointed out several methods by which this injustice might be removed.

The Head Master of Rugby, Dr. Percival, expressed his strong feeling of the importance of the subject alike to the service, the cadets, and the schools, and said he wished to see both modern languages and science duly encouraged, he thought they might both be made compulsory, as he believed that early education should rest on a wide basis, and that specialising should only be encouraged later. Alluding to the work in science done at the Royal Military Academy, Dr Percival mentioned that he knew of one cadet who, owing to the absence of any higher teaching there at the earlier stages, was lately learning science which he, the cadet, was well fitted to teach

The Principal of Cheltenham College, Mr James, confessed that his own interests and convictions on educational matters were those of a linguist rather than those of a man of science, but practical experience showed him that the present system told most unfairly against scientific boys who entered Woolwich, science was being gradually edged out Many other head masters of public schools felt with the deputation He thought also that the present system tended to the disadvantage of the smaller schools, where science was often exceedingly well taught He hoped that in making any changes the authorities would be careful to consider the interests of linguistic boys, and

would not add to the number of subjects taken up at entrance, for boys were already overburdened in their preparation.

The Head Master of Clifton College, Mr. Glazebrook, said that this was a question on which the public schools had a strong claim to be heard, since an increasing number of boys passed direct from them to Woolwich—the proportion last July being about four-fifths of all the candidates. But the discouragement of science was not so serious to the great schools as to the smaller and less expensive schools, where as a rule science is well taught, but not German. He thought it undesirable that these latter should be debarred from competition. It was not only by the assignment of marks that science was now discouraged, but also by the system of instruction. Boys who went up to Woolwich tolerably proficient in chemistry were put back to the elements, and at the end of their first year knew less than when they entered. Such boys were naturally inclined to complain that science at Woolwich was a farce, and to urge their friends at school to take up another subject which was treated more seriously.

Further remarks were made by Sir B. Samuelson, who especially advocated the encouragement of all types of boys from the public schools, by Prof. Jelf, and by Mr. Shenstone. Statements were made by the Director-General of Military Education and the Inspector-General of Fortifications, the latter officer emphasised the importance of German and of electricity, and said many cadets were markedly deficient in the latter subjects when they left Woolwich. In concluding, Mr. Campbell-Bannerman expressed his obligation to the deputation, and his sense of the importance of the matter brought under his notice, which would have his most careful attention.

It will be seen from this report that the position of cadets of scientific ability at the Royal Military Academy is, as we pointed out some time ago, far from satisfactory, and that this view is now not only held by men of science but also by many head masters and by distinguished members of the military profession, who on this and on other occasions recently have spoken clearly on the subject.

The main defects of the present system seem to be:—(1) That science and German, two subjects which ought to go hand in hand in the early education of officers of the scientific branches, are at present brought into distinct conflict; (2) that in effect so great a bonus is given to German in the course of work at the Royal Military Academy as to be likely very soon to drive science out of the entrance examination, and to a corresponding extent out of the public schools; (3) that the standard of work of the cadets in science, and particularly in electricity when they leave the Royal Military Academy, is lower than it ought to be in very many cases.

Of these defects the last, which is doubtless largely the outcome of the first two, is probably the most important, and it will never be remedied so long as the authorities cling to the idea that a sufficient knowledge of several branches of science can be given to the cadets, even when they are quite new to such studies, in the moderate amount of time that can be spared for them during the comparatively brief course of work at the Royal Military Academy. That this idea is wrong we have pointed out again and again. If those who are responsible for the education of the cadets at Woolwich really desire that the cadets shall attain to a higher standard in science, they must not only encourage the admission of lads of scientific ability, but they must either set apart much more time to such work at the Academy, and give opportunities for, and more encouragement to, advanced work on the part of those who take up the subject, and do well in it at the entrance examination; or, if the giving of more time to science at the Royal Military Academy is impracticable, as is very possibly the case, they must so alter the conditions of the entrance examination as to secure that the cadets shall learn their elementary chemistry and heat at school, and be able to devote their science work at Woolwich wholly to electricity, which is technically of such great importance to them, but to which at present they can only give a portion of their time.

By doing this the authorities of the Academy will not only advance the interests of the service, they will also avoid that discouragement of the more scientific cadets and of the teaching of science in schools which is admittedly a result of the present system as a whole.

In conclusion, we would urge strongly what was pointed out by Sir Henry Roscoe on Friday, that it is not merely scientific knowledge but scientific ability which is wanted, and that it is only by giving due weight to science at the entrance examination and afterwards that this can be secured.

CLIMBING PLANTS[1]

THIS forms the fourth part of A. F. W. Schimper's "Botanische Mittheilungen aus den Tropen," and is devoted to the description and illustration of the various adaptations for climbing exhibited by native Brazilian plants observed on the spot. Following Darwin, the author distinguishes four different classes of climbing plants, according to the manner in which they climb; but his four classes are not quite the same. Darwin divided them into those having stems which twine spirally round a support; those which climb by means of irritable organs; those which climb by means of hooks; and those which climb by means of roots. Darwin's investigations, it will be remembered, were chiefly directed to the elucidation of the phenomena exhibited by twiners, and such plants as climb by means of tendrils. Schenck treats in a general way of all four classes of climbers; and his work is more in the nature of a text-book than an account of experimental research. He divides climbing plants into Spreizklimmer, Wurzelkletterer, Windepflanzen, and Rankenpflanzen, corresponding nearly to the hook, root, twining, and tendril climbers of Darwin and others. But the Spreizklimmer include all climbing plants that neither twine nor possess either irritable climbing organs or clinging roots, whether armed or unarmed. Thus the least organised of climbing plants are those having weak, slender, rampant stems and branches which grow up among other plants and rest upon them without any other means of support; whilst the most perfectly developed climbing plants are those provided with highly sensitive nutating tendrils, such as the Cucurbitaceæ and the Passifloraceæ. It is difficult to find an exact English equivalent for "Spreizklimmer," but "incumbent climbers" might be employed to designate this class. Twiners revolve with the sun, as the hop (*Humulus Lupulus*), or against the sun, as the scarlet-runner bean (*Phaseolus vulgaris*); but Schenck agrees with Darwin and other observers that they are not sensible to contact. It is only the plants classed as tendril-climbers that exhibit this property; and this irritability is developed both in caulomes and in phyllomes—that is in branches and in leaves, more or less modified for the purpose. In England there are only three woody climbers, namely: the ivy, a root-climber; the honeysuckle, a twiner; and *Clematis vitalba*, a leaf-stalk climber; but in Brazil, and in other tropical countries, they are exceedingly numerous, and present a great variety of adaptations to this end. Dr. Schenck, however, does not confine himself to Brazilian forms. He briefly reviews all the types that have come under his observation. Plants climbing by means of tendrils (irritable organs), conceived in the widest sense, are classified according to the organs, or parts of the organs, by means of which they climb. First he takes the leaf-climbers, which climb by means of

[1] "Beiträge zur Biologie und Anatomie der Lianen im Besonderen der in Brasilien einheimischen Arten." Mit 7 Tafeln. Von Dr. H. Schenck. (Jena: Gustav Fischer, 1892.)

sensitive revolving leaflets (*Fumaria*), by the petioles (*Clematis* and *Tropæolum*), by the tips of the leaves (*Tillandsia* and *Flagellaria*) Then come the leaf-tendril climbers proper, such as *Pisum sativum* and *Cobæa scandens* But the almost peculiarly tropical branch-climbers, plants climbing by means of modified caulomes (branches or inflorescences), present the most singular forms Dr Schenck divides them into branch-climbers proper, which have elongated naked or leafy revolving branches clasping the branches of other plants, hook-climbers, which develop hook or claw-like supports, "watch-spring" climbers and thread-climbers The grape-vine and passion-flower are classed under the last The climbing organs of the "watch-spring" type are very curious They are naked, attenuated branches, which roll up in one plane, forming a loose elastic spiral, between the coils of which the support is caught The spirals usually thicken only at the point of contact, thereby effecting a firm hold of the support Dr Schenck does not enter deeply into the anatomy of climbing organs, though he states that differentiation of the tissues of sensitive organs only takes place after contact The plates are all devoted to the illustration of the external morphology of climbing organs A systematic list of genera containing climbing species is given, and there is also a chapter on the geographical distribution of climbing plants W BOTTING HEMSLEY

CLAPHAM JUNCTION AND PADDINGTON RAILWAY

THE statement that appeared in the press towards the end of last week, that the promoters of this railway had applied to the committee who rejected the bill for permission to bring the subject again before the House of Commons did not represent the fact What really occurred may be gathered from the following extract from the *Times* of Saturday, the 25th inst ---

"It had been the intention of the promoters of the Clapham and Paddington Railway Bill to ask the committee, presided over by Sir J Kennaway, to grant permission to have the bill recommitted, in order to meet the objections as to electric traction raised by the Royal College of Science and the City and Guilds Institute After a private consultation with the chairman, it has been decided that the public application to this effect should not be made until some arrangement has been come to with the authorities of these institutions in the Exhibition Road, and until steps had been taken to find out whether they would agree to the substitution of cable for electric traction on that portion of the line coming within the radius of the scientific colleges "

Even the preceding corrected statement rather represents the aspect which the promoters would like the matter to assume than the strict truth For as a matter of fact it has been pointed out first that the passage of the electric locomotives and the train of iron-framed carriages running nearly due north and south within some 40 feet of magnetometers would stop all work, even if the motive power were a cable, secondly, that the vibration caused by the quick moving trains and by the slapping cable would be ruinous; and lastly, that no one but an over-sanguine company promoter would imagine that an electric railway with a fragment worked by cable in the middle would be a lasting arrangement Let but the bill pass, and within six months after the railway was open an interesting collection of broken cables would be on exhibition in the Houses of Parliament It is amazing that the question of the shifting of the route of the proposed railway a few hundred yards to the east or west of Exhibition Road seems to be altogether neglected.

NOTES

HONOUR has been done lately to two British men of science by the Academy of Sciences of the Institute of France On March 6 Sir Joseph Lister was elected a Foreign Associate in succession to the late Sir Richard Owen, and on March 20 Sir Henry Roscoe was elected a Correspondent in the section of chemistry in succession to the late M Abria

THE Brazilian expedition, under charge of Mr A Taylor, for the observation of the solar eclipse has arrived safely at Ceara

THE Liverpool Marine Biology Committee have recently appointed Mr J Henry Vanstone, from Prof Howes' Laboratory at the Royal College of Science, South Kensington, as Resident Curator of their Biological Station at Port Erin in the Isle of Man The important addition which has been made to the station during the winter, viz a two storied tank and aquarium house, is now finished, and will be open for use at Easter, when Prof Brady, Mr Thompson, Prof Herdman, and several other biologists are going to Port Erin to work Nine investigators and students have already applied for accommodation at the station during April, and others are coming at later periods during the summer, so there seems every prospect of the institution being well used this season

IN connection with the conversazione to be held at the Royal College of Surgeons of England on July 5, to celebrate the jubilee of the Fellowship of the College, it has been decided, as this year is also the centenary of the death of John Hunter, to organise an exhibition of pictures, MSS, books, furniture, &c, connected with the great surgeon In addition to the articles which are the property of the College of Surgeons, the exhibition will include other relics, the loan of which has been kindly promised by the present possessors The librarian of the College will be pleased to give further information to any owner of Hunterian relics who may be willing to lend them for exhibition

A VERY successful conversazione was held by the students of the Royal College of Science in the South Kensington Museum on Thursday, March 23 Mr C V Boys concluded the various entertainments by exhibiting Mr Henry Dixon's photographs of spiders walking on water, Lord Rayleigh's and his own photographs of bursting bubbles, and by showing his interesting experiments with soap bubbles

THE council of the City and Guilds Institute for the Advancement of Technical Education have nominated the following as members of the Technical Educational Board of the London County Council, viz.—Mr Herbert Saunders, Q C, Sir Owen Roberts, and Dr W. J. Russell, F R S

THE Camera Club announces that the seventh annual Photographic Conference will be held in the theatre of the Society of Arts on Wednesday and Thursday, April 12 and 13, under the presidency of Captain W. de W. Abney, F.R.S Papers will be read by some of the leading students of photography, and all photographers are invited to take part in the conference

SOME time ago the Egyptian Government appointed a commission to examine the building in which the archæological collection is housed at Ghizeh This commission has now finished its investigations, and, according to the Cairo correspondent of the *Times*, its report shows the condition of the building to be even more dangerous than it was known to be. A fire would completely destroy the building in the course of a few hours. The Egyptian Government propose to have the Museum made fireproof at a probable cost of £90,000, but the result is not expected to be satisfactory A new building on a

more accessible site would be very much better, but unfortunately the Egyptian Prime Minister declines to sanction the necessary expenditure, which would be about £130,000. He seems to have a very inadequate conception of the extraordinary interest and importance of this famous collection

THE Gottingen Society of Sciences has recently proposed the following prize subjects —For 1893 From Rontgen and Kundt's researches on changes in the optical properties of quartz in an electrical field, there seems to be a close relation between the electro-optic phenomena and elastic deformations of that substance by electrostatic force An extension of this inquiry to a large number of piezo electric crystals of various properties of symmetry seems desirable, and attention should be given to whether the phenomena are due exclusively to the deformations occurring in the electric field, or also to a direct action of electrostatic forces on light motion For 1894 Between the state of a hard elastic body and that of a liquid are a series of intermediate states, producible by mixture The properties of these need elucidation by experiment, and especially it should be investigated how in the case of viscous bodies the laws of those movements vary, which, in the case of liquids of small viscosity, can be used to determine internal friction Papers to be sent in with motto, &c, before the end of September in each year. The prize in either case is about £25

THE following are the arrangements for lectures at the Royal Victoria Hall during April —April 11, Principal Garnett, "Some Pioneers of Electricity," with experiments, April 18, Prof A C Haddon, "The Life of a Papuan Savage," with lantern illustrations taken by the lecturer in New Guinea; April 25, Prof Hudson Beare, "The Printing Press" with special reference to newspaper work

MR G P BAILEY writes to us that the meteor seen on Saturday, March 18, by the Dundee correspondent whose communication we printed last week was observed also at Kingsland, Hereford Mr Bailey was informed of it by the observer on the following day From what Mr Bailey can gather, the meteor appeared about 6 20 in a north-north-easterly direction When first seen it was evidently nearing the end of its flight, and after moving towards the north west for about three seconds it was hidden by an intervening hill The trail left behind was visible for about twenty minutes When first seen the altitude would be about 30°

THE weather during the past week has been exceptionally fine in the British Islands, owing to anti-cyclonic conditions, which extended over the whole of western Europe During the first part, the day temperatures were much above the average, generally exceeding 60°, and even reaching 69° in the Midland and eastern counties, while the nights have been very cold, with sharp frosts on the ground, and fog was prevalent in many parts in the early morning The range of temperature has consequently been very large, exceeding 40° in the twenty-four hours on one occasion. On Sunday both solar and lunar haloes were visible at many stations in the south, and the anti cyclone partially disappeared from western Europe, but these indications of disturbed conditions were only of a temporary character, although the barometer began to fall irregularly. The day temperatures became several degrees colder, owing to the persistence of easterly winds, but the readings were still high for the season. A special characteristic of the week has been the dryness of the atmosphere, scarcely any rain having fallen in any part of the British Islands, with the exception of a quarter of an inch measured at Valencia Observatory on the 25th instant The *Weekly Weather Report* shows that for the first quarter of the present year there is a deficiency of rainfall in all districts, amounting to nearly four inches in the west of Scotland. The percentage of possible sunshine for the week ended the 25th instant was higher in nearly all districts than any obtained in the month of March since sunshine recorders were established, in 1881 The duration ranged from 36 to 66 per cent in Scotland, 52 to 60 in Ireland, and 62 to 82 in England, while in the Channel Islands the percentage was 91°, being a higher weekly value than hitherto recorded at any time of year

THE Deutsche Seewarte has recently published part v. of the observations made under its auspices beyond the sea The stations now number sixteen, of which six are in Labrador, five in Africa, one in each of the following places —Korea, Apia (Samoa), Brazil, Arabia, and Persia Four of the stations included in this part are new, viz Tripoli, Bahburg (West Africa), Apia, and Campinas (São Paulo) The observations are taken thrice daily, with good instruments, and all needful particulars are given about the stations, so that the series forms a very valuable contribution to our knowledge of the meteorology of remote regions

WE have received from Mr S B J Skertchly an account of a remarkable cold wave which passed over the southern part of China in January last Since the establishment of the Hongkong observatory in 1884 the lowest temperature observed in any previous month was 40 3, and this did not last more than an hour, but from January 15 to 18 inclusive the thermometer did not rise above 46°, and fell as low as 32° at the sea level on the 18th Simultaneous observations collected for 4h. p m from other localities show that the cold wave travelled a considerable distance from the north to the south of Hongkong The readings were —Canton 37°, Hongkong 35°, Macao 36° on the 16th, and Haiphong 46° on the 17th The comparative severity of the cold is also shown by the following values deduced from Hongkong observations for January 1884-8 — Mean minimum 56° 1, absolute minimum 41° 8 Dr Doberck reported that neither snow nor hail was seen in Hongkong, but the hills appeared to be covered with snow or hoarfrost, and a few hundred feet above the sea level both the grass and branches of the trees were covered in unusually clear and transparent ice, without any appearance of crystallisation The Chinese, who had never seen such a sight, brought down a quantity and sold it as medicine At Macao, however, a quantity of soft hail fell and lay from 3 to 6 inches in depth where the wind had drifted it The effect upon vegetation a few hundred feet above the sea was disastrous; nearly all the trees seemed burnt up, and nearly the whole of the butterflies on the wing were killed This was the coldest spell known to have occurred in China for over fifty years, and it was apparently due to a tongue of cold air being pushed below the warmer stratum The atmospheric circulation at the time was anticyclonic, and snowstorms were reported from the northward and eastward of Hongkong

THE Central Physical Observatory of St. Petersburg has commenced from January last the issue of a monthly meteorological bulletin referring to European Russia. It contains four pages of tabular matter, one of which includes the observations taken at 73 telegraphic reporting stations, and the other three contain rainfall observations taken at 312 stations, all the monthly means being calculated according to the Gregorian calendar The tables are followed by a general discussion of the weather of the month, and of the various meteorological elements, and, lastly, a map is given showing the mean monthly isobars, isotherms, and distribution of rainfall. With the exception of the preface, which Dr Wild has translated into German on a fly-leaf, the whole of the work is written in Russian, which, although one of the most methodical of modern languages, is not yet generally read in Western Europe, so that the usefulness

of this valuable publication is more restricted than it otherwise would have been

AN instructive record of medical experience at Davos Platz is given by Dr Spengler in *Fortschritte der Krankenpflege* It relates to the two and a half years from November 1887 to May 1890. Communication is kept up with patients after leaving, and the statistics give, in 177 cases, 28 8 per cent (51 cases) as "cured," 14 0 per cent as "perfectly fit for work," 17 0 as "still ill," and 31 6 as dead (In 17 cases, or 9 6 per cent, there is no record) Thus, a permanent cure seems to have been effected in 42 8 per cent of the cases It is noted that most of the patients were subject to influenza in the epidemic of 1889–90 Dr Spengler gives details of the treatment followed at Davos We note that, at the outset, till acclimatisation is completed, and the patient has slept well one or two weeks, he lies much in the open air, and takes little exercise Patients who come with fever soon lose it, and for this reason Dr Spengler has found Koch's much denounced tuberculin advantageous in certain cases, and still makes use of it The local or valley wind at Davos is always from the north-east, so that patients can enjoy the sun on the south side of the houses, and in this Davos has an advantage over the Engadine valley (also lying north-east to south-west), where the valley wind is from the south-west

PROF ELIHU THOMSON in the *Electrician* gives an account of a curious case of the apparent attraction of closed circuits by an alternating magnetic pole He finds that when a disc of copper is brought near the pole of an electro-magnet traversed by an alternating current it is at first repelled, but that if its diameter is less than that of the core of the magnet, the repulsion diminishes as it gets nearer and at last becomes an attraction The explanation given is that the currents induced in the disc, on account of its small diameter, do not suffer as great a lag as when induced in rings or discs which surround the pole, hence the repulsion is feeble, so that it is at last overpowered by the attraction between the induced currents and the iron of the core

AT a recent meeting of the Société Française de Physique M d'Arsonval gave an account of his experiments on the physiological effects of electric currents of high frequency The currents used ranged from one-half to two amperes and were obtained as follows The internal coatings of two small Leyden jars were connected to the terminals of a large Rhumkorff coil, while the internal coatings were connected through a spiral of from fifteen to twenty turns of thick copper wire When a spark passes between the terminal knobs of the coil, oscillations are set up, and on account of the self induction of the spiral of wire if the person or tissue to be experimented on is connected to the two ends of this spiral it will be traversed by a current of very high frequency. The following results were obtained — (1) The currents are not felt although they are of sufficient strength to light up a lamp requiring two amperes, when held between two persons who complete the circuit (2) The power of feeling the effects of currents of low frequency is diminished in all parts of the body traversed by these high frequency currents (3) Zones are formed round the electrodes (which consist of wet sponges) in which all sensitiveness to pain is for the time being lost (4) A remarkable effect is observed on the nerves which regulate the size of the blood-vessels (vaso-motor nerves), for the vessels dilate to such an extent that in some cases, when an animal was subjected to the current, the arterial pressure fell more than a quarter of its normal value. M. d'Arsonval maintains that these observations show that the reason these currents are not felt cannot be owing to their being confined entirely to the skin. He also suggests as the true explanation that the frequency is so high that the sensory nerves are not affected, just as the auditory and visual nerves are not sensitive to vibrations of certain frequencies

THE Royal Commission appointed to investigate the condition and education of the blind, the deaf and dumb, &c, did everything in its power to secure the best evidence that could be obtained Among those who brought forward facts as to the deaf were the well-known American authorities, Dr E M Gallaudet and Dr A G Bell Last year their evidence was printed in America, with some other matters, in a separate volume, and an elaborate index was prepared by Dr J C Gordon. This index has been carefully revised, and has now been issued by the Volta Bureau, Washington, the compiler having added to its value by the preparation of various "notes and observations" The volume may be of considerable service to serious students of the subject

THE *Board of Trade Journal* gives an account of a very interesting report prepared by M P Mouillefert, Professor at the National School, Grignons, on the vineyards of Cyprus He thinks that by its situation, its broken surface, its general incline, rising from sea-level to an altitude of over 6000 feet, Cyprus offers the most varied and favourable conditions for the cultivation of the vine This cultivation is, even at the present day, of real importance, not only from its area, which covers almost 145,090 deunums (100 deunums = 2 47 acres), but from the value of the produce it yields, which exceeds 3,500,000 francs, and affords a livelihood to over 10,000 families The method of cultivation, however, and the manufacture of the wine fall far short of what they should be, and this is owing to the ignorance and the poverty of the people M Mouillefert gives elaborate instructions as to the changes of method which he considers necessary, and expresses his belief that if they were adopted Cyprus might become "the vineyard of Great Britain" One of his proposals is that a professor of agriculture should be appointed who would confer with the villagers and gradually induce them to adopt the proper system of vine cultivation Meetings and exhibitions, at which prizes were given, would also, he thinks, be an excellent way of encouraging the producer to improve his method of cultivation and his produce

IN the current number of the *Mediterranean Naturalist* it is noted that upwards of 60 per cent of the earthquakes that have been recorded have occurred during the six colder months of the year—the maximum number in January and the minimum number in July. These are the results of calculations for the whole area of the globe The calculations made for separate earthquake districts are said to be in full accord with them, and to show in some cases even a greater proportion for the cold than for the warm season This is especially the case in the Mediterranean area, where the number of shocks experienced during December, January, and February are to the number felt during June, July, and August as 5 to 2.

THE Technical Instruction Committee of the Essex County Council has published what it calls a "Report and Handbook." The volume contains a most creditable record of work done during 1892, and ought to be of no small service to similar committees in other parts of the United Kingdom

MESSRS. GAUTHIER-VILLARS have issued the fifteenth report of the International Committee of Weights and Measures The report relates to the work done in 1891.

THE fifth volume of the "Œuvres Complètes de Christian Huygens" has just been published It consists of correspondence carried on in 1664–65 This magnificent edition, to which we have repeatedly called attention, is being issued by the Société Hollandaise des Sciences.

Messrs J. B Baillière et Fils, Paris, have issued the first volume of a work entitled "Eléments de Paléontologie," by Felix Bernard No fewer than 266 figures appear in the text The same publishers have issued in their "Bibliotheque Scientifique Contemporaine" a book on "Les Lichens," by A Acloque He deals with the anatomy, physiology, and morphology of the lichenic organism

Messrs George Bell and Sons have issued the second volume of Mr George Massee's "British Fungus-Flora," a classified text book of mycology The work will be completed in three volumes

Prof B Kotô has contributed to the Journal of the College of Science, Imperial University, Japan (vol v part 3) a learned paper on the Archæan formation of the Abukuma Plateau The paper is illustrated with several plates

Messrs Baillière, Tindall, and Cox have published a second edition of Veterinary Captain F Smith's "Manual of Veterinary Hygiene" The only important alterations in the book are those in the chapter on ventilation

A valuable "Catalogue of American Localities of Minerals,' by Prof E S Dana, has been reprinted by Messrs John Wiley and Sons from the sixth edition of Dana's "System of Mineralogy"

The Wagner Free Institute of Science proposes to issue a reprint of T A Conrad's monograph of "The Medial Tertiary Fossils of the United States," if subscriptions for 150 copies can be obtained The original plates would be reproduced by a process of photo-engraving, and a brief introductory chapter and a table would show the present state of the nomenclature of the species contained in the work

Starting with an observation by Hertz, that the cathode rays causing phosphorescence can pass through thin metallic plates, Herr Lenard has recently made some interesting experiments (described to the Berlin Academy) with an arrangement in which the rays from a small aluminium disc (as cathode) were projected on a thin aluminium "window" (0 003 mm thick), in a thicker metal plate at the opposite end of the tube The lateral anode was connected to earth, and a large inductorium was discharged through the tube These cathode rays passed through the window, and made the air faintly luminous, with bluish light, brightest at the surface of the window There was a strong smell of ozone Phosphorescent bodies, bodies brought near the window, glowed, having the same colour as *in vacuo* At about 2 4 inches distance the phenomenon ceased, it also ceased when the cathode rays were deflected with a magnet, or when a screen of sufficient thickness was interposed But owing to diffuse spread of the rays the phosphorescent action extended into the shadow of the opaque screen This field of observation beyond the window could be enclosed and evacuated, and the higher the vacuum, the greater was the distance at which phosphorescence took place, and the sharper and brighter were the rays—indicating (in the author's opinion) that these cathode-rays are a process in the ether Herr Lenard tried other gases besides air, and found varying penetration by the rays. When coal gas was let pass between the window and the phosphorescent body the latter brightened When the field of observation (enclosed) was filled with hydrogen at atmospheric pressure, the phosphorescence extended thrice as far as in air at the same pressure (viz. to about 8 inches) Oxygen and carbonic acid were less penetrable than air. "One may say that hydrogen molecules cause less turbidity in the ether than those of oxygen, and the latter less than those of carbonic acid."

Notes from the Marine Biological Station, Plymouth — Last week's captures include the Nemertine *Lineus marinus* (= *longissimus*) and the long spined sea-urchin (*Echinus acutus*) In the floating fauna the principal change has consisted in a great reduction in the numbers of Echinoderm larvæ and in the gradual disappearance of *Aurelia*-ephyræ, as well as in the appearance of numbers of *Arachnactis* (larva of the Actinian *Cerianthus*), of the Leptomedusa *Irene pellucida* (Claus, *non* Haeckel), and of a few *Porcellana* larvæ In addition to these, small *Obelia* medusæ and the Appendicularian *Oikopleura dioica* have been abundant, and young Ctenophores and Planarians have been occasionally present The Hydroid *Eudendrium ramosum*, the Nemertine *Amphiporus pulcher*, and the crab *Portunus arcuatus* are now breeding

The additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythus* ♀) from Zanzibar, presented by Mr C E Reynolds, a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr J W Jones, a Coypu (*Myopotamus coypus*) from South America, presented by Mr Arthur Hunt, a double banded Sand Grouse (*Pterocles bicinctus*) from Senegal, presented by Mr H H Sharland, F Z S, three Common Peafowls (*Pavo cristatus*, ♂ ♂ ♀) from India, presented by Mr W Murphy Grimshawe, ten —— Fishes (*Girardinus guppyi*) from Trinidad, presented by the Marquis of Hamilton, a Hawfinch (*Coccothraustes vulgaris*), four Bramblings (*Fringilla montifringilla*) British, purchased, a Hog Deer (*Cervus porcinus*) born in the Gardens

OUR ASTRONOMICAL COLUMN

Comet Holmes (1892 III) —Prof Keeler, in speaking of the hypothesis that this comet has been produced by a collision between two asteroids, says that the character of the spectrum has little to support this view He accounts for the brightening on January 16 by supposing that an increase in the number of reflecting particles in the space surrounding the comet took place, *i e* by an increase of density, which might result from a contraction following the previously observed expansion of the comet, or, which is more in accordance with the observations, from fresh emanations from the nucleus (*Astronomy and Astro physics* for March)

Apropos of the same hypothesis, Prof C A Young queries whether, if the asteroids were formed by a series of "explosions," breaking up first the original planet and afterwards the pieces from it, this might not be an event of that sort—an eruption from an asteroid We continue the ephemeris for the week —

12h Paris Mean Time

1893		R A. (app) h m s	Decl (app) ° ′ ″
March	30	3 20 48 7	+36 7 2
	31	22 38 7	9 44
April	1	24 28 9	12 25
	2	26 19·2	15 5
	3	28 9 7	17 44
	4	30 0 3	20 22
	5	31 51 1	22 58
	6	3 33 42 0	36 25 33

Wolsingham Observatory, Circular No 34 —The star Es-Birm 180 6h. 15 5m + 47° 43′ was found to be 10 5 March 20 and is variable On March 18, a red III Type star, 8 5 mag was seen at 3h 23 5m + 58° 11′ and may be variable Not in D.M. Places for 1900

Jupiter and his Satellites —Writing from Arequipa, Peru, Prof. Pickering communicates to *Astronomy and Astro physics* for March an account of the very valuable and important observations that he made during the past favourable opposition of the planet Jupiter A minute study of the planet's surface gave him the impression that his surface consists of a "uniform white mass of cloud," over which is stretched a gauzy and thin veil "of a brown material, resembling in struc-

ture our cirrus clouds. Where this veil occurs in denser masses there are the belts, and the phenomena of white spots is nothing less than holes in this veil itself exposing the uniform white layer below. During this period of observation the great red spot was extremely faint and seemed to belong to the white portion beneath, being apparently seen through a hole in the gauzy structure. Since October 8 last, when Prof. Pickering commenced a series of measures with the 13-inch telescope of the diameters of the satellites, some most interesting results have been forthcoming. It was on that day also that he observed one of these small bodies first as an elliptical figure, and then afterwards as a circular one, and later he had the good fortune to watch and observe the disc as it gradually began to assume the elliptical form. After this observation it was found that the other three satellites had at some time been reported as representing an elliptical disc, the shortening taking place equatorially, thus they would seem to revolve about their minor axes. To make quite sure that this was the case and not the result of some optical delusion, Prof. Pickering seems to have instituted various experiments, but the elongations, as he says, "nevertheless remained persistent in the same direction." The first satellite then is a prolate ellipsoid revolving about one of its minor axes in a period of 13h. 3m., while the other three assume at regular intervals the form of ellipses, these periodic changes being produced by the rotation upon their axes.

With respect to the second satellite, the shape of which, by the way, is put down as that of an ellipsoid of three unequal axes revolving about the middle one, and whose period of rotation is 41h. 24m., a curious observation was made in December last. Just about the time of occultation, the equatorial diameter being "decidedly shortened," the satellite retained its shape until almost in contact with the limb, when suddenly "the major axis of its ellipse changed its position angle through thirty degrees, becoming parallel to the limb of the planet." With regard to the other two satellites Prof. Pickering mentions many new facts relating to colour, size, rotation, &c., too numerous to refer to here, but we may say that he has been led to the conclusion that all the four satellites are nothing more than condensed swarms of meteorites, like Saturn's ring. In the case of each satellite he gives an ephemeris which indicates the time at which each presents its maximum elliptical phase.

THE HORIZONTAL PENDULUM.—In a volume of 216 pages entitled "Das Horizontal Pendel und seine Anwendung zur Beobachtung der absoluten und relativen Richtungs-Aenderungen der Lothlinie," Dr. E. von Rebeur-Paschwitz brings together all his observations made in the years 1889–92 at the observatories at Wilhelmshaven and Potsdam, and also in Puerto Orotava on Teneriffe. Besides containing a long discussion on the observations themselves, a very useful collection with short notes of the literature on this subject is added. The pendulum, which was of an isoceles triangle shape, carried a small mirror at the middle part of the shortest side, the movements of which were photographically recorded with the help of sensitised paper and an oil lamp. In addition to numerous seismical appearances, three distinct periodic pulsations were recorded. The first he says is with great probability due to the different positions of the moon, and after supplying the terms containing lunar factors he finds a close agreement between the observed and calculated values—the observations indicating the existence of a tide with a coefficient of 0″.01. With regard to the daily period, he finds that these movements are by no means local, but quite general over the earth's surface; the real cause of these motions do not seem to have been fully brought home, as the magnitudes of the amplitudes seemed to differ considerably locally; but in a note Dr. Paschwitz mentions that the action of the moon on the daily period is in all cases of great importance. The third and last movement, that of the motion of the zero-point, seems to be totally dependent on meteorological conditions.

THE RISING AND SETTINGS OF STARS.—At the present day there are many who are interested in the calculation of star places, times of rising of stars, &c., for times very remote, such as, for instance, in the solution of such problems that have arisen with regard to the orientation of temples, occultations, eclipses, &c. Where we now use the meridian, our early ancestors adopted the horizon, and it was to this plane that they referred many of their astronomical measurements. The heliacal rising and setting, and the cosmical rising and setting are only some of the expressions that were in use to define different relations between heavenly bodies and the horizon at a given time, and only quite recently has the importance of such terms as these been pointed out. In a late publication of the *Astronomischen Gesellschaft*, Bd. xx. Dr. Walter F. Wislicenus has worked out a set of tables for the computation of the yearly risings and settings of stars, and the special problems which can more easily with their help be solved may be stated as: (1) Given ϕ, ϵ, α, δ the latitude, obliquity of ecliptic and coordinates of a certain star for a certain year to find the longitude of the sun at the time of the heliacal rising. (2) Given ϕ, ϵ, for a certain date, and λ for the heliacal rising of an unknown star to find α and δ. (3) Given ϵ, α, δ, for a certain date and also the value of λ at the time of the heliacal rising to find ϕ the place of observation.

GEOGRAPHICAL NOTES

FRENCH exploration towards Lake Chad is being carried on steadily and successfully. The latest results have been obtained by M. Maistre, who set out from the Mobangi in July, 1892, traversed the south of Bagirmi through the Shari valley, and entered Adamawa by a route never before traversed by Europeans, ultimately descending the Niger, where the expedition reached Akassa on March 25. The health of the expedition was good, and in the earlier part of their work friendly relations were kept up with the natives. In Adamawa, however, there were hostile encounters.

MR. MACKINDER concluded his course of educational lectures for the Royal Geographical Society last week by a masterly discussion of some of the geographical aspects of British history. The effect of the position of the British Isles on their history was summarised concisely in the statement that Britain stands out of the continental world, yet looks into it through its south-east window, and looks not merely into the world, but into the great historic avenue of the world's life. Naturally, therefore, the centre of Britain's national and commercial life has been drawn eccentrically to the south east corner. This accounts for the inevitable position of London. The configuration of the country, with its natural zones of highlands and lowlands, led with equal clearness to the distribution of peoples and interests, which caused the historic opposition of England and Scotland.

MR. AND MRS. THEODORE BENT, after some delay at Massowa, on account of tribal wars, reached Adowa on the way to Aksum in the middle of February. At Adowa there are Himyaritic ruins of some importance, which Mr. Bent proposes to study before going on to Aksum, where he hopes to have several weeks of active archæological research.

IN a recent report on the triangulation of the north-west portion of South Australia published by the Government of that colony, the work of the surveyors during the last few years is briefly summarised. From 1888 to 1890 16,000 square miles were surveyed in the form of a belt, about fifty miles wide, stretching from the Anthony Range to the western boundary of the province, a distance of 320 miles. Up to the end of the 1892 season 11,300 square miles of additional land were surveyed. The work in many places was extremely arduous on account of want of water, a supply for the camels having sometimes to be carried for more than forty miles, and for more than a year no rain whatever fell.

THE INSTITUTION OF NAVAL ARCHITECTS

THE annual spring meeting of this Institution was held last week in the hall of the Society of Arts on Wednesday, Thursday, and Friday, March 22, 23, and 24. There was a fair number of papers on the agenda, of which the following is a list:—

On the present position of the cruiser in warfare, by Rear-Admiral S. Long. Merchant cruisers considered with reference to the policy of maintaining a reserve of vessels by annual subventions to shipowners, by Lord Brassey. Some considerations relating to the strength of bulkheads, by Dr. F. Elgar. On the measurement of wake currents, by George A. Calvert. On the new Afonassieff's formulæ for solving approximately various

problems connected with the propulsion of ships, by Captain E E Goulaeff, Imperial Russian Navy Some experiments on the transmission of heat through tube plates, by A J Durston, Engineer-in-Chief of the Navy Some notes on the testing of boilers, by J T Milton, Chief Engineer Surveyor, Lloyd's Registry of Shipping On an apparatus for measuring and registering the vibrations of steamers, by Herr E Otto Schlick On the repairs of injuries to the hulls of vessels by collisions, stranding, and explosions, by Captain J Kiddle, R N On approximate curves of stability, by W Hok Some experiments with the engines of the s s *Iveagh*, by John Inglis On the cyclogram, or clock face diagram, of the sequence of pressures in multi-cylinder engines, by F Edwards

Admiral Long's paper was the first taken, and was a useful contribution to a subject which is more of a military than an engineering or constructive interest Lord Brassey's paper, on the other hand, is chiefly of interest to the shipowner from a commercial point of view, although a very wide imperial matter is encompassed within the scope of the paper Lord Brassey maintains that this country cannot maintain her supremacy in first-class ocean liners of high speed, and carrying small quantities of cargo, in face of the foreign competition supported by state subsidies. Our own post office contribution for carrying mails is insufficient for the purpose of enabling British shipowners to compete with those of foreign states In the humbler class of ocean cargo steamers we can hold our own, as proved by the figures quoted The matter is well worthy of the attention of statesmen Admiral Long's and Lord Brassey's papers were discussed together, and occupied the whole of the Wednesday morning sitting

On the Thursday, the second day of the meeting, a paper by Dr Elgar was the first on the list, and is the outcome of some remarks made by the author in a speech during the discussion of Mr Martell's paper of last year upon a similar subject Dr Elgar refers to the report of the Board of Trade Committee upon the spacing and construction of water tight bulkheads in ships, saying that this report raises broadly and pointedly the question of how the strength of a large area of perfectly flat thin steel plating, which is supported at the edges and subjected to normal pressure, may be determined by calculation This, the author says, is the simplest form of the question thus raised In applying it to the case of a ship's bulkhead we require to deal with a continuous area of plating whose thickness is uniform, but with an area made of separate plates of varying thickness, and connected with riveted joints, which has stiffening bars riveted across in parallel lines at equal distances apart Dr Elgar pointed out that what is required is further experimental data upon which to base a theory of use to ship-designers in determining these points In the discussion which followed Dr W H White, the Director of Naval Construction, and assistant controller, supported the author's contention, as also did Mr Martell, the chief surveyor of Lloyd's, and Mr Bryan, of Cambridge The two former, who, it is needless to state, are influential members of council, advocated that a research committee should be formed for the purpose of investigating the matter and accumulating experimental data Sir Edward Harland, who was chairman of the Board of Trade Committee before referred to, opposed this suggestion on the ground that the Board of Trade Committee had made experiments sufficient for the purpose, and until those experiments had been proved to be defective he thought that any further sums spent would be largely wasted We do not think the meeting was in accordance with Sir Edward's views As Dr White pointed out, the experiments made under the supervision of Sir Edward Harland were more of the nature of experiments on individual girders, rather than on plated surfaces, supported by stiffeners, the stiffeners being treated as the girders. As Mr. Bryan said, what ship-builders really want is a rule based on scientific investigation by which they can be guided in cases where there is not absolute experimental data. We quite agree with Mr Bryan that this subject wants to be lifted out of the region of empiricism which has always surrounded it. There is, however, not much prospect of the committee of the Institution being formed, not on account of its being unnecessary, but because there are not sufficient funds at the disposal of the Institution. Dr White was anxious that the members should be asked to express formal approval of the step to be taken in carrying out this investigation, in order to strengthen the hands of the council We think, however, that no strengthening of this nature is requisite, for, if we mistake not, such work as this is directly within the scope of the Institution, as set forth by the original design upon which it is based

Lord Brassey, who occupied the chair, advised that the council should memorialise the Board of Trade in order that the Government might take the matter up No doubt if such a step be taken, a committee will be formed, and those members who have taken a prominent position in the discussion of these matters would no doubt be willing to act—in fact they could not very well refuse It is to be hoped also that Mr. Bryan, although not a member of the Institution, will be included in the list It is very desirable that practical consideration should be kept strictly in view in such a matter as this, but in order to be practical, the investigation should be based on a scientific foundation There are several naval architects who are mathematicians in the best sense of the word Mr Bryan is, however, a mathematician first, and that of a very high order, having distinguished himself at Cambridge His grasp of mechanical subjects has also proved considerable, as evidenced by the original work done at the Cambridge Philosophical and his contributions to the British Association. His paper on the buckling of the thin plate will be remembered in this connection, and since then he has turned his attention to a study of the buckling of plates. His inclusion in the committee would be a guarantee that any experiments made would include the whole subject and not be simply girder tests

Mr Calvert has take up a very interesting subject for investigation The measurement of a steamer's wake is a problem that has been looked on by many as practically insoluble, but Mr Calvert has attacked it in a practical and philosophical manner He has towed a large vessel, 260 feet in length, measuring the velocity of the wake by means of towing logs This vessel was towed from Holyhead to Liverpool Unfortunately the experiment was not so successful as might have been hoped. The speed of the vessel varied during the voyage and the logs only showed the average The action of the rudder also affected the stream lines There were other sources of error The author therefore was reduced to model experiments, the vessel he used was 28½ feet long, and 3 66 feet draught Across the stern was fitted a framework upon which several fine vertical wires were stretched, extending from the deck to some distance below the keel, each of these wires, and the apparatus connected with it, being exactly similar to its neighbours Upon the wires at the level at which the weight measurement was required a horizontal tube, ¼ inch internal diameter, was carried by a universal joint near its forward open end The end of this tube was in communication with another tube, closed at its upper and lower ends, and hung by trunnions to one end of a weighted lever One of the trunnions being hollow formed a connection through the rubber tube to the under side of a gauge glass inside the model, so that through this system of jointed tubes there was free communication between the gauge glass and the water outside On the after end of the tube four thin radial feathers were fixed, and as the weight of that end of the system of tubes was accurately balanced by a lever, the horizontal tube necessarily assumed a position parallel to the direction of any current in which it might be placed, and its open forward end was consequently always presented normally to the current

In order that the attitude of the submerged tube might be noted by the observers in the boat, the vertical tube carried a light rod, the top of which indicated the inclination in any direction of the tube; four or five of such horizontal tubes were fitted at one time, each on its vertical wire, and having its connections as described, and another such tube with similar connections was carried by an outrigger reaching out into water that was practically undisturbed Records were taken by means of a photographic camera. If the water into which these horizontal tubes advanced were at rest, or if its velocity throughout were uniform, then the water in the gauge glasses, rising higher and higher as the speed increased, would still stand at the same level in all the glasses. Assuming that the tube carried by the outrigger was always advancing into undisturbed water, then the water in the gauge glass connected with that tube would serve as a datum line from which, at that instant, the relative elevation or depression of the water in any other gauge glass could be measured, indicating to its corresponding horizontal tube that the water through which it was passing was either following or meeting the boat. The wave of the boat was a disturbing element which had to be allowed for The data being appraised

by means of photographing the waves' profile. The author also towed a flat plank, 28 feet long, at a speed of 406 feet a minute The speed of current recorded at distances of 1 foot, 7 feet, 14 feet, 21 feet, and 28 feet from the leading end were respectively 16 per cent, 37 per cent, 45 per cent, 48 per cent, and 50 per cent of the velocity of the plank These proportions appear to be maintained at all speeds between 200 and 400 feet per minute Having thus determined the maximum velocity of the frictional water, other experiments were made with this plank to show the manner in which the motion of the water in contact with the surface was gradually imparted to the layers of water lying underneath This was done by means of tubes, the forward ends of the tubes being open, and their after ends connected to gauge glasses The results of experiments at 200, 300, and 400 feet per minute would appear to show that the velocity decreases in a geometrical progression as the distance from the surface increases in arithmetical progressions The retardation of velocity in the somewhat analogous conditions of orbital wave motion of the flow of rivers, and possibly of glaciers, appears to confirm the foregoing observations as regards the ratio of decrease in velocity of the frictional weight Mr Calvert next went on to refer to the labours of Dr Froude, and his report to the British Association for 1874 We regret that space does not allow us to accompany him in this most interesting investigation, and we must refer our readers to the Transactions, in which the whole matter will be published in full In the discussion which followed, Dr White, Mr Froude, and others spoke, but no new facts were brought forward

The next paper of interest was a contribution by Mr A J Durston, Engineer-in Chief of the Royal Navy, and dealt with the important matters which are comprised in the problem of leaky tubes Our readers will be aware of the trouble that has arisen in the Navy from the leakage at tube plates and tube ends, where marine boilers have been driven to their maximum The difficulty has been got over to a certain extent by the introduction of a peculiar form of ferrule These ferrules are bent over at their ends and protect the joint of the tube and tube plate from the fierce impact of flame Naturally the ferrules themselves get burnt away, as there is an air space between them and the heated surface of the boiler by which the heat would be abstracted from the end With malleable cast-iron, the destruction is not so rapid as one would imagine, for, we believe, although the fact was not stated at the meeting—that a spare set is all that is provided for a commission, that is to say, two sets of ferrules, one in position and one spare will last for three years The experiments upon which Mr Durston's paper is founded were made in various ways, with parts of boilers constructed especially for the purpose. The temperatures were generally ascertained by means of plugs at fusible alloys let into the plates through which the heat was transmitted An interesting series of experiments was also made as to the temperature of the products of combustion at different distances within the tubes of a boiler This was done by means of a Le Chatelier pyrometer And it may be said that the curve of temperatures obtained in this way agrees very closely with the curve of evaporation obtained by Mr Wye Williams We have not space to give the details of Mr Durston's many trials One very striking thing was the extremely deleterious result of grease in the boiler, by preventing the proper transmission of heat.

Mr. Milton's paper followed. Its object was to show that when a cylindrical boiler of the return tube type is subjected to pressure the staying of the combustion chambers to the shell has an effect of distorting the shell, dragging it out of the cylindrical form, thus the flat surfaces of the combustion chambers tend to bulge inwards on themselves, and away from the shell. This sets up strains which are not equally distributed around the whole circumference of the shell In order to overcome this, Mr. Milton proposes to stay the combustion chambers with stays radiating from the centre of the shell and distributed all round, so that the stress will be equal on all parts The author quoted experiments showing that the distortion due to the cause named is far greater than is generally supposed by engineers, in one case amounting to as much as one-eighth of an inch on the diameter This was at a pressure of 320 lbs. on a boiler 14 feet in diameter having three combustion chambers

Herr Schlick's paper was of remarkable interest He has devised an instrument by which a record is obtained, not only of the vertical but of the horizontal vibrations of steamers Without the aid of illustration it would be impossible for us to describe this very ingenious apparatus Vibration is an important factor in the design of modern steamers of high speed Our readers will remember Mr. Yarrow's contributions on this subject, and the very valuable practical results he adduced from the experiments made on torpedo boats In ocean steamers the question of vibration is now one of great moment. In one well-known Atlantic liner the vibration at one time was a serious objection to the vessel, and the nodal points of vibration were well marked in the length of the vessel, so much so that cabins on these points were greatly preferred, and those who were fortunate enough to be in the confidence of the stewards were able to secure these cabins It has been shown that the action of the screw itself had very little to do with this vibratory disarrangement, it being the synchronisation of the reciprocating parts of the engine with the natural vibration of the structure of the hull that produces the effect in the most aggravated form

Mr Hok's paper on curves of stability is a valuable contribution to the Transactions of the Institution The author is himself engaged practically in work of the nature which he describes, being a draughtsman in a shipyard on the north east coast The Institution can hardly have too many papers from authors of Mr Hok's position and attainments We do not propose here to enter into a description of the geometrical principles upon which the author bases his formula, and must refer our readers to the Transactions of the Institution for details The system claims to give no more than approximation, but it is applicable to all kinds of ships and has the great merit of being readily constructed

The last evening of the meeting Mr John Inglis gave some interesting particulars of experiments made with a view to test the desirability of running triple compound engines as two cylinder compounds when low power only is required The system has been frequently advocated with a view to save coal, but Mr Inglis's results do not seem to bear out this claim. Two four-hours' trials were made, one with the engine working as an ordinary triple, and the other with the intermediate cylinder thrown out of use Working triple, the I H.P was 810, working two cylinders, 351 In the former case the coal consumed per I H P per hour was 147 pounds With the intermediate cylinder out of use the coal was 2 238 The consumption of feed water corresponding was 15·25 pounds, and 23 18 pounds per I H P per hour Of course the comparison must not be taken as indicating degree of the superiority of the triple expansion engines over the ordinary compound, great as that superiority undoubtedly is

A paper by Mr Cole on the same subject follows, but the results obtained are not sufficiently conclusive to demand quotation

The last paper at the meeting was the contribution by Mr. Edwards. Its title sufficiently explains its scope, and it would be quite impossible for us to follow the author's explanation without the aid of the diagrams which he exhibited on the walls of the theatre

The chief event of the meeting was reserved for the last It was the presentation of an address to Lord Ravensworth, who for fourteen years has occupied the position of president to the Institution He now retires, his successor being Lord Brassey The address referred to the great services that Lord Ravensworth had rendered to the Institution, and the authors of it gave utterance to no conventional platitudes. Lord Ravensworth has worked hard for the Institution of Naval Architects, and has conducted its meetings without favour to any, so that the humblest member could get a hearing equally with the most distinguished. It is not always so in societies of this nature

A summer meeting of the Institution will be held at Cardiff, a very cordial invitation having been received from the Welsh metropolis. The meeting promises to be of unusual success, judging by the programme which is set forth, and the arrangements made

THE ACTION OF GLACIERS ON THE LAND

PROF. T G BONNEY, F R S, read a paper to the last meeting of the Royal Geographical Society on the question, Do glaciers excavate? In view of the correspondence recently published in our columns the arguments adduced in support of the negative conclusions may be cited in some detail.

The question of the glacial origin of lakes involves many separate considerations While lakes undoubtedly abound in regions now or formerly subjected to glaciation, many of these are formed by the damming of valleys by moraine heaps, or by extensive landslips The school of Sir A Ramsay affirm that glaciers are powerful excavating agents, and that there is no other agent but ice competent to form a rock-basin The last argument breaks down when one considers the number of depressions of all sizes gradually increasing from mere volcanic craters to those of the Jordan Valley and the Caspian Sea, in the formation of which ice could have had no part The argument that Greenland alone holds the key to the phenomena of glaciation breaks down, for the Alps were once the seat of a vast ice-sheet, which over rode all the minor inequalities of the surrounding country, and of which the existing glaciers are the shrunken remnant. Thus the Alpine valleys should serve to show the typical results of ice action on the land This is the sum of their evidence toothed prominences have been broken or rubbed away, the rough places have been made smooth, the rugged hill has been reduced to rounded slopes of rock (like the backs of plunging dolphins) But the crag remains a crag, the buttress a buttress, and the hill a hill, the valley also does not alter its leading outlines, the V like section so characteristic of ordinary fluviatile erosion still remains, all that the ice has done has been to act like a gigantic rasp, it has modified, not revolutionised, it has moulded, not regenerated No sooner do we come to study in detail the effects of the ancient glaciers in the upper valleys of the Alps than we are struck by their apparent inefficiency as erosive agents Here, where the ice has lingered longest, just beneath the actual glacier we see that a cliff continues to exist Again and again in a valley we may find that on the lee side of prominences crags still remain, sometimes in sufficient frequency to be marked features in the scenery The Haslithal is an excellent and representative example The result of prolonged personal study of the Alps may be summed up in the words—"Valleys appear to be much older than the Ice Age, and to have been but little modified during the period of maximum extension of the glaciers"

The evidence as to the erosive power of glaciers is very slight Dr. Wright showed that the great Muir Glacier in Alaska covers great stretches of undisturbed gravel in which upright tree stems remain Prof Bonney proceeded to say — In the Alps about the year 1860 the glaciers began to dwindle By 1870 considerable tracts of bare rock or debris were exposed, which a dozen years before had been buried under the ice On none of these have I seen any basin like hollow or sign of excavation as distinguished from abrasion The Unter Grindelwald Glacier in the last stage of its descent passes over three or four rocky terraces The angles of these are not very seriously worn away, nor are hollows excavated at the base of the steps The bed of the Argentière Glacier (I made my way some little distance under the ice) was rather unequal, and was less uniformly abraded than I had expected There were no signs whatever of the glacier being able to break off or root up blocks of the subjacent schistose rock it seemed simply to wear away prominences This also is true of other glaciers. Prior to 1860, and again in 1891, I saw glaciers which were advancing They ploughed up the turf of a meadow for a foot or two in depth, they pushed moraine-stuff in front of them, showing some tendency to over ride it, and nothing more. In 1875, at the foot both of the Glacier des Bois and of the Argentière Glacier, was a stony plain Both these proved to have been recently uncovered by the ice, in other words, the glacier had not been able to plough up a boulder-bed even at a place where, owing to the change of level, some erosive action not unreasonably might have been expected. But, further, on both these plains big blocks of protogine were lying which were striated on sides and top, thus showing that the ice had actually flowed over them, as if it were a stream of mud Some of the difficulties in the way of believing in the scooping out of lake-basins have now to be considered.

First, in regard to their position some of them, such as Constance, Geneva, Como, Maggiore, &c., are comparatively near to the lower limits of the great ice sheets, and so would be covered for a relatively short time. All of them are many miles from the ends of the existing glaciers, yet we are asked to admit that a rock basin, in depth sometimes exceeding 1000 feet and generally more than 500, has been scooped out in a time much shorter than that which has proved insufficient for the obliteration of the original features of the upper valleys or for the deepening of their beds by more than a few yards at most—indeed, as a rule, the ice seems never to have been able to overtake the torrent

The radiating arms of the Lakes of Lucerne, Lugano, and Como are insuperable difficulties in the way of accepting a glacial theory of the origin of these lakes, and the configuration of the Lake of Geneva and the other lakes in France recently minutely surveyed, lends no countenance to the theory of excavation

One fact to which Prof J Geikie has called attention seems at first sight strongly to support Sir A Ramsay's hypothesis, and is the only real addition, in my opinion, which has been made to the original reasons. It is that many of the Scottish lochs are true rock basins, and that similar basins frequently occur outside their mouths This also often holds of the fjords in Norway, New Zealand, and elsewhere Prof Geikie points out that several of these basins occur just when the ice might be expected to obtain an increased scooping power His map at first sight appears very convincing, but a study of the larger charts reveals many anomalies Loch Linnhe, for example, from below the entry of Loch Leven, maintains a general depth of from 34 to 50 fathoms, then, below Loch Corrie, a channel may be traced which varies in depth from 50 to 60 fathoms, after which, in the Lynn of Morven, we find it deepen to 70 fathoms, then to 90 fathoms, and at last, a little north-east of the line joining Barony Point with Lismore Point, it expands into a basin with a maximum depth of 110 fathoms But outside, in the Sound of Mull (to the north west) the depths become very irregular, varying from about 35 to 70 fathoms Barony Point appears to be connected with Mull by a submerged isthmus, generally less than 20 fathoms below the surface But here, if the glacier were stopped by impinging on Mull, it ought in splitting to be pushing hard upon its bed In all this region the irregularities of the bed are very perplexing, whatever hypothesis be adopted, but I will restrict myself to a single instance Off the west coast of Scarba, under the lee of the "Islands of the Sea," and where the opening towards Colonsay makes it improbable that the ice can have forced into a narrower space, an elongated basin occurs in which the soundings—outside about 60 fathoms—deepen to 100, and at one place to 137 fathoms The sea-bed about Arran presents similar difficulties In short, here, at Loch Etive, Loch Lomond, and in other places, all goes well only so long as we restrict ourselves to generalities and abstain from details

The theory of the origin of rock basins, which I brought forward full twenty years ago, is now supported by much additional evidence It is that the lake beds are ordinary valleys of sub-aerial erosion, affected by differential earth-movements This has been very strongly confirmed by the surveys of the old beaches of the great lakes of North America, the Iroquois beach being full 600 feet higher at the north eastern part than it is at the western end of Lake Ontario.

To conclude, glaciers, when the paths which they have traversed are carefully studied, appear to have acted, as a rule, as agents of the abrasion rather than of erosion Even in the former capacity they have generally failed to obliterate the more marked pre-existent features due to ordinary fluviatile and sub-aerial sculpture In the latter capacity they seem to have been impotent, except under very special circumstances, thus, while we may venture to ascribe to glaciers certain shallow tarns and rock basins in situations exceptionally favourable, we cannot assign to their agency either the greater Alpine lakes or any other important lakes in regions which were overflowed by the ice only during the period when it attained to an abnormal development In the discussion which followed the paper, Dr. Blanford, Sir Henry Howorth, Mr Freshfield, and Mr. Conway took part

FURTHER STUDIES ON HYDRAZINE

A FURTHER contribution to the chemistry of hydrazine, N_2H_4, is communicated by Prof Curtius to the current number of the *Berichte* The first portion of the memoir deals with the preparation and properties of substituted hydrazines containing the radicles of the organic acids. In the latter portion a number of inorganic salts containing hydrazine are described.

When hydrazine hydrate is brought in contact with the amides,

chlorides, or esters of the organic acids, primary acid hydrazines are produced, of the general structure R CO NH NH_2, where R represents the hydrocarbon radical contained in the acid Ammonia, hydrochloric acid, or alcohol is simultaneously formed, according as an amide, a chloride, or an ester is employed The reactions proceed with facility and regularity, frequently in the cold, and afford theoretical yields of the substituted hydrazines. For many reasons, however, the esters are most convenient for the preparation of these acid hydrazines upon a large scale.

The primary acid hydrazines are colourless, non volatile solids which usually crystallise well The first member of the series, formyl hydrazine, H CO NH NH_2, melts at 54°. They are usually soluble in water and alcohol, but insoluble in ether Most of them form stable salts with one molecule of hydrochloric acid The hydrogen of the imido group NH is replaceable by metallic sodium or by the radical acetyl They possess reducing properties similar to those of phenyl-hydrazine, and they condense readily with aldehydes and ketones to form insoluble tertiary hydrazines Upon heating, frequently by simply boiling their aqueous solutions, they become converted into secondary symmetrical hydrazines in accordance with the equation $2R\ CO\ NH\ NH_2 = R\ CO\ NH\ NH\ CO\ R + N_2H_4$ The liberated hydrazine decomposes into ammonia and free nitrogen

The secondary symmetrical acid hydrazines are very stable substances, soluble only to a slight extent in water They are usually colourless, possess high melting points, and behave as acids By the action of powerful oxidising agents they are converted into substances endowed with brilliant colours, ranging from yellow to bright red, which appear to be of the nature of "azo" compounds

Of particular interest is the substituted hydrazine obtained by the action of hydrazine hydrate upon urea, the amide of carbonic acid When urea is boiled with hydrazine hydrate a monohydrazide is first produced, NH_2 CO NH NH_2 This substance, however, is unstable and passes spontaneously into the secondary symmetrical compound NH_2 CO NH NH CO NH_2 with elimination of hydrazine, N_2H_4 This secondary hydrazide is identical with a compound of the same constitution previously obtained in an entirely different manner by Thiele

An extremely interesting reaction occurs when the acidyl hydrazines of monobasic acids are treated with nitrous acid They are directly converted into esters of azoimide, N_3H, in accordance with the following equation —

$$R\ CO\ NH\ NH_2 + NO\ OH = R\ CO\ N_3 + 2H_2O$$

During the course of work upon this latter reaction it was observed that the organic azoimides, both those containing acid and those containing hydrocarbon radicles, R.CO N_3 and RN_3, behave in a peculiar manner with water Thus diazobenzene imide $C_6H_5.N_3$ resinises with a copious evolution of gas, similarly benzoylazoimide, C_6H_5 CO N_3, when boiled for some time in contact with water evolves large quantities of nitrogen and carbon dioxide, and becomes converted into a magnificently crystallising base of the composition of a symmetrical diamido benzophenone, $C_6H_4.NH_2$ CO NH_2 C_6H_4

The hydrazines of dibasic acids do not yield derivatives of azoimide, but break up with a violent evolution of nitrogen and formation of secondary symmetrical hydrazines For instance the hydrazine of oxalic acid yields the symmetrical compound

$$\begin{array}{c} \text{CO.NH NH CO} \\ | \qquad\qquad\quad | \\ \text{CO NH NH CO} \end{array}$$

Several of the hydrazines of unsaturated acids behave in a manner peculiar to themselves. Thus the hydrazine derived from fumaric acid, $C_2H_2(CO\ NH.NH_2)_2$, yields with nitrous acid an extremely explosive colourless compound, of the nature of a diazofumaramide, $C_2H_2(CO\ NH\ N_2.OH)_2$.

Prof. Curtius has succeeded in preparing a large number of double salts of metallic sulphates and chlorides with hydrazine sulphate and chloride. The double sulphates are constituted according to the general formula $(N_2H_4)_2H_2SO_4.R''SO_4$, and are distinguished by their difficult solubility and by the absence of water of crystallisation Salts of the series have been prepared containing as the metal R″ copper, nickel, cobalt, iron, manganese, zinc, and cadmium , magnesium does not appear capable of forming a double sulphate. The blue copper salt is only soluble to the extent of one part in 1150 parts of water at 10° It dissolves in ammonia with evolution of nitrogen

The double chlorides are constituted according to the general formula N_2H_4 HCl.RCl They are readily soluble in water, and certain of them may also be recrystallised from alcohol Some contain water of crystallisation, while others are anhydrous and exhibit sharp melting points

Hydrazine likewise forms a double phosphate with magnesium, which closely resembles ammonium magnesium phosphate

Hydrazine appears to be remarkably stable towards nitric acid, but Prof Curtius has eventually obtained the nitrate, N_2H_4 HNO_3, in splendid crystals which melt at 70° If these crystals are heated suddenly they explode with great violence The acid salt, N_2H_4 $2HNO_3$, loses nitric acid when its solution is evaporated It may be remembered that Prof Curtius observed a similar greater stability of the monacid salt in the case of the chlorides, for upon heating the dihydrochloride, N_2H_4 2HCl, to 140°, it was found to be completely converted into the monohydrochloride, N_2H_4 HCl

A E TUTTON

THE INTERNATIONAL CONGRESS OF PREHISTORIC ARCHÆOLOGY AND ANTHROPOLOGY

IT is probably unique in the history of congresses that a report of the proceedings should be published within a period of three months from the time of the meeting Such a feat was accomplished by the publication committee of the International Congress of Prehistoric Archæology and Anthropology, the eleventh session of which was held some time ago at Moscow All the communications are printed in French The first volume of the Report is divided into five sections, of these the first is devoted to geology and palæontology in their relations to primitive man In his paper upon the constitution of the quaternary deposits in Russia and their relations to the finds resulting from the activity of prehistoric man, S Nikitine draws the following conclusions —The subdivision of the stone age into palæolithic and neolithic epochs should be retained for Russia in Europe, because it coincides with the geological subdivisions pleistocene and recent, which in their turn are based upon palæontological facts The study of the glacial deposits of Finland and of the western region do not furnish any proof of the existence of two special glacial epochs and of an interglacial epoch , all the facts can be explained by phenomena of the oscillation of a glacier at the time of its gradual but irregular retreat The time corresponding to the inter-glacial epoch and that of the second glaciation of the Swedes was probably for the greater part of Russia the period of the formation of ancient lacustrine deposits, of the loess and of the upper fluviatile terraces, containing the bones of the mammoth and other extinct mammals. Man lived simultaneously with the mammoth during the second half of the glacial epoch along the limit of glaciation, knowing amongst other things the use of fire, but only making splintered flint implements As the glacier retreated man advanced towards the north and north-west; he arrived in Finland and in the Baltic region after the close of the glaciation, and after the disappearance of the mammoth , but man then possessed the more advanced culture of the neolithic period, and besides chipped flint implements he knew how to make implements of polished stone, pottery, &c. Russia in Europe does not present any traces of man in the first half of the pleistocene or of still more ancient man.—Prof W W Dokoutchaiev contributes a valuable essay on the Russian steppes, past and present, in which he deals with the last page of Russian geology, and comes to the conclusion that before the glacial period the difference between the relative altitudes of the north west and of the centre of Russia were much more considerable than at present. The author describes the carving of the steppes and their surface drainage , their soil, and that of the forests, the vegetation, fauna, and climate of the

steppes As the soil of the forests differs in character from that of the tchernozème the author and M. Gheorgievsky were able to prove the greater extent formerly of the Poltava forests.—The second section deals with prehistoric archæology In a paper entitled comparison of the primitive industries of France and Asia, G Chauvet discusses the question "Can one establish general divisions, applicable to both Western Europe and Asia, for prehistoric times and especially for the palæolithic period?" The general progress of the industrial arts has been the same in Asia and in Europe during prehistoric times, but how far these epochs were synchronous is unknown In order to have terms for comparison it is necessary to have a "fixed base" such a base is afforded by the glacial phenomena He concludes by urging that the great engineering works which are now progressing in Asia afford opportunities for obtaining information on these problems which should not be neglected —Lubor Niederle (of Prague) calls attention to the latest results of prehistoric archæology in Bohemia, and its relations with Eastern Europe, and arrives at the conclusion that the Slavs arrived in Bohemia earlier than is admitted by historians He believes that the Slavs, like the Germans and Gauls, were originally dolichocephalic, and of a blonde complexion —The other papers in this section are short, two of them being on nephrite —The third section is confined to tumuli and encampments (*Kourganes et gorodistchtschés*) —A Spitzine reports on the bone encampments in the north of Russia.—P Krotov comes to the following conclusions in his paper on the layers of stone implements in the district of Iaransk, government of Viatka, the stone implements of the district of Iaransk do not belong to the true stone age, but to the epoch of the encampments and other ancient dwellings of the Finns, who made use of implements of stone and bone, along with utensils in iron and bronze During this period of the life of the Finns, elements of a more advanced civilization penetrated into their country, coming from the centres of civilization of eastern Russia, flint and bone implements being replaced by iron tools.—B Pérédolsky has a paper on the "jalnik" (necropolis) of Iuriévo, in the district of Borowitchi, government of Novgorod "—The first paper in the Anthropological Section is by Topinard on race in anthropology, in which he asserts, (1) On no part of the surface of the globe can one discover a population entirely free from mixture, and presenting only a single type, (2) that the anthropological materials on which we work, and from which we extract the double notion of the type to begin with, and of its continuity in time, are only peoples, (3) that if the first factor, the type, is accessible with labour, the second, its permanence in time, is only a conjecture which it is impossible to demonstrate, (4) that in consequence the notion of race in the two factors, and especially in the latter, is only a subjective notion, a mental conception, peoples and their historic elements being the only objective realities Later on he says · "In order to show how in Europe, for example, the question of nationalities is foreign to that of races, or even of the constituent elements of peoples, one need but remember that three or four races (using the word conditionally) only are fundamentally concerned in the formation of the numerous peoples which at the present time are distributed from north to south, and from east to west. The races are the whites, the brachycephals, and the browns. They are found everywhere, with only here and there some secondary additions. Their proportions alone vary To the north there are more blondes; in the centre, from the Urals to Portugal, the brachycephals dominate, to the south, around the Mediterranean, the browns are in the majority If two peoples agree in certain characters it does not follow that they have the same nationality Kollmann, in an illustrated paper on the human races of Europe and the Aryan question, argues that it is necessary to distinguish at least four different types in Europe (the *Dolichocephalic leptoprosopes* and *chamæprosopes* and the *Brachycephalic leptoprosopes* and *chamæprosopes*) which have continued, without any doubt, since the neolithic period, that the intellectual European culture is a common product of these types —In his paper on the weight of the brain among several peoples of the Caucasus, Dr. N. Giltchenko gives valuable data on fifty-seven subjects. Anoutchine has a paper entitled, "On Ancient, Artificially Deformed Skulls found in Russia."—The last section is devoted to Prehistoric Ethnography. In his contributions to the prehistoric ethnography of Central and North-East Russia, J. Smirnov concludes that the linguistic facts permit the supposition that only a part of the remains of the neolithic period of Central Russia can belong to the Finns The antiquity of sepultures can be determined, besides other ways, by the animal bones deposited with the dead The N-S position of the skeleton may be regarded in Central Russia as one of the indices of ancient Finnish sepultures To the category of the monuments of prehistoric epochs belong geographical names The place names of northern and central Russia prove that its pre- or protohistoric population has been more homogeneous to the east, in the region of the Permiens and Ougriens, and more mixed to the west —N. Troitzky has a very interesting paper on vestiges of paganism in the region situated between the upper courses of the Oka and of the Don Fire, tree, and stone cults persist, but modified by Christianity —E Chantre has a project for reform in the nomenclature of the peoples of Asia", and A Ivanovsky, some information upon the questions (1) of the simultaneous employment of sepulture and incineration, and (2) of the stone statues called "Kamennya baby"—The last is the most important communication, "Which is the most ancient race in Russia?" by Prof. A Bogdanov, of Moscow He finds that the most ancient skulls are dolichocephalic In passing to the more modern tombs since the fifteenth century, we see a diminution of the quantity of dolichocephals and the preponderance of brachycephals In the ancient tombs of the government of St Petersburg, as well as in some districts of Novgorod, we meet from the stone age onwards skulls of a type quite distinct from those characteristic of the tumuli (*kourganes*) of Central Russia From Moscow eastward, and as far as the Urals and Siberia (Tobolsk), we find the tumuli of the brachycephals In the governments of Moscow, Smolensk, Riasan, and Don, we have only in some localities the series of the dolichocephals, and in others a kind of mixture of characters, in these localities, more than in the others, mixture was possible, since they are found either on the great routes of migrations, or at the limit of the distribution of different races In the tombs called "Scythian" the majority of the skulls quite resemble the dolichocephalic tumuli-population of Central Russia One finds only occasionally Mongoloid skulls in the tumuli of Central Russia, and in the tombs of Southern Russia, whilst in the tumuli of Tobolsk, and of the Uralian countries they abound and often predominate The territory of this dolichocephalic leptoprosopic primitive people is very distinctly limited to the north, east, and south by the tumuli, with a population quite brachycephalic, or presenting this type in preponderance There is no south-west limit In Galicia, north and south Germany, and Sweden we meet with the same type in the ancient tombs as in those of Central and Southern Russia There are true primitive dolichocephalic chamæprosops in Asia among the Mongolians, but not in Europe Kollmann's European types appear to be the result of mixture with brachycephals, or of what Virchow calls "pathological races" Dolichocephalism is more and more diminishing in Europe The larger and broader heads of the civilized classes should be attributed to other causes than merely to mixture.

A C H.

SCIENTIFIC SERIALS

The Quarterly Journal of Microscopical Science for January, 1893, contains.—On the relationships and *rôle* of the Archoplasm during mitosis in the larval salamander, by John E. S Moore (plate xxi).—On the occurrence of embryonic fission in cyclostomatous polyzoa, by Sidney F. Harmer (plates xxii.–xxiv) The extraordinary phenomena described in detail in this paper were announced in brief to the Cambridge Philosophical Society a couple of years ago. The completed investigations of the author indicate in the clearest way that the young larvæ of *Crisia ramosa* are produced as buds from an embryonic mass of cells found in the young ovicell. "At the end of segmentation the embryo consists of a small mass of undifferentiated cells, lying near the distal end of the follicle, which has increased largely in size, and now forms a spherical knob projecting freely into the interior of a spacious tentacle sheath;" after a time "the embryo, although remaining a solid mass

without differentiation of organs, grows out into several finger shaped processes, which are generally directed towards the distal end of the ovicell" "these finger-shaped processes are divided up by a series of transverse constrictions into rounded masses of cells, each of which becomes a complete larva," the few rare cases in the Tunicates and Cœlenterata, where the asexual reproduction of buds takes place from very feebly developed embryo forms are cited —On two new genera and some new species of earthworms, by Frank E Beddard, F R S (plates xxv and xxvi) Describes *Trichochæta hesperidum*, nov gen et spec from Jamaica, *Alvania millsoni*, nov gen et spec from Lagos, *Polytoreutus magilensis*, n sp from Magila, East Central Africa; and *Pygmæodrilus lacuum*, n sp from Lagos. There are also notes on *Siphonogaster millsoni*, F E B —Observations on the gregarines of Holothurians, by E A Minchin, B A (plates xxvii and xxviii) These gregarines apparently first indicated by Kolliker, and identified by Schneider (1858), have since been studied by Cuenot, Mingazzini, Ludwig and Léger, and have now been closely investigated from fresh material found at Naples and Plymouth, by the author *Gregarina irregularis*, n sp found on the blood vessels of Holothuria, at Plymouth, is described, numerous details about the spores and sporozoites are given, and the difficult question of the affinities of these forms is discussed —A new Sporozoon in Amphioxus, by E C Pollard (plate xxix) These minute parasites were discovered in the epithelium of the intestine Miss Pollard also figures a ciliate Protozoan found in the atrium of Amphioxus, which had been found some time back by Prof Ray Lankester, he suggests that possibly the Sporozoon may be a stage in the life history of the ciliate form —Studies on the Protochordata, by Arthur Willey I On the origin of the branchial stigmata, præoral lobe, endostyle, atrial cavities, &c, in *Ciona intestinalis*, Linn, with remarks on *Clavelina lepadiformis* (plates xxx and xxxi) As the result of prolonged and very complete investigations, the author finds himself compelled to completely alter his previously published views as to the homologies existing between the various organs of the Ascidians and Amphioxus

Wiedemann's Annalen der Physik und Chemie, No 3, 1893 —Electromagnetic theory of colour dispersion, by H von Helmholtz. A mathematical deduction of Fresnel's and Cauchy's formulæ from the electromagnetic theory of light by means of an application of the principle of least action to electrodynamics —Magnetisation of a radially slit iron ring, by Heinrich Lehmann The method employed was practically that of Ewing, with ballistic measurement The normal curve for the closed ring was first determined The ring was then slit radially, and the width of the slit regulated by plane parallel discs of brass introduced between the faces, the ring being tightened by a brass collar whenever necessary To measure the flow of induction through the slit, the brass disc was wound with a number of turns of very fine copper wire The width of the slit was varied from 0·4 mm. to 3 57 mm, and the strength of the magnetic field from 1 to about 300 It was found that the coefficient of dispersion, *i e* the ratio of the mean induction to that at the slit, increased with the width of the slit and finally decreased with increasing field intensity The divergence of lines of force was practically limited to the neighbourhood of the slit. For each width of slit the coefficient of demagnetisation was constant up to about half saturation point. A formula is given for calculating this coefficient from the geometrical dimensions of the system.—On the influence of temperature upon circular ferro-magnetic polarisation, by Emil Hirsch Transparent plates of iron, nickel and cobalt were prepared by electro deposition upon a transparent film of platinum burnt into a glass plate 2 mm. thick and free from double refraction. Lippich's half-shadow polarimeter was used for measuring the circular polarisation. The light was furnished by a zirkonium burner, and the magnetic field by a large electromagnet fed with a current of 33 amperes giving a field of 9000 C G S. units The metallic films were enclosed in a brass box heated by two Bunsens, the temperatures being measured by thermometers and an iron german silver-thermopile. As a result, Kundt's constant, or the ratio of the rotation of the plane of polarisation to the increase of "magnetisation potential" from one side of the film to the other, was found to be independent of the temperature within the limits of observational error.—Also papers by E. Lommel, F Richarz, K Ångstrom, H Ruoss, P Drude, and H E J G du Bois

Bulletin de l'Académie Royale de Belgique, No 2, 1893 —We notice the following papers —On a new form of blende, by G Cesàro The specimen occurred in the granular dolomite of Binnen, in the form of a light yellow translucent crystal 3 mm in diameter Its crystalline form is that of the tetrahexahedron, the trihedral angles being truncated by striated scalene triangles —A new electrical process permitting the production of temperatures superior to those actually realisable, by Eug Lagrange and P Hoho The new method consists in the passage of a current through a conducting liquid by means of electrodes, one of which is made of the substance to be raised by a high temperature M Violle has recently estimated the temperature of the electric arc at 3500° C and found that it is constant, so that it represents the highest temperature attainable by that method In the new method the heat is developed at the surface of the electrode During the passage of a current of, say, 2000 volts and 150 amperes through a 10 per cent solution of sulphuric acid, a layer of gas is formed round an electrode consisting of a plate of graphite, and since the resistance of the circuit is concentrated in this layer of gas, practically the whole energy of the current is transformed into heat in the immediate vicinity of the substance to be operated upon. The temperature rises until the amount of heat, dissipated by conduction and radiation, is equal to that produced If the production of heat is very rapid, this limit will be very high, and the temperature obtainable depends simply upon the strength of the available current

Annalen des K K Naturhistorischen Hofmuseums Bd. vii. (Wien, 1892) —The last two parts (Nos 3 and 4) of the seventh volume of the Annals of the Royal Natural History Museum of Vienna fully maintain the credit of this publication —In his Contributions to the knowledge of the Crustacea of the Canary Islands, K Koelbel describes and figures *Livoneca sulcata*, n sp and *Munidopsis polymorpha*, n sp —The species of *Alectoria* and their geographical distribution, by Dr E Stizenberger —A contribution to the morphology of Corundum, by Dr H. Barvír Two twin sapphires are described and figured —In Part II of his "Meteoric Studies" E Cohen gives analyses of twelve American meteorites.—Two plates illustrate F Siebenrock's paper on the skulls of the Scincoidæ, Anguidæ, and Gerrhosauridæ, twenty-six species of the first and three each of the second and last are referred to —New forms of Hymenoptera, by F F Kohl (three plates), thirty-eight new species are described and one new genus *Heliocausus* —On the typical specimens of *Lacerta mosorensis*, Kolomb. (1886) (= *Lacerta koritana*, Tom 1889) by Dr F. Steindachner (pl xvi) —Contributions to the Microlepidopteran fauna of the Canary Archipelago, by Dr. H. Rebel (pl. xvii). Ten new species and two varieties are described and figured, and one new genus, *Hypotomorpha* The paper concludes with a valuable index and table of the geographical distribution of sixty three Microlepidoptera; the distribution includes west and east Canary Islands, Azores and Madeira, N W. Africa, Mediterranean region, and other regions.—Part IV contains the following papers:—Remarks upon the species of the genus Potamogeton in the Herbarium of the Royal Natural History Museum, by A Bennett; three new species are described.—Compositæ Hildebrandtianæ et Humblotianæ in Madagascaria et insulas Comoras collectæ, by Dr F. W. Klatt (six new species)—Lichenes exotici Herbarii Vindobonensis, by Dr J. Müller—The birds of Austro-Hungary and of the land of occupation in the Royal Natural History Museum of Vienna, by Dr L R L. v Liburnau.—On vertebral assimilation among the Lizards, by F Siebenrock. Normally but two sacral vertebræ support the pelvis in lizards, but in 1864 Hyrtl described under the term "Wirbelassimilation" deviations from this rule In this paper several examples are given in which the last lumbar or the first caudal vertebra is connected with the pelvis, a figure is given of the latter arrangement in a specimen of *Uromastix spinipes*, and of the former in a specimen of *Lacerta Simonyi* The last paper—Old Mexican relics from the Castle Ambras in the Tyrol, by F. Heger—is of ethnological interest Four photographic plates, and one in colours, illustrate this paper, and, like the majority of the illustrations of this journal, are of the highest excellence

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, March 9.—Mr. A. B. Basset, F.R.S., Vice-President, in the chair.—Mr. T. J. Dewar exhibited, with the aid of a stereoscope, twenty stereographs of the regular solids. These were not photographs of a solid object from two points of view for binocular vision, but the same object was drawn twice over by Mr. Dewar in perspective with different station points. The relief was aided by making the lines in the foreground thick, and those behind thin.—Mr. Love read a note on the stability of a thin rod loaded vertically. Suppose a thin rod or column is held vertically at its lower extremity, and loaded at its upper extremity. It is well known that, unless the load exceeds a certain limit, the rod will be simply compressed longitudinally without being bent. If, however, the limit is exceeded there exists a curved form in which the rod can be held by the application of the given load. This form must belong to the *elastica* family of curves. Now when the length and the load are given the elastica is not entirely determinate. In fact for the same length and the same load (if sufficiently great) there exist forms having respectively 1, 2, 3 ... inflexions. These are the curves figured in Thomson and Tait's "Nat. Phil.," part ii. p. 148, and for our present application the rod must be supposed held at the middle point of one of the bays, into which it is divided by the line of action of the load. Thus the part of the curve between the point of support and the nearest inflexion is half a bay, the rest of the curve up to the point of attachment of the load consists of an integral number of complete bays. Now although all these forms are possible there is only one which is stable, and that is the form with a single inflexion. To prove this we have to investigate the potential energy in the configuration with a single inflexion, in which the curve forms a single half bay, and in the configuration with $2n+1$ inflexions, in which the curve forms $n+\frac{1}{2}$ bays. It is not difficult to prove that in every case the latter potential energy is the greater. It follows that the figures given by Euler's "Theory of Struts" in which the rod forms a curve which is nearly a curve of sines of small amplitude crossing the line of action of the load more than once are all unstable forms. The stable form is a curve of finite curvature, which never crosses the line of action of the load.—Prof. Lloyd Tanner next made a communication on complex primes formed with the fifth roots of unity. The object of the paper is to explain a method of calculating the complex prime factors of real primes included in the form $10\mu+1$. The only published method which I have met with is due to Kummer. This is not restricted to the particular case here considered; but as it involves the determination of the G.C.M. of two complex numbers, it is probably more laborious than the method now communicated. The method adopted by Reuschle in the calculation of his tables does not appear to have been published. The process here is based on the indeterminate equation

$$X^2-5Y^2=4p$$

A minimum solution of this equation gives the "simplest" prime factor according to Kummer's definition (*Berlin Monatsberichte*, 1870, p. 413) and solutions in which Y is a multiple of 5 give the "primary" prime factors which Kummer found it necessary to use in order to establish the general law of reciprocity. In solving the equation Lagrange's method turns out to be impracticable, and a short discussion—treated graphically—is introduced, which is sufficient to show the relations between the different solutions. These relations can be expressed in the form—

$$\begin{pmatrix}2, & 0\\ 0, & 2\end{pmatrix}\begin{pmatrix}X, & Y\end{pmatrix}=\begin{pmatrix}a, & 5b\\ b, & a\end{pmatrix}\begin{pmatrix}X', & Y'\end{pmatrix}$$

and it is interesting to note the intimate connection between these matrices and the complex units. From any solution (X, Y) three numbers A_0, A_1, A_2 are found, A_0 being the integer next greater than $2X/5$, and these serve to determine the values and sequence of the co-ordinates a_0, a_1, &c., in the required prime factor

$$a_0+a_1\omega+a_2\omega^2+a_3\omega^3+a_4\omega^4.$$

The first condition is

$$A_0=a_0^2+a_1^2+a_2^2+a_3^2+a_4^2.$$

The values of a have to satisfy other conditions, some of which are tested by mere inspection. To give some idea of the facility of the method from the calculator's point of view it may be stated that the determination of the prime factors of two primes selected at random in the second million (viz. 1,562,051 and 1,671,781) was completed in three hours. The only auxiliary table required is a table of squares; and if this extends to the square of 7000 it will suffice for the factorisation of all primes in the first nine millions. Tables are appended giving the simplest—and simplest primary—prime factors of all suitable primes less than 10,000. The reciprocal factors are also given after the first thousand. For the first thousand the reciprocal factors have already been published, and instead of giving these again, a comparison is indicated between the factors here given and those published in Reuschle's tables. The result of the comparison suggests that Reuschle's method of calculation was not the same as that now communicated.—The dioptrics of gratings, by Dr. J. Larmor, F.R.S. When a beam of light falls on a continuously ruled or striated surface, in addition to the principal portion that passes on and the portion that is scattered and lost by the roughnesses of the surface, there are formed a series of secondary diffracted beams that are propagated onward in oblique directions. Each of these beams is produced in the well-known manner by the union of the elements from the different striations (or homologous groups of striations), which arrive at its front in a common phase. The dioptrical discussion of such diffracted beams, that is so far as regards their geometrical properties, forms a rather simple case of the theory of the refraction of a general dioptrical pencil, which has been developed by Hamilton, Maxwell, and other writers. In the case of homogeneous wave-length λ, when the principal beam, coming from its focal lines, is refracted at the striated surface to two other focal lines, the nth diffracted beam is propagated as if it were simply refracted at a new surface formed by adding on at each point a thickness $(\mu-1)nm\lambda$, of the refracting medium in front of the original surface, where m is the number of striations counting from any arbitrary origin on the surface up to the point. The case of reflexion is included by making $\mu=-1$. As a special example, it is well known that the positions of the primary and secondary foci for conical pencils in a spherical Rowland grating, are determined by the same formulæ as hold for reflexion in a curved mirror. The treatment of the aberration at the focal lines, or the discussion of the caustic surfaces of the diffracted beams, is reduced immediately to the Hamiltonian formulæ by noting that the characteristic function of the beam is increased by the quantity $(\mu-1)nm\lambda$, exactly, in crossing the diffracting surface.—The secretary read a brief abstract of a note by Prof. L. J. Rogers on a three-fold symmetry in the elements of Heine's series.—Messrs. Greenhill, Walker, Cunningham, and the Chairman joined in the discussions on the papers.

Royal Microscopical Society, March 15.—A. D. Michael, President, in the chair.—The president said that a series of thirty six photomicrographs had been sent to the Society of Arts, in compliance with the request read at the last meeting, for exhibition at Chicago.—An electric turntable was exhibited on behalf of Mr. Payne, of Newcastle. It consisted of a brass turntable of ordinary pattern having an electric motor fitted beneath the plate, the whole was caused to revolve by the current from a bichromate battery cell.—Dr. W. H. Dallinger gave a brief description of Prof. Butschli's experiments on the so-called artificial protoplasm, and said in conclusion, that he could not suppose that any one looking at these forms would regard them as in any way allied to living matter. The more intimately they became acquainted with them the more sure they would become that they were only forms, and that those which appeared under a low power to be so much like tissue were under a high power seen to be minute bubbles and nothing more. He believed the movements observed would be found to be due to the effect of differences of surface tension, and that the study of them would no doubt help them to understand some of the mechanical properties of protoplasm, but they did not leave an impression that they had caused an approximation in the least degree towards the artificial production of protoplasm.—Mr. R. T. Lewis exhibited and described a new species of Aleurodes (*A. asparagi*) which had been found upon the leaves of asparagus in Natal.—Mr. T. F. Smith read a note on the use of monochromatic yellow light in photomicrography.—Prof. F. Jeffrey Bell read a note from Dr. A. M. Edwards on

a simple mode of illumination for the microscope —Surgeon V. Gunson Thorpe's paper on the rotifera of China was read by Prof Bell —Dr G M Giles's paper on certain cystic worms which simulate the appearances of tuberculosis was also read by Prof Bell —Dr R G Hebb said that he had never met with any of the worms described in England. He had found nodules in the lungs of sheep, and although unable to find the worm, he had supposed it to be the cause of what he had found —Prof Bell thought that what Dr Giles stated in the beginning of his paper was of considerable importance, because if the large number of animals which were killed as being tuberculous were really not so, it might be possible to prevent their destruction There was, he imagined, a general dislike amongst most persons—except such as were fond of high game—to eating meat which swarmed with parasites of any kind, for if it was correct that the cattle in India which were reputed to be highly tuberculous were not so, it was very important that the fact should be widely made known —The president said that he fully agreed with Prof Bell in his remarks —Dr A C Stokes's paper on new brackish water Infusoria from the United States was taken as read

Linnean Society, March 16 —Prof Stewart, President, in the chair —A curious freshwater alga, growing in a perfectly spherical mass without any visible point of attachment, and described as a condition of *Cladophora*, was exhibited by Mr. A W Bennett, who stated that specimens had been found in English and Welsh lakes, as well as in Sweden, and that the peculiar spherical form of growth was difficult to explain Mr G R Murray suggested that it might be due to the action of a current, which would cause a continuous revolution of the mass —Mr R I Pocock exhibited a singular nest, so called, of a myriopod received from Sierra Leone, and formed of a clayey earth, which had become hardened by exposure It was suggested that it was not a nest in the proper sense of the word, formed by the creature itself, but rather a case fashioned by ants for the purpose of entombing their enemy.—Mr G F Scott Elliot gave an interesting account of the botanical results of the Sierra Leone Boundary Commission, and of the collections made by him during five months travelling His remarks were criticised by Messrs J G Baker, C B Clarke, W Carruthers, and Dr Stapf, who was present as a visitor —Mr J H Venstone described some points in the anatomy of a mollusk (*Melongona*) from recent dissections made by him, and exhibited several preparations in support of his statements Prof G B Howes bore testimony to the originality and value of the observations which in some respects were at variance with the views of the most recent writers on the subject Messrs. G R Murray and Horace Monckton offered some remarks on the similarity in certain respects of the fauna and flora of the West Coast of Africa and the East Coast of South America, with reference to the statements made by Mr Pocock and Mr Scott Elliot —The meeting adjourned to April 6

Anthropological Institute, March 21 —Prof. A Macalister, F R S, President, in the chair —Dr Tylor exhibited a collection of the rude stone implements of the Tasmanians, showing them to belong to the palæolithic or unground stage of the implement maker's art, below that found among prehistoric times in Europe, and being on the whole the lowest known in the world Fragments or rough flakes of chert or mudstone, never edged by grinding, but only by chipping on one surface with another stone, and grasped in the hand without any handle, served the simple purposes of notching trees for climbing, cutting up game, and scraping spears and clubs The Tasmanians appear to have kept up this rudimentary art in their remote corner of the world until the present century, and their state of civilisation thus becomes a guide by which to judge of that of the prehistoric drift and cave men, whose life in England and France depended on similar though better implements. The Tasmanians, though perhaps in arts the rudest of savages, were at most only a stage below other savages, and do not disclose any depths of brutality. The usual moral and social rules prevailed among them, their language was efficient and even copious, they had a well-marked religion in which the spirits of ancestors were looked to for help in trouble, and the echo was called the "talking shadow" Such facts make it clear that neither antiquity nor savagery reaches to really primitive stages of human life, which belongs to a remoter past —A paper by Prof Politis on burial customs in modern Greece was read, also a paper on the cave paintings of Australia, by the Rev John Mathew

EDINBURGH.

Royal Society, February 20 —The Hon Lord Maclaren, vice-president, in the chair. Mr Malcolm Laurie read a paper on the anatomy of the *Eurypterida* Chelicerae exist in front of the mouth in *Slimonia* and *Eurypterus*, thus making the number of cephalothoracic appendages in these forms agree with that of the arachnida in general The presence of an epicoxite on the basal joint of the walking limbs is also an arachnid character The third to sixth free segments in *Slimonia* carry paired plate-like appendages, each of which appears to have borne one or more branchial lamellæ There are sternites covering the whole ventral surface of each segment, *Slimonia* differing in this respect from *Eurypterus*, which, according to Schmidt, has no sternites on these segments. The suppression of the sternite of the second free segment and the reduction of its appendage to nothing but branchial lamellæ is due to the enormous development of the genital operculum which covers this region This suppression of the second segment seems to point to a closer relation of these forms to the *Pedipalpi*, in which the same thing occurs, than to the scorpion, in which the second segment and its appendage are well developed —The Rev Prof Duns discussed the early history of some Scottish mammals and birds —Prof Rutherford communicated a paper, by Dr W. G Aitchison Robertson, on the digestion of sugar in health

March 6 —Mr T B Sprague discussed a new algebra, by means of which permutations may be transformed in a variety of ways, and their properties investigated In this algebra seven symbols of operation are used, the multiplication table being—

	r	i	p	s	t	l	m
r	1	ir	pi	$s^{-1}r$	tr	slr	mr
i	ri	1	pr	si	$t^{-1}i$	li	tmi
p	ip	rp	1	tp	sp	mp	lp
s	rs^{-1}	is	pt	s^2	ts	$s^{-1}ls$	ms
t	rt	it^{-1}	ps	st	t^2	lt	$t^{-1}mt$
l	$s^{-1}rl$	il	pm	s^2l	tl	l^2	ml
m	rm	$t^{-1}im$	pl	sm	t^2m	lm	m^2

Prof Tait read a note on the compressibility of liquids in connection with their molecular pressure

March 20.—Dr D. Gill, H.M. Astronomer at the Cape of Good Hope, communicated a paper illustrated by photographs on recent progress in celestial photography The method recently used for the determination of the sun's distance by observations of the planet Victoria was also described A number of separate series of observations have been made—each series by itself being more trustworthy than observations made during a transit of Venus The results indicate also that the present estimate of the mass of the moon is about one per cent. too large.—A paper was communicated by Dr Robert Munro on a remarkable glacier lake, formed by a branch of the Hardanger-Jokul, near Eidfiord, Norway.

PARIS

Academy of Sciences, March 20.—M Lœwy in the chair. —On the next solar eclipse, by M. J Janssen —On the preparation of a variety of swelling graphite, by M Henri Moissan M. Luzi has divided the varieties of graphite into two classes, according to their behaviour on treating with a little nitric acid and calcining Those which swell up he calls graphites, and those which do not graphitites The varieties produced ordinarily in the electric arc and by solution in iron do not swell. It can, however, be obtained in the first condition by suddenly cooling the casting in water, when the swelling graphite will be found in the more interior portions. The best way of preparing it is by means of molten platinum About 200 gr. of platinum are fused in a carbon crucible placed in the elec-

ric furnace. When the metal fuses it gets saturated with carbon, forming a carburet mixed with free carbon, which after solidification exists in the form of swelling or true graphite. It is separated by aqua regia. The residue consists of slate-grey hexagonal crystals of density 2·06 to 2·08, burning in a current of oxygen at 575°. From 400° upwards it swells like mercury sulpho-cyanide. It is not attacked by fused nitrate of potassium, chromic acid, or hot sulphuric acid, but is rapidly attacked by warm iodic acid and fused sodium carbonate. The swelling up is attributed to the sudden liberation of heated gas due to the decomposition of a very small quantity of graphitic oxide produced under the influence of nitric acid at the expense of a trace of amorphous graphite mixed with the crystallised variety, and more easily attacked than the latter.—Researches on samarium, by M. Lecoq de Boisbaudran.—The pancreas and the nerve centres regulating the glycæmic function, experimental demonstrations derived from a comparison of the effects of a removal of the pancreas with those of bulbary section, by MM. A. Chauveau and M. Kaufmann. Medullary section, preceded or followed by bulbary section, produces exactly the same effects as medullary section preceded or followed by the removal of the pancreas. As regards, therefore, the physiological action exerted upon the sugar-forming apparatus, this last operation behaves exactly like the bulbary section. Now the latter determines the super activity of the liver by suppressing the transmission of the influence of an inhibitory centre situated in the medulla oblongata. As a necessary result, the removal of the pancreas acts in an analogous way in producing hyperglycæmia and glycosuria. This operation amounts to the annihilation of the centre controlling the glycogenic function. Hence the pancreas acts upon this function by exciting the activity of this inhibitory centre, and probably also by influencing the exciting centre, which is, on the other hand, checked in its activity by the products of internal pancreatic secretion poured into the blood. The results of the whole experimental investigation on the pathogeny of diabetes are embodied in sixteen propositions.—On the distribution in latitude of the solar phenomena observed at the Royal Observatory of the Roman College during the fourth quarter of 1892, by M. P. Tacchini.—Photography of the solar corona apart from total eclipses, by M. George E. Hale.—On electric waves along fine threads; calculation of the depression, by M. Birkeland.—On initial capacities of polarisation, by M. E. Bouty.—Influence of frequency upon the physiological effects of alternating currents, by M. d'Arsonval.—Measurement of large differences of phase in white light, by M. P. Joubin. A new method of rendering visible the fringes produced by two interfering systems of waves consists in placing an anisotropic compensator upon both the groups which have traversed the interference apparatus. This compensator then receives polarised light which, before being analysed, passes through a plate of quartz with its principal section at an angle of 45° to the plane of polarisation. Such an arrangement has been carried out in one of Fizeau's apparatus for measuring expansions. It reads direct to $\frac{1}{10}$ of a micron.—On spherical aberration of the human eye; measurement of senilism of the crystalline, by M. C. J. A. Leroy. The mean aberration is a function of the age which grows slowly in young people and very rapidly after mature age, tending towards a maximum in old age. The spherical aberration of the eye also depends principally upon the crystalline and notably upon the variability of its index of refraction. In young people this variability is rapid enough to sensibly correct the aberration. It decreases with age, and tends to a limiting value which it would have if the crystalline had a uniform index throughout.—Electrical crucible for the laboratory, with directing magnet, by MM. E. Ducretet and L. Lejeune.—On a phenomenon of dissociation of sodium chloride heated in presence of a wall of porous earth, by M. de Sanderval.—On hydurilic and desoxyamalic acids, by M. C. Matignon.—Action of cotton upon sublimate absorbed in dilute solutions, by M. Léo Vignon.—Influence of the alkalinity of blood upon the process of intra-organic oxidation provoked by spermine, by M. Alexandre Poehl.—Production of sugar diabetes in the rabbit by the destruction of the pancreas, by M. E. Hédon.—Improvement of potato-culture for industrial and forage purposes in France, by M. Aimé Girard.—On the employment of ruthenium red in vegetable anatomy, by M. Louis Mangin.—Permian fish fauna in France, by M. H. E. Sauvage.—On the manifestation, for more than six hundred years, of sudden variations of temperature on fixed dates during the second fortnight of January, by M. Dom D. Démoulin.—Destruction of trees and public health, by M. J. Jeannel.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Books.—Laws and Properties of Matter: R. T. Glazebrook (K. Paul).—British Fungus Flora, vol. 2: G. Massey (Bell).—Text-book of Comparative Geology: Dr. E. Kayser, translated and edited by P. Lake (Sonnenschein).—Beiträge zur Biologie und Anatomie der Lianen. Zweiter Theil.—Beiträge zur Anatomie der Lianen, Dr. H. Schenck (Jena, Fischer).—Œuvres Complètes de Christian Huygens, vol. 5 (La Haye, M. Nijhoff).—Statistics of the Colony of Tasmania, 1891 (Tasmania).—Meteorological Observations made at the Adelaide Observatory, &c., 1890 (Adelaide).—Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbelthiere, Dr. O. Hertwig (Jena, Fischer).—Topographische Anatomie des Pferdes. Erster Teil.—Die Gliedmassen: Drs. Ellenberger and Baum (Berlin, P. Parey).—Distribution de la Vapeur: A. Madamet (Paris, Gauthier-Villars).—Le Lait: P. Langlois (Paris, Gauthier Villars).—Universal Atlas. Part 25 (Cassell).

Pamphlets.—Diagrams of Isothermal Lines of New South Wales.—Hailstorms: H. C. Russell.—Das Genetische System der Chemischen Elemente: W. Preyer (Berlin, Friedländer).—Further Studies of Yuccas and their Pollination: W. Trelease (St. Louis, Mo.).—Museums Association, Report of Proceedings, &c., at the Third Annual General Meeting.—The Negro in the District of Columbia: E. Ingle (Balt.).

Serials.—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, vol. 7, No. 1 (Manchester).—Journal of the College of Science, Imperial University, Japan, vol. v., part 3 (Tōkyō).

CONTENTS.

THURSDAY, APRIL 6, 1893.

MATHEMATICAL ELASTICITY

A Treatise on the Mathematical Theory of Elasticity By A E H Love, M A, Fellow and Lecturer of St John's College, Cambridge. Vol I (Cambridge University Press, 1892)

MR LOVE'S treatise is the necessary complement to Todhunter and Pearson's "History of the Theory of Elasticity," in which an abstract is given of all the most important original memoirs bearing on this subject, arranged in historical order

But the student who wishes to make himself acquainted with the works of these original authorities, by the guidance of Todhunter and Pearson's History, will find the necessity of an acquaintance with Mr. Love's work as an introduction to the elements and to the notation of the subject of elasticity.

Mr. Love has prepared an elegant and modern artillery of analysis, and he is not afraid to fire off his guns To pursue the simile, there is no fear of the subject being obscured in the smoke of his own guns—in these days of smokeless gunpowder

The size of the book is kept within reasonable dimensions, compared with the scale of a continental treatise, by leaving the heaviest parts of the analysis as exercises to be worked out by the trained mathematical student, to whom the work is addressed.

The author says in the preface, "I have not thought it advisable to introduce collections of examples for practice" But such collections do not exist, and the author would find it as formidable a task as that he has already carried out to attempt to construct the examples himself. In the present state of his subject any really novel example would be worthy to take rank as a new and independent theorem.

The examples which we see around us of the physical and industrial applications of the Theory of Elasticity are the best check in existence to keep the subject from becoming a mere development of pure mathematics, with such generalisations as to space of n dimensions, and based upon physical laws adopted merely because of the analytical elegance they confer, quite apart from any experimental verification

The first five chapters are occupied with the general theory, including the analysis of strain and stress, stress-strain relations, the strength of materials, and a number of general theorems In the analysis of strain the method of Thomson and Tait's "Natural Philosophy" has been followed, beginning with the geometrical and algebraical theory of finite homogeneous strain, deducing thence the physical state of infinitesimal strain. Hooke's law, made such a mystery of by its inventor, now becomes a necessary consequence of the expansion by Taylor's theorem of the stresses as functions of the displacements and strains, neglecting power above the first or second; and the law receives ample experimental justification in the observed isochronism of the small vibrations of elastic bodies, as exhibited by the musical notes they give out.

In the treatment of the bending of a beam and the torsion of a cylinder in Chapter VI., Saint-Venant's method has been followed, and the warping and distortion of the cross-section carefully investigated and illustrated in fig 10, p 156.

This warping effect is well known to engineers, though hitherto generally ignored in the mathematical treatment, as impairing the sweet simplicity of a bending moment and consequent proportional curvature resulting only from the extension and compression of the fibres, thus ignoring the shearing stresses called into play We can now begin to perceive the reason why a beam is so much stronger and stiffer than it ought to be according to the ancient theory

In the investigation of the torsion of a cylinder, where cross-section is a rectangle, the analysis of Thomson and Tait has been closely adhered to Dr Ferrers, the Master of Gonville and Caius College, has made this analysis more complete and symmetrical, and has exhibited the hydrodynamical analogies more clearly, by employing a pair of Fourier series, one proceeding by sines and cosines of multiples of x, and the other of y; each series representing separately the motion or displacement corresponding to a simple shear of the rectangular section The elliptic function interpretation of this pair of series, in which the corresponding moduli are obviously complementary, is very interesting, but has not been pursued by Mr Love.

Now that Prof Karl Pearson has dedicated the first part of the second volume of the History to the "Memory of Saint-Venant," the political cloud, vaguely described in M Bertrand's recent *éloge* of Chasles, which overshadowed Saint-Venant's official career, is clearing off, and full tribute is beginning to be paid in France to the great advances due to him

Lamé, too, like Saint-Venant, appears to have lived in official neglect, although his method of Curvilinear Coordinates, expounded in Chapter VII, has been a powerful analytical engine for the solution of elastical problems, and his "Théorie de l'Élasticité" is a standard text-book to the present day.

The solution of the elastic deformation of a sphere, treated in Chapter X., is also due to Lamé. Mr Love applies his analysis to the consideration of the effect of a flaw in the shape of a spherical cavity, and shows that in this case the engineer's factor of safety of 2 is the theoretically correct factor.

The most important application on a large scale of the analysis of the elastic deformation of a sphere is the investigation of the effective rigidity of the earth, considered as an elastic solid, under the action of its own gravitation, and slightly disturbed by the rotation and the tide-producing forces. Elaborate calculations and observations have been carried out by Prof G. H Darwin; if we could observe and measure the bodily tides in the earth, an estimate of its rigidity could be obtained Mr Love gives the numerical results corresponding to mean rigidities equal to those of steel and glass

Mr. Chree's valuable investigations of the strain produced by rotation in an elastic circular disc, in a sphere or an ellipsoid, are introduced here, and receive careful analysis and interpretation

Chapter XI. treats of the vibrations of a sphere. The free vibrations have been completely worked out by Prof. Lamb. In the forced vibrations the lag or change

of phase is the interesting subject of inquiry, as showing to what extent the "equilibrium theory" of the bodily tides of the earth, considered in the preceding chapter, can be adopted as a working theory.

Lord Kelvin has shown how the inertia of a pendulum appears reversed in sign if the point of support is actuated by a vertical vibration, when the forced and free periods are as two to one; but when the periods are made in the ratio of three or four to one, the equilibrium theory can be adopted. This principle has been employed recently by Sarrau and Vieille in the measurement of powder pressures by means of spring gauges; the free period of the spring is so adjusted in comparison with the period of the applied pressure, so that the vibrations of the spring do not make their appearance, and the indications of the gauge are the same as those for an equal statical pressure, steadily applied.

Valuable work in the discussion of particular problems of a somewhat general nature has been carried out by the late Prof. Belti, of Pisa, and continued by his disciple Cerruti; particularly also by M. Boussinesq, in his theory of "local perturbations" in an elastic solid bounded by a plane, as illustrated, for instance, in the deflection produced in a sheet of ice by a man standing on it; these questions occupy Chapters VIII and IX.

The applications of conjugate functions in Chapter XII introduce some interesting problems. The book concludes with the consideration of an elliptic cylinder, turned through a small angle. Something appears wanting here as the balancing couples on the interior and exterior confocal ellipses are not brought into evidence. When the exterior ellipse becomes indefinitely large the stresses over it are evanescent, but their resultant is a finite couple. So, too, when the inner ellipse becomes the line joining the foci; in this case the Jacobian h becomes infinite at the centre, and the displacements u and v at this point require closer investigation.

It is unfortunate, as Maxwell remarked, that we have no space functions corresponding to the conjugate functions of a plane. But by the rotation of these conjugate plane curves about an axis, Wangerin has obtained a system of space co-ordinates, suitable for application to certain surfaces of revolution, and he, Mr. Hicks, and Mr. W. D. Niven, have worked out the analysis completely for certain quadric surfaces, cones, and tores.

In the questions considered in this first volume the forces which produce the elastic displacements are of moderate amount, so that the proportionality of stress to strain may be taken as true, and they act as distributed forces throughout the solid, such as gravity and the *forces of inertia* introduced by vibrations.

Mr. Love measures these forces per unit mass, and not per unit volume, as in Thomson and Tait's "Natural Philosophy," so that the component forces appear as ρX, ρY, ρZ, qualified by ρ, the density as a factor.

Cases might arise, however, say in a dynamo, where some of the forces, the forces of inertia and gravity, would be measured per unit mass, and the others, the electromagnetic forces, per unit volume; for this reason the Thomson and Tait method of measurement appears preferable, as the factor ρ can be inserted where required.

The difficulties of constructing a rational theory will turn up in the second volume, when the question of the elastic equilibrium of a lamina has to be considered, in which the stresses are due to an applied finite pressure on one side of the lamina. Mr. Basset has performed a valuable service in pointing out the insufficiency of preceding methods for constructing a theory of such an important practical question as the collapse of boiler flues (*Phil. Mag.*, September, 1892), and he might have added of the Bourdon gauge. We await with interest Mr. Love's contribution to this delicate and baffling part of the Theory of Elasticity.

In the preface of the "Treatise on Solid Geometry," by Frost and Wolstenholme, the authors, after thanking the proof-readers for their trouble, conclude by "expressing their regret that they have not escaped a large number of errors, which it will be punishment enough to them to see tabulated in an adjoining page."

Where the critic has also been a proof-reader he lays himself open to this ambiguous acknowledgment, if he points out any misprints; but we are pleased to find that the present volume, on careful re-examination, appears to be very clearly and correctly printed.

A. G. Greenhill

BIOLOGY AND THE MEDICAL STUDENT

Text-book of Elementary Biology. Introductory Science Text-book Series. By H. J. Campbell, M.D. (London: Swan Sonnenschein and Co. New York: Macmillan and Co., 1893.)

THIS volume of 266 pages octavo is an ultra-elementary one, subdivided into a first part of 155 pages, which deals with generalities of plant and animal morphology and physiology, together with the principles of classification, and into a second of 111 pages devoted to the consideration of certain type organisms. With the exception of the dog-fish, which the author dismisses in four short pages, the said types are those of the examination syllabus of the Conjoint Board of the Royal Colleges of Physicians and Surgeons; and the fact that the book is the first one which has been written up to that standard invests it with a special interest. It is illustrated by 136 borrowed woodcuts, some of which are very poor and antiquated, while others are defective. Its author shows himself to be possessed of a considerable power of discretion, and his book is clear and attractive in style. It is, however, a pure compilation, for the most part from well-known text-books, as is only too apparent in certain gross errors transcribed, for example, that of the assertion that the Monotreme brains are "not convoluted"; its only novelty lies in the judicious introduction of concise and useful historical *résumés*, giving the dates, names, and achievements of epoch-making investigators. Trivial errors abound, and controversial matters of the moment are here and there dogmatically introduced, as though finally established; to wit (α) the allusion (pp. 39 and 145) to the ectoblastic origin of the segmental duct, which, so far as it may be to-day regarded as an undisputed fact, rests upon Van Wijhe's discovery of a dividing nucleus connecting it with the parent epiderma, and (β) the assumed conjugative reproduction of Amœba (p. 160). Conversely

it is refreshing to find that in this, a most elementary work, the pulmonary sacs of spiders are alluded to as "fantracheæ" (p 105) and the lung hooks of scorpions as "chambered tracheæ" (p 112) The author distinguishes between more general matter printed in large type, and more detailed set up in smaller, pointing out in his preface that "in reading the book for the first time the student is advised to read only" the former. The fact that in some cases a knowledge of the details in question is indispensable for the appreciation of the broader statements laid down for first reading, somewhat detracts from the utility of the method employed; and in at least one case (two top paragraphs of p 7) the sentences are so worded that the exclusion of the smaller type involves error and confusion of ideas One of the most characteristic features of the work is its marked brevity "A general review of the Mammalia" is essayed in eleven pages, while the "Infusoria" are despatched in one line and a word (but a cross reference to the Vorticella described in full in a subsequent chapter) No wonder then, that for want of due qualification, descriptions of things and conditions in reality individual and special should serve for those general and of broad application (as, for example, the assertion that the spiders as an order have an unsegmented cephalo-thorax, and that "all cells resemble each other when they are first formed"), and that negative characters should be occasionally employed for diagnostic purposes, to the exclusion of others of a positive and more forcible nature but requiring a more detailed declaration (*cf* the treatment of the limbs of Primates) Some of the more lengthy descriptions are, nevertheless, inadequate and unfortunate, notably that of the sponges, which are defined (p 85) as "the connecting link between unicellular animals on the one hand and multicellular animals on the other," and whose complex structure is illustrated by a diagram unlike anything in nature In dealing with the vertebrate reproductive system and cloaca, the author has so mixed up details and definitions that his statements are misleading, contradictory, and in part erroneous (*cf* pp 155 and 264, and 135, 153, 252, and 256) In dealing with the lower plants, the existence of sieve-tubes in the marine algæ (*Macrocystis*) might with advantage be alluded to as an all-important elementary fact, and the definitions of the Thallophyta and the Pteridophyta might well be modified accordingly Minor errors and deficiencies, such as the implied absence of sensory cells in the hydra, the too-frequent employment of the adjective "horny" in allusion to structures having no such constitution (*cf* especially pp 102 and 192), the confusion between the "wing" and patagium, and the definition of important orders and families in terms which in their scantiness convey no adequate meaning, will doubtless be duly corrected and made good This notwithstanding, the book has many good points, and its clearness of style is a high recommendation, its greater subdivision, if amplified and supplemented by way of introduction of great groups not even named in the present edition (*e g.* the Brachiopoda and Polyzoa), might be worked up into a generally serviceable volume.

The lesser subdivision of the volume chiefly merits attention for having been avowedly compiled for the examinees of the conjoint medical board above alluded to The programme is as follows --Amœba (5 pp), Yeast Plant (3 pp), Protococcus and Glœocapsa (6 pp), Bacteria (6 pp.), Vorticella (7 pp), Gregarinæ (5 pp), Hydra (9 pp), the Liver Fluke (11 pp), Tape Worms (21 pp.), Nematoda (12 pp), the Leech (11 pp), General Review of the Mammalia (11 pp) = 107 pp in all, of which 66 are devoted to animal parasites—a veritable diet of worms! We know not upon what principles this *régime* has been prescribed, but when it is considered that the doctrine of phagocytosis, which has of recent years done more than all else to advance and revolutionise medical science, is the direct outcome of comparative biological inquiry, and that its founder is a non-medical man, we confess to a feeling of astonishment The programme itself savours of the "Technical Education" bogie of our times, than which no greater deception has ever existed. The principles of an elementary scientific training must be the same for the medical man and the mechanician, the philosopher and the plumber Natural laws and ultimate principles are for all time and unalterable, and experience shows that the medical student whose elementary biological training embraces a comprehensive structural analysis of some small mammal (if of no lower vertebrate in addition) together with the principles of comparative morphology, working from the tree thus surveyed as a whole through the scattered leaves of his surgical anatomy, emerges a thinking man, rather than a mere pedant, as has been so often the case in the past The chief value of biological science to the medical student is unquestionably educational To sink this all-important aspect of his scientific training, in preference for a mere dabbling in helminthology, as we venture to think has been done in the case before us, is to neglect one of the surest safeguards for the future, and to ignore the dictates of common sense based upon experience The attitude is indicative of a retrogressive return to the days when medicine was the only channel of approach to science, and to that order of things, the lingering relicts of which, still hovering over certain of our English-speaking Universities, to-day bar the way to the employment of all but medical graduates as responsible teachers of science in certain of their medical departments The time is fast dawning, when in London and other great centres, the preliminary scientific training of the medical student must of necessity be imparted either in central institutions devoted to the purpose, or in no less special ones attached to the medical schools themselves This work, if it is to be done properly and to the credit of the nation, must clearly be entrusted to trained specialists, whose business it shall be to keep abreast of the times, and by such men the text-books of the future will have to be written The principles which have called forth the volume now under review, on the other hand, favour a professional monopoly, under which the medical practitioner will tend to usurp the functions of the trained non-medical educationalist, to the detriment of his own calling and the reversion to a well-nigh obsolete constitution. Indications of the exercise of this monopoly are abroad, but we shall be much surprised if, in the bidding for the medical student now rife, it obtains a foothold.

G B. H.

THE MORPHOLOGY OF BACTERIA

Contribution à l'Étude de la Morphologie et du Développement des Bactériacées. Par A Billet, Doct. en Méd, Médécin-Major de 2e classe. (Paris Octave Doin)

SINCE the publication of the "Peach-coloured Bacterium," by Prof Lankester, the subject of the morphology of the bacteria cannot be said to have received much attention from English investigators The department of bacteriology has to a great extent been monopolised by the physician, who appears to confine himself almost exclusively to the study of the more practical bearings of the subject It is therefore refreshing to find a surgeon-major devoting his time to a very thorough investigation of bacterial morphology

Dr Billet's work dates back from 1885, and was carried on for the most part in the Wimereux Laboratory under the able direction of Prof Giard His communications were first published in the *Bul Sc. de la France et de la Belgique*, and the present work is a collected and revised edition of these The work consists of some 287 pages, and includes (1) an historical introduction, which, owing to its succinctness and chronological sequence, will be found of great use to the general bacteriologist; (2) a minute description of the life histories of *Cladothrix dichotoma* and *Bacterium parasiticum*, and of two new species named by Dr Billet, *Bacterium Balbiani* and *Bacterium osteophilum*, (3) a very large bibliographical index embracing some 662 references, (4) a very beautiful series of drawings

The author briefly sketches the progress of morphology from the time of the doctrine of immutability of Cohn and that of pleomorphism of Prof Lankester, Cienkowski, and Zopf He shows how C Robin (1847), in his wonderfully interesting work, pointed to an affinity between certain bacteria, his *Leptothrix baccalis*, for instance, and certain filamentous algæ, the Leptothrix of Kutzing (1843), how, after the lapse of twenty-six years, Prof Lankester (1873 and 1876), determined, in his well-known *Bacterium rubescens*, the coexistence of micrococcal, bacillary, and spirillar forms, and finally, how the theory of the "form phases" became further elucidated by Cienkowski in 1887 in the "Morphologie der Bakterien," and by Zopf in 1871 in his "Genetische Zusammenhang von Spaltpilzformen" The latter observer describes in the life history of the higher bacteria, coccal, bacteroid, bacillary, vibrio, spirillar, leptothrix, and zooglea forms, the *Clathrocystis roseo-persicina* of Cohn becomes the zooglea phase described in *Bacterium rubescens* of Lankester, or more correctly, of the higher *Begginiotoa roseo persicina* Starting with the above series of form phases, the author ingeniously consolidates and groups them into four stages, viz. —1. The *filamentous*, in which the bacteria are associated into larger and shorter filaments 2. The *dissociated* stage in which the elements become free and motile, and assume the well-known coccal bacteroid and other forms 3. The *interlacing* stage—*état enchevêtré*—where the elements interlace with one another 4. A *zooglea* stage, in which the elements loose their movements and aggregate themselves into certain definite forms The author goes on to show how definite and characteristic are these groupings in the case of the organisms which he has examined (see above). He points out that their presence or absence depends upon surrounding conditions —media, temperature, &c But he further widens the whole question in seeking to show that in the less highly developed bacteria there are traces of the form phases and form groupings of the more morphologically perfect organisms In this connection he briefly brings together the observations which have been made upon the life history of the lower bacteria. Thus the encapsulation observed in the pneumococci, streptococci, tubercle, and anthrax bacilli, sarcinæ, &c, &c, may correspond to the zooglea stage, for he recognises both pneumococcal, merispomedia, and sarcina forms in his zooglea stage He regards the zooglea as protective, and forming when the medium is becoming exhausted We may add that in the animal tissues encapsulation often appears dependent upon the resistance offered by the tissues He further points out that the zooglea is often pigmented

In describing the life histories of his bacteria, Dr Billet makes some interesting remarks Thus, he is inclined to believe that the cilium of the vibrio form is nothing else than the residuum of the inner coat, and that it is formed during the process of segmentation by a drawing out and attenuation of the inner coat, like, for example, when a glass rod is drawn out in a flame As many vibrios move about which have no cilia, he agrees with Van Zieghem that the bacterial element has a proper movement of its own, which is not dependent upon a cilium, and he believes that the cilium of the Bacteria is quite a different thing from the cilium of zoospores He carefully describes the movements of the vibrio forms, and adds that they are greatly accentuated by a powerful light, a point first observed by Engelmann, in his *Bacterium photometricum* He also states that the passage from the rectilinear forms to the less curved (vibrio) and more curved (spirilla) forms, depends upon the degree of temperature and amount of putrefaction, the greater the latter the more the twisted and appendiculate forms. He concludes by giving the evidence in favour of a relationship between the Bacteria and the Algæ, the relationship appears great in the case of the organisms which he describes, but probably if he had studied Actinomyces he might have similarly found very many points in favour of a relationship with the mycelial fungi

Rubert Boyce

OUR BOOK SHELF

Introductory Modern Geometry of Point, Ray, and Circle By W. B Smith (London · Macmillan and Co, 1893.)

This work of Prof. Smith's has a "very practical purpose," viz "to present in simple and intelligible form a body of geometric doctrine, acquaintance with which may fairly be demanded of candidates for the Freshman class" of the Missouri State University It is shaped on the lines of such modern works as those by Newcomb, Halsted, and Dupuis, to refer to English text-books only, but it most nearly resembles in some parts the excellent little manual "on congruent figures," by Prof. Henrici. "The work asks to be judged, at least in its name, according to (the) spirit of modern geometry, and not according to the letter."

It is hard at this date to write anything new on the subject of elementary geometry, and for the class addressed by the author it is not desirable, but the well-known facts may be treated in very diverse ways: in this case there is a novelty and freshness which must commend the treatment of them to all intelligent students. Take this "precise definition" of a plane. Take two points A and B and suppose two equal spherical bubbles formed about A and B as centres. Let them expand, always equal to each other, until they meet, and still keep on expanding. The line where the equal spherical bubbles, regarded as surfaces, meet, has all its points just as far from A as from B. As the bubbles still expand, this line, with all its points equidistant from A and B, itself expands and traces out a *plane* as its path through space. Hence we may define the *plane* as the region (or surface) where a point may be, that is, equidistant from two fixed points. It is evident that the plane, as thus defined, is reversible. The superiority of this definition consists in its not only telling what surface the plane is, but also making clear that there actually *is* such a surface. Thence our author readily derives the notion of the *ray* (anglicè, straight line; a *tract* being a part bounded by end points).

This manner of illustration occurs repeatedly, and adds, we think, much to the interest of the book.

As a specimen of the mode of proof employed we take what is equivalent to part of Euc. I. 5. *Data*, ABC, an isosceles triangle, AB its base, AC and BC its equal sides (here we may remark the figure is badly drawn; a similar remark applies to figures on pp. 60 and 91). *Proof*. Take up the triangle ABC, turn it over, and replace it in the position BCA. Then the two triangles ACB and BCA have the equal vertical angles, C and C, also the side AC = BC (why?) and BC = AC (why?), hence they are congruent (why?), and the ∠A = ∠B.

In the more elaborate proofs there is a larger crop of "whys," and in some cases the interrogation is answered by the author.

The amount of ground covered is considerable, and yet, as we have gone through the whole of the text, it is so clearly opened up that the intelligent student, to whom we have previously referred, should be able to master it all, and successfully grapple with the well-chosen exercises which are arranged in fitting places throughout the book. "These exercises have been chosen with especial reference not so much to their merely disciplinary as to their didactic value, the author being persuaded that quite as good exercise may be found in going somewhither as in walking round the square."

We have no hesitation in heartily commending Prof. Smith's introduction to teachers and pupils as an excellent one, and this we vouch, adapting the language of the learned counsel cited by Bailie Littlejohn, *nostro periculo*.

Primer of Horticulture. By J. Wright. (London: Macmillan and Co., 1893.)

THIS primer contains the substance of ten lectures delivered by Mr. Wright for the Surrey County Council. Besides the lectures, some sets of questions, asked after the lectures, are given together with the answers to these questions.

The primer is eminently practical, and is sure to prove very useful both to gardeners and to students. It cannot, however, be considered quite free from errors, and a careful revision would increase its value.

Sometimes the text is rather loose.

On p. 54 the word *pistil* is used indefinitely, sometimes meaning the style and at others the whole gynœcium.

Speaking of phosphatic manures on p. 64 the author says:—

"Mineral superphosphate is ground coprolite treated with sulphuric acid.

"Coprolite is antediluvian petrified manure, of which there are large beds in the Eastern Counties. It is fairly active, yet sustaining.

"Thomas's phosphate powder, or basic slag— . . . is composed of 15 to 25 per cent. of phosphoric acid and about 45 per cent. of lime. It is not very quick in action, but lasting in effect."

From this description one cannot get much idea of the relative values of these three phosphatic manures, and basic slag suffers by comparison with ground coprolite. Practical experience shows that basic slag has a much higher value than ground coprolite as a manure, and has, moreover, an additional value as a check upon wireworm.

Again, on p. 77, the description of the fungus causing potato disease (phytophthora infestans) is scarcely accurate. In describing the aerial hyphæ which spring from the mycelium in the leaves and push their way through the stomata, the author says:—

"These stem-growths of the fungus produce 'fruit'-spores (DD) in cells (Oogonia), that divide (F) and liberate the active agents in reproduction, tailed zoospores (G) which float in the air, and swim in the moisture, dew, or rain, on potato leaves." The letters in parentheses refer to fig. 18, p. 79. Neither text nor description below fig. 18 is correct. What Mr. Wright calls oogonia are really conidia, and what he calls conidia (F in fig. 18) represent the formation of an oospore from oogonium and antheridium. We must also dissent from the author's views on zoospores floating in the air.

Apart from these defects the primer is well worthy of perusal, and will no doubt meet with success. The practical part is very well done, and this is, of course, the most essential part of the book.

WALTER THORP.

Ornithology in relation to Agriculture and Horticulture. Edited by John Watson. 220 pp. (London: W. H. Allen, 1893.)

THIS book contains a series of papers by well-known writers. The chief interest will gather around chapters III. to VII. inclusive, which treat of the common sparrow. The trial of the sparrow is opened very ably by Mr. Chas. Whitehead (for the prosecution). He is well supported in the next chapter by Miss Eleanor A. Ormerod. These two writers for the prosecution will have the support of the vast majority of agriculturists in England, and their arguments contrast favourably with the less practical defence put forward in the two succeeding chapters by the Rev. F. C. Morris and the Rev. Theodore Wood.

Chapter VII. is written by J. H. Gurney, Jun., and from the result of 755 dissections he draws up a table showing that "in England about 75 per cent. of an adult sparrow's food is corn, chiefly barley and wheat, with a fair quantity of oats." Nobody with experience of grain-growing in England will deny that the sparrow is a terrible pest, and it is time that a movement be made not towards exterminating the troublesome bird, but towards reducing its numbers to normal limits.

Chapter IX. is an interesting defence of the rook, much of which defence this bird merits. It is written by O. V. Aplin, who also contributes a very useful chapter on miscellaneous small birds.

WALTER THORP.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Vectors *versus* Quaternions.

HAVING a vivid recollection of the pleasure I derived from Prof. Gibbs's attacks upon the quaternionic system in the rather one-sided discussion that took place about two years ago in this

journal, I have delayed replying to the letters of Profs. MacAulay and Tait, from an expectation that Prof. Gibbs would have something to say In this I have not been mistaken, and, as there is a general agreement between us on the whole, I have merely to add some supplementary remarks Prof MacAulay refers to me as having raised the question again I can assure him it has never been dropped Apart from the one sided discussion, it has been a live question with Prof. Gibbs and myself since about 1882, and is now more alive than ever I cannot help thinking that Prof MacAulay's letter was overhastily written, and feel sure that if he knew as much about the views and methods of those to whom he appeals as he does about Quaternions, he would have written it somewhat differently, or perhaps not have written it at all, from a conviction of the uselessness of his appeal There is no question of suicide with us, on the contrary, quite the reverse I am asked whether the "spoonfeeding," as he terms it, of Maxwell, Fitzgerald, &c, is not good enough for me Why, of course not It is quaternionic, and that is the real point concerned Again, he thinks nothing of the inscrutable negativity of the square of a vector in Quaternions, here, again, is the root of the evil As regards a uniformity of notation amongst antiquaternionists, I dare say that will come in time, but the proposal is premature We have first to get people to study the matter and think about it I have developed my system, such as it is, quite independently of Prof Gibbs. Nevertheless, I would willingly adopt his notation (as I have adopted his dyadical notion of the linear operator) if I found it better But I do not I have been particularly careful in my notation to harmonise as closely as possible with ordinary mathematical ideas, processes, and notation, I do not think Gibbs has succeeded so well But that matters little now, the really important thing is to depose the quaternion from the masterful position it has so long usurped, whereby the diffusion of vector analysis has been so lamentably impeded I have been, until lately, very tender and merciful towards quaternionic fads, thinking it possible that Prof Tait might modify his obstructive attitude But there is seemingly no chance of that Whether this be so or not, I think it is practically certain that there is no chance whatever for Quaternions as a practical system of mathematics for the use of physicists How is it possible, when it is so utterly discordant with physical notions, besides being at variance with common mathematics? A vector is not a quaternion, it never was, and never will be, and its square is not negative, the supposed proofs are perfectly rotten at the core Vector analysis should have a purely vectorial basis, and the quaternion will then, if wanted at all, merely come in as an occasional auxiliary, as a special kind of operator It is to Prof Tait's devotion to his master that we should look for the reason of the little progress made in the last 20 years in spreading vector-analysis

Now I have, in my turn, an appeal to make to Prof MacAulay I have been much interested in his recent R S paper As the heart knoweth its own wickedness, he will not be surprised when I say that I seem to see in his mathematical powers the "promise and potency" of much future valuable work of a hard headed kind This being so, I think it a great pity that he should waste his talents on such an anomaly as the quaternionic system of vector analysis I have examined a good deal of his paper, and can find nothing quaternionic about it except the language concerned in his symbols. On conversion to purely vectorial form, I find that it is greatly improved. I would suggest that he give up the quaternion If he does not like my notation, or Prof Gibbs's, or Prof Macfarlane's, and will invent one for himself, it will receive proper consideration He will greatly extend the sphere of his usefulness by the conversion A difficulty in the way is that he has got used to quaternions. I know what it is, as I was in the quaternionic slough myself once But I made an effort, and recovered myself, and have little doubt that Prof. MacAulay can do the same.

Passing to Prof Tait's letter, it seems to be very significant The quaternionic calm and peace have been disturbed. There is confusion in the quaternionic citadel, alarms and excursions, and hurling of stones and pouring of boiling water upon the invading host. What else is the meaning of his letter, and more especially of the concluding paragraph? But the worm may turn, and turn the tables.

It would appear that Prof. Tait, being unable to bring his massive intellect to understand my vectors, or Gibbs's, or Macfarlane's, has delegated to Prof. Knott the task of examining them, apparently just upon the remote chance that there might possibly be something in them that was not utterly despicable Prof Knott has examined them, and has made some remarkable discoveries. One of them is that those vector methods in which the quaternion is not the master lead to formulæ of the most prodigious and alarming complexity He has counted up the number of symbols in certain equations Admirable critic!

Now, since this discovery, and Prof Tait's remarks, are calculated to discourage learners, I beg leave to say, distinctly and emphatically, that there is no foundation for the imputation. Prof Knott seems to have found a mare's nest of the first magnitude, unless, indeed, he is a practical joker, and has been hoaxing his venerated friend Speaking from a personal knowledge of the quaternionic formulæ of mathematical physics, and of the corresponding formulæ in my notation and in Prof. Gibbs's, I can say definitely that there is very little to choose between them, so far as mere length goes. Perhaps Prof. Knott has been counting the symbols in a Cartesian formula, or in a semi cartesian one, or some kind of expanded form. I do not write for experts who delight in the most condensed symbolism I do not even claim to be an expert myself I have to make my readers, and therefore frequently, of set purpose, give expanded forms rather than the most condensed

But so far as regards the brief vector formulæ, I find that the advantage is actually in my favour. I attach no importance to this, but state it merely as a fact which upsets Profs Knott and and Tait's conclusions. It is desirable that I should point out the reason, otherwise the fact may not be believed In common algebra there is but one kind of product of a pair of quantities, say F and v, which is denoted by Fv In vector algebra there are two kinds of products One of these closely resembles the usual product, whilst the other is widely different, being a vector itself Accordingly, to harmonise with common algebra, I denote the scalar product by $\mathbf{Fv}$ It degenerates to Fv when the vectors have the same direction Now, since the quaternionists denote this function by $-\mathrm{S}\mathbf{Fv}$, which is double as long, whilst $\pm \mathbf{Fv}$ becomes $\mp \mathrm{S}\mathbf{Fv}$, it is clear that there must be an appreciable saving of space from this cause alone, because the scalar product is usually the most frequently occurring function

But there are other causes The quaternionic ways of specialising formulæ are sometimes both hard to read and lengthy in execution Look at $\mathrm{S}\ \mathrm{U}\alpha\mathrm{U}\rho\mathrm{S}\ \mathrm{U}\beta\mathrm{U}\rho$, which I see in Tait's book I denote this by $(\alpha_1\rho_1)\ (\beta_1\rho_1)$, or else by $\alpha_1\rho_1\ \beta_1\rho_1$ Tait is twice as long But the mere shortness is not important It is distinctness that should be aimed at, and that is also secured by departing from quaternionic usage Examples of shortening and clarifying by adopting my notation may be found on nearly every page of Tait's book

Consider, for example, rotations Quaternionists, I believe, rather pride themselves upon their power of representing a rotation by means of a quaternion Thus, $\mathbf{b} = q\mathbf{a}q^{-1}$. The continued product of a quaternion q, a vector $\mathbf{a}$, and another quaternion q^{-1}, produces a vector $\mathbf{b}$, which is $\mathbf{a}$ turned round a certain axis through a certain angle. It is striking that it should turn out so, but is it not also a very clumsy way of representing a rotation, to have to use two quaternions, one to pull and the other to push, in order to turn round the vector lodged between them? Is it not plainer to say $\mathbf{b} = r\mathbf{a}$, where r is the rotator? Then we shall have $\mathbf{ac} = \mathbf{a}rr'\mathbf{c} = r'\mathbf{a}r'\mathbf{c} = \&c.$, if r' is the reciprocal of r Then Prof Tait's $\mathrm{V}q\mathbf{a}q^{-1}q\phi\,(q^{-1}\mathbf{b}q)\,q^{-1}$ is represented by $\mathrm{V}r\mathbf{a}r\phi r'\mathbf{b}$. See his treatise, p 326, 3rd edition, and note how badly the $q\ (\quad)\ q^{-1}$ system works out there and in the neighbouring pages.

What, then, is this rotator? It is simply a linear operator, like ϕ It is, however, of a special kind, since its conjugate and its reciprocal are one, thus $rr' = 1$, or $r' = r^{-1}$ Far be it from me to follow Prof Tait's example (see his letter) and impute to him an "imperfect assimilation" of the linear and vector operator. What I should prefer to suggest is that his admiration for the quaternionic mantle is so extreme that he will wear it in preference to a better-fitting and neater garment If we like we can express the rotator in terms of a quaternion, in another way than above, though involving direct operations only But I am here merely illustrating the clumsiness of the quaternionic formulæ in physical investigations, and their unnaturalness, by way of emphasising my denial and disproof of the charge made by Prof. Tait against vectorial methods. The general anti-quaternionic question I have considered elsewhere.

Paignton, Devon, March 24. OLIVER HEAVISIDE.

Severe Frost at Hongkong

THE occurrence of severe frost at moderate elevations within the Tropics must be rare It seems worth while therefore to place on record in the columns of NATURE some portion at least of an official report on the low temperature which (as was stated in NATURE last week) occurred at Hongkong between the 15th and 18th of January

Botanic Gardens, Hongkong, February 4, 1893

SIR,—The unprecedented cold weather which the region about Hongkong was recently subjected to calls for some notice by this department. Records of experiences of meteorological phenomena such as we have just had besides being of passing interest are so frequently of use in practical dealings with various subjects that for this reason opportunities to record unusual phenomena should not be neglected It does not, however, come within the province of this department to go much further into the meteorological aspects of the subject than is demanded in connection with its injurious effects on vegetation

(2) After a period of ordinary Hongkong dry, cool weather rain fell on January 13, and continued daily up to the 16th instant In the gardens, at 300 feet above sea level, the following quantities of rain were registered with a Glaisher's rain gauge —

January	14	14
,,	15	35
,,	16	46
,,	17	45

(3) On the 15th instant the temperature fell in the afternoon to 39° F, at 350 feet above sea level On the 16th, at 9 a.m, it stood at 35° On the 17th the thermometer stood at 31° at 9 a m, which was the lowest temperature observed at the Gardens. During this period the sky was overcast except for a short time about noon on the 17th, but on the morning of the 18th it was clear and the sun shone brightly throughout the day, the temperature having risen to 43° at 4 p m

(4) Unfortunately there are no official records of temperature at Victoria Peak, 1818 feet above sea level, but, by such information as could be obtained from private observers in the hill district and observations made here, it seems that the temperature must have fallen at the summit to about 25° or 24° F

(5) On the river at Canton, and between this port and that place, low temperatures were recorded in the reports of the steamships *Powan* and *Honam* They gave—

January	16 at	1 A.M	23°	about 28 miles below Canton
,,	,,	at 10 A M	26°	about 25 miles from Hongkong
,,	,,	at 1 P M	25°	at Canton
,,	18	at 10 A.M	28°	about 25 miles from Hongkong

I am indebted to the Office of the Hongkong, Canton, and Macao Steamboat Company for these returns

(6) On the peninsula of Kowloon the cold appears to have been greater than in Hongkong, ice was seen on pools of water in the roads within fifty feet of sea-level, and at the Kowloon Docks ice was observed at the bottom, thirty feet below sea-level, of an empty dock.

(7) In the harbour the rigging of ships was coated with ice

(8) Since the records began in 1884 the temperature has not fallen, until now, at the observatory, below 40° F. I remember on one occasion, I think about seventeen years ago, ice was found at Victoria Peak, but there is no record within my experience, which extends back nearly twenty-two years, when ice was observed below 1700 feet altitude.

(9) The continued low temperature combined with fall of rain from an apparently warmer stratum of air above, resulted in the formation of ice varying in quantity from a thin coating on the upper leaves of pine trees growing at 300 feet above sea level, to a thick encasement of perfectly transparent solid ice of $3\frac{1}{2}$ inches in circumference on the blades and bents of grass at the summit of Victoria Peak The grass bents themselves, which were the foundation on which the ice accumulated, were not more than an eighth of an inch in diameter, yet the formation of ice was so gradual that with the enormous accumulation of ice, which became its own support, the bents retained their natural upright, or but slightly pendent position. These large accumulations of ice were on the windward side of the hill where rain drifted, but even on the lee side the average coating of ice was about 3 inches in circumference

(10) Evergreen shrubs and trees carried on their leaves solid coverings of ice $\frac{3}{8}$ of an inch in thickness The great weight of this ice caused the branches of trees to assume a pendent form, the strain in many cases causing the limbs to snap off with a crash. All vegetation throughout the hill regions of the Colony was thus covered with ice, as were also most other objects Telegraph and telephone wires from Victoria Gap upwards were covered with ice $\frac{3}{4}$ of an inch in thickness, and, in addition, carried icicles as much as three inches in length as close as they could be packed side by side This caused many of the telephone wires to break, and the iron post at Victoria Gap which supported them was snapped off a few inches above the ground

(11) The windward sides of the walls of the look-out house at the Peak were from top to bottom covered with perfectly transparent ice $\frac{3}{4}$ of an inch in thickness

(12) All the hills on the mainland and Lantao island were likewise white with ice, one of the hills (3147 feet) of Lantao having what appeared to be snow for some few hundreds of feet down from its summit As early as the evening of January 15 the summit of Taimoshan (about 3300 feet) on the mainland had assumed a whitish appearance, presumably from ice or snow

(13) The effect of the extremely low temperature on vegetation has been disastrous.

(15) The damage in the gardens consist chiefly in the injury or destruction of leaves, but some plants are quite killed, these being natives of much warmer regions than Hongkong Many of the decorative plants which were not killed will be months before they can regain their ornamental appearance

(16) Every possible precaution was adopted to minimise the effect of the cold. The plant houses, which are provided with screens merely to produce shade, were all matted in and the roofs covered with straw In spite of these precautions, however, many plants suffered very severely Of ferns in the houses *Polypodium Heraclium* and *Adiantum tetradactylon* suffered most, other kinds being but little affected

(17) In the orchid-house, which was covered with mats and straw, all our best orchids have suffered very greatly, many being entirely killed while others were so much injured that, even if they survive, it may be some years before they regain their previous luxuriant state. A healthy plant, received from Calcutta several years ago, of *Dendrobium aggregatum*, is apparently killed, while plants of the same species growing by its side, and also others on trees where they had no shelter, which I collected ten years ago on the Lo-fau mountains, about sixty miles from Canton, have escaped unharmed This seems to show the capability of the plant in adapting itself to colder regions than it is generally found in

(19) The highest point of the Gardens is 320 feet above sea-level, the lowest part 175 feet Some plants of the same kinds which were damaged at the upper portions were uninjured at the lower parts of the Gardens

(20) Of exotic trees planted on the hills *Albizzia Lebbek*, *Aleurites triloba* (candle-nut-tree) and *Eugenia Jambos* (the rose-apple tree) had all their leaves killed at and upwards of 600 feet above sea level Trees of the rose-apple at about 800 feet altitude have been entirely killed.

(21) At 600 feet altitude indigenous plants began to be affected, the injuries increasing with higher altitude until at about 900 feet when the extreme limit of low temperature which some plants could bear was reached, and death ensued Most of these are tropical plants of which Hongkong, Formosa, the Luchu Islands in the Far East, and Sikkim and Himalaya in India are the northern limits of the geographical area from which they have been recorded Of the plants killed or injured, *Ficus Hanceana*, Benth, *Gordonia anomala*, Spreng, and *Garcinia oblongifolia*, Champ, are known only from Hongkong. Although many of our indigenous plants have not been yet discovered elsewhere, it is to be expected that when China is better known they will be found over a larger area than the restricted one of this island The fact of the above named plants having succumbed to the late frost indicates that when they are discovered elsewhere they will be found southward of Hongkong.

(22) Considerable damage to vegetation seems to have been caused about Canton, where the alluvial lands are highly culti-

vated The Rev Dr. B. C Henry, in a letter dated January 26, informs me that "the destruction of vegetation about Canton has been very great The banana plantations are ruined, and the bamboos have suffered The *Aleurites triloba* look all shrivelled up, while Begonias, Euphorbias, Crotons and scores of others are simply destroyed" What Dr Henry reports indicates severer weather at Canton than here, *Aleurites triloba* leaves being shrivelled up at Canton, while they are here at 300 feet altitude uninjured, but at 600 feet they are affected, and completely destroyed a little higher up the hill

(23) Accompanying this report are six photographic views which were taken on January 16 showing the ice at various places in the Peak district It is somewhat difficult to represent ice in photographs, as bright light has much the same effect as ice which owes its white appearance merely to reflected light, but it will be understood that the white in these views is produced by ice.

CHARLES FORD,
Superintendent Botanical and Afforestation Department

HON. G. T M O'BRIEN C M G,
Colonial Secretary, &c

The importance of such facts as these in connection with geographical distribution can hardly be overrated It is customary to compare the range of a plant with the corresponding mean annual temperature But it is obvious that the exterminating effect of occasional low temperature must override every other condition An island is often the last refuge of a species not found elsewhere. Such a frost as occurred in Hongkong would erase the Double Cocoa-nut in all probability from the face of creation, if it occurred in the Seychelles In any case islands are not easily restocked except with littoral vegetations and the trees distributed by carpophagous birds It seems evident therefore that the geographical distribution of plants may still be influenced by causes which are catastrophic in their nature Of this, although not from cold, there is already a striking illustration in the simultaneous destruction of the entire forest vegetation which at one time covered the island of Trinidad in the South Atlantic. Mr Knight, in the account which he has given in the "Cruise of the Falcon," conjectures that the cause was more probably volcanic than a long drought

The wave of cold which affected Hongkong (or at any rate the atmospheric conditions which produced it) seems to have been tolerably extended in its range My friend, Dr Trimen, writes to me on February 6 from Ceylon —

"We are having a wonderfully fine and dry time here, with extraordinary cold mornings Here at Pecadeniya we have been registering at 6 a.m 53° and 54° F, the lowest ever previously known being a little below 60° The middle of the day is very hot Hakgala has been getting frost for the first time on record"

He does not give any dates, but the two exceptional circumstances are sufficiently near together to make it probable that some common cause produced them both

W T THISELTON-DYER.

Royal Gardens, Kew, March 28.

P S —Since writing the above I have received from the Colonial Office the accompanying report on the weather of January from the Hongkong Observatory —[W. T. T.-D]

The mean temperature was below the average from the 14th to the 24th The coldest day (air 35°2, damp bulb 32°·8) was the 16th The lowest mean temperature of the damp-bulb thermometer occurred on the 17th (air 36°·2, damp bulb 30°·9) Circumstances were anti-cyclonic, with probably abnormally slight decrease of temperature with height. Snow storms were reported from China to the north and east of the colony. From Macao snow was reported, but that appears to have really consisted of small-sized hail, which fell for four hours. Neither snow nor hail were seen in Hongkong, but the tops of the hills appeared to be covered by snow or hoar-frost. Water exposed in buckets or in pools was several mornings found covered with ice about ¼ inch thick, and a few hundred feet above sea-level both the grass and branches of trees, being cooled below the temperature of the air (which did not fall below freezing-point) owing to evaporation and radiation, were encased in unusually clear and transparent ice without any appearance of crystallisation As far south as the Straits Settlements the cold was felt, but in a less degree. The temperature appears not to have fallen below 70° in Singapore. At sea strong northerly breezes were observed during the greatest cold The colony was sheltered by the mainland, and only light northerly breezes were registered till the 20th, when the wind backed to west It veered to east on the 21st During the coldest days the pressure was from one to two-tenths of an inch of mercury above the mean The sky was overcast, but cleared on the evening of the 17th Owing to radiation the extreme temperatures occurred after this epoch: the lowest air-temperature 32°·0 about 7 a.m on the 18th, and the lowest damp-bulb temperature 27°·7 about 2.30 a.m on the same day

W DOBERCK, Director

Hongkong Observatory, February 1

Mr Preece on Lightning Protection

IN the recent Presidential Address to the Institution of Electrical Engineers by Mr. Preece, I find the following reference to myself

"Prof Oliver Lodge has . . endeavoured to modify our views as to the behaviour of lightning discharges, and as to the form of protectors, but without much success. His views have not received general acceptance, for they are contrary to fact and to experience"

I was quite prepared to laugh at this with the rest, but I find that the general and semi-scientific public are apt to take Mr Preece's little jokes, of which there are many towards the end of this address, as serious and authoritative statements of scientific fact. And it has been represented to me that unless I take some notice of the above, it may be assumed that I wish silently to withdraw from an untenable position without acknowledging having made a mistake

Indeed, I have already been questioned by a scientific worker as to whether I accepted the above statement as in any sense corresponding to truth

My reply is that so far was I from that attitude, that I did not suppose that the statement was either meant or would be taken seriously

The broad question of scientific fact is this —Given an electrostatic charge at high potential, can the potential be reduced to zero most quietly and safely by a good conductor or by a bad one?

The old lightning-rod doctrine (or drain-pipe theory) said, by an extravagantly good one I say, by a reasonably bad one. If you employ too good a conductor the mean square of current is appallingly strong, and all manner of dangerous oscillations are set up, whereas in a bad conductor the discharge can be more nearly dead-beat These oscillations have been experimentally and mathematically demonstrated in a great variety of ways, the unexpected and distinct effects they are able to produce have been displayed, and Messrs Whittaker have published for me a large book about them

Some critics have sensibly objected that the book is too big, but I am not aware of any scientific authority who controverts my position.

If Mr. Preece only means that these views regarding lightning and its dangers are not yet practically accepted by the great British Telegraphic Department, that is, I admit, perfectly true.

OLIVER LODGE.

The Author of the Word "Eudiometer"

FOR some time past I have been endeavouring to find out the originator of the name eudiometer, which is now applied to the measuring tubes used in gas analysis, and possibly the result of the search may be of interest to some of the readers of NATURE

Naturally my first resort was to text-books and dictionaries, but although the derivation of the word is sometimes given, the name of the author is not stated.

I had great hopes that the third edition of the "Encyclopædia Britannica," published in 1797, would contain the desired information, for the article "Eudiometer" must have been written not long after the invention of the instrument, but it merely calls it "an instrument for observing the purity of the atmospherical air." Descriptions of many forms of eudiometer follow.

The New English Dictionary gives the derivation and the first quotation is "1777. De Magellan (*title*), Glass apparatus for making mineral waters.. ...with the description of some new Eudiometers"; another is "1807. Pepys. *Eudiometer* in *Phil.*

Trans xcvii. 249 Known quantities of the air to be tried, and of nitrous gas being mixed, were admitted into a graduated tube, which he [Priestley] denominated a eudiometer" This seems to point directly to Priestley as the author of the name as he certainly was the author of the process. (It may be mentioned in passing that, in this paper, Pepys describes the method of calibrating eudiometers, by pouring in equal quantities of mercury from a tube closed at one end and with the mouth ground flat, against which a piece of plate glass is pressed in order to obtain an exact measure of the mercury)

With these directions I searched in the library of the Royal Society and found Magellan's book, but he uses the name eudiometer as if it were well known. Mr White, the librarian, very kindly interested himself in the matter and found in Priestley's book, "Observations on different kinds of Air," a statement that he had received from Landriani one of his eudiometers together with a description that he asks Priestley to print, but the latter excuses himself on the ground that it would not be convenient for him to publish the letter at that time Mr White found the title of a book by Marsilio Landriani, "Ricerche fisiche intorno alla salubrità dell' aria" (Milano, 1775, 8°) It is not in the libraries of the Royal or of the Chemical Society, and the title does not appear in the catalogue of the library of the Royal Institution, but last week I found the book at the British Museum. On page viii of the Introduction there is a paragraph of which the following is a translation: "The account of the discovery of nitrous air and of some of its principal properties is briefly set forth, certain defects of Priestley's apparatus are removed, and there is added a detailed description of the *Eudiometer*, for that is the name which I give to my little instrument, from *Eudios*, a Greek word signifying goodness of the air (bontà dell' aria) accompanied by the more useful precautions for its construction." There are some plates at the end of the book containing drawings of the apparatus, and one of them is marked "Eudiometro 1775" This seems to leave it without a doubt that it is to Landriani that we owe the word

Next as to its exact meaning by tradition we have been taught that the eudiometer is an apparatus for measuring the goodness of air, and this is obviously what was intended by Landriani The New English Dictionary derives it from εὔδιος clear (weather) and μέτρον; Roscoe and Schorlemmer derive it from εὐδία, fine weather, and μέτρον, these meanings of the Greek words are no doubt correct, and the name would seem to be more applicable to some kind of weather glass, a signification which the above quotation shows could hardly have been in Landriani's mind HERBERT MCLEOD

Cooper's Hill, March 21

Blind Animals in Caves

ALTHOUGH in my previous letter I did not give evidence directly supporting the proposition that blind cave-animals are born or hatched with relatively well-developed eyes, that thesis is a good deal more than a mere supposition, as Prof Lankester calls it Nor did I, as Prof Lankester asserts, proceed to state that no such fact is known or recorded The condition of the eyes in the newly-born young of the viviparous Amblyopsis, or other cave-fishes, does not appear to have been investigated, although living young were born under observation as long ago as 1844, and exhibited as spirit specimens to the Belfast Society of Natural History Nor have the early stages of the European Proteus been obtained. But, on the other hand, with respect to cave crustacea, Tellkampf, the original describer of the blind *Cambarus pellucidus* of the mammoth cave, stated that the eyes were larger in the young than in the adult (A. S. Packard, *Amer. Nat.* 1871), and Garman (*Bull. Mus. Comp. Zool.* xvii 1888-89) states that in very young specimens of *C setosus*, the blind crayfish of the Missouri caves, "the eyes are more prominent, and appear to lack but the pigment." In another blind subterranean species, *Troglocaris Schmidtii*, occurring in Central Europe, Dr Gustav Joseph found and demonstrated that the embryo in the egg was provided with eyes. (See Packard, "Cave Fauna of N. America," *Nat Acad Sci.* vol iv. Mem 1.)

Thus, although it is obvious enough that further investigation of the development of cave-animals is required, it cannot be said that it is altogether a "hitherto unattempted embryological research." A discussion of this kind ought not, however, to be a mere logomachia My purpose is to show that cave animals afford a particular case of the general problem how to reconcile the law of recapitulation with the theory that adaptations or degenerations are explained by the selection of congenital variations. J T CUNNINGHAM

The Value of the Mechanical Equivalent of Heat

IN NATURE for March 16 you published a summary of a communication which I had the honour to make to the Royal Society My conclusion as to the value of the C G S unit of heat was 4 1940 × 10⁷ ergs (see NATURE, p 478), and I added the following comment "If we express Rowland's result in terms of our thermal unit we exceed his value by 1 part in 930, and we exceed the mean value of Joule's (selected) determinations by one part in 350, if we attach equal value to *all* the results published by Joule his value *exceeds* ours by 1 part in 4280"

I have received so many communications with regard to this last statement, that you will perhaps permit me to answer my correspondents through your columns

I thought it unnecessary in a short summary to point out that the value (in gravitation and Fahrenheit units) resulting from Joule's own experiments is *not* the usually accepted 772 55 To me it appears an extraordinary thing that 772 is to this day given in the text books when, so far back as 1880, Rowland conclusively proved that the results obtained from Joule's experiments give a higher value (see Proceedings, American Academy, March 1880)

In 1879 Rowland forwarded to Joule a thermometer by Baudin, which had been directly compared with Rowland's air thermometer Joule himself then made a careful comparison of his thermometer with the Baudin one, and communicated the results to Rowland. The complete table is given on p 39 of the paper already referred to In addition to the correction thus shown to be necessary, further corrections for the capacity for heat of the calorimeter and contents were included, and as the results were published in Joule's lifetime, there can be little doubt but that these corrections received his approval

I give an example (from p 44) of Rowland's corrections —

Joule's value (by friction of water, in 1878)		772 7
Correction for thermometer		+3 2
,,	capacity for heat	+ 2
,,	latitude (Baltimore)	+ 9
,,	vacuum	− ·9
Corrected value at Baltimore		776 1

It is evident that Rowland did not claim for his air thermometry an order of accuracy greater than ± 01° In the appendix to his paper (p 197) he remarks that *if* a certain improvement (not then adopted by him) was made, "it is probable that an accuracy of 01° C could be obtained from the mean of two or three observations I believe that my own thermometers scarcely differ much more than that from the absolute scale at any point up to 40° C"

A study of Rowland's methods, and of the tables given in his admirable paper, leads to the conclusion that it is possible that his thermometry is in error by 1 in 1000 over the range 15° to 25°, and such an error would suffice to bring together the results (both in the value of J and in the temperature coefficient of the specific heat of water) obtained by Rowland and myself The error would, however, but slightly affect the correction of Joule's results

If we attach arbitrary values to Joule's later experiments, the mean of the corrected values (by Rowland's thermometer) is 776·75 ($g = 32\ 195$), and the mean of all his determinations by various methods is 779 17,[1] and we may regard the above as within 1 in 1000 of the value resulting from Joule's own work on this subject

I trust that in future our engineers and text-book writers will (even if they ignore the work of later observers) do Joule the justice of discarding the traditional 772, and adopt a value more in harmony with the investigations of that great experimentalist. E H GRIFFITHS

12, Parkside, Cambridge

[1] In terms of a thermal unit at 15° C.

THE SENSITIVENESS OF THE EYE TO LIGHT AND COLOUR.[1]

THERE may be some here who have had the pleasure—or the pain—of rising very much betimes in a Swiss centre of mountaineering in order to gain some mountain peak before the sun has had power enough to render the intervening snow-fields soft, or perhaps dangerous Those who have will recollect what were the sensations they experienced as they sallied out of the comfortable hotel, after endeavouring to swallow down breakfast at 2 a m, into the darkness outside Perhaps the night may have been moonless, or the sky slightly overcast, and the sole light which greeted them have been the nervous glimmer of the guides' lanterns By this feeble light they may have picked their way over the stony path, and between the frequent stumbles over some half hidden piece of rock lying in the short grass they may have had time to look around and above them, and notice that the darkness of the night was alone broken by stars which gave a twinkle through a gap in the clouds, or if the sky were cloudless, every star would be seen to lie on a very slightly illuminated sky of transparent blackness Although giant mountains may have been immediately in front of them, their outlines would be almost if not quite invisible As time went on the sky would become a little brighter, and what is termed the *petit jour* would be known to be approaching. The outlines of the mountains beyond would become fairly visible, the tufts of grass and the flowers along the path would still be indistinguishable, and most things would be of a cold grey, absolutely without colour The guide's red woollen scarf which he bound round his neck and mouth would be black as coal But a little more light, and then some flowers amongst the grass would appear as a brighter grey, though the grass itself would still appear dark, but that red scarf would still be as black as a funeral garment The mountains would have no colour The sky would look leaden, and were it not for the stars above it might be a matter of guesswork whether it were not covered over with cloud

More light still, and the sky would begin to blush in the part where the sun was going to rise, and the rest would appear as a blue-grey, the blue flowers will now be blue, and the white ones white, the violet or lavender coloured ones will still appear of no particular colour, and the grass will look a green grey, whilst the guide's neck-gear will appear a dull brown.

The sun will be near rising, the white peaks beyond will appear tipped with rose, every colour will now be distinguished, though they would still be dull, and, finally, the daylight will come of its usual character, and the cold grey will give place to warmth of hue.

But there may be others who have never experienced this early rising, and prefer the comfort of an ordinary English tramp to that just described; but even then they may have felt something of the kind. In the soft autumn evening, when the sun has set, they may have wandered into the garden and noticed that flowers which in the day-time appear of gorgeous colourings—perhaps a mixture of red and blue—in the gloaming will be very different in aspect. The red flowers will appear dull and black, a red geranium, for instance, in very dull light, being a sable black, whilst the blue flowers will appear whitish-grey, and the brightest pale yellow flowers of the same tint, the grass will be grey, and the green of the trees the same nondescript colour. A similar kind of colouring will also be visible in moonlight when daylight has entirely disappeared, though the sky will have a transparent dark blue look about it, approaching to green. These sensations, or rather lack of sensations of light and colour, which as a rule attract very little attention, as they are common ones, are the subjects of my discourse to-night

Experiments which can be shown to a large audience on this subject are naturally rather few in number, but I will try and show you one or two

We are often told that the different stages of heat to which a body can be raised are black, red, yellow, and white heat, but I wish to show you that there is an intermediate stage between black and red heat, viz a grey heat. An incandescent lamp surrounded by a tissue paper shade, has a current flowing through it, and in this absolutely dark room nothing is seen, for it is black hot An increase of the current, however, shows the shade of a dim grey, whilst a further increase shows it as illuminated by a red, and then a yellow light A bunch of flowers placed in the beam of the electric light shows every colour in perfection, the light is gradually dimmed down, and the reds disappear, whilst the blue colours remain and the green leaves become dark These two experiments show that there is a colour, if grey may be called a colour, with which we have to reckon

Now the question arises whether we can by any means ascertain at what stage a colour becomes of this grey hue, and at what stage of illumination the impression of mere light also disappears, and whether in any case the two disappear simultaneously

As all colours in nature are mixed colours, it is at the outset useless to experiment with them in order to arrive at any definite conclusion, hence we are forced—and the forcing in this direction to the experimentalist is a very agreeable process—we are forced to come to the spectrum for information

The apparatus on this table is one which I have before described in this theatre, and it is needless for me to describe it again I can only say that it has in all colour investigations been of such service that any attempt on my part to do without it would have been most disadvantageous The apparatus enables a patch of what is practically pure monochromatic light of any spectrum colour to be placed upon the screen at once, and an equally large patch of white light alongside it, by means of the beam reflected from the first surface of the first prism

It should be pointed out that this beam of white light reflected from the first prism of the apparatus, having first passed through the collimator, must of necessity diminish with the intensity of the spectrum, when the collimator slit is closed

Having got these patches, the next step is to so enfeeble the light that their colour and then their visible illumination disappear

An experiment which well demonstrates loss of colour is made by throwing a feeble white light on one part of the screen, and then in succession patches of red, green, and violet alongside it. The luminosity of the coloured light gradually diminishes till all the colour disappears, the white patch being a comparison for the loss of colour

If red, green, and violet patches be placed alongside each other, and they are bedimmed in brightness together, it will be noticed that the red disappears first, then the green, and then the violet; or I may take a red and green patch overlapping, which when mixed form orange, and extinguish the colour. the slit allowing red light to fall on the screen may be absolutely closed, and no alteration in the appearance of the patch is found to occur This shows, I think, that when all colour is gone from a once brilliant colour, a sort of steel-grey remains behind, and that red fails to show any luminosity when the green still retains its colour

The measurement of the extinction of colour from the different parts of the spectrum was made on these prin-

[1] A Lecture delivered at the Royal Institution of Great Britain by Capt. W de W Abney, C B, R.E., D C L, F.R S

ciples A box, similar to Fig 2, was prepared, but having two apertures, one at each side Through one the coloured ray was reflected, and through the other a white

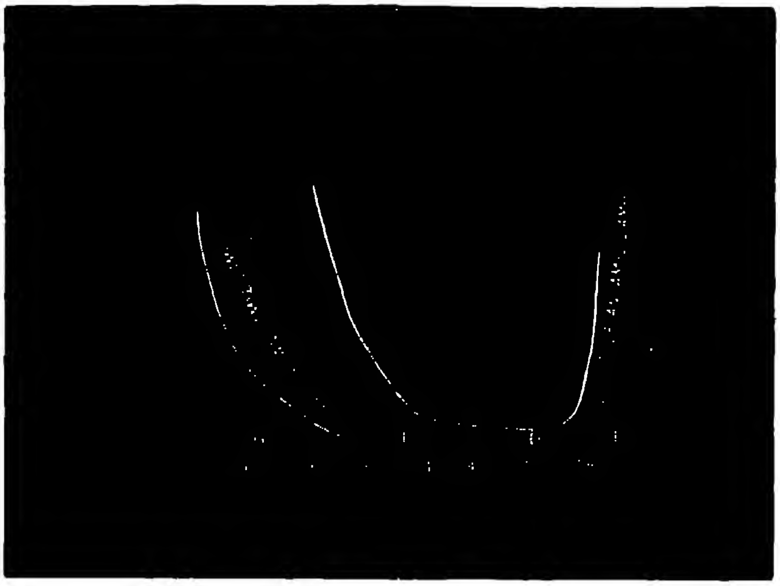


FIG 1 —Extinction of Spectrum Colours

beam of light to a white screen Both beams were diminished, and when the white and coloured patches appeared the same hue, the amount of illumination was calculated Fig 1 shows graphically the reduction of illumination, when the D light of the spectrum is the same intensity as one amyl-acetate lamp at one foot from the screen To measure the extinction of light, a box was made as in the diagram, closed at each end, but having two apertures as shown, Fig 2 —E is a tube through which the eye looks at S, which is a black screen with a white spot upon it, and which can be illuminated by light coming through the diaphragm D first falling on a ground glass which closes the aperture, and reflected on to it by M a mirror

The patch of light of any colour being thrown on D, rotating sectors, the apertures of which could be opened and closed at pleasure, were placed in the path of the beam, thus enabling the intensity of the patch to be diminished. D could be made of any desired aperture, and thus the illumination of the ground glass would be diminished at pleasure After keeping the eye in darkness for some time, the eye was placed at E, when the white spot illuminated by the colour thrown on D was visible, and the sectors closed till the last scintilla of light was extinguished. This was repeated for rays at different parts of the spectrum, and the results are shown in Fig 3 by the continuous curved lines. The diagram would have been too large had the same scale been adopted throughout for the ordinates], each curve is therefore made on a scale ten times that of its neighbour, counting from the centre

In the diagram the sodium light of the spectrum before extinction was made of the luminosity of the amyl-acetate lamp (hereafter called AL), which is about 8 of a standard candle, at 1 foot distance from the source. Before it ceased to cause an impression on the eye, the illumination had to be reduced to $\frac{350}{10,000,000}$ A L

E light	to	$\frac{65}{10,000,000}$			Of its spectrum luminosity
F light	,,	$\frac{150}{10,000,000}$	or	$\frac{15}{1,000,000}$	
G light	,,	$\frac{3000}{10,000,000}$	or	$\frac{3}{10,000}$	
C light	,,	$\frac{11,000}{10,000,000}$	or	$\frac{11}{10,000}$	
B light	,,	$\frac{70,000}{10,000,000}$	or	$\frac{7}{1000}$	

There was one objection which might have been offered to this method, and that was to the use of the rotating sectors, and perhaps to the ground glass. This objection was met by first of all reducing the light by means of a double reflection of the beam forming the patch from one or two plain glass mirrors, and also by using a plain glass mirror in the box instead of a silvered glass By this plan the light falling on the first plain glass mirror was reduced, before it reached the end of the box, 1000 times, and again, by narrowing the slit of the collimator, and also the slit placed in the spectrum, another similar reduction would be effected. All rays thus enfeebled were within the range of extinction. It was found that neither ground glass nor rotating sectors

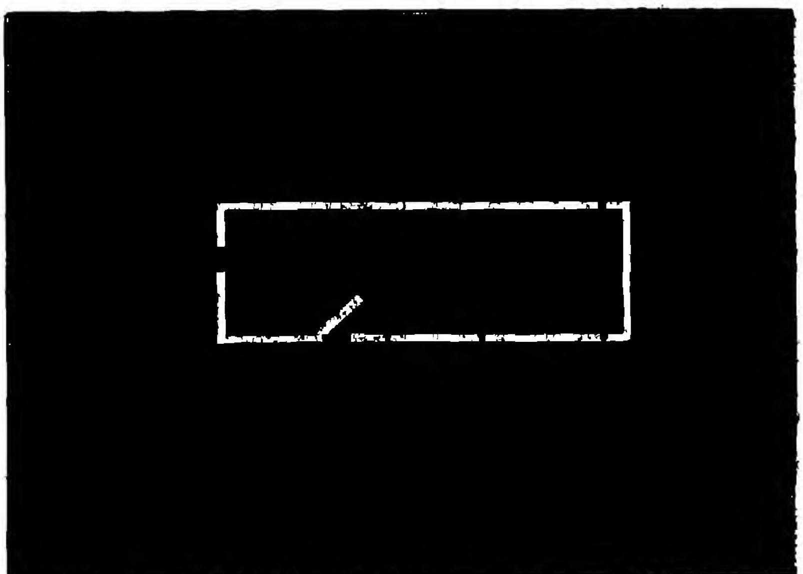


FIG 2 —Extinction Box

had any prejudicial effect, and therefore this extinction curve may be taken as correct

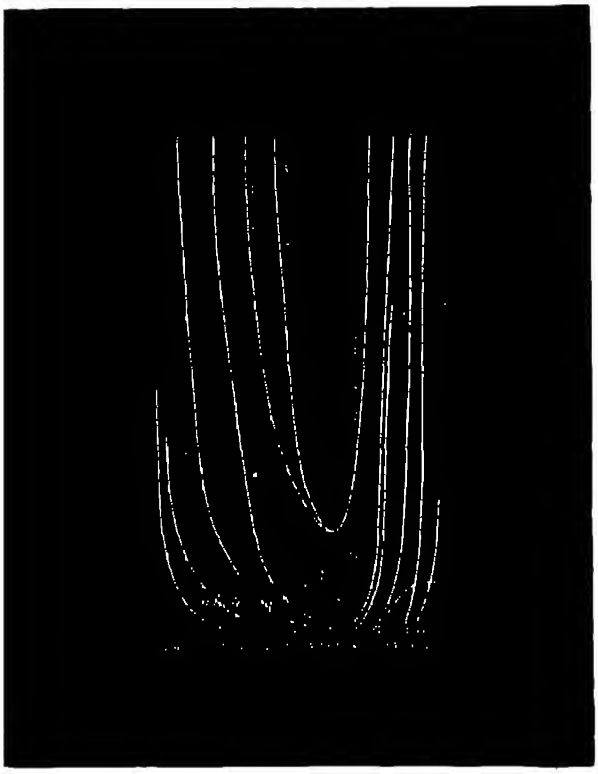


FIG. 3.—Extinction of the Spectrum

In the curves there are two branches at the violet side, and this requires explanation One shows the extinction when viewed by the most sensitive part of the eye, wherever that may be, and the other when the central portion of the eye was employed. The explanation of this difference in perception is chiefly as follows —

In the eye we have a defect—at least we are apt to call it a defect, though no doubt Providence has made it for a purpose—in that there is a yellow spot which occupies some 6° to 8° of the very centre of the retina, and as it is on this central part that we receive any small image, it has a very important bearing on all colour experiments. The yellow spot absorbs the blue-green, blue, and violet rays, and exercises its strongest absorption towards the centre, though probably absent in the very centre, that is, in the "fovea centralis," and is less at the outer edges. That absorption of colour by the yellow spot takes place can be shown you in this way. Any colour in nature can be imitated by mixing a red, a green, and violet together, and with these I will make a match with white and then with brown, two very representative colours, if we may call them colours. Now if I, standing at this lecture table, match a white by mixing these three colours together, using a large patch, the image will fall on a part of the retina of considerably larger area than the yellow spot, and it will appear too green for those at a distance; but it is correct for myself If I place a mirror at a distance, and make a match again by the reflected image, the match is complete for us all, as we all see it through the yellow absorbing medium If I look at it direct from where I stand the match is much too pink. It may be asked why the comparison patches and the mixed colours do not always match since both images are received on the same part of the retina The reason is that the green I have selected for mixture is in the part of the spectrum where great absorption takes place, whilst the comparison white contains the green of the whole spectrum, some parts of which are much less absorbed than others I may remark that just outside the yellow spot the eye is less sensitive to the red than is the centre, and this is one additional cause of the difference. See Fig 5

More on this subject I have not time to say on this occasion, but it will be seen that the extinction of light for the centre and the outside of the eye differs on account of this.

I must take you to a theory of colour vision which, though it may not be explanatory of everything, at all events explains most phenomena—that is, the Young-Helmholtz theory. The idea embodied in it is that we have three *sensations* stimulated in the eye, and that these three sensations give an impression of a red, a green, and a violet. These three *colours* I have said can be mixed to match any other colour, or, in other words, the three sensations are excited in different degrees, in order to produce the sensation of the intermediate spectrum colours, and those of nature as well.

The diagram Fig 4 shows the three sensations as derived from colour equations made by Kœnig It will be seen that there are three complete colour sensations, all of which are present in the normal eye. I would ask you to note that at each end of the spectrum only one sensation is present, viz. at the red end of the spectrum, the red sensation, and at the violet end the violet

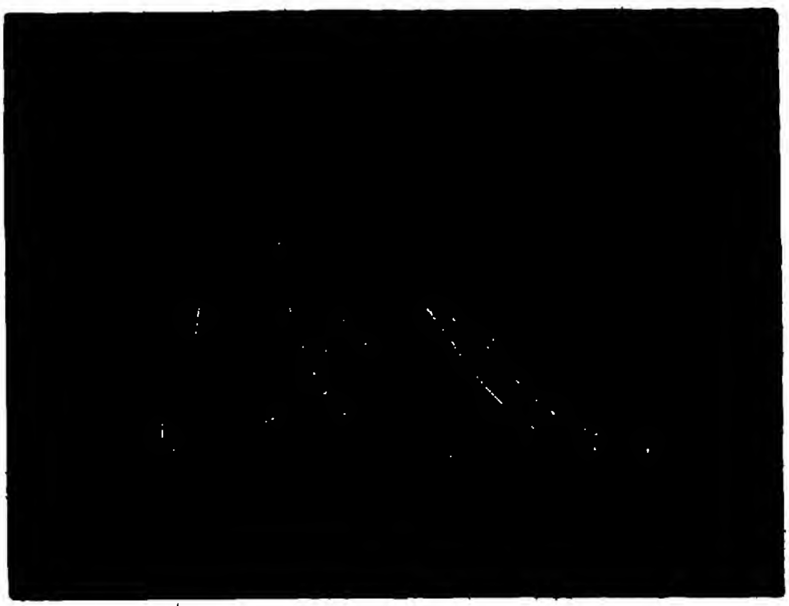


FIG. 4.—Colour Sensations

This is a matter of some importance, as we shall now see.

It will be recollected that in making the extinctions, the D light of the spectrum was made equal to one amyl-acetate lamp, and the other rays had the relative luminosity to it, which they had in the spectrum before they were extinguished The luminosity curve of the spectrum is shown in Fig 5

Suppose we make all the luminosities of the different rays equal to one A L, we should not get the same extinction value, as shown in the continuous lines in Fig 3 The violet would have to be much more reduced, but by multiplying the extinction by the luminosity we should get the curve of reduction for equal luminosities, and we get the dotted curves in Fig 3.

It will be seen that it is the violet under such circumstances that would be the last to be extinguished, and that all the rays at the violet end of the spectrum would be extinguished simultaneously, as would also those at the extreme red This looks like a confirmation of the Young-Helmholtz theory which I have briefly explained, for we cannot imagine that it can be anything but a single sensation which fails to be excited

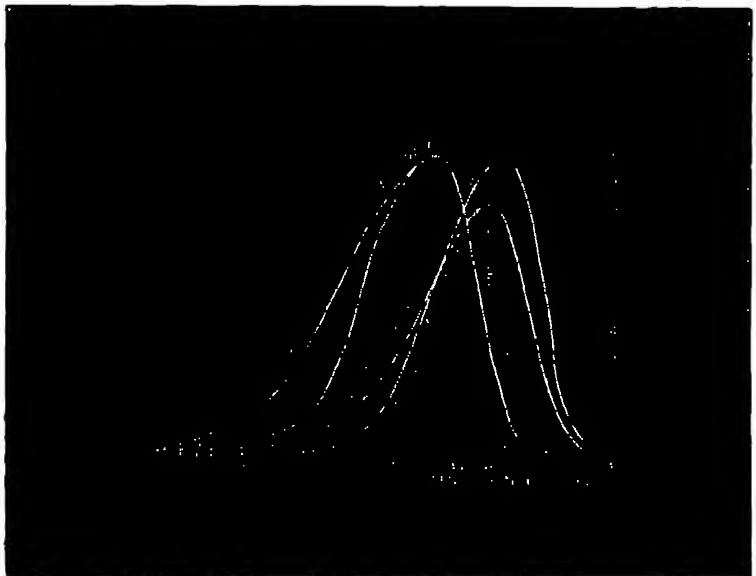


Fig 5.

The violet is extinguished when it is $\frac{15}{10,000,000}$ A L, that is, a screen placed 817 feet away and illuminated by an A L violet lamp would be invisible. The blue-green (F) light when it is $\frac{17}{10 \text{ millionths}}$ or 770 feet away The green (E) light $\frac{35}{10 \text{ millionths}}$ or 550 feet away. The orange (D) light is extinguished as before at $\frac{350}{10 \text{ millionths}}$ or 180 feet away, whilst the red (C) light has only to be reduced to $\frac{2200}{10 \text{ millionths}}$ or an A L lamp radiating C light would have to be placed only 67 feet away, whilst the radiation for an A L of the colour of the B light of the spectrum would have to be diminished to but $\frac{2600}{10 \text{ millionths}}$ or the screen would have to be placed 60 feet away.

It is therefore apparent that with equal luminosities the violet requires about 175 times more reduction to extinguish it than does the red, and probably about 25 times more than the green.

This being so, I think it will be pretty apparent that, at all events from the extreme violet to the Fraunhofer line D of the spectrum, the extinction is really the extinction of the violet sensation, a varying amount of which is excited by the different colours If then we take the reciprocals of the numbers which give extinction of the spectrum, we ought to get the curve of the violet sensation on the Young-Helmholtz theory. For if one violet sensation has to be reduced to a certain degree before it is unperceived, and another has to be reduced to half that amount, it is evident that the violet sensation must be double in one case to what it is in the other, that is, the degrees of stimulation are expressed by the reciprocal of the reduction

Such a curve is shown in Fig 5 (in which also are drawn the curves of luminosity of the spectrum when viewed with the centre of the retina and outside the yellow spot). And it will be noticed that it is a mountain which reaches its maximum about E. Remember that the height of the curve signifies the amount of stimulation given to the violet sensatory apparatus by the particular ray indicated in the scale beneath

Turning once more to Fig 3, it will be noticed that if any one or two of the three sensations are absent, the persons so affected are, what is called, colour-blind Thus if the red sensation is absent, they are red blind, if the green, then green-blind, if the violet, then violet-blind, if both red and green sensations are absent, then the person would see every colour, including white, as violet. The results of the measurement of the luminosity of the spectrum by persons who have this last kind of monochromatic vision should be that they give a curve exactly or at all events very approximately, of the same form as the curve given by the reciprocals of the extinction curve obtained by the normal eye, as the violet sensation is that which is last stimulated.

It has been my good fortune to examine two such persons, and I find that this reasoning is correct, the two coinciding when the curves for the centre of the retina are employed

Further, I examined a case of violet blindness, and measured the luminosity of the spectrum as apparent to him. Now if the Young-Helmholtz theory be correct, then in his case the violet sensation ought to be absent, and the difference between his luminosity and that of the normal eye ought to give the same curve as that of the violet sensation. This was found to be the case.

Again, the reciprocal of the extinction curves of the red-blind and green-blind ought to be the same as those of the normal eye, for the violet sensation must be present with them also. This was found to be so. We have still one more proof that the last sensation to disappear is the violet.

If we reduce the intensity of the spectrum till the green and red disappear to a normal eye, and measure the luminosity of the spectrum in this condition, we shall find that it also coincides with the persistency curve On the screen we have a brilliant spectrum, but by closing the slit admitting the light and placing the rotating sectors in the spectrum and nearly closing the apertures, we can reduce it in intensity to any degree we like The whole spectrum is now of one colour and indistinguishable in hue from a faint white patch thrown above it. If the luminosity of this colourless spectrum be measured we

shall get the result stated. The curve obtained in this way is in reality identical with the other curves. By these four methods then we arrive at the conclusion that the last colour to be extinguished is the sensation which when strong gives the sensation of violet, but which when feeble gives a blue-grey sensation.

One final experiment I may show you. It has been remarked that moonlight passing through painted glass windows is colourless on the grey stone floor of a cathedral or church.

We can imitate the painted glass and moonlight. Here is a diaper pattern of different coloured glasses, and by means of the electric light lantern we throw its coloured pattern on the screen. The strength of moonlight being known, we can reduce the intensity of the light of the lamp till it is of the same value. When this is done it will be seen that the pattern remains, but is now colourless, showing that the recorded observations are correct, and I think you are now in a position to account for the disappearance of the colour.

I have now carried you through a series of experiments which are difficult to carry out perfectly before an audience, but at any rate I think you will have seen enough to show you that the first sensation of light is what answers to the violet sensation when it is strong enough to give the sensation of colour. The other sensations seem to be engrafted on this one sensation, but in what manner it is somewhat difficult to imagine. Whether the primitive sensation of light was this and the others evolved, of course we cannot know. It appears probable that even in insect life this violet sensation is predominant, or at all events existent. Insects whose food is to be found in flowers seek it in the gloaming, when they are comparatively safe from attack. Prof. Huxley states that the greater number of wild flowers are certainly not red, but more or less of a blue colour. This means that the insect eye has to distinguish these flowers at dusk from the surrounding leaves, which are then of a dismal grey; a blue flower would be visible to us whilst a red flower would be as black as night. That the insects single out these flowers seems to show that they participate in the same order of visual sensations. I venture to think, without adopting it in its entirety, that these results at all events give an additional probability as to the general correctness of the Young-Helmholtz theory of colour vision. Where the seat of colour sensation may be is not the point, it is only the question as to what the colour sensations make us feel which the physicist has to deal with. The simpler the theory, the more likely is it to be the true one, and certainly the Young-Helmholtz theory has the advantage over others of simplicity.

"THE EPIGLOTTIS"[1]

FROM an anthropotomical point of view the epiglottis had for a long time been generally looked upon as a kind of sentinel for the protection of the upper air-passages, when Ruckert's comparative anatomical observations showed that the human epiglottis greatly differed from that of mammals, in so far as its relations to the soft palate were entirely altered, and that its physiological conditions *pari passu* had undergone important modifications. The new points of view thus obtained induced Gegenbaur to study the comparative anatomy of the epiglottis and its relations to the larynx, and the present volume is the outcome of his investigations.

The inquiry being undertaken from a morphological point of view the author begins with a study of the different forms of the epiglottis or epiglottoid structures in low classes of animal life. He next discusses the mammalian epiglottis and its relations to the soft palate. The conclusions here arrived at, and which concern the act of deglutition in the lower classes of mammals, lead to a consideration of other organs of the oral cavity, and to an attempt at establishing a connection between these and the apparatus consisting of the epiglottis and soft palate. This in turn induces a minute investigation of the structure of the epiglottis, and of its relationship to the framework of the larynx and the general structure of the respiratory organs in the lowest forms of animal life. In the last chapter the author summarizes the results obtained by his comparative studies and throws out such suggestions concerning the origin, development, and function of the epiglottis as would seem justified by his researches.

Brief as this survey of the course of Gegenbaur's essay necessarily has been, it will be sufficient to show that it is quite impossible to give in the space of a short review a detailed analysis of its contents. Conclusions derived from the synthetic conception of an enormous number of single observations, which extend over a large part of the entire animal kingdom, can only be properly appreciated by a study of the original, and this may be warmly recommended.

The final and most important conclusion arrived at by the author may be briefly summarized as follows:—

Whilst as high up in the scale as in the sauropsidæ, parts of two branchial arches only contribute towards forming the primary hyoid, three more arches are added in the mammals. Two of these growing together form the transition into the thyroid, which becomes intimately connected with the larynx.

The mammalian larynx, however, has received a further addition, viz. the epiglottis, the cartilage of which can only be looked upon as the further development of the fourth branchial arch, which in fishes still serves its primitive function, and in the amphibia appears in a rudimentary form. The exact manner in which this rudiment passes over into the supporting organ of the epiglottis in mammals is, on the whole, still obscure. So much, however, is certain, that the cartilage of the epiglottis is not a product of mucous membrane, but a genuine part of the skeleton, and that it communicates its supporting function to the whole of the epiglottis, which serves as well the purpose of keeping the air-passages open as of protecting the vestibule of the larynx.

From this final conclusion it will be seen that, according to Gegenbaur, the *rôle* of the epiglottis in its highest development is purely a respiratory and protective one.

Pathological observation in man does not admit of these functions of the part being looked upon in any way as indispensable for the existence of the individual. Total loss of the epiglottis has often been observed in various diseases, without the patients either suffering from dyspnœa or from increased liability to the entrance of foreign bodies into the lower air-passages, the *constrictor vestibuli laryngis* (Luschka) in such cases vicariously taking its function. The supposed phonatory *rôle* of the epiglottis, upon which much stress is laid by some eminent singing masters (*e.g.* Stockhausen), inasmuch as they maintain that it influences, according to its more erect or more horizontal position, the "timbre" of the singing voice, is not even mentioned in Gegenbaur's essay. Thus many points connected with this subject still demand elucidation. Still it is impossible to withhold the expression of admiration and of gratitude to the author of the present work for his patient and extensive researches in a very obscure field of comparative anatomy.

[1] "Die Epiglottis," Vergleichend anatomische Studie, by Carl Gegenbaur, with two plates, &c. (Leipzig: Wilh. Engelmann, 1892.)

NOTES.

ON Saturday the British Eclipse Expedition to West Africa arrived safely at Bathurst. The *Alecto* was there, ready to convey the party up the Salum River to the selected site.

ON Tuesday next, April 11, Mr J. Macdonell will begin at the Royal Institution a course of three lectures on symbolism in ceremonies, customs, and art, on Thursday, April 13, Prof Dewar will begin a course of five lectures on the atmosphere, and on Saturday, April 15, Mr James Swinburne will begin a course of three lectures on some applications of electricity to chemistry. The Friday evening meetings will be resumed on April 14, when Sir William H Flower will deliver a discourse on seals.

THE Academy of Sciences in Turin announces that the ninth Bressa prize of 10,416 francs, for which all men of science and inventors of all nations are free to compete, is now offered (from January 1, 1891, to December 31, 1894) The prize will be given to whoever, in the judgment of the Academy, shall have, within the period indicated, made the most important and useful discovery, or shall have published the most profound work in the domain of the physical and experimental sciences, natural history, pure and applied mathematics, chemistry, physiology and pathology, geology, history, geography, and statistics. Any one wishing to compete must send his printed work (manuscripts are not accepted) to the President of the Academy Unsuccessful works are returned, if it be desired

AT the meeting of the Chemical Section of the Franklin Institute, on February 21, a resolution was passed to the effect that the members had heard with deep regret of the death of their distinguished fellow-member, Dr F A Genth, whose services as an investigator had "added lustre to American science" A committee was appointed to prepare a suitable memoir of Dr Genth for publication in the proceedings of the Section

ARRANGEMENTS have been made for another series of summer excursions by the London Geological Field Class The object of these excursions, which are planned by Prof H G Seeley, F.R S, is the study of the physical geography and geology of the Thames Basin. The first excursion will take place on April 29, when the students will go from Edenbridge to Westerham by Toys Hill Each excursion will be under Prof. Seeley's personal direction

A SCHEME for the organisation of the proposed University for London was adopted at a general meeting of the Association for Promoting a Professorial University for London on March 23, and has been submitted to the University Commissioners It is printed in the *Times* of April 3

THE Scottish Technical Education Committee—appointed more than a year ago at a conference held in Edinburgh—has issued a report, from which it seems that Scotland has still a great deal to do before she can be said to possess a satisfactory system of technical instruction At a recent meeting the Committee passed the following resolution —"That, in the opinion of the meeting, it is desirable that the whole subject of higher and technical education should be dealt with in a comprehensive measure, and that the opportunity be not lost when the provision for secondary education is being inquired into in all parts of Scotland, to formulate a scheme for organising education beyond the elementary, and reducing in some degree the complications now existing, and the waste resulting from the various authorities that now have a connection with various parts of the educational system of Scotland, and that the chairman (Lord Elgin) be requested to take the necessary steps to bring the subject under the attention of the Government." At the same meeting the future action of the Committee was under consideration. It was felt that in present circumstances it would be very desirable to continue its existence if possible in some more definite shape, and a sub-committee was instructed to inquire under what conditions it might be brought into connection with the National Association for the promotion of secondary and technical education, and, if the sub-committee thought fit, to submit a form of constitution to the next meeting.

SHORTLY after eight o clock on the morning of April 1 a severe earthquake shock was felt at Catania, and other places at the foot of Mount Etna. It was more especially pronounced at Nicolosi and Zaffarana-Etnea, where the population fled from their houses into the fields

THE weather continued exceptionally fine over England during the whole of last week, and in Scotland and Ireland the weather was generally fair, although slight rain occurred at times in a few places The first few days of the period were the warmest experienced as yet this season, and 70° was reached in parts of England In the suburbs of London the shade thermometer registered 68° or upwards on four consecutive days, and this is the average maximum temperature in June, while on Saturday, April 1, the thermometer reached 71° in the outskirts of the metropolis The general indications on Saturday were more favourable to a change than for some time past, but the unsettled appearance suddenly gave way to an anticyclone, which reached our islands from the Atlantic, and the conditions again became settled, although the maximum day temperatures during the last few days of the period were generally somewhat lower under the influence of a gentle easterly breeze The mean temperature for March was several degrees in excess of the average over the whole kingdom, and at Greenwich the excess amounted to 5°, while the mean of all the maximum day readings, which was 57°, was higher than in any previous March during the last half century The total rainfall for March was also small over the whole country, and at Greenwich the aggregate amount was only 0 38 inches, which is the smallest fall in March since 1854. The *Weekly Weather Report* for the week ending April 1 shows that the duration of sunshine was 85 per cent in the Channel Islands, 76 per cent in the south of England, and 72 per cent in the east of England.

WE recently referred to the unsatisfactory condition of practical meteorology in Spain The Royal Observatory at Madrid had for many years published results of observations taken at various stations in the peninsula, which furnish valuable materials for climatology, but daily telegraphic reports such as are issued in most other countries were necessary to complete the general synoptic view of weather conditions We are glad to be able to report that this want has now been supplied The first daily weather bulletin was recently issued, containing on one side a map showing isobars, wind direction and force, &c, and on the other the actual telegraphic observations at a number of stations distributed over Spain and south western Europe. The bulletin is published by the Central Meteorological Institute, which was established some little time since under the direction of Prof A. Arcimis, to whose persistent efforts we are chiefly indebted for this new contribution to our knowledge of current weather

THE Meteorological Institutes of Hamburg and Copenhagen have issued their synoptic daily weather charts of the North Atlantic Ocean for the year ending November 1888 These charts contain the best materials for studying the various tracks and positions of the high and low pressure systems over the Atlantic; it is at once seen from them that in different parts of the ocean the storms take different routes, some follow a direct easterly track, others a more northerly course, while some form and others die out in mid ocean. The great difficulty in storm prediction at present is to determine the routes that storms will take; a serious study of the conditions shown on such charts may eventually lead to the desired end, by enabling us to establish characteristic types of weather which accompany various depressions.

MR. W H. GREENE and Mr W H. Wahl have elaborated a new process for the manufacture of manganese on the commercial scale. A paper by them on the subject was read before a recent meeting of the Chemical Section of the Franklin

Institute, and is printed in the Section's Proceedings for March

A SIMPLE contrivance for determining the refractive index of a liquid without the use of a circular scale or a hollow glass prism, is described in *Wiedemann's Annalen* by Mr H Ruoss, of the Stuttgart Technical High School The liquid is poured into a rectangular vessel, closed on one side by a plane-parallel glass plate. A small plane mirror is half immersed in the liquid, and mounted so that it can be placed exactly parallel to the plane-parallel side A telescope is directed towards the mirror from outside, about 4 m distant, its axis being normal to the glass side To this telescope is attached at right angles a scale 3 m long On looking through the telescope the image of the scale in the mirror appears broken into two by the surface of the liquid, the lower image being formed by rays which have undergone refraction and reflection in the liquid The divisions on the cross wire measure the tangents of the angles of incidence and refraction respectively, which, since both the sets of rays after reflection are parallel, determine the refractive index of the liquid A correction has to be applied for the thickness of the plate-glass, and it is best to make the angle of incidence as large as possible Before taking the readings, the instrument should be adjusted by making the cross-wire coincide with its two reflections in the mirror and the plate, and placing the scale in a parallel and horizontal position with its reflected zero on the cross wire. With these adjustments and corrections the apparatus is capable of giving very accurate results The angles can be measured to within 5", and a large number of readings may be taken with different inclinations of the mirror A set of five measurements for water in sodium light, for instance, gave a refractive index of 1 33276, which coincides with Walther's value to the fourth decimal place, and is subject to a probable error of 0 00003

AT the magnetic observatory of Potsdam some interesting improvements have been made in registration of the needle's variations, a brief account of which is given by Herr Eschenhagen (*Met Zeits*) He uses a greater length of abscissæ than usual (20 mm per hour), and obtains a fine curve by cutting off the border rays by means of a paper screen on the lens, by determining exactly the chemical focus, and by use of a very small mirror The slit is 0 25 mm In the case of great magnetic disturbances, trouble sometimes arises from the movable light point going beyond the recording surface, even where, as in Potsdam, this has a width of 190 mm (7 6 inches), so that the most interesting parts of disturbances may be lost An attempt was made to remedy this with prisms of a certain angle of refraction, but there are objections to this plan A more simple and effective method was hit upon, the magnetic mirror is made in three parts, or facets, inclined to each other at an angle of 3° It is enclosed in a bell-jar, in which the air is kept dry and free from sulphur vapour The mirror gives three beams, of which usually only the middle one is concentrated in a fine light point on the drum During a strong disturbance, and just before this light point leaves the drum, another point appears on the opposite side, which takes up and continues the record. These and other improvements will be described in detail ere long in publications of the Observatory.

ACCORDING to recent researches by M. T. J van Beneden on the fossil Cetacea found in the regions of the Black Sea, the Caspian, and the Sea of Aral, the basin of the Black Sea contains all those forms which to-day characterise ocean fauna (Balænides, Ziphioides, Delphinides, and Sirenides), and taking also the region of rivers now flowing into that sea into account, it is probable that the whole of Central Europe at the end of the Miocene period was traversed by numerous arms of the sea, the Black Sea reaching to Vienna, Linz, and even to the Lake of Constance Towards the end of the Pliocene, or the beginning of the quaternary period, owing to considerable depressions, the Straits of the Bosphorus were formed, and the water of the Mediterranean pressed into a basin formerly connected with the Arctic Sea. Thus the passage of a new fauna was made possible, which gradually, under favouring conditions, displaced the older The Caspian was separated before the new forms had spread so far, and we find in it fifty four species of fishes, which are neither in the Sea of Aral nor the Black Sea, and only six species which it has in common with those two others

FROM recent researches on transference of material in plants (represented, *e g* by transference of starch in the potato), Herr Brasse is led to present the following view of what goes on The assimilation of carbon in the sun's rays is manifested directly in deposition of starch in the chlorophyll grains Through action of diastase in the leaves, and at a temperature lower than that of its formation, this starch is changed into reducing sugar, which spreads by diffusion from its place of formation into all the tissues of the plant In certain parts, and especially in the tubers, the sugar is continuously transformed The tubers, with regard to dissociation, act like the cold wall in vaporisation of a volatile liquid in an enclosed space The sugar-content of all cells of the plant seeks to enter into equilibrium with that of the cells of the tubers, in which the content is less, because a change of sugar into starch takes place, and the coefficient of this change is here less than that of the converse change in the leaf, the temperature of the tuber being less Owing to this inequality, there is a transference of starch from the leaf into the tuber, in which it passes through the intermediate stage of sugar In a similar way Herr Brasse would explain the transference of nitrogenous and mineral plant materials, and their storage in special organs (*Comptes Rendus de la Société de Biologie*)

MR E LOMMEL has succeeded in fixing photographically the equipotential lines due to a current flowing through a conducting sheet A current of 20 amperes was sent through sheets of copper 0 5 mm thick and of various forms The sheets were covered with sensitive paper strewn with iron filings, which arranged themselves along the lines of magnetic force due to the current, or, what amounts to the same thing, the lines of equal electrical potential along the conductors The configurations thus obtained were fixed by holding a lighted match for a few seconds above the paper, yielding on development a beautiful representation of the flow through the current sheets. Two of these figures are reproduced in the last number of *Wiedemann's Annalen* One of them represents the flow through a ring formed by two concentric circles, the current being conveyed by wires soldered to two diametrically opposite points. The other exhibits the equipotential lines in a rectangle with a hole in the middle and wires soldered to two opposite corners A consideration of the various ways in which the presence of a strong magnetic field affects the configuration of the lines observed has led the author to a possible explanation of the "Hall effect" This phenomenon is only produced by magnetic lines of force running in a direction normal to the plate, or by the normal component of slanting lines. If in a rectangular current sheet made of diamagnetic material two points at equal potential, but on opposite edges of the sheet, be connected with a galvanometer, no current will be indicated until the sheet is brought into a strong magnetic field. According to Weber's theory of diamagnetism, currents are then generated in the molecules opposite in direction to the amperian currents. These molecular currents give rise to a resultant current round the edge of the sheet, strengthening the ordinary current on one side and weakening it on the other. This state of things

will be indicated by a deflection of the galvanometer needle and a distortion of the lines of flow, usually designated by "negative rotation" In the case of a paramagnetic body the rotation will be positive.

SEVERAL correspondents have written to us with regard to Mr Hilderic Friend's letter on "Luminous Earthworms" (NATURE, March 16, p 463) Several of them record observations which seem to them to confirm his statements Mr R I Pocock, of the British Museum (Natural History), points out, however, that the property of phosphorescence exists in a highly developed state in certain terricolous, nocturnal animals, which, although both luminous and vermiform, are certainly neither glowworms, nor yet earthworms "The power of producing adhesive phosphorescent matter from pores opening upon the ventral surface of the body has," says Mr Pocock, "been recorded from different quarters of the globe, in the case of several genera of centipedes of the family *Geophilidæ*, and since no special affinity is traceable between all the forms that are known to be sometimes luminous, it is highly probable that the presence of appropriate glands for the secretion of the matter in question is, or has been in the past, characteristic of the whole group About a dozen species of *Geophilidæ* occur in the south of England All may be described as worm like, and some of them are known to be phosphorescent Curiously enough, the specimens that have been not uncommonly brought to the Natural History Museum as phosphorescent phenomena are referable to a species, *Linotænia crassipes*, which is the most earthworm-like of all, so far, at least, as colour is concerned An example of this species was, I venture to suggest, the 'luminous earthworm' with the story of which Mr Friend opens his account of the subject This centipede is about one or two inches in length, and, although it is impossible quite to acquiesce in the statement that it is 'worm-like in all respects,' nevertheless I think it more than probable that a lady, finding one in the dusk of evening, when it could be but dimly seen, would summarily describe her idea of its appearance by some such expression as that used"

MR J E HARTING, writing in the April number of the *Zoologist*, says that during a recent visit to Greece he lost no opportunity of interrogating the natives as to the birds and beasts to be met with, and was everywhere struck with the ignorance displayed on this subject, and the general indifference which prevailed respecting it It was not until he reached the great plain of Larissa, where a plague of field voles has been for some time manifest, that he encountered those who could impart some information on at least one small indigenous mammal, namely, that which was causing such mischief and pecuniary loss to the resident land owners That it was a vole (*Arvicola*) of some sort was certain, but as to the precise species some difference of opinion had been expressed. Mr Harting gives much very interesting information as to the animal's habits.

A PAPER on the foundations of the two river piers of the Tower Bridge, by Mr G E W Cruttwell, was read at the last meeting of the Institution of Civil Engineers before Easter. It was stated that the materials in the two piers, from foundation line up to a level of four feet above Trinity high-water (a height of 60 feet), consisted of 25,220 cubic yards of cement concrete, 22,400 cubic yards of brick-work in cement, and 3340 cubic yards of Cornish granite, making a total of 50,960 cubic yards.

THE Agricultural Research Association for the north-eastern counties of Scotland has issued its report for 1892. A general outline of some of the past year's results is presented, and this is followed by a record of observations, by Mr Thomas Jamieson, relating especially to grass and clover roots.

MESSRS E AND F N SPON have issued a convenient little volume of waistcoat-pocket size, containing electrical tables and memoranda, by Prof Silvanus P Thompson and Eustace Thomas The type is small but clear, and there are some illustrations

MESSRS CROSBY LOCKWOOD AND SON will publish in a few days a new work by Mr J D Kendall, of Whitehaven, on "The Iron Ores of Great Britain and Ireland," giving an account of our present knowledge of the origin and occurrence of such ores, and the means of reaching and working them Some of the more important iron ores of Spain are also noticed in the volume

DR E SYMES THOMPSON will deliver lectures on the nose and mouth at Gresham College on April 11, 12, 13, and 14, at six o'clock

UNTIL comparatively recently bacteriologists have regarded the macroscopic appearances to which organisms give rise when grown on potatoes as affording valuable assistance in distinguishing between otherwise very similar microbes One notable instance of this is the alleged different behaviour of the typhoid bacillus and the closely allied *B coli communis* when inoculated respectively on to potatoes But more recent research has shown that as a diagnostic agent the potato is extremely untrustworthy, and this has moreover been conclusively demonstrated in the case of just these two organisms Further evidence on this subject has lately been brought forward by Krannhals, "Zur Kenntniss des Wachsthums der Komma bacillen auf Kartoffeln" (*Centralblatt fur Bakteriologie*, vol xiii p 33), and the results he has obtained in the case of the cholera organism are very instructive When cholera declared itself at Riga last August, Krannhals, as Prosector and Bacteriologist at the city infirmary, was deputed to demonstrate officially to the city medical authorities that it really was cholera which had broken out The culture tests employed exhibited all the typical appearances associated with the cholera organism with the exception of its development on potatoes, upon which it obstinately refused to grow Suspecting that this might be due to the acidity of the potatoes, slices were prepared and artificially rendered alkaline On these the bacillus grew abundantly and moreover at from 16°–19° C, whereas it has hitherto been stated to be capable of only developing on this medium at from 30°–40° C On the acid slices the same negative results were obtained as in all the previous experiments. In consequence of this discovery Krannhals conducted a large number of investigations on the behaviour of the cholera bacillus on acid and alkaline slices of potatoes respectively, and whereas he never failed to obtain vigorous growths on the latter even at the low temperature, he was only in very few instances (4 out of 136 experiments) able to induce its development on non-alkalised slices But on testing those acid slices on which growths had appeared, it was found that they exhibited a distinct alkaline reaction This alkalinity, moreover, had nothing to do with the growth of the bacillus, for sterile slices prepared in the same manner were tested both immediately on preparation and after they had been preserved some days, and the same astonishing result was obtained, *i e* that the slices of potato originally acid had during keeping become alkaline. Krannhals is led to suggest that in reality the cholera organism is incapable of growing on acid potatoes and that in those cases where it is stated to have developed on such, the medium unknown to the investigator must have, as in his experiments, changed from acid to alkaline. It is important that in future, therefore, the reaction of the potato should be noted both at the time of inoculation and later, when describing the growth of organisms on this medium.

Notes from the Marine Biological Station, Plymouth —Last week's captures include the rare Nudibranch *Hero formosa*, specimens of the spiny shrimp (*Crangon spinosus*), and of the starfishes *Porania pulvillus* and *Henricia* (*Cribrella*) *sanguinolenta*. In the floating fauna *Plutei*, large and small, have now quite taken the place of the *Auricularia* and *Bipinnaria* larvæ, which were so plentiful a few weeks ago *Arachnactis* is still obtainable The unmodified ephyræ of *Aurelia* are now very scarce most of them are passing through various phases of their metamorphosis into the definitive medusa-form , and, instead of being plentiful everywhere, are now restricted to special localities

The additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*, ♂) from India, presented by Mr J Pitcher , a Bengalese Cat (*Felis bengalensis*) from Manilla, Philippine Islands, presented by Mr D M Forbes, F Z S , three Peafowls (*Pavo cristatus*, ♂ ♀ ♀) from India, presented by Mr T Guy Paget , a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mrs W Everett Smith , five Black-headed Gulls (*Larus ridibundus*), a Common Gull (*Larus canus*) European, presented by the Rev E. M Mitchell , three Rhomb marked Snakes (*Psammophylax rhombeatus*), a Hoary Snake (*Coronella cana*) from South Africa, presented by Messrs H M and C Beddington , three Spring boks (*Gazella euchore*, ♂ ♀ ♀) from South Africa, a Raccoon (*Procyon lotor*) from North America, a Green Monkey (*Cercopithecus callitrichus*) from West Africa, deposited , two silver-backed Foxes (*Canis chama*), a Cape Bucephalus (*Bucephalus capensis*) from South Africa, purchased , a Short Death Adder (*Hoplocephalus curtus*) from Australia, received in exchange , four Great Cyclodus (*Cyclodus gigas*) born in the Gardens

OUR ASTRONOMICAL COLUMN

Comet Swift (*a* 1892) —At the Boyden Station, Arequipa, Peru, during the visibility of this comet, all the photographic telescopes were turned towards it, with the result that a fine series of photographs were obtained In the Bache 8 inch photographic doublet, fifty six pictures (20 millimetres to the degree) were taken, sixteen of which "are of the first quality" , in the 2·5 inch photographic doublet (3 8 millimetres to the degree) twelve satisfactory plates were taken, while in the 13-inch refractor and 20-inch reflector several additional negatives were collected An examination of the negatives, especially of those belonging to the first series, indicated two important facts, as Mr A E Douglass (*Astronomy and Astrophysics* for March) informs us (1) That the tail of the comet was composed of luminous masses receding from the head at a measurable rate, and (2) that the form of the tail depended largely on some varying force acting at the head. The former of these results was deduced from measurements of the distance of prominent points (8 points were here used) from the nucleus, and the acceleration he obtained amounted to 477,000 miles per day In discussing the second fundamental results, he deals with the general characteristics of the tail and the special phenomena within half a degree of the head, separately The tail he describes as "a bundle of slightly divergent straight streamers, branching from each other and joined to the head by one, two, or three well marked lines" At the southern part of the tail the photographs showed the appearance of a curious twisting effect, while a number of faint streamers, in many cases not joined to the main part of the tail, were also visible The curve of the natural tangents of the position angles for the date on which they left the head, is, as plotted out by Mr. Douglass, quite irregular, and suggests "non periodic outbursts from the head of the comet or variations in the repulsive force of the sun" , where the tail swings to one side there are "large jets in the opposite direction as if the whole resulted from some increase in activity in the head." He suggests that this activity may be connected with solar disturbances, just as magnetic storms on the earth may be connected with certain classes of sunspots

Paris Observatory in 1892 —From the annual report on the condition of the Paris Observatory during the year 1892, which was presented to the Council in January last by M Tisserand, the Director, we gather the following brief notes

Commencing with a short reference to the late Director, l'Amiral Mouchez, and to the great loss both to the Observatory itself and to astronomical science in general, M Tisserand informs us that, at the suggestion of M O Struve, the presidency of the Comité permanent de la Carte du Ciel has passed to the present Director of the Paris Observatory. This choice has been received very favourably, and been confirmed by all the members of the committee Let us here tender our congratulations to M Tisserand, who, without doubt, will, in his capacity as president, bring such a grand work as nearly as possible to perfection In fact, he has commenced by increasing the personnel du Bureau de Mesures des Clichés at the Observatory, and constructing a new machine for the measures, while he hopes soon to publish a fascicule of the *Bulletin de la Carte du Ciel*, which will contain the method of reducing the measures, and of the definite computations of the positions of the stars

The large equatorial Coudé has this year been subjected to a minute study by M Lœwy from the point of view of its optical qualities, and of the possibility of improving it still more The experiments have as yet been restricted to the mounting of the mirror, and it seems that important results may soon be forthcoming The spectroscopical department, under the direction of M Deslandres, has, as we are informed, quite assumed a definite form since its foundation in 1890 , the work done is tabulated under the three headings—sun, stars, and laboratory work As we have previously referred in these columns to most of the work here accomplished, such as, for instance, the researches of the velocities of stars in the line of sight (250 stars will here be included), photographs of protuberances, faculæ, new hydrogen radiations, &c , further notice will be unnecessary. With the Equatorial de la Tour de l Ouest, the programme of observations has been the same as in previous years, measures of the positions of comets, nebulæ, and double stars having been obtained Among the observations here recorded as many as 136 were made of Comet Swift (1892), 41 of Comet Denning (1892), while 250 nebulæ and 120 double stars have been measured All the above were made by M Bigourdan M Faye also made 77 observations of comets With the Cercle Méridien du Jardin under the special service of M Lœwy, the total number of observations amounted to 16 686 , 453 observations were made of the sun, moon, and planets M Paul and Prosper Henry have been occupied in obtaining clichés of the international chart and of the catalogue ; photographs have also been taken of the late nova in Auriga, Jupiter, and Comet Holmes The Bureau des Mesures des Clichés du Catalogue, under the direction of Mdlle Klumpke, has been very busy At this part of the report a brief description of the measuring machine is given, and in a paragraph on "reflexions sur le catalogue et la durée de son exécution," we are told that, if simply the 1200 or 1400 clichés which are demanded for the work in each of the eighteen observations are obtained "on peut espérer d'y atteindre en cinq ou six ans au plus." For measuring the clichés with one machine, and two persons to observe and write the results, 130 clichés could be done in a year, but it would take about 10 years to measure the clichés attributed to one observatory, with one machine and two persons working incessantly. The report contains also all the meteorological work and that done with the minor instruments, concluding with the usual lists of personal publications, observatory publications, changes in the personnel, &c

The Large Nebula near ξ Persei (N. G C 1499) —Dr F Scheiner, in *Astronomische Nachrichten* (No 3157), describes briefly this great nebula near ξ Persei, several photographs of which he has been able to obtain During November and December last, employing an objective of 4-inch aperture, he took fine photographs, with exposures varying from 1 to 6 hours. The longest exposed plates showed that the size of this nebula has been considerably under-rated, and that it comes nearly up to that of Orion and Andromeda. This nebula, it will be remembered, was discovered by Prof. Barnard with a 6-inch objective, and the position which he gave, 3 h 54·0 m R A + 36° 1' Decl (1855 0), referred to

the more northern part Dr. Scheiner's photographs show that its extension southward is very considerable, but, owing to its dimness, was not seen by Prof Barnard The form of this nebula, a copy of which is given in this number, is inclined to be spirally, although not so apparent as that of Andromeda, and, curiously enough, it lacks a bright nucleus, as in the latter

MINOR PLANETS —The work of discovering minor planets seems, at the present time of the year, to be in a very flourishing condition, although rather restricted to two observers, according to the current number of *Astronomische Nachrichten* (No 3157) Charlois with 10 and Wolf with 2, bringing the present notation up to 1893 X, is a good number for the first quarter of the year, and if this average be kept up we shall soon be driven to indulge in the Greek or German alphabet, or both

GEOGRAPHICAL NOTES

MR JOHN BARTHOLOMEW, of Edinburgh, whose reputation as one of the foremost British map makers is world wide, died on March 30, at the age of 61 His career will be remembered as an epoch in the history of the perfecting and popularising of English maps Trained in Edinburgh and afterwards under the late Dr Petermann, in London, Mr Bartholomew succeeded his father in a cartographical business in Edinburgh, which he steadily enlarged and improved, paying attention not only to excellence of mechanical production, but to the improvements of methods of representation But the leading characteristic of Mr Bartholomew's work was his conscientious endeavour to produce the most accurate topographical delineation The general use of maps coloured orographically in this country is mainly due to the efforts of the Edinburgh Geographical Institute, of which he was the head Mr Bartholomew gradually withdrew from active work on account of failing health, and his son, Mr J G Bartholomew, has taken his place in the Geographical Institute

MR THEODORE BENT (see p 519) has been able to reach Aksum, where, however, he only remained for eight days, on account of tribal wars The party had to retire abruptly because of a threatened fight, in which they were very nearly compelled to take sides, but fortunately the report of an advance of Italian troops to their relief solved the difficulty, and they reached the coast in safety Despite the shortness of the working time, some good archæological results have been obtained

THE March number of *Petermann's Mitteilungen* contains a valuable paper on North-west Patagonia by Dr J von Siemiradzki, with a map showing the results of his surveys and coloured to bring out the pastoral possibilities of the region His route in 1891–92 led up the Rio Negro and Rio Limay to Lake Nahuel Huapi and thence northward through the grassy valleys and bare slopes of the Cordillera to the Upper Bioblo valley, whence the expedition passed to the coast of Chile

THE Royal Geographical Society has given a grant to Dr H R. Mill to defray the expenses of a careful bathymetrical survey of some of the larger English lakes The work, which will be carried out next summer, would be greatly facilitated if use could be had for a few days of a steam launch upon any of the lakes Windermere, Coniston Water, and Wastwater will probably be sounded in the first place, as they are the most interesting from the limnological point of view

A PAPER on the Geography and Social Conditions of the Iberian Peninsula read at the March meeting of the Berlin Geographical Society by Prof Theobald Fischer is published in abstract in the April number of the *Geographical Journal* The paradoxical character of the peninsula in the variety of its conditions has long been known. The great central plateau with its broken mountain border sloping steeply to the sea throws the bulk of the population towards the coast line In the border zone of the peninsula comprising 45 per cent of its area, more than 66 per cent. of the inhabitants are settled The only large city in the central plains is Madrid; all the rest of the plateau is occupied by wheat-growers and sheep-rearers, the mining, fruit-growing and industrial interests being all confined to the seaward slopes. There are few parts of Europe in which the physical conditions so plainly dominate the whole character of a country.

GRAPHICAL SOLUTIONS OF PROBLEMS IN NAVIGATION

1 IF we suppose the two angles P, S of a spherical triangle SPZ to be together less than two right angles, a plane triangle $S_1P_1Z_1$ may clearly be drawn such that $P_1 = P$ and $S_1 = S$ The sides of the spherical triangle PS, PZ, SZ being respectively denoted by p, c, z, those of the plane triangle may be taken in the following ratios —

$$P_1S_1 = \tan \tfrac{1}{2}p,$$
$$P_1Z_1 = \tfrac{1}{2}\tan \tfrac{1}{2}(c + z) + \tfrac{1}{2}\tan \tfrac{1}{2}(c - z),$$
$$S_1Z_1 = \tfrac{1}{2}\tan \tfrac{1}{2}(c + z) - \tfrac{1}{2}\tan \tfrac{1}{2}(c - z),$$

These results may be easily verified

Hence $$S_1Z_1 + P_1Z_1 = \tan \tfrac{1}{2}(c + z),$$
and $$P_1Z_1 - S_1Z_1 = \tan \tfrac{1}{2}(c - z)$$

From these equations we infer that Z_1 is the intersection of an ellipse and hyperbola which have the same foci P_1 and S_1 Suppose now that the line S_1P_1 contains, say, 100 divisions, and that a system of ellipses, having S_1 and P_1 as foci, with major axes 101, 102, 103 and a system of hyperbolas whose axes are 99, 98, 97 are drawn on one side of S_1P_1, then, by finding m_1, m_2 from the equations

$$m_1 = 100 \tan \tfrac{1}{2}(c + z) \cot \tfrac{1}{2}p,$$
$$m_2 = 100 \tan \tfrac{1}{2}(c - z) \cot \tfrac{1}{2}p,$$

we should be able to localise the point m_1m_2 as coming between two successive ellipses and also between two consecutive hyperbolas in the diagram

2 The usefulness of such a diagram lies in its application to problems in navigation For p may be taken as the north polar distance of the sun, z the complement of his altitude, and c the colatitude of the place of observation Having determined m_1, m_2 and thus localised Z_1 in the diagram, the angle $Z_1P_1S_1$ is the hour angle which may be suitably measured

If we interchange p and c in the diagram, thus making P_1 and Z_1 the foci, the point to be localised is S_1 from the equations

$$n_1 = 100 \tan \tfrac{1}{2}(p + z) \cot \tfrac{1}{2}c,$$
$$n_2 = 100 \tan \tfrac{1}{2}(p - z) \cot \tfrac{1}{2}c.$$

The difficulties attending this mode of representation will present themselves in another form in § 4 It is sufficient to notice here that this use of the diagram has the advantage of giving two useful angles—$S_1P_1Z_1$, the hour angle, and $S_1Z_1P_1$ the azimuth

3 The merit of both these modes of representation consists in their being each a single diagram, applicable at any time of year, though in northern latitudes more favourable to accurate measures in summer than in winter Their demerit consists in the preliminary calculations of m_1, m_2, or n_1, n_2 This, however, might be minimised by supplying, along with the diagram, tables of the values of m for two arguments θ and ϕ given by

$$m = 100 \tan \tfrac{1}{2}\theta \cot \tfrac{1}{2}\phi$$

The whole amount of preliminary calculation would then consist in adding and subtracting p and z, and looking out m_1 and m_2.

I shall now investigate the nature of a diagram which requires no preliminary calculation

Returning to the spherical figure SPZ, let us suppose SP to be fixed while the sides PZ, SZ vary so that Z describes a curve on the sphere The corresponding point Z_1 will describe a corresponding locus on the plane For example, if Z describes a small circle with P as centre, the locus of Z_1 will be given by

$$\tan c = \tan\{\tfrac{1}{2}(c + z) + \tfrac{1}{2}(c - z)\}$$
$$= \frac{P_1Z_1}{1 - P_1Z_1^2 + S_1Z_1^2}$$

Now, if we draw a perpendicular Z_1N to the side P_1S_1 we shall have

$$P_1S_1^2 - S_1Z_1^2 = P_1N^2 - S_1N^2$$
$$= \tan \tfrac{1}{2}p(2P_1N - \tan \tfrac{1}{2}p),$$
$$\therefore P_1Z_1 = \tan c \tan \tfrac{1}{2}p(\operatorname{cosec} p - P_1N)$$

This shows that the curve described by Z_1 is a conic section of eccentricity $\tan c \tan \tfrac{1}{2}p$, with focus at P_1 and directrix perpendicular to P_1C_1 at a distance $\operatorname{cosec} p$ from P_1

Similarly, the curves corresponding to small circles about S_1 are conics with a common directrix and with focus at S_1, their curvatures being turned the opposite way from those about P_1.

The lines whose focus is P_1 are curves of equal latitude, and those whose focus is S_1 are Sumner lines. Suppose systems of both kinds of lines to be drawn, the figure will be divided into small quadrilaterals, and the eye, aided by a scale with small divisions, would approximately determine the point within any quadrilateral at which the values of c and s are given, intermediate between those of the bounding sides. It is difficult to estimate the error to which this determination would be liable, but supposing the linear dimensions of a quadrilateral at a distance of 10 inches from P_1 were comparable with the tenth of an inch and that an error of one-hundreth of an inch were committed in the direction $\perp^r$ to P_1Z_1, this would mean an error of 3 or 4 minutes in the measured value of the hour angle. This error would be important, but not large enough to condemn the method, and the estimate shows that the scale of the diagram should be as large as is practicable.

If we confine the diagram to points in north latitudes c may be taken to range between 30° and 90°, though it would obviously be desirable also to draw a few lines for which c is $>90°$. The range of s may be taken between 10° and 80°. The distance between the foci is, as we have seen, $\tan \frac{1}{2}p$ and the distance between the directrices is readily proved to be $\cot \frac{1}{2}p$. The consideration which determines the scale on which the curves should be drawn is that the Sumner for which $s = 80°$ should appear in the diagram as far as it may be required.

The curves in each diagram are different from those in every other for different values of p, for although it might at first appear that since the distance from the focus to the directrix is the same for $180° - p$ as it is for p some saving would be effected, the indications of the same curves in the two cases are different, and the Sumners are placed differently in regard to the parallels of latitude. In the case of the sun a diagram for every ten minutes change in declination would probably be necessary, and this would mean an enormous amount of work. Diagrams for a few of the best stars could, however, be constructed on this principle and would be extremely useful.

It will have been noticed that the angle $Z_1S_1P_1$ is equal to the angle ZSP in the spherical figure, but the azimuth is not represented in the plane figure. The following properties of the plane curves may therefore be stated:—

(1) The angle at which S_1Z_1 cuts the sumner at Z_1 is equal to the angle at which P_1Z_1 cuts the parallel of latitude.

(2) If a tangent at Z_1 be drawn to either curve, say the sumner, to cut S_1P_1 in T and perpendiculars be drawn from T to Z_1P_1, Z_1S_1 meeting them in M and N, then

$$\cos(\text{azimuth}) = \mp \frac{TM}{TN}$$

according as T falls between S_1 and P_1 or not. From this result a graphical determination of the azimuth is easily obtained.

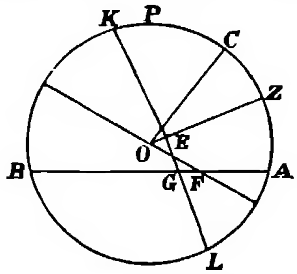
4. If we take Z_1P_1 for base line the curves to be drawn are curves of altitude and polar distance. This method of representation is tempting as the angles at P_1 and Z_1 are then the hour angle and azimuth. Moreover it would be a very convenient way of producing the diagrams to arrange them for consecutive values of the colatitude. Unfortunately there are serious objections. Suppose the common directrix of the polar distance lines cuts P_1Z_1 produced in X, then when the sun is in the southern hemisphere these lines are hyperbolas on the remote side of the directrix from P_1 and they diverge rapidly for consecutive values of $p > 90°$; so much so that, when the colatitude is between 30° and 40°, it is impossible to represent them on a scale which would be of any value. For places in the tropics there would not be the same objection, and diagrams drawn on this principle would be convenient in those regions.

There is another difficulty. In winter, in northern latitudes, the azimuth and hour angle may be together greater than two right angles or, what is equivalent, $p + s$ may be $>180°$. In that case the construction we are going upon fails, although it is possible to meet the difficulty.

The point is interesting, and admits of the following explanation:—In the figure P is the north pole, Z the place of observation, AB the diurnal path of the sun. If C be the middle point of PZ, then all points above the plane through the centre O perpendicular to OC may appear in the plane diagram supposed large enough. Again a plane KL perpendicular to OZ corresponding to $s = 80°$ limits the area in which observations may be taken. If, therefore, the sun were observed between F and G he would be out of the diagram, and this means that $p + s > 180°$.

The difficulty may be overcome by solving graphically another triangle $S_1{}^1P_1Z_1$ corresponding to S^1PZ in the spherical figure where S^1 is diametrically opposite to S. For, if $SZP + SPZ > 180°$ then $S^1PZ + S^1PZ < 180°$. Hence, if we interchange Z_1 and P_1 in the diagram and pick out the intersection of the curves $180° - s$ and $180° - p$ we shall thereby find graphically the supplements of the hour angle and azimuth.

5. To these modes of representation may be added stereographic projection on the plane of the equator which admits of lines of equal latitude and Sumner lines being represented by



systems of circles and of two angles of the spherical triangle being represented in the corresponding plane figure.

6. The object of all such methods is to facilitate the drawing of lines of position on a Mercator's chart, and as the hour angle must be determined with the greatest possible precision, the diagram should be on a large scale with hour angle lines drawn upon it at suitable intervals.

With this in mind the most practical of the foregoing methods would seem to be the first, viz. that in which there is a single diagram, cut into sections, not necessarily on the same scale, but large enough to admit of the hour angle lines and perhaps also azimuth lines being drawn upon it.

ANTHROPOLOGICAL USES OF THE CAMERA.

AN interesting paper on the anthropological uses of the camera was lately read by Mr. E. F. im Thurn before the Anthropological Institute of Great Britain and Ireland, and is now reprinted in the Institute's "Journal."

Mr. im Thurn points out that primitive phases of life are fast fading from the world in this age of restless travel and exploration, and urges that it should be recognised as almost the duty of educated travellers in the less known parts of the world to put on permanent record, before it is too late, such of these phases as they may observe. It is certainly, however, he says, not a sufficiently recognised fact that such records, usually made in writing, might be infinitely helped out by the camera.

As illustrating the small use of the camera for this special purpose, Mr. im Thurn calls attention to the almost universal badness of illustrations of living primitive folk in books of anthropology and travel, when these illustrations are not merely what may be called physiological pictures. Of old the book illustrator, if, as was usual, he was not himself the traveller, drew as pictures of primitive folk, merely the men and women that surrounded him, drew figures of men and women of his own stage of civilisation, and merely added to these such salient features as he was able, from the traveller's tales, to fancy that his supposed primitive subjects had. So in 1599 the imaginative artist of Nuremberg who drew the pictures for the rare Latin abbreviation of Sir Walter Raleigh's "Discoverie of Guiana" gave to the world his impressions of the "Amazons," the "Headless Men," and the "Men who dwelt on trees" which are typical of the pictures of "savages" which adorn the travellers' books up to nearly the present century.

Mr. im Thurn refers also to the beautifully executed illustrations by Bartolozzi in Stedman's "Dutch Guiana," in which, in place of natives, are shown, with the necessary change of dress, simply Europeans of more than average beauty of form. There were doubtless exceptions to the misrepresentation of primitive folk, and the greatest of these exceptions known to Mr. im Thurn is the beautiful series of drawings by Catlin of North American Redmen. But Catlin enjoyed the unusual advantage not only of considerable technical skill as an artist,

but of living among the folk whom he drew and about whom he wrote. Even his drawings, valuable as they are, and artistically superior as they are, are far from having the value of the accuracy of photographs.

The modern anthropological illustrator does indeed generally draw from photographs, but almost always from photographs taken under non-natural conditions. Mr. im Thurn mentions as an example a picture of the Caribs of his own country of Guiana, which appears in one of the most valuable and accurate of recent anthropological books. This picture was the best attainable, and is evidently taken from a photograph, yet it gives no hint of what Caribs are like in their natural state. The explanation is easy. During Mr. im Thurn's many years' acquaintance with these Caribs, both in their native wilds and during their brief visits to the town, he has often been struck by the marvellous difference in their appearance when seen under these two differing conditions. It is true that in his natural surroundings the Carib is but very lightly clad, whereas, on the rare occasions when he enters the town he sometimes, but by no means always, puts on a fragmentary and incongruous piece or two of the cast-off clothing of white men, intending, by no means successfully, to adorn his person; but such separable accidents of rags by no means explain the full change in his appearance. Mr. im Thurn has seen the same men, in their distant homes on the mountainous savannahs between Guiana and the Brazils, though clothed with but a single strip of cloth, two or three inches wide and perhaps a yard in length, and either unadorned or adorned with but a scrap of red or white paint, look like what the novelists describe as well-groomed gentlemen. Yet the same individuals in Georgetown, without any added clothing or adornment, look the meanest and wretchedest folk imaginable. The sense of shyness and mean cringing fear which in the town doubtless drives out from them their innate sense of freedom and happy audacity, seems to find outward expression and completely to alter their bodily form. And it was quite evidently under some such depressing circumstances as these that the Redmen—who, by the way, were probably Ackawois and not "True Caribs"—who are shown in the illustration referred to, were photographed.

Just as the purely physiological photographs of the anthropometrists are merely pictures of lifeless bodies, so the ordinary photographs of uncharacteristically miserable natives seem to Mr. im Thurn to be comparable to the photographs which one occasionally sees of badly stuffed and distorted birds and animals.

Mr. im Thurn gives a clear and most attractive account of his own photographs of phases of primitive life in Guiana—photographs which, at the time of the reading of his paper, were shown on the screen. The following are some extracts from this part of the paper:—

Fifteen years ago I went out to Guiana as curator of the public museum, and in that capacity travelled much in the interior of that colony, only the seaboard of which was, and very little more now is, inhabited. Ten years ago I entered the service of the Government, and, as magistrate, took charge of a large district inhabited almost solely by Redmen. And I remained under those circumstances until, about two years ago, I was transferred to a neighbouring and still larger district of which it may be said that up to the time of my going there the white men who had visited it might be counted on the fingers of one hand. Throughout this time I have lived really among these pleasant red-skinned folk, now and again, for periods of greater or less duration, living not only among, but as they do; and throughout that period I have had none but Redmen as my servant friends. They have got used to me, and I have got used to them, and doubtless in this respect I have enjoyed greater advantages in the matter of gaining their confidence than the ordinary traveller, who merely passes through a country, could hope to enjoy. Some ten years ago, in a book on the "Indians of Guiana," I told all that I then knew about them. Though of course further experience has now taught me a good deal more about them, I must not here linger on anything that does not touch my special subject of to-night—my experiences as a photographer among them.

That to gain the confidence of uncivilised folk whom you wish to photograph is one of quite the most essential matters you will easily understand. The first time I tried to photograph a Redman was among the mangrove trees at the mouth of the Barima River. My red-skinned subject was carefully posed high up on a mangrove root. He sat quite still while I focussed and drew the shutter. Then, as I took off the cap, with a moan he fell backward off his perch on to the soft sand below him. Nor could he by any means be persuaded to prepare himself once more to face the unknown terrors of the camera. A very common thing to happen, and to foil the efforts of the photographer at the very moment when he has but to withdraw and to replace the cap, is for the timid subject suddenly to put up his hand to conceal his face, a proceeding most annoying to the photographer, but interesting to the anthropologist, as illustrating the very widespread dread of primitive folk of having their features put on paper, and being thus submitted spiritually to the power of any one possessing the picture.

With reference to my earlier remarks on the difficulty of discerning in the ordinary illustrations the real bodily appearance of uncivilised folk, photographs of the True Caribs of Guiana will be shown on the screen. And in so doing it may, without entering into elaborate detail, be once more pointed out that the red-skinned inhabitants of Guiana are distinguishable into three groups or branches (see "Among Indians of Guiana," p. 159, and "Proceedings of Royal Geographical Society," October, 1892). Though the actual pre-European history of these three is, unfortunately, still greatly a matter of conjecture, it is convenient to use such conjectures as seem most reasonable on this subject as a means of distinguishing the branches—that is to say, it is well to bear in mind that probably of the tribes at present in Guiana the Warraus, who inhabit the swamps about the mouth of the Orinoco, were the earliest occupiers, but that there is at present no evidence at all to show whence these people reached their present homes; that another of the branches, represented only by the Arawacks, who inhabit the whole sea-coast of that country with the exception of the more swampy lands of the Warraus, probably reached their present homes from the West Indian Islands long after the Warraus were already established in those parts; and that the third branch, usually called the Carib branch, and represented by the Ackawois, Macusis, Arecunas, and by the "True Caribs," came also from the Islands, but at various times, and made their way, in somewhat various directions, into the back lands of the country. The first set of pictures I am about to show you all are of this last or "True Carib" branch.

The first is of a middle aged man who lives in the first falls of the Barima River. A single glance at it and a comparison of it with the ordinary, even the best book illustrations of Caribs, will at once serve to make plain the advantage of the photographic method used among the people in their own homes over any other method of showing what these primitive folk are really like. Before shooting the falls in their canoes the Redmen always carefully examine the state of the river to see which rocks are exposed, which lurk as hidden dangers beneath the surface in that particular state of the water; and it was while he was engaged in this cautious survey that this photograph of this Carib was taken. The next is of the same man taken under somewhat different circumstances. The hospitality of these persons is almost unbounded, and the etiquette of its observance is rigidly fixed. The master of the house, when expecting guests, grooms himself carefully and puts on his best dress and ornaments, these often, as in this case, consisting only of a narrow waistcloth by way of dress and of a necklace and armlets of white beads by way of ornament. Thus honouring the occasion to the best of his ability, he sits, somewhat stolidly, outside his house awaiting his guests, with whom, when they arrive, he will, without rising or in any other way testifying any interest, exchange one or two entirely conventional and monosyllabic sentences, dropping them out one by one at long intervals.

It is generally supposed that these red-skinned folk are undemonstrative in their bearing towards one another. But this really is only in the presence of strangers. When alone, or before others with whom they are familiar, their bearing toward each other is even caressing. Such a picture as this, of three Caribs standing with their arms round each other's necks, may often be seen.

The next picture, of a young Carib man, perhaps a little above the average in physique, is intended to show that these people, though not tall, are a fine people in the point of physical and muscular development.

Again, in the matter of facial expression, the ordinary conception of these people as dull and expressionless should give place to the truer idea that, when not made shy by the presence

of unaccustomed strangers, there is a great deal of life and even in some cases of beauty in their appearance It is practically impossible for a stranger to see them in this their more pleasing and natural state, except when, as I now do in this picture of three Carib lads, they are taken under the most natural conditions, and distance and time being for the purpose annihilated, they are shown you in the most natural conditions but without their knowledge

That it may not be said that in my anxiety to impress you with my own too favourable ideas of these red-skinned friends of mine, I have elected only to show you young fellows in their too brief prime, I next show you an old Carib I must, however, admit that he is only old for a Redman His age was probably about forty-five But these happy childlike people lead but a short if a happy life, and are old at fifty, and rarely survive to sixty .

Another obvious, but insufficiently used, use of the camera for anthropological purposes would be for the better illustration of collections of objects of ethnological interest Those who have tried know best the difficulty of showing these in an effective and interesting manner. Comparatively elaborate and correspondingly artistic objects made and used by a people who have made considerable progress without attaining what we are pleased to call civilisation, are easily shown in an attractive manner, but the simpler objects, illustrating the daily life of people in a much more primitive state of civilisation, are not so easily placed The articles which constitute the dress and ornaments of a people which makes but little use of ornament and less of dress, are generally of so simple a nature that when stored in rows or, as I am afraid is sometimes the case, in heaps or even in bundles, in museum cases, they too often seem deficient in interest to the very curators of the museum, and are naturally much more so to the outside public Yet these same things, very likely, to one who has seen them in actual use, seem, just because of their simplicity, more interesting than the elaborate dancing masks and such like It has been suggested —possibly the suggestion has been carried into effect—to display these on lay figures, but when it is remembered how very few of these simple articles of dress or ornament are worn at any one time, it is obvious that for their proper display in the suggested manner the number of lay figures which would be required would, for reasons both of economy and of space, make the plan ineffective A much more feasible plan would be to place by the side of each object, or group of objects displayed, a photograph of the object—preferably of the identical object A few examples will better explain what I mean —

The first is a photograph of a Partamona (Ackawoi) Redman in a curious dress made and worn for a special festival celebrated by those people and called Parasheera The dress consists of three parts, which may be described as skirt, cloak, and mask, all made of the bright greenish-yellow, immature leaves of the Æta palm (*Mauritia flexuosa*) Probably there is not an example of this dress in any existing museum, for it is probable that no white man except myself has ever seen it, and I frankly confess that I was deterred, as has often been the case under similar circumstances, from bringing away an example of the dress by the consideration that when seen off the body of the wearer it would look like nothing in the world but a small bundle of withered palm leaves, and would to the uninitiated seem supremely uninteresting

The next example I show you is a picture of a Macusi lad in full dancing dress. Those who are acquainted with the ordinary heaped curiosities of the average ethnological collection will perhaps recognise the typical head-dress of bright parrot and macaw feathers, the loose hanging ruff of alternate black curassow and white egret feathers, and the strip of waist-cloth upheld by a cotton belt, which constitutes the whole of this dress; and such persons will probably recognise that these articles seen, as in this photograph, *in situ*, acquire a new interest

Again, one of the commonest articles from Guiana seen in museums is the necklace of peccary teeth, much affected by all the Carib tribes. But in now showing you one of the finest specimens of this ornament I have ever seen, it will probably gain very much in interest from the fact that I am able at the same time to throw on to the screen a picture of the actual necklace on the Macusi, named Lonk, from whose shoulders I acquired it. And it may in passing be of interest to add that these necklaces, in the manufacture of which only the tusk teeth of the peccary are used, so that in proportion to its size each represents a very large number of animals, are most highly valued as heirlooms, and as representing the accumulated prowess not only of the wearer for the time being, but also of his ancestors, for this property is handed down in the male line of descent, and is added to by each holder

In short, a good series of photographs showing each of the possessions of a primitive folk, and its use, would be far more instructive and far more interesting than any collection of the articles themselves Or, if it is desired to illustrate not the possessions but the habits of such folk, the thing can be done in the same way A few examples from a large series showing the games of these people will illustrate this

Many of their games are dramatic representations of ordinary incidents in their work-a-day life One represents their rare and eventful visits to the distant town Of the many figures in this game one represents the fully-manned canoe in which they go on their journey down the big rivers of the country All but two of the players, seated on the ground, the one behind the other, and each clasping the player in front of him, form a long line, which, by the action of the feet and thighs of its constituent members, drags itself slowly forward, the whole swaying from side to side In this way—which must certainly involve a considerable amount of somewhat painful friction, considering the hardness of the stony ground traversed and the unprotectedness of the skins of the players—a very realistic representation of the forward rolling motion of a large and well manned canoe, such as would be used on a real journey, is attained And the illusion is assisted by the players' noisy imitation of the regular and most characteristic rhythmic beat of the paddles against the sides of the canoe, and of the shouts of the paddlers

After several other figures, another comes, in which the players, all standing in line, each falls forward on his hands and feet, his thighs the highest part of him, so that the whole line of players, with their closely pressed bodies, forms a long tunnel, through which each player in turn has, as in a well-known figure in the old-fashioned dance of Sir Roger de Coverley, to pass, but by creeping The journey, that is, is nearly over, and the home comers, leaving the broad river up which they have come so far, have turned into the narrow creek or side stream densely roofed with low hanging trees, which leads directly to their homes, and under this natural tunnel the canoe has to force its way

Other games to be seen among the Redmen of the borders of Guiana and Brazil are simple representations of the doings of animals. For instance, one represents an aguti in a pen and the attempts of a jaguar to get him out The players form a ring, their arms round each other's necks Inside this circle one of the players crouches, and represents an aguti—a small animal often kept in captivity by the Redmen—inside the pen Outside the pen another player watches; it is the jaguar looking with hungry eyes on the aguti He tries to get the aguti out between the bars of the pen, that is, between the legs of the ring of players. But the living pen whirls round and round, and it is no easy task for the jaguar to seize the aguti and drag it out.

Yet more curious is the whipping game of the Arawacks. It is played by any number of persons, but generally only by men and boys, for one, two, or three days and nights—as long, that is, as the supply of *paiwari*, the native beer, holds out The players, with but brief intervals, range themselves in two lines opposite each other Every now and then a pair of players, one from each line, separate from the rest One of these puts forward his leg and stands firm, the other carefully measures the most effective distance with a powerful and special whip with which each player is provided, and then lashes with all his force the calf of the other. The crack is like a pistol shot, and the result is a gash across the skin of the patient's calf. Sometimes a second similar blow is given and borne Then the position of the pair of players is reversed, and the flogged man flogs the other Then the pair retire, drink good temperedly together, and rejoin the line, to let another pair take their turn of activity, but presently, and again and again at intervals, to repeat their own activity.

It has been said that the most active players of this extraordinary game are the men and boys. But occasionally the women take a part also. And it is noteworthy that when this is the case a wooden figure of a bird, a heron, is substituted for each of the whips, and a gentle peck with this bird is substituted for the far more serious lash of the whip. I do not know that any equivalent example of the fact that the germ of the idea of courtesy to the weaker sex exists among people even in this stage of civilisation is on record.

SOCIETIES AND ACADEMIES

LONDON

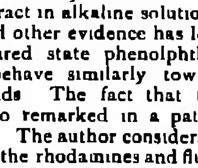
Chemical Society, March 2.—Dr J H Gladstone, vice-president, in the chair The following papers were read —The magnetic rotation and refractive power of ethylene oxide, by W H Perkin The magnetic rotation of ethylene oxide is remarkably low, and the refractive power is also below the calculated value —The origin of colour (including fluorescence), vii The phthaleins and fluoresceins, by H E Armstrong The author has previously taken exception to the formulæ usually assigned to phenolphthalein and its congeners, the exhibition of colour by these substances could not be accounted for by the formulæ generally ascribed to them The correctness of the author's views has now been demonstrated by Bernthsen and Friedlander independently The former chemist has shown that the rhodamines afford true ethereal salts, proving that they form carboxy-compounds and not lactone derivatives Bernthsen also points out that the characteristic development of colour observed on adding alkali to phenolphthalein is probably due to the hydrolysis and subsequent conversion of the colourless lactone derivative into a quinolic compound, the latter then suffers dehydration, affording a coloured quinonoid derivative —

$$C_6H_4\left\{\begin{array}{l}CO\diagdown\\ \quad\quad O\\ C\ \ \text{—}\ (C_6H_4\ \ OH)_2\end{array}\right. + H_2O$$

$$= C_6H_4\left\{\begin{array}{l}CO_2H\\ C(OH)(C_6H_4\ \ OH)_2\end{array}\right.$$

$$C_6H_4\left\{\begin{array}{l}CO_2H\\ C(OH)C_6H_4\ \ OH\\ \ |\\ C_6H_4\ \ OH\end{array}\right. = H_2O + C_6H_4\left\{\begin{array}{l}CO_2H\\ C\ \ \ C_6H_4\ \ OH\\ \ \|\\ C_6H_4O\end{array}\right.$$

Friedlander also has lately shown that phenolphthalein and hydroxylamine interact in alkaline solution with formation of a hydroxime, this and other evidence has led him to the opinion that in their coloured state phenolphthalein and the allied phthaleins which behave similarly towards alkalis, are all quinonoid compounds The fact that the rhodamines yield ethereal salts is also remarked in a patent specification by a German colour firm The author considers the recognition of the quinonoid nature of the rhodamines and fluoresceins to be an important argument in favour of the views that fluorescence is a form of colour, and that all quinonoid derivatives would be visibly fluorescent were it not that the rays which cause the fluorescence sometimes become absorbed in the solution.—The origin of colour, viii The limitation of colour to truly quinonoid compounds. Change of colour as indicative of change of structure, as in the case of alizarin, by H E Armstrong A quinonoid compound may be defined as a *hexaphene*, *i e* an unsaturated cycloid composed of six "elements," of which two are C⊃R″ groups in either para- or ortho positions Coloured substances generally appear to fall within this definition, the few exceptions to the rule may be explained either by the author's view of isodynamic change or as resulting from the presence of traces of impurity Some of the keto-chlorides prepared by Zincke possess an intense yellow colour, although containing the group—CCl_2—CO—; it is, however, not improbable that in such substances the group CCl_2 is the true equivalent of the C⊃R″ group The usual constitution assigned to alizarin does not explain its red colour, red being the characteristic colour of the orthoquinones, the colour may be accounted for by regarding alizarin as an isodynamic form of dihydroxyanthraquinone thus —



The red colour of the chloranilates may be explained in a somewhat similar manner.—Notes on optical properties as indicative of structure, by H. E. Armstrong. From a consideration of the refractive and dispersive powers of the metallic carbonyls, the author anticipates that quinonoid compounds generally will be found to possess specially high refractive powers. There are indeed experimental data supporting this view—anthracene, a hydrocarbon which is probably quinonoid in structure, having a high refractive power, further evidence is afforded by the specific refractions of the ortho and para nitranilines. The author then proceeds to discuss the orthodox formulæ for trimethylene, ethylene oxide, and diazoimide—

$$\begin{array}{ccc} CH_2 & O & NH\\ H_2C\diagup\diagdown CH_2 & H_2C\diagup\diagdown CH_2 & N\diagup\diagdown N\end{array}$$

contrasting these substances with nitrous oxide, he contends that the above structural formulæ have no real justification, and that latent affinities may exist in these compounds just as in carbonic oxide Thus nitrous oxide may be regarded as $<N - O - N>$, and diazoimide as $< N - NH - N >$ The influence exerted by the ethenoid and benzenoid groups in organic substances upon their refractive and dispersive powers, is also considered.—The origin of colour, ix Note on the appearance of colour in quinoline derivatives and of fluorescence in quinine, by H E Armstrong From considerations based upon the previous notes, the author shows that any amidoderivative of quinoline might become quinonoid in structure, owing to a change from the centric to an ethenoid form, and would hence be coloured Similarly, an ethenoid form of naphthalene would be quinonoid, it is therefore possible that the fluorescence exhibited by many derivatives of this hydrocarbon is characteristic of the pure substances, and does not always originate in impurities —The ethereal salts of glyceric acid, active and inactive, by P Frankland and J MacGregor The authors have prepared and characterised a number of ethereal salts of inactive and lævo-glyceric acid, they point out regularities between the rotatory powers of the active salts of a somewhat similar nature to those observed amongst the ethereal salts of tartaric acid —Formation of the ketone 2 6-dimethyl-1-ketohexaphane, by F S Kipping On distilling the calcium salt of dimethylpimelic acid with soda lime, an oil is obtained which contains a ketone of the composition $C_8H_{14}O$ This ketone is apparently a dimethylketohexamethylene, it is doubtless a homologue of the ketone recently prepared by von Baeyer by distilling calcium pimelate with soda lime —Note on the interactions of alkali metal haloids and lead haloids, and of alkali metal haloids and bismuth haloids, by Eleanor Field. By boiling potassium or ammonium iodide with lead haloids in aqueous solutions, double compounds are obtained, whose composition depends upon the proportions in which the constituents are used Salts of the compositions, $3PbI_2 4KI$, $3PbI_2 4NH_4I$, $PbI_2 3PbCl_2$, $PbI_2 5PbCl_2$, and $PbI_2 2PbBr_2$, are described. The interactions of haloid salts of the alkali metals with bismuth haloids lead to the formation of compounds having the following compositions—$BiBrCl_4K_2$, $BiClBr_4K_2$, and $BiCl_3Br_2(NH_4)_2$ The composition of the products obtained depends, not only on the proportions in which the reacting salts are employed, but also on the nature of the halogens and the metals —An isomeric form of benzylphenylbenzylthiourea by A E Dixon. Phenylthiocarbimide and dibenzylamine interact to form the compound PhN C(SH) $N(C_7H_7)_2$, isomeric with the thiourea C_7H_7N C(SH) NPh C_7H_7 melting at 103°, previously obtained by the author from benzylthiocarbimide and benzylaniline, the new substance melts at 145–146°. —A new atomic diagram and periodic table of the elements, by R. M Deeley The author constructs a new atomic diagram of the elements by plotting "volume heats" against "volume atoms" The volume heats are the products of the specific heats and densities, whilst the volume atoms are obtained by dividing relative density by atomic weight.

PARIS.

Academy of Sciences, March 27 —M. Lœwy in the chair.—The two candidates selected as competitors for the place of *Astronome Titulaire* at the Paris Observatory were In the first place, M Prosper Henry; in the second, M Paul Henry —On the construction of the chart of the heavens, and the determination of the co-ordinates of the centres of the negatives, by M. Lœwy —On the organic substances constituting vegetable soil, by MM Berthélot and André "Humus" may be defined as that portion of the remains of vegetation which resists the action of the air and lower organisms, and remains as an insoluble residue in the soil, supplying the roots of the higher plants with nitrogen, sulphur, phosphorus, alkalies, &c. One specimen of earth freed from all visible plant remains, cellulose, and carbohydrates, taken from the experimental soil of the Vegetable Chemistry station at Meudon, contained 19 1 parts of organic carbon, 1·5 of hydrogen, 1 7 of nitrogen, 11 9 of organic oxygen, total 34·2 parts of organic matter Some of

the principles could be isolated by dissolving them in alkalies, and reprecipitating by acids. These were found to contain 55·2 per cent of carbon, 6·8 of hydrogen, 3·0 of nitrogen, 35·0 of oxygen, 3·5 of ashes. A repeated treatment with hydrofluoric and hydrochloric acids left in one instance 1·4 per cent of insoluble matter of a constitution similar to the preceding. This insoluble matter acted upon solutions of potassium salts in much the same manner as artificial humic acid obtained from sugar. It forms potassium compounds which are capable of resisting even prolonged washing by rainwater. This explains the "absorbing" action of the soil upon the alkalies, and especially upon potash.—On the interference fringes of grating spectra on gelatine, by M. A. Crova.—Researches on samarium, by M. Lecoq de Boisbaudran.—Remarks on the native iron of Ovifak and the bitumen of the crystallised rocks of Sweden, by M. Nordenskiold. Among the blocks of native iron brought from Ovifak in 1870 there was one of about 40 kgr. which it was impossible to saw or to cut. It is now supposed that this is due to black diamonds disseminated through the iron. Considerable masses of bitumen are found in the crystalline rocks of Sweden, notably near Norberg and Dannemora. One of the two kinds found gives a large number of distillation products and leaves hardly any ashes. The other resembles anthracite. It yields little on distillation, and leaves much residue on combustion. This residue contains, besides silica, iron, lime, magnesia, &c., some oxide of nickel, uranium (3 per cent.), cerium, and yttrium, the three last in the form of carbon compounds resembling nickel carbonyl. These also occur in carbon forming large nodules in the oldest sedimentary strata of Sweden, the alum schists.—Observations of small planets made at the Toulouse Observatory, by M. B. Bailland.—The Bielids, by P. François Denza.—On orthogonal correspondance of elements, by M. Alphonse Demoulin.—On the possibility of defining a function by an entire divergent series, by M. H. Padé.—A new sclerometer, by M. Paul Jannettaz.—On the indications of water level in boilers by a glass tube, and their influence upon explosions, by M. Hervier.—On initial capacities of polarisation, by M. E. Bouty. The electricity absorbed in virtue of capacity of initial polarisation is entirely recoverable, on the condition of employing for the discharge an external circuit of negligible resistance.—On the distillation of mixtures of water and alcohol, by M. E. Sorel.—A general method for the calculation of atomic weights according to the data of chemical analysis, by M. G. Hinrichs.—On the formation of gallanilide, and on its triacetyl and tribenzoyl derivatives, by M. P. Cazeneuve.—On the lakes of Sept-Laux (Isère) and La Girotte (Savoie), by M. A. Delebecque.—On a means of preserving beetroot plants and economic or ornamental young vegetables against the attacks of greyworms (*Chenilles d'Agrotis*) and other insect larvæ, by M. A. Laboulbène, with remarks by M. Chambrelent.

BERLIN

Physiological Society, March 3.—Prof. du Bois Reymond, President, in the chair.—Dr. J. Munk gave an account of one part of the experiments on the nutrition of fasting-men, which he had carried out in conjunction with Messrs. Lehmann, Müller, Senator, and Zuntz. The same observers having some years ago made experiments on the fasting-man, Cetti, whose outcome was not in accord with the results of experiments made on dogs, they had more recently experimented again over a period of six days on another fasting man, Breithaupt. This man's nutrition was followed for several days, on an ordinary diet, before the period of fasting, and again after the latter had ended. During the fast the patient was at liberty to consume as much water as he pleased, the amount taken being carefully noted. The following were the results of the experiments. The output of nitrogen sank slowly and continuously during the whole period of fasting. The urinary phenol increased in amount up to the fourth day (the sixth day in Cetti's case) and then sank to a minimum. Indol was only found in traces, and acetone was absent altogether. The amount of chlorine, as of alkali, diminished progressively, and continued below the normal even after food was once more taken. The urine contained a large quantity of phosphoric acid, as also of lime and magnesia. Prof. Zuntz reported on the respiratory interchange of the above man. When at rest the intake of oxygen was the same as that of a normally fed person twelve hours after a meal. The respiratory quotient varied from 0·66 to 0·69, and was thus less than that due to the oxidation of fats alone (0·7), or of proteids alone (0·8). During the fast the patient's power in turning a wheel against friction was the same as that observed when feeding, but fatigue set in much sooner, and was most marked in the cardiac muscles. During the earlier days of the fast, the consumption of oxygen when working was the same as for a normal person, but later on it became greater. The after effects of work lasted longer than when food was taken. The speaker regarded the above extremely low respiratory quotient during the fast, as due to the possibility that the proteids split up into glycogen and some other substance, which was then oxidised and gave rise to the small quotient observed. In support of this view experiments were made by Dr. Vogelius on the construction of carbohydrates in the fasting body. In the fasting animals on which the experiments were carried out, all glycogen was removed by moderately strong doses of strychnine. After this they were sent to sleep for eighteen hours by means of chloral-hydrate, and at the end of this period glycogen was found in considerable quantity both in their liver and muscles—glycogen which must presumably have been formed from the metabolism of their own proteids.

Meteorological Society, February 7.—Prof. von Bezold, President, in the chair.—The President gave a short account of a paper he had recently published in the *Sitzungsberichte* of the Berlin Academy on the thermal exchanges of the atmosphere, and entered into details as to the general propositions therein put forward. The latter are as follows:—1. The total radiant heat received by the whole earth in a year is equal to the total amount given off by radiation in the same period. 2. The total heat received by any portion of the earth or the atmosphere is on the average equal to that given off by the same portion. 3. The total heat received and given off in the course of a year is not the same for different portions of the earth or atmosphere: in some parts the amount received is greater than that given off, and *vice versâ*. 4. The heat received by given portions of the earth or atmosphere during any given period of the year is in general not equal to that passed off during the same period. 5. The total amount of heat taken in at the surface of the whole atmosphere during a given portion of the year is not necessarily equal to that given out at the same surface during the same period.

CONTENTS.

THURSDAY, APRIL 13, 1893.

THE PLANET MARS

La Planète Mars et ses Conditions d'Habitabilité Par Camille Flammarion (Gauthier-Villars et Fils, 1892)

IN this very handsome volume the author brings together every available observation and piece of information that can be gathered from published and unpublished works with respect to our sometimes very near neighbour, the planet Mars To make such a compilation as this, is, as every one will acknowledge, no light task, and since up to the present no one has made any attempt to collect existing observations and discuss them (although perhaps the value of this book is the more enhanced thereby) the difficulty of the undertaking has been very considerable, but in such hands as M Flammarion's it has been thoroughly mastered

With regard, first, to the form of arrangement which the author has thought advisable to adopt—since in a work of this kind many courses are open depending on the standpoint from which the book is written—the writer might, in the first instance, have divided the text into chapters dealing with the climate, calendar, heat, mass, density, geography, &c, treating each of these at full length, and discussing all the observations bearing on each separately That this would have formed a good and logical sequence is unquestionable, but it is accompanied by many drawbacks, the chief of them being that as observations increased and our knowledge consequently advanced, each part of the work would have to be rewritten, or, at any rate, undergo a thorough revision The method actually chosen is one which will seem more simple and therefore appeal more to the astronomer, and will perhaps be productive of better discussion M Flammarion places the facts before the reader in simple, chronological order, tracing out the work on the planet from the very first observations, step by step, down to those made during the opposition of 1892

The volume is divided into two main parts, the first including the exposition and discussion of the observations themselves, and the latter containing the conclusions that have been drawn from the study of all the facts The interval from 1636 to 1892—that is the whole time covered by our records—is divided into three chief periods, the first two of which terminate in the years 1830 and 1877 respectively.

Dealing first with the period commencing with the observations of Fontana (1636-1638), we are at one of the most interesting parts of the book. Here the author has been plunging into all the old original records, and has treated us to the tit-bits both as regards illustrations and text. As we cannot here conveniently produce the earlier drawings of the planet as made by Fontana, but which are represented in this volume, we may at least give the original observations as recorded in words —

"1636 Martis figura perfecte spherica distincte atque clare conspiciebatur. Item in medio atrum habebat conum instar nigerrimæ pilulæ.

"Martis circulus discolor, sed in concava parte ignitus deprehendebatur. Sole excepto, reliquis aliis planetis, semper Mars candentior demonstratur"

The second drawing, which was made on August 24, two years later, was accompanied with the text —

"Martis pilula, vel niger conus, intuebatur distincte ad circuli, ipsum ambientis, deliquium, proportionaliter deficere quod fortarse Martis gyrationem circa proprium centrum significat"

Following Fontana, Riccioli, Hirzgarter, Schyrle de Rheita, Hévélius, and Huygens (1656) were the next to make a special study of this planet, the last mentioned of whom added much to the knowledge of the planet's surface markings Up to the end of this period (1830) the number of observers, and consequently the number of observations had very much increased, while the rapid stride made in the perfection of the telescope was not the least important factor in this advance Summing up the conclusions which can be drawn from these 192 years of observations it may be said that they related more to the elements of the planet than to its surface features, although spots varying in size had been many times noticed, the general idea of the different shadings as representing land and water had been thrown out, and the polar caps had been recorded as variable and not coincident with the geographical poles

The second period, commencing in the year 1830, opens with an account of the fine series of observations made by Beer and Madler It was about this time that the real geography of the planet's surface began to be better known, and a systematic method of mapping brought into vogue Following these two workers come a host of others, all adding their mite, in some cases rather a large one, to solve the riddle relating to this orb Among these we may mention, Warren de la Rue, Secchi, several of whose fine drawings are here inserted, Lockyer, whose drawings, sixteen of which appear here, and "sont les plus important pour la connaissance de Mars de tous ceux que nous ayons étudiés depuis les premières pages de cet ouvrage", Phillips, Lord Rosse, Lassell, Kaiser, Flammarion, Trouvelot, &c With such observers as these, and many others as able, but whose names are too numerous to mention, it is no wonder that good work was done, and our knowledge by the year 1877 greatly extended More accurate values for the elements were deduced, land and water features confirmed, cloud drifts observed, variations in the polar caps again noticed, &c, in fact, to put it shortly, all observations pointed to a singular likeness of Mars, physically speaking, to the earth herself

In the third and last period—the Martian cycle from 1877 to 1892—we have observations extending over as many as 239 pages of the volume The epoch commences very appropriately with Prof Asaph Hall's discovery of the two small satellites, and introduces to us the observations of Schiaparelli, whose work on this planet has been rewarded by such brilliant discoveries To enter, however briefly, into the mine of interesting and valuable material here brought together would lead us far beyond the limits of this article, but we must leave it to the readers of this journal to refer to the book itself, suffice it to say that M Flammarion has given each observer his just due and merit.

Arriving now at the second part, which gives the results deduced from the general study of the planet, M Flammarion is also quite at home, and in his masterly way

brings all the main facts to a focus, sifting and sorting them and ultimately deriving the final results. In the following few brief extracts we propose to give in the author's own words some of the more important conclusions to which the examination of the facts has led him, and we will commence with the ruddy appearance that the planet puts on, the cause of which has always been and still is doubtful *Apropos* of the suggestion that there may be red and not necessarily green vegetation on the surface of Mars, he says—

"Pourquoi, dira-t-on, la végétation de Mars ne serait-elle pas verte?"

"Pourquoi le serait-elle? répondrons-nous La terre ne peut pas être considerée à aucun point de vue, comme le type de l'univers"

"D'ailleurs, la végétation terrestre pourrait être rougeâtre elle-même, et elle l'a été en majorité pendant bien des siècles, les premiers végétaux terrestres ayant été des lycopodes, dont la couleur est d'un jaune roux tout martien La substance verte que donne aux végétaux leur coloration, la chlorophylle, est composée de deux éléments, l'un vert, l'autre jaune Ces deux éléments peuvent être séparés par des procédés chimiques Il est donc parfaitement scientifique d'admettre que, dans des conditions différentes des conditions terrestres, la chlorophylle jaune puisse seule exister, ou dominer Sur la terre, la proportion est de 1 pour 100 Ce peut être le contraire sur Mars"

In a most interesting chapter comparing the Martial with the terrestrial seasons, many important points of similarity and difference are indicated While the seasons of Mars are of nearly the same intensity as ours, yet the respective "working powers," so to speak, last nearly twice as long The cold and hot seasons in the northern hemisphere continues for 381 and 306 days respectively, and it is this fact which explains the great difference between the two hemispheres The polar caps, as with us, vary with the seasons, but attain their maxima and minima three to six months after the winter and summer solstices respectively The dimensions which they assume cover in winter 45° to 50° in diameter, and become reduced in summer to 4° or 5° Just outside the polar regions, "des chutes de neige ont été observées dans les régions tempérées, et parfois même jusqu'à l'équateur On a vu dans l'hémisphère boréal des traînées en spiral venant du pôle, indiquant des courants atmosphériques influencés par le mouvement de rotation de la planète La calotte polaire boréale paraît centrée sur le pôle L'Australe en est éloignée à 5°, 4 ou 340 kilomètres, à la longitude 30°, de sorte qu'aux époques de minimum le pôle sud est entièrement découvert. *la mer polaire est libre.*"

That actual changes have taken place on the planet's surface, in spite of the numerous sources of errors to which such delicate observations are liable, seems to have been proved by the discussion of the material. In speaking of these sources of errors he says, "Ces diverses causes de variations apparentes dans les aspects des configurations géographiques de Mars suffisent-elles pour rendre compte de toutes les variations observées?"

"Non"

"Des changements réels ont lieu à la surface de la planète, changements qui n'ont rien d'analogue dans ce qui passe à la surface de la terre" "Nous voulons parler de celle de l'étendue des taches sombres regardées comme mers, lacs ou cours d'eau"

The channels, the origin of which has been productive of so many hypotheses, are, according to the author, "dus à des fissures superficielles produites par les forces géologiques ou peut-être même à la rectification des anciens fleuves, par les habitants, ayant pour but la repartition général des eaux à la surface des continents" With regard to their doubling, after an examination of several hypotheses, he is led to look upon this fact as the result of refraction, although he remarks that "notre savoir est insuffisant," and "le connu n'est qu'une île minuscule au sein de l'océan de l'inconnu" He says,

"Quant aux dédoublements, il est difficile d'admettre que réellement de nouveaux canaux se forment du jour au lendemain, semblables et parallèles aux premiers nous préférons imaginer qu'ils puissent être dus soit aux brumes dont nous avons parlé, soit plutôt à une double réfraction dans l'atmosphère martienne Etant données les conditions de température (la chaleur solaire traversant facilement l'atmosphère martienne pour échauffer le sol), l'évaporation doit être très intense, et il doit y avoir constamment, au-dessus de ces cours d'eau, une grande quantité de vapeur rapidement refroidie, qui peut donner naissance à des phénomènes de réfraction spéciaux"

In the concluding chapter, giving us a *résumé* of the conditions of life at the planet's surface, the author sums up some of the main results The world of Mars "paraît être, comme le remarquait déjà William Herschel, de toutes les planètes de notre système solaire, celle qui ressemble le plus à la nôtre Nous pouvons répéter aujourd'hui, sur les habitants de Mars, ce que ce grand observateur écrivait, il-y-a plus d'un siècle, le 1er Décembre 1783 'its inhabitants probably enjoy a situation in many respects similar to ours'" It is possible, he adds, that this world may be peopled with beings analogous to our own. a race superior and in a more advanced stage, for the globe of Mars, M Flammarion holds, is an older member of the solar system than our own

Such, then, is a general sketch of the contents of this handsome volume of 600 pages A glance through it is sufficient to show that no pains have been spared either by the writer or by the publisher, which might in any way add to its completeness, while the illustrations, which in such a work as this are of the highest importance, have been scattered with a lavish hand, and with all due regard to accuracy and purpose, no less than 580 telescopic drawings and 23 maps appearing.

In such a collection of facts as we have here, only one slight erratum has been observed, and this occurs on page 287, where it is stated that M (now Prof) Schur, at the observatory of *Breslau* made some measurements of the planet's diameter, while it should have been, "at *Strassburg* with a Breslau heliometer"

Throughout the work M Flammarion has in every case given full references, which greatly enhances its value, while in the appendix several drawings made during the opposition of 1892 are inserted

Never before was the planet viewed with such keenness by astronomers as was the case last year, and it is by these, as well as by those that have never had such an opportunity, that this work will be found of absorbing interest, astronomical literature is considerably enriched by its appearance WILLIAM J. S. LOCKYER

MAGNETIC OBSERVATIONS IN THE NORTH SEA

Magnetische Beobachtungen auf der Nordsee angestellt in den Jahren 1884 *bis* 1886, 1890 *und* 1891 Von A. Schück. (Hamburg Selbstverlag des Verfassers, 1893)

THE extended and valuable magnetic surveys—notably those of Rücker and Thorpe in England, and of Moureaux in France—which have been made during the last ten or fifteen years, have provided magneticians with considerable information as to the conditions of the earth's magnetism in the countries bordering on the North Sea From such data, there should be no difficulty in calculating normal curves of the three magnetic elements for the comparatively small intervening region covered by that sea

The surveys on land have, moreover, shown that there are several regions of local magnetic disturbance, and therefore the chief interest of a magnetic survey of the North Sea, would lie in the discovery from observation on board ship, whether local magnetic disturbance existed in the land under the sea The settlement of such a point would be a valuable contribution to our knowledge of terrestrial magnetism, and certainly if large disturbance were observed in any locality, of great practical importance to navigation

Captain A Schück has, for some years, past been making observations of the three magnetic elements with a special set of instruments well designed for observations at sea Great pains have been taken by him to eliminate all sources of instrumental error, and he selected those wooden ships which appeared to him so far free from iron in their construction, that his magnetic instruments when mounted on board would be undisturbed. The results of his four years' work are given in the text with full descriptions, and illustrated by drawings of the instruments, as well as a chart of curves of equal value for each magnetic element

The execution of these charts leaves much to be desired, for the figures on the land are in many places so crowded together as to be almost illegible, and it would have been much more to the purpose, if the lines of equal values had been at once taken from the published maps of the several observers, whose work the author fully acknowledges, instead of crowding together the data upon which their lines are based

Again, the curves for those regions covered by the sea are in places so abnormal that they invite inquiry as to the accuracy of the small number of observations upon which they in many parts depend

Although the author gives general assurances as to the selected ships being free from any source of magnetic disturbance, there are really no results recorded, to show that the observations at sea were really free from the effects of iron in the several vessels on board which the magnetic instruments were used. Long experience shows, that unless specially built, no wood-built ship is so far free from iron that its action can be neglected, especially when minutes of arc in an observation are of importance

If observations at sea over so small an area as the North Sea, and the channels south and west of Great Britain, are to effectually supplement those extensive magnetic surveys made on the countries adjacent thereto, they must be stripped of every source of error It does not appear that the observations recorded in this work are of the exact order suitable to modern requirements, however useful they might have been many years ago

A work like that undertaken by the author, requires a specially constructed vessel, devoted for the time to magnetic observations and other subjects of scientific inquiry His objects were evidently delayed in execution by insufficient means to a satisfactory end

MANUAL OF DAIRY WORK

Manual of Dairy Work By James Muir, M R A C, Professor of Agriculture in the Yorkshire College, Leeds 93 pp (London Macmillan and Co, 1893)

THIS small primer on dairy work is in several respects a contrast to some of the books and pamphlets relating to dairy matters which have appeared within the last two or three years Many of these have had too many points in common with a dairy utensil manufacturer's catalogue, and the information they contain has not always been either condensed or trustworthy It is therefore a pleasure to take up Prof Muir's little manual, which gives in small compass a great deal of information likely to be of value to every one interested in the production and use of milk Apparently the book is intended for those who, having practical knowledge of the management of milk and its products, desire further knowledge of the principles upon which their practice is based, together with hints as to the best means of utilising their commodity according to the demands of their own particular market

The information given is in most cases well up to date, but at the same time the discussion of obscure matters connected with the bacteriology of milk is carefully avoided This is the more to be commended because every teacher of agriculture must know that looseness in describing the work of micro-organisms producing decay, or nitrification, or fixation of free nitrogen, has in many cases caused utter confusion in the minds of students, and more especially harmful is the imagination sometimes exercised by reporters and writers for the agricultural press It is difficult to estimate the importance of Bacteriology in its relations to Agriculture and to Dairying, but in all discussion of the subject it is well to keep to ascertained and confirmed fact

Prof Muir's book is divided into ten chapters, the first of which deals with the formation and composition of milk The description of the formation of milk in the udder is a trifle loose, the entire process being described as a casting off and breaking down of the cells which line the alveoli of the mammary glands. Milk is no doubt largely produced in this way, and especially must this be the case with colostrum when the glands commence or resume their activity; but it is more than probable that afterwards the milk is to some extent elaborated from the blood through the activity of the cells without so much actual shedding of the cells taking place The great difference in composition between colostrum and normal milk shows that this latter process must be an important one

In the third chapter some tests of the quality of milk are discussed The value of milk is gauged by the percentage of butter-fat, and although there are many methods of estimating this, most of those which are trustworthy are troublesome to work Prof Muir does not speak well of the lactobutyrometer—an instrument designed for the separation and direct reading of the fat The method is certainly rough, and almost useless, except in the hands of a very careful worker. There are two methods, not described by Prof Muir, which are of much greater value and not more troublesome, these are the Babcock milk test and Soxlet's method of estimating fat in milk from a determination of the specific gravity of an ether extract

In speaking of cream separation on p 45, Prof Muir mentions that "some kinds of separator have an arrangement for regulating the thickness of the cream," and also "that frequently separated cream is rather frothy" A fuller treatment of these points would have been useful The methods of regulating thickness of cream from a separator depend upon varying the rate of revolution of the separator bowl, or else upon varying the time the milk remains in the bowl The latter plan is most convenient, and is usually effected by diminishing the inflow of milk In the Danish separator the same end may be secured by adjusting the movable skimming tube Frothiness of cream is most marked in the case of the Danish machine when the cream is taken off thick. This frothiness might possibly be remedied by using a smaller nozzle for the cream delivery tube

In dealing with the principles of cheesemaking on p 69, the author says, "The state of the milk with regard to acidity is of the greatest importance just when the rennet is added, and should it then be too acid little can afterwards be done to counteract the mistake On the other hand, should the amount of acid be slightly too little, it may be counteracted to some extent in the subsequent processes"

As a matter of fact even the most skilful workers sometimes find the milk too ripe, and in such cases, by hastening the curd into the curd-sink and then washing with water at 100° F, good results may be obtained, at least by the "stirred-curd process"

The book concludes with a short appendix on cream raising trials, made at the Yorkshire College

Prof Muir's manual, though small, is to be welcomed as a most useful addition to our dairy literature

WALTER THORP

OUR BOOK SHELF

William Gilbert of Colchester, Physician of London, on the Loadstone and Magnetic Bodies, and on the Great Magnet the Earth A New Physiology, Demonstrated with Many Arguments and Experiments A Translation, by P Fleury Mottelay (London: B Quaritch, 1893.)

AMONG men of science there is no difference of opinion as to the value of the original Latin work, "De Magnete," of which this is a translation. Some time ago (NATURE, vol. xliii p 279) we gave an account of a meeting held at Colchester by members of the Essex Field Club and the Gilbert Club, for the purpose of doing honour to the memory of Gilbert, who was born there in 1540. In a speech delivered at this festival Lord Rayleigh not only spoke highly of Gilbert's work, but went on to say that although we owe to an investigator who lived so long ago the theory that the earth is a great magnet, we are not much in advance of that position at the present time, as nobody has yet explained the origin of terrestrial magnetism It was most desirable that a work which may be said to have marked a definite stage in the evolution of physical science should be presented in an English form, and this has now been done by an American scholar, who, as he himself explains, has "translated with latitude, keeping in view the author's sense more particularly than his words, and amplifying without altering the former" Mr. Mottelay has also brought together in a short biographical memoir the leading facts relating to Gilbert's career. The volume is well printed on good paper, and will be very welcome to students of the history of scientific ideas

Report on Manurial Trials By Dr William Somerville (Newcastle Ward, 1893)

THIS pamphlet, extending to 61 pages, gives the results of manurial trials in the county of Northumberland during the season 1892

The plan of the experiments is an extensive one, but we may say that many of the experiments are designed to show what manures can be economically applied in the growth of turnips and potatoes in ordinary rotation

From the experiments made upon farms at Rothbury, Ilderton, Tweedmouth, and Wark-on-Tyne, Dr Somerville concludes that (1) basic slag is the cheapes phosphatic manure, though the best result is obtained with a mixture of slag and superphosphate, (2) kainit up to 2 cwt per acre is a profitable dressing to turnips and potatoes, (3) the turnip crop requires nitrogenous manure, and (4) small dressings of artificial manures are more directly profitable than large dressings

It is to be hoped than many of these experiments will be repeated in the county this year W T

The Food of Plants By A P Laurie, M A, B Sc (London Macmillan Co, 1893)

THIS little book is intended to be an introduction to agricultural chemistry It contains descriptions of a series of simple experiments which may be undertaken without any previous knowledge of chemistry These experiments illustrate the part played by water in the nutrition of plants, the nature of the soil and of the air, and how plants obtain their food from these sources, &c

The experiments are carefully chosen and described, and can be performed with inexpensive materials, and the book, especially if used as the author suggests, in conjunction with a Chemistry Primer, can well be recommended as an interesting guide to the study of agriculture

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications]*

Fossil Floras and Climate.

I HAVE read with some interest the communications in recent numbers of NATURE based on a review by my friend Mr. Starkie Gardner of a book which I have not yet seen; and as an exile in the south owing to a serious illness, I have not means of reference even to my own papers on the topic in discussion. I think, however, it may be well to direct attention to some Canadian facts published in the Transactions of our Royal Society and elsewhere, to which neither Mr. Gardner nor Mr. De Rance have referred [1]

[1] See Report of Dr G M. Dawson on the 49th Parallel 1875, Reports Geol. Survey of Canada, 1871-77 79, Transactions Royal Society of Canada 1883 to 1892

In Western Canada, in the Rocky Mountains, and in the Queen Charlotte Islands (latitude 55°) we have a lower cretaceous flora, characteristically mesozoic, and even allied to the jurassic. Two of its characteristic species are closely allied to *Dioon edule* of Mexico (*Dioonites Columbianus* and *D. borealis*, Dawson). Along with these are species of *Zamites* and of *Podozamites*, and leaves of Salisburya, very near to those described by Heer from the so called jurassic of Siberia. The lowest beds of this series contain no angiosperms, but in beds a little higher these begin to occur. This has been named in Canada the Kootanie flora, from the river of that name in the Rockies. The late Dr. Newberry, in one of his latest papers, described the same flora with identical species as occurring in Montana, and it coincides in part with the Potomac flora of Fontaine in the south eastern states. Its character and distribution show an extension of warm climate from Florida to the Queen Charlotte Islands, coincident with a great northward extension of the warm waters of the Gulf of Mexico, which in my judgment is sufficient to account for the climatal conditions. This lower cretaceous flora may be considered to be Neocomian in age, and to correspond with the Wealden of England, and the Komé of Heer in Greenland, which shows the extension of at least a temperate climate beyond the latitude of 60°.

The middle cretaceous brought in a still greater extension of the warm Mediterranean Sea of interior North America, indicated by the chalky foraminiferal Niobrara beds of the United States geologists, which extend into Canada. North of these marine beds, however, we have in Canada, in N. lat. 55°, the Dunvegan sandstones and shales, which hold not only cycadaceous plants but a rich angiospermous flora, including such warm temperate genera as *Magnolia* and *Laurus*, with more northern forms as *Betula* and *Populus*. This we regard as a middle cretaceous flora, in its older part approaching the well-known Dakota flora of the United States, and corresponding to the Atané of Heer in Greenland. The climate in this period must have been humid, equable, and temperate, all around the great American Mediterranean, but it is not impossible that our Dunvegan collections may include some plants of mountain districts mixed with those of lower grounds.

This was succeeded by the upper cretaceous, in the older part of which we have the magnificent flora of the coal series of Vancouver Island, which represents a Pacific coast flora, with fan palms, live oaks, and other trees comparable with those of modern Georgia and Florida. By this time, however, there would seem to have been a geographical separation between the Pacific coast and the plains, as the latter have not yet afforded anything equivalent to the Vancouver flora, and there are some indications that, toward the close of the cretaceous, the climate was cooler than previously. This is equivalent to the Patoot series of Heer in Greenland.

The Laramie period proper, that of the lignite tertiary formations of the plains, seems to indicate a swampy and lacustrine condition of the interior plateau, and the rich angiospermous and gymnospermous flora of this time, characterised very markedly by species of *Platanus* and *Sequoia*, has a temperate aspect in Canada, as far north as the McKenzie river. It corresponds with the so called miocene of Heer in Greenland, but is shown by stratigraphy and by its affinity with the eocene of England and Scotland, as described by Mr. Starkie Gardner, to be of that age if not constituting a transition group between the cretaceous and tertiary. The palæobotanists of the United States, at first, following Heer, regarded this flora as miocene. More recently some are disposed to consider it upper cretaceous. In Canada it has all along been regarded as paleocene or eocene, and so far as its flora is concerned this is its true position. In a recent number of NATURE I see that Prof. Osborn is disposed to regard the small mammals of the Laramie of the United States as of eocene affinities. If so, they will agree with the plants. It seems more difficult to account for the great northward extension of the Laramie temperate climate than for that of the preceding cretaceous, as the great Mediterranean of the latter seems to have dried up, though still existing in part, or replaced by swamps and lakes. Possibly some other arrangement of the warm Atlantic currents, as suggested by Mr. Starkie Gardner, may have produced some effect, in conjunction with obstruction of the Arctic currents, and a lower level of Greenland.

The general bearing of these facts on American climate is that we have no evidence of a tropical climate in Northern Canada or Greenland, but that both the geographical and botanical facts indicate a warm temperate climate, at least in the cretaceous period, and that in the earlier eocene the climate was becoming cooler and less equable.

We have little to show for the miocene, but what there is, as in the Similkameen flora of British Columbia, would go to show a cooler climate and more of local variation.

I have little faith in attempts to deduce a mean temperature in degrees of Fahrenheit from fossil plants, but if carefully collected, so as to keep separate those that belong to different horizons, and if studied in strict relation to the geological conditions of their occurrence, they must afford excellent general indications of climate. Allowance must, however, be made just as in the case of animal fossils, for differences of station, altitude, &c., and for extent of probable driftage or occurrence *in situ*.[1] In studying large collections of our mesozoic and tertiary fossil plants, from different localities and horizons, I have as a geologist naturally had reference to these points, and the work of such men as Selwyn, Richardson, G. M. Dawson, and Mr. Connell has left nothing to be desired as to careful collecting and determination of stratigraphical relations, while the study of animal fossils by Mr. Whiteaves has gone on *pari passu* and in harmony with that of the plants.

I sympathise with Mr. De Rance in his defence of Heer's studies of the Greenland plants, for I know that my own work in Canada would be liable to still more severe criticism. It must be borne in mind that the palæobotanist has very imperfect material, and that he is always liable unconsciously to multiply species. If, however, his names serve to designate the things, and if their geological relations are known, an important work has been accomplished—always, however, provisional and liable to correction as new discoveries are made. One of my Kootanie leaves is scarcely distinguishable on the one hand from Heer's *Salisburya sibirica*, and on the other from Lindley's *Cyclopteris digitata*, even when I have specimens of both to compare it with. All may be the same, though referred on the one hand to ferns, on the other to coniferæ, and this may not be settled till specimens in fruit are found. But in any case something has been done, and a widely distributed vegetable form has been recognised at a particular stage of the world's history.

I hope to discuss some of these points more fully in a work now in the press. WM. DAWSON.

Augusta, Georgia, March 13.

P.S.—Since writing the above I have obtained access to a copy of Dall and Harris's "Neozoic Correlation Papers,"[2] which throws some additional light on the cretaceous and eocene floras of Alaska, which, from its high northern latitude, affords a good term of comparison with Greenland. It would appear that fossil plants occur at two horizons. One of these (Cape Beaufort), according to Lesquereux and Ward, holds species of Neocomian age, equivalent to the Kootanie of British Columbia and to the Komé of Greenland. The other, which occurs at several localities (Elukak, Port Graham, &c.), has a flora evidently of Laramie (eocene) age, and equivalent to the "miocene" of Heer and Lesquereux and to the McKenzie river and lignite tertiary of Canada. The plants are accompanied by lignite, and evidently *in situ*, and clearly prove harmony with Greenland and Northern Canada in two of those periods of high Arctic temperature indicated above.

Notes on a Spider.

I SEND you the following notes on a spider, whose curious habits I had an opportunity of observing, last year, on the West Coast of Africa:—

In the month of August, 1892, I was travelling by hammock from Chama to Sekundi, two small towns on the Gold Coast. That part of the country is somewhat hilly and is covered with "bush" and other forest growth. The road skirts the sea shore, sometimes following the beach itself, at other times taking turns inland and winding round bases of small hills.

It was about three in the afternoon and I was being leisurely carried along by my bearers, when I noticed in the bushes that bordered the path something which appeared to me to be a sort of white flower.

[1] Ward, of the U.S. Geol. Survey, has directed attention to these points in an excellent paper published by the Survey.

[2] *Bulletin U.S. Geol. Survey* 1892.

I stopped and examined it Instead of being a flower, I found it was the web of a spider, and it was hanging between the branches of a shrub about three feet from the ground

The outer lines of the web were of considerable strength and were stretched between points from eight to ten inches apart From these lines, supported by a few radii, hung a beautiful rosette shaped centre, much resembling a delicate pattern in white silk lace The central space was open and measured about a quarter of an inch in diameter The notched space was adorned by three circular zig zag cords of thick white flossy silk I did not notice any of MacCook's so-called "ribbon braces" The spiral space was very open and the threads composing it were so slight as to be almost invisible So thin were they that the ribboned centre appeared to be hanging in the air without any support whatever The appearance of this web was almost exactly similar to that of the web of *Uloborus*, shown in Fig 57, p 58 of MacCook's "American Spiders" I did not notice any "fenders" or protective wings on the outer side of the web, there were, however, a few strengthening strands on the side turned towards the bush.

The web, however, especially bore a strong resemblance to a flower, the more so as in the exact centre of its outward side was stationed a spider with a light blue body This light blue colour gave one the impression that it was the centre of the flower, while the yellow legs spotted with brown were symmetrically disposed in the shape of an X across the ribboned hub, thus dividing it into the semblance of petals. The illusion was remarkable

The spider remained motionless until I touched the web She then fell into the net which I was holding under the snare

As soon as she touched the net (a white gauze one) she changed colour From blue she became white and then, on being shaken, her body turned a dark greenish brown I then placed her in a glass tube and gradually she resumed her blue tint Whenever shaken, however, she turned a greenish brown I placed her in spirits and her colour remained a grey brown

On the same road later in the day, I noticed another strange web which bore even a stronger resemblance to a flower

The "foundation space" was the same as in the other, but somewhat larger and stronger The white silk ribbon, however, instead of being disposed around the centre in circular zig zag lines, was extended in two thick white ribbons stretched crosswise along four of the radii In this instance also the spiral space was very open and the spirals very delicate

The spider inhabiting this web was considerably larger than the foregoing specimen, but appeared to be otherwise exactly similar to it Her body was a very light blue, placed exactly in the centre of the cross, head downwards, while her long legs were disposed in pairs over the four arms of the white silk pattern The whole thing bore a great resemblance to an orchid, and the legs of the spider gave it just sufficient stability for it to be taken for a flower

When I touched the web the spider immediately darted through two strands in the spiral space and placed herself on the reverse side of her web, being almost completely concealed by the thick flossy white ribbons

I captured this spider, and her body, like the other specimen's, immediately turned a dark greenish brown I did not, however, see her turn white I placed the insect in a glass tube, and five days later put her in a cage

I also took the web and succeeded in fastening the centre of it on to a black card, where it remains in exactly the same shape as when it was hanging on the bushes I have this web, and also a photograph of it.

The day after the spider was placed in the cage she made a web It was spun during the night, and I did not observe the operation. The web was of the same pattern as the one on which I discovered her on the bush It did not have any circular zig-zag cords

This spider remained in her cage for four or five weeks, and then I placed her in spirits She was fed principally with flies.

On one occasion I put a very large blue-bottle fly into the cage The spider seized it immediately, violently vibrated her web, and at the same time rolled the fly round and round between her legs. In the space of three or four seconds the fly was completely swathed in an envelope of white silk, and was motionless The spider then fastened her fangs into the body, and sucked it for about two hours.

I have since seen several of these spiders on their webs, and have noticed that the pattern of the snare appears to depend on the size of the insect, the smaller specimens making the circular rosette shaped snare, while the larger insects weave the cross orchid-like flower I saw one small web composed of two little rosettes, joined side by side, but I did not notice whether it was inhabited by two spiders I frequently found wings and other debris of insects hanging to the rosettes of the webs, and in one case saw a wing of what must have been a butterfly of considerable size

When does the spider alter the pattern of her snare? Can it be that, when the spider attains to full growth, finding that the rosette shape, becoming too large, no longer deceives butterflies and other insects, she adopts the orchid like pattern which has more *vraisemblance*, and over which she can dispose her long legs with a better chance of successful trickery

The web of this spider being so like a flower would appear to be intended as a veritable "snare" The insect by assuming its bright blue colour increases the resemblance and the mimicry is probably practised not so much for the protection of the spider herself, but rather for the attraction it presents to butterflies and other flower frequenting insects

MacCook in "American Spiders," writing of the mimicry of spiders, and of their perception of colour, says (vol ii p 346) — "There is indeed another theory which may be suggested, namely, that the colour surroundings of the spider, in some manner not now explicable, so rapidly influence the organism of the creature that a change of colour is produced in harmony with its environment *Can we suppose in this case that the spider possesses the power to influence at will the chromatophores or pigment bodies, so that she may change her colour with changing site?*"

The specimen observed by me would seem to be an answer to MacCook's suggestion, and I should be very glad to know, through the medium of NATURE, or otherwise, whether the spider described by me, as above, is already known to naturalists

I took the specimens which I possess to the Natural History Museum, at South Kensington, and the spiders were declared to be a species of Argiope

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Origin of Lake Basins

ONE of the chief reasons for the prevalence of lake basins in glaciated countries has not been alluded to in the letters which have recently appeared in NATURE on the origin of lake basins

Whenever earth movements take place in limited areas such movements will tend to form basins, but as the movements are as a rule gradual such basins will only come into existence under exceptional conditions Water borne detritus, the growth of vegetation, and erosion will obliterate them in most cases as fast as they are formed by slow unequal movements of subsidence or elevation

In glaciated countries, however, basins in the course of formation by unequal earth movements will be largely protected from such destructive action by being filled with ice, and will thus be preserved to appear as lake basins when the ice melts

So, too, in countries where the rainfall is very small and the action of the forces destructive to lake basins is accordingly much diminished basins may be and are formed by earth movements. In rainless countries they are probably more numerous than we are aware of, for there is little to attract attention to them, but they will become of more importance as works of irrigation are required in such countries An important depression, the Raian basin, has lately been surveyed in Egypt by Mr Cope Whitehouse with a view to utilising it for irrigation purposes (Proceedings Royal Geographical Society, 2nd series, vol ix p 608)

Wind-borne detritus will tend to diminish the depths of such basins in rainless countries So, too, the capacity of ice filled basins to hold water in the future will be diminished somewhat by the erosion of the sub-glacial river, but on the other hand as the movement of the earth deepens the basin the ever-thickening mass of ice will acquire increased power to grind it deeper still This grinding action cannot be ignored, and some shallow lake basins may be almost entirely due to it, but there is scarcely a limit to the formation of such basins by earth movements under suitable conditions.

J C HAWKSHAW.
33, Great George Street, Westminster, S.W., March 29.

THE MUSK-OX

THE Zoological Society of London being anxious to obtain living specimens of the musk-ox (*Ovibos moschatus*), well known as one of the characteristic inhabitants of Arctic regions, the Council of the Society have determined to offer the sum of five hundred pounds for five examples of this animal (two males and three females) delivered alive and in good condition in the Regent's Park Gardens, or a proportionate sum for a smaller number It has been pointed out by Col Feilden, in an article upon "Animal Life in East Greenland," published in *The Zoologist* for February last, that the southern range of the musk-ox, which was formerly supposed to be met with only in Arctic America, has now been satisfactorily shown to extend as far south on the east coast of Greenland as midway between the parallels of 70° and 71° N L, and that it will in all probability be found in the future to extend along the coast line of Egede Land as far as the sixty-fifth parallel Thus the abode of the musk ox is brought comparatively close to Europe, and there seems to be no insuperable difficulty in procuring living specimens Young musk-oxen are very easily reared and tamed, and there could not be any very great difficulty in catching either old or young in Jameson's Land

Although the more southern portion of the coast of East Greenland is shut off from access by an almost impenetrable ice barrier, it has been ascertained of late years that the more northern portion of this coast may

Musk-ox (from Flower and Lydekker's "Introduction to the Study of Mammals," p. 358)

be reached with comparatively little difficulty In 1889 Captain Knudsen, of the Norwegian sealer *Hekla*, landed on Claverlng Island in 74° 10' N L, and found musk-oxen in considerable numbers Again, during the recent Danish East Greenland Expedition of 1891–92, Lieut Ryder managed to land on Jameson's Land in Scoresby's Sound, although the year was very unfavourable, and passed the winter there with great success, no sickness having occurred amongst the members of the expedition during all the time they were there.

Animal life, Lieut Ryder tells us, is rich, especially in Jameson's Land, where reindeer are seen in wonderful numbers Many musk oxen were seen around Hurry's Inlet, and traces of foxes, hares, bears, ermines, and lemmings were observed in Jameson's Land The richness of vegetation (150 flowering plants having been gathered in Scoresby's Sound) and the size attained by it, especially around the western basin, are most astonishing, especially in comparison with what is the case on the western coast of Greenland.

It is, therefore, evident that it is quite possible for the well equipped Arctic navigator to land on this part of the east coast of Greenland in almost any ordinary year, and that he will find there an abundant supply of both animal and vegetable life In the former category are the musk-oxen, the young of which, as already stated, are easily captured and reared When they are once placed on board ship there would appear to be no great difficulty in bringing them safe to England

We subjoin the description of the musk-ox given in Flower and Lydekker's "Introduction to the Study of Mammals," the publishers of which (Messrs Black) have kindly allowed us the use of the accompanying illustration

The animal commonly known as the musk-ox (*Ovibos moschatus*), though approaching in size the smaller varieties of oxen, is in structure and habits closely allied to the sheep, its affinities being well expressed by the generic name *Ovibos* bestowed upon it by De Blainville The specific name as also the common English appellatives, "Musk-Ox," "Musk-Buffalo," or "Musk-Sheep," applied to it by various authors, refer to the musky odour which the animal exhales This does not appear to be due to the secretion of a special gland, as in the case of the musk-deer, but it must be observed that, except as regards the osteology, very little is known of the anatomy of this species It about equals in size the small Welsh and Scotch cattle The head is large and broad The horns in the old males have extremely broad bases, meeting in the median line, and covering the brow and whole crown of the head They are directed at first downwards by the side of the face, and then turn upwards and forwards, ending in the same plane as the eye Their basal halves are of a dull white colour, oval in section and coarsely fibrous, their middle part smooth, shining, and round, their tips black In the females and young males the horns are smaller, and their bases are separated from each other by a space in the middle of the forehead The ears are small, erect, and pointed, and nearly concealed in the hair The space between the nostrils and the upper lip is covered with close hair, as in sheep and goats, without any trace of the bare muffle of the oxen The greater part of the animal is covered with long brown hair, thick, matted, and curly on the shoulders, so as to give the appearance of a hump, but elsewhere straight and hanging down, that of the sides, back, and haunches reaching as far as the middle of the legs and entirely concealing the very short tail There is also a thick woolly underfur, shed in the summer The hair on the lower jaw, throat, and chest, is long and straight, and hangs down like a beard or dewlap, though there is no loose fold of skin in this situation as in oxen The limbs are stout and short, terminating in unsymmetrical hoofs, the external one being rounded, the internal pointed, and the sole partially covered with hair

It is gregarious in habit, assembling in herds of twenty or thirty head, or, according to Hearne, sometimes eighty or a hundred, in which there are seldom more than two or three full grown males The musk-ox runs with considerable speed, notwithstanding the shortness of its legs Major H W Feilden, Naturalist to the Arctic Expedition of 1875, says,—"No person watching this animal in a state of nature could fail to see how essentially ovine are its actions When alarmed they gather together like a flock of sheep herded by a collie dog, and the way in which they pack closely together and follow blindly the vacillating leadership of the old ram is unquestionably sheep-like When thoroughly frightened they take to the hills, ascending precipitous slopes and scaling rocks with great agility." They feed chiefly on grass, but also on moss, lichens, and tender shoots of the willow and pine The female brings forth a single young one in the end of May or beginning of June, after a gestation of nine months.

ON THE CARBURISATION OF IRON

II

IN a previous communication (NATURE, vol xlvi p 283) the problem of the distribution and absorption of carbon by iron has been discussed, and it has been shown that the process is akin to that of the solution of a salt soluble in water or an acid liquid, that at low temperature solution proceeds slowly, the solubility increasing with the temperature, until at the final high heat of Bessemer blown metal, or fluid nearly pure iron, the reaction is almost instantaneous, the carbon, and also manganese, contained in the spiegel-eisen used for this purpose diffusing throughout the fluid metal in a very short space of time The same occurs when carbon only, in the form of charcoal or coke, is added in lieu of spiegel, as in the Darby process of carburising By this latter process, however, about 30 per cent excess of carbon must be added over and above the theoretical quantity required to insure a given percentage of carbon, for instance, ½ per cent For lower percentages the excess must still be maintained, but with a corresponding diminution of the total weight of carbon used In some instances more than 30 per cent is used, according to the methods of procedure In practice this holds good and the quantity of carbon required can thus be regulated

A priori this would seem impossible An excess 30 per cent above the quantity necessary being used, it seems strange that, at the high temperature in the presence of a considerable excess of fluid metal, that nearly the whole of the carbon is not taken up, more especially when iron, as is well known, may absorb as much as 5 per cent of carbon in the blast furnace, usually, however, cast iron contains not more than 4 and spiegel eisen 5 per cent carbon, the latter alloy of manganese and iron apparently conferring greater solubility It even suffices to pour the fluid metal on the pulverised carbon previously placed in the ladle, and a very even product is thus obtained, sufficing for all practical purposes, the variation in the percentage of carbon absorbed or dissolved falling within the limits of experimental error It is possible that after absorption of carbon equalling say ½ per cent, if the iron were left in contact with carbon for a longer period, more might be taken up, and that with iron already charged with carbon, solution may be retarded, the rate at which the latter is taken up probably bearing a certain ratio to the amount previously absorbed If carbon simply exists in solution this is very probable, and yet the theory would hardly afford at first sight a feasible explanation of the even absorption of carbon which thus takes place, were it not well known that most chemical reactions, so to speak, fall into the same category

Chemical affinities are not entirely governed by actual values, or the affinity of one element for another, the mass or relative weight of the bodies present influences the final result, and it is conceivable that, assuming we have two bodies in solution, the addition of a reagent having a greater affinity for one of these may not, in the presence of an excess of the other, exert its full power, the greater mass or weight of the latter apparently weakening, or rather partly neutralising, the chemical force of the reagent added

Further cases can be quoted where relative masses in solution are so evenly balanced that a slight excess of the reagent added determines the precipitation of one or the other at the will of the operator

Barium sulphate is somewhat soluble in acids, and by prolonged digestion a portion is dissolved. Either barium or sulphuric acid may be precipitated by merely, as regards barium, adding a slight excess of sulphuric acid On the contrary the addition of a little barium chloride determines the precipitation of sulphuric acid Apparently, then, excess or mass of one element overcomes the greater affinity of the other for the reagent added, or, as often happens, a portion is left uncombined and in solution, requiring an excess of the reagent for the complete precipitation or combination

Such cases as those above quoted are not uncommon in metallurgical processes conducted at high temperatures Thus in the case of the manufacture of Bessemer steel, analysis indicates the presence of diverse elements existing together.

One has—silicon, carbon, hydrogen, oxygen, manganese—also sulphur and phosphorus together with, it is said, carbon monoxide in solution—also probably dissolved oxygen in addition to iron oxide Further, steel with more than ½ per cent of carbon, and also silicon and manganese in sensible quantities, always contains O and H, and thus we have the elements of water side by side in the presence of a tolerable excess of no less than three bodies, Si, C, and Mn, having affinities for oxygen

It is quite true that the abnormally high temperature of the process may weaken ordinary chemical reactions by a species of dissociation, this has been acknowledged Yet mass or relative proportions of the elements present must, one would think, influence final results, and thus prevent the complete elimination of the elements named for the reasons already stated

The treatment of fluid iron with reagents such as C, Si, Mn, or alkalies, as now practised, is as strictly a chemical process as that pursued by the chemist in his laboratory In both, reagents are employed which are known to be suitable for the elimination or precipitation of substances known to be present, and, so far as can be ascertained from actual practice, the steel-caster deals with molten metal containing certain elements in solution, and endeavours to get rid of some of these, or adds others assumed to be beneficial, just as the chemist works with solutions known to contain bodies possibly existing or combined with the fluid solvent in much the same manner as the worker with fluid iron There seems but little difference, take it as one may, the same laws of combination, solution, &c, seem equally applicable, and differences of opinion as to what is really meant by the terms solution, chemical combination, or simply mixtures, are common to both Further, it must not be forgotten that pure fluid iron, although exerting a direct solvent action on certain bodies, may take up or dissolve a chemical combination or double salt, just as pure water does. This, however, remains an open question, but it would be interesting to know if certain combinations of iron with other elements are thus held in solution

As regards carbon there can be little doubt of the existence of definite carbides of iron, and it may be that combinations of iron with bodies other than carbon may play a part. Some recent work on certain alloys of iron points to the probability of the formation of these Assuming the presence of a definite carbide of iron which may not be in solution, but diffused evenly throughout the fluid iron, although we cannot be absolutely sure of this, the behaviour of steel under certain conditions of heating and manipulation may be explained on the assumption that iron carbide, being certainly more fusible than pure iron, must become soft and plastic at a temperature at which the mass of pure metal is scarcely at all affected This plastic compound would bind the noncoherent particles of the greater mass of iron together, and this mixed or heterogeneous body could be welded or beaten out under the hammer It is the general opinion that the weldable metals are mixed bodies, are not homogeneous, inasmuch as bodies purely homogeneous cannot as a rule be welded together.

Wrought iron welds easily, far more easily than steel, and it is certain that the former is not homogeneous, whatever may be said of the latter. Wrought or puddled iron is well known as an irregular mixture, composed of grains

of pure metal intermixed with carburised metal, and also slag The latter is said to play its part in rendering the total mass more coherent when heated and worked This latter material when fused and cast into ingots is a totally different material, and behaves somewhat like steel If this now comparatively homogeneous substance contain enough carbon (which sometimes is not the case, in the latter instance it is brittle and redshort, behaving somewhat like Bessemer blown metal) it works like a soft steel

It follows, therefore, that if fusible compounds are present, and evenly diffused throughout the pure metal, their effect on steel is purely *physical*, and a heterogeneous metal like steel may be compared with rocks, which are known to be composed of siliceous particles, cemented or bound together by other compound bodies Dr Sorbys long ago noted this, and drew attention to the comparative uselessness of ordinary chemical elementary analysis, simply stating the percentage of elements present, and suggested that proximate analyses were equally required The writer is fain to agree with him, his own experience of the comparative failure of ordinary analysis as a trustworthy guide in the manufacture having been somewhat extensive The purest form of iron known to the writer is the Bessemer blown metal, beyond traces of carbon, with less than $\frac{1}{10}$th per cent of sulphur and phosphorus It is pure iron (with some kinds of iron only traces of these latter can be detected) This metal is worthless for commercial purposes, and this is said to be due to the presence of oxide of iron or possibly dissolved oxygen absorbed during the blow, to a certain extent this has been proved to be true But the writer thinks that on the whole the pure material, even when freed from oxygen, would be commercially valueless, and if, shortly speaking, the cement theory or mixture of bodies (the one more fusible than the other), be true, pure iron is unworkable

The opinions quoted are apparently not in accord with the theory of solution previously summarised, and leave unexplained the undoubted fact of the diffusion or solution of carbon in iron at low temperatures, tending, of course, if time be allowed, to the formation of a homogeneous material Yet a carbide of iron is known, "Fe_4C," and has been isolated It appears to the author that one somewhat reasonable explanation of this anomaly has been afforded by W Mattieu Williams He compares the union of carbon and iron to the processes of tinning or galvanising If a plate of copper is immersed in melted tin a film of tin adheres to its surface, and if continued the tin will gradually soak into the copper, and in time will go through Tin or zinc penetrates iron in the same way, mercury also amalgamates with copper, therefore carbon (Fe_4C) may be similarly distributed in iron

This may or may not be the case, but in the author's opinion it does not meet all the difficulties, or afford a complete explanation of the phenomena taking place when iron is heated and worked in contact with carbon Neither does the alternative theory of solution, either in the ordinary sense of the word or, better, as defined by modern physicists, afford a complete explanation. Yet on the whole the latter seems to afford a better and more complete all-round explanation of some curious changes observable when steel is heated up to certain varying temperatures, the results of which are now familiar to us.

Referring once again to the curious fact of the even distribution of carbon throughout iron, when plates of uneven composition as regards the percentage of carbon are heated together, it appears as the outcome of recent research[1] that chemical action, "or something closely approximating to it," takes place between solids, and even at low temperatures. Many experiments are given—thus dry ice and rock salt unite when placed in contact at a temperature decidedly below zero

This is a very old experiment, but it is interesting as an example of the union of two solids below the fusing point of either, but above that of the product He obtained similar results in other cases with sodium, potassium, calcium, and ammonium chloride, &c This suggests the question, Are the metals combining to form an alloy "in the new way," *i e* in the form of solids, a freezing mixture?

Space does not admit of further quotation, the fact remains that solids combine with solids to form an alloy, or possibly what is termed a chemical combination

At first sight this seems inconceivable and irrational Many alternative theories and explanations of these curious phenomena are at our disposal Yet there remains one simple way of accounting, at least in some degree, for this alloyage—or one ought perhaps to say the interpenetration of one element into another, as with carbon and iron It is now, we think, generally admitted, in the light of recent researches on the vaporisation of the elements, "both in vacuo and at ordinary pressures," that no known element, however infusible, can be said to be *perfectly* stable at any temperature when freely exposed in space, and it is extremely probable that even such substances as iron and carbon are slowly dissociating at ordinary temperatures very much as water evaporates, and it follows that these are always enveloped in a thin atmosphere of their own vapour The *quantity* of matter present in this form may never be recognisable, it may indeed be beyond the limit of our senses Yet if such a process takes place, it affords a probable explanation of the diffusion of solids into each other For admitting this it is evident that any mass or mixed masses of matter exist in an atmosphere formed by themselves Such masses of matter cannot be discontinuous, strictly speaking, the sensible particles of which they are composed are not completely isolated from each other, and from this point of view the conception of the interpenetration of iron by carbon, or indeed other bodies, is, one thinks, rendered more easy

JOHN PARRY

[1] William Hollock, *American Journal of Science*, vol xxxvii 1889.

NOTES

BOTANISTS all over the world will be sorry to hear of the death of the famous Swiss botanist, Alphonse de Candolle. He was in his eighty-seventh year We hope to give on a future occasion some account of his services to science.

WE regret to hear, through the *Botanical Gazette*, of the death of the Rev. T. Wolle, pastor of the Moravian Church, Bethlehem, Pennsylvania, an ardent student of freshwater algæ Of his three most important publications, "Freshwater Algæ of the United States," "Desmids of the United States," and "Diatoms of the United States," at least the first two will always be standard works in the subject of which they treat

THE ordinary general meeting of the Institution of Mechanical Engineers will be held on Thursday evening and Friday evening, April 21 and 22, at 25, Great George Street, Westminster The chair will be taken at half past seven p m on each evening by the president, Dr William Anderson, F R S. The following papers will be read and discussed, as far as time permits:—Second report to the Alloys Research Committee, by Prof. W C Roberts-Austen, F R S (Thursday, and discussion possibly continued on Friday), tensile tests and chemical analyses of copper plates from fire-boxes of locomotives on the Great Western Railway, by Mr William Dean (in connection with the above report); Research Committee on marine-engine trials: abstracts of results of experiments on six steamers, and conclusions drawn therefrom in regard to the efficiency of marine boilers and engines, by Prof T Hudson Beare. The anniversary dinner will take place on Wednesday evening, April 19.

The Council of the Marine Biological Association of the United Kingdom have appointed Mr Edward J Bles director of the Laboratory at Plymouth Mr Bles has held an honorary research fellowship in zoology at the Owens College, Manchester

The seventh annual photographic conference, organised by the Camera Club, was opened yesterday in the theatre of the Society of Arts, under the presidency of Captain Abney Various papers were read, and others are to be read to day The annual exhibition of photographs by members will be on view at the club after conference week, and will remain open for about six weeks

The thirteenth annual general meeting of the Essex Field Club will be held at Chelmsford on Saturday, April 15 It is proposed that before the meeting the members shall have a ramble in the neighbourhood of Chelmsford, and thus open the field meetings for the season After the transaction of official business an address will be delivered by Dr Laver, the retiring president, on "periodicity in organic life" His object will be to show that animals have periods of abundance and rarity, and that this is not due either to meteorological causes or to the agency of man

The Council of the City and Guilds of London Institute, recognising the increasing importance in the mechanical reproduction of pictures, will, in the forthcoming examinations, to be held on May 3 and 13 next, give special importance to this branch, by dividing the examination in the Honours Grade into two classes, one for pure Photography, and the other for photo mechanical Photography. Special examiners have been appointed for each branch, and candidates have the option of declaring in which branch it is their intention of entering They will not, however, be allowed to compete in both branches The certificates granted will show in which of the two divisions the candidate has passed The Council of the Institute hope that the encouragement thus given to the photo mechanical division will tend to form in this country a school of competent craftsmen in this branch of photographic work.

The twenty fourth annual meeting of the Norfolk and Norwich Naturalists' Society was held recently at the Museum, Norwich, the president (Mr H B Woodward) in the chair Mr T Southwell was elected president for the ensuing year, and after the usual routine business the retiring president delivered the annual address After giving some account of the work of the society during the session, he remarked that there was a slight increase in the number of members, also that the financial position was satisfactory Turning attention to the geology of Norfolk, he expressed regret that the gaps left by the deaths of the older geologists were not filled by new-comers Even collectors of fossils, who rendered such good service, were not nowadays so plentiful as formerly Enthusiasm was damped by the difficulties in naming specimens, and these difficulties were increased by modern palæontological work There were varieties of species which co-existed with the type; and there were variations which followed the type in chronological succession, and to the latter the name "mutations" had been given He regarded the giving of specific names to these mutations as the most serious obstacle ever placed in the pathway of the student of nature. Allusion was made to the subject of geological "zones," and mention was made of the discovery of layers of phosphatic chalk in Buckinghamshire, and to their possible occurrence in Norfolk Having referred to various other matters, Mr Woodward expressed a hope that some day Norwich might have a university college, where prominence would be given to subjects of special practical importance in East Anglia.

Sir Thomas Gresham's Reader in Geometry at Gresham College being unable, owing to ill health, to give the Easter course of lectures, the City Side of the Gresham Committee have permitted their delivery by deputy. The following course of lectures on special applications of the laws of chance is to be given —April 18, "On Frequency Curves, their Nature, Variety, and Use," by Dr John Venn, F R S, April 19, "Chance in the Field of Biology," by Prof W F R Weldon, F R S, April 20, "On some Points in the Philosophy of Chance," by the Rev W A Whitworth, April 21, "Probability as the Guide of Astronomers," by Sir Robert S Ball, F R S, Lowndean Professor of Astronomy in the University of Cambridge. The lectures are free to the public, and begin at six o'clock p m

Miss Caroline A Foley contributes to the new number of *Mind* a vivid and very interesting account of the late Prof Croom Robertson as a teacher No one who reads it will have any difficulty in understanding the affection and respect with which his memory is cherished by his old pupils Miss Foley, while regretting, as many others have done, that Prof Robertson did not live to present "an integral view of his thoughts on any great questions of philosophy," suggests that some who heard him give expression to his ideas may have in their possession as much recorded material as would enable "any of his more competent contemporaries to synthesise and perpetuate what of it is chiefly and worthily distinctive" The editor of *Mind*, in a note, states that "this suggestion will probably be carried out"

A report of the first annual meeting of the Association of Head Masters of Higher Grade and Organised Science Classes has been issued The meeting was held lately at Manchester, the chair being occupied by Mr James Scotson, of the central higher grade school, Manchester The report includes not only Mr Scotson's address, but a vigorous paper by Dr David Forsyth, head master of the central higher grade school, Leeds, on "higher education for the children of the people"

On April 8 several shocks of earthquake were felt over a wide area of south-eastern Europe They were especially severe in western Servia Shocks were also felt in Bulgaria and at various places in Hungary They are said to have occurred in Hungary between 2 and 3 o'clock in the afternoon, in Servia at 2 55 P M, at Sofia about 4 o'clock P M From Sofia the movement is reported to have been of an undulatory character and to have lasted about thirty seconds, the direction being from west to east On Sunday and Monday fresh shocks were experienced in various parts of western Servia, but they were less severe than those of the previous day According to a Reuter's telegram from Belgrade, the districts most seriously affected by the earthquake of Saturday are those of Morava and Pozarevac Great damage was done in the towns of Svilajnac and Gradista, where the shocks followed one another in quick succession At Livadica-Cuprija, as well as at Svilajnac, great fissures were opened in the earth, whence streams of water and quantities of yellowish matter were still issuing forth on Monday Thousands of houses and a great number of churches are either in ruins or have become so severely cracked that the people are afraid to enter them So great is the panic in the two districts named that not a single person ventures to sleep indoors

Mr W. R Elliott, writing to us from Prince Ruperts, Dominica, W.I, on March 19, says that the northern end of the Island of Dominica had for some time been the scene of what he calls "a most extraordinary display in the way of earthquakes." The house in which he was staying at the time is situated on a spur off the main ridge of the island, and, therefore, somewhat in the direct line of volcanic action in these islands. The shocks began on February 17, and were felt

occasionally until March 18 They seem to have been most intense on March 12 Mr Elliott says with regard to the shocks on that day —" The shocks between 7 10 p m and 7 20 p m were very sharp, and followed one another rapidly The sharp succession of shocks at 3 10 a m on the 13th inst very much resembled this batch The loud roar that accompanied each shock was very noticeable, and we could hear it distinctly immediately before each shock, in fact, could hear the earthquake coming along the hills to us None of the shocks had that long undulatory motion that is usually felt when we have an earthquake that is felt throughout the islands, but the feeling was that we were being heaved up and twisted round, and the bumps seemed to give us a push northwards, and I could not help imagining that we were being pushed up to Guadaloupe I mention this as showing how marked was the direction of the shocks After 3 10 a.m on the 13th the shocks became so frequent that I stopped noting them down, until after a short lull a sharp one was felt at 9 15 a m "

The weather has continued very fine over the British Islands during the past week, scarcely any rain having fallen in any part With a very trifling exception in the south and east, the drought has continued since March 4, and in the south-east of England there has been no rain for upwards of three weeks. The temperature has been somewhat lower generally in the daytime, although in the inland and southern portions of the Kingdom the maxima during several days varied between 60° and 70°, but at the eastern coast stations the maximum temperature on several days did not exceed 45°, owing to the sun's rays being obscured by cloud and fog During the latter part of the period the barometer fell slowly but uniformly, in the north of our islands the weather became less settled, and on Tuesday snow was falling in the Shetlands, still the general conditions indicated a probable continuance of dry weather, and an anticyclone in the north was spreading southwards The *Weekly Weather Report* of the 8th instant showed that the percentage of bright sunshine for that period ranged from 38° to 60° in Scotland, from 53° to 66° in Ireland, and from 61° to 74° in England, while in the Channel Islands it was as high as 79°

A summer excursion to the Giant's Cause way for scientific study is being organised by Mr C Carus-Wilson It is proposed that the party shall start for Portrush on July 1 or earlier, and return, if possible, through Dublin, so that they may have an opportunity of meeting the members of the Geologists' Association, who are this year to visit the Wicklow Mountains

We have received a copy of a new prospectus of the electrical and general engineering college and school of science, Penywern House, of which Mr G W de Tunzelmann is principal It gives an account of recent extensions, and of others which are in progress.

In the "Annals of Natural History" for the present month will be found an account of a very interesting zoological novelty Mr R T Günther describes and figures a remarkable new form of *Medusa*, or jelly-fish, that occurs in Lake Tanganyika Until recent years, when the little *Limnocodium* was found living in the Victoria Lily-tank of the Botanic Gardens, Regent's Park, it was believed that the *Medusæ* were nearly exclusively oceanic. It is now shown that the freshwater lake Tanganyika is the home of a peculiar member of this group. The existence of such an organism in Tanganyika was asserted some years ago by the German naturalist, Dr. Boehm, and Prof. v. Martens, of Berlin, even went so far as to name it *Tanganyicæ*, although he had never seen a specimen. Mr. Günther now supplies us with a full description of this singular Hydrozoon, which he refers to a new genus, *Limnocnida*, adopting the suggestion of v Martens as to its specific name. *Limnocnida tanganyicæ* is, as might have been anticipated, perfectly different from all the members of the group hitherto known, and probably represents a distinct family, but its exact position cannot be settled positively until the mode of its development has been ascertained

A good descriptive article on the prehistoric remains at Abury is contributed by Mr A L Lewis to *Science* of March 24 The editor appends a note in which he says it has been thought that many Americans who, when in England, visit Stonehenge, may not be aware how many remains of a similar character, which they might also wish to inspect, exist in the British Isles He has accordingly made arrangements for a series of short articles which shall give a description of each of the principal circles, and state what points should be noted and how it may be most easily visited

Mr H L Jones records, in the *Botanical Gazette*, an example of a graft-hybrid between two different varieties of geranium, a red and a white In several successive years the flowers partook of the characters of both parents, some were pure red, and others pure white, others had some of the petals white, others red, while in others again the petals were red mottled with white, or white mottled with red

If we may judge from the tone of an article on "conditions of forestry as a business," contributed by Dr W J Beal to the New York *Engineering Magazine*, a good deal of anxiety is felt by some Americans about the extraordinary rapidity with which trees are vanishing from their country Michigan had at one time a supply of standing pine which was believed to be well-nigh inexhaustible Now it is found only in "small tracts in the back counties" The fathers and grandfathers of the present generation of Americans "cut down and burned the finest of the trees to make room for crops and pasture" "We have been taught," says Dr Beal, "to destroy trees, not to save them—much less to replant" The growth of interest in forestry will, he thinks, be slow for some time yet, but he anticipates that popular feeling about the matter will be greatly changed, and that salutary laws will be passed, before the close of the present century

Mr L J Tremayne notes, in the current number of the *Entomologist*, that he was walking down the Thames Embankment about two o'clock on March 8 (the sun being just at the time rather powerful), when a specimen of *Vanessa polychloros* alighted on the pavement about a couple of yards from him The insect was, he thinks, perfect, and appeared very fresh He tried to catch it, but it flew into the gardens on his left, and he saw no more of it There was, however, no mistaking the specimen, which expanded its wings right in front of Mr Tremayne This occurred just above Waterloo Bridge

At the Technical Institute of St Petersburg, M Vladimiroff has deduced from experiment a set of rules for estimating the quality of vulcanised caoutchouc (*Rev Sci*). Recourse is had to physical properties, chemical analysis not giving any sure result The following, in brief, are the conclusions.—(1) Caoutchouc should not give the least sign of cracking when bent to an angle of 180°, after 5 hours' exposure in an air-bath at 125° C (the specimens 2 4 in thick) (2) Caoutchouc having not more than half its weight of metallic oxides should bear stretching 5 times its length before rupture (3) Caoutchouc exempt from all foreign matter except sulphur should be capable of stretching at least 7 times its length before rupture (4) The extension measured just after rupture should not exceed 12 per cent of the original length (with given dimensions) (5) Suppleness may be determined by calculating the percentage of ash after incineration This may form the basis of choice for certain uses. (6) Vulcanised caoutchouc should not harden in cold. These rules are adopted for the Russian Navy.

The French Minister of War has recently had some experiments made on the resistance of ice With a thickness of 4 centimetres (say 1 6 inches), it begins to bear the weight of a man marching alone, at 9 centimetres detachments of infantry in files may go on it, at 12 centimetres it will carry "pièces de 8" on carriages, and so on, till at 29 centimetres, it will bear the heaviest weights M Forel (*Rev Sci*) sees danger in this note, if an officer, trusting in the figures, ordered a troop on ice of measured thickness, he might, in some cases, be courting catastrophe Those estimates, in fact, apply only to young ice, lamellar ice in process of freezing. When ice has for a few weeks been subject to alternations of temperature it changes in structure and loses much of its tenacity The old ice of a pond, absolutely compact in appearance, is traversed by a multitude of vertical fissures dividing it into irregular prismatic needles, comparable in arrangement to columns of basalt, and from a half-centimetre to 1 or 2 centimetres in thickness The structure becomes evident on breaking suddenly, in sunlight, a block of ice taken from a pond Under these conditions old ice has not nearly such resistance as young ice

The Michigan Mining School has published a "Catalogue," in which a full account is given of the various departments of its work The institution was established and is supported by the State of Michigan "in accordance with that liberal educational policy which has placed the university of Michigan amongst the foremost educational institutions of America" It is stated with admirable directness that students at the school are supposed "to understand what they are there for, to attend strictly to that business, and to conduct themselves as gentlemen"

The new number of the *Internationales Archiv fur Ethnographie* (Band vi, Heft 1) is occupied wholly with the concluding part of Dr W Svoboda's interesting notes (in German) on the inhabitants of the Nicobar Islands The illustrations, as usual, are excellent

The American Philosophical Society, Philadelphia, has issued a new instalment of its Proceedings (vol xxx, no 139) It opens with a paper on the mutual relations between the orbits of certain asteroids, by Daniel Kirkwood There are also articles by Dr D G Brinton on the Betoya dialects, and on the Etrusco Libyan elements in the song of the Arval brethren, and by Prof E D Cope on the phylogeny of the vertebrata (with two cuts), on some points in the kinetogenesis of the limbs of vertebrates, and on false elbow joints (with two plates)

A "Catalogue of Australian Mammals, with Introductory Notes on General Mammalogy," by J D Ogilby, has been published by order of the trustees of the Australian Museum, Sydney Mr E P Ramsay states in the preface that the work contains descriptions of all known mammals indigenous to Australia, with notes on allied fossil forms, compiled from various sources which are duly acknowledged by the author Nearly all the species, Mr Ramsay says, are represented by one or more specimens in the Museum

The new number of *Records of the Australian Museum* (vol ii, no 4) contains the following papers —On further traces of *Meiolania* in N S Wales, by R Etheridge, jun; notes on Australian Aquatic Hemiptera (No 1) by Frederick A. A. Skuse, remarks on a new *Cyria* from New South Wales, by Frederick A A. Skuse, geological and ethnological observations made in the valley of the Wollondilly River, at its junction with the Nattai River, Counties Camden and Westmoreland, by R. Etheridge, jun

A volume on "Ironwork from the Earliest Times to the End of the Mediæval Period," by J Starkie Gardner, has been issued as one of the South Kensington Museum art handbooks. It is mainly artistic, but the author has a good deal to say that is of scientific interest, and his scientific training enables him to present in an orderly way the historical facts with which he is chiefly occupied Ironwork of later times will be dealt with in a second volume

Some time ago Mr C E de Rance prepared for the information of the County Councils a very useful map of the river basins in England and Wales, the object being to define the natural jurisdiction of joint committees of county councils for the prevention of pollution of rivers under section 14 (iii) of the Local Government Act, 1888, and other matters requiring united control The map has now been reprinted by J E Cornish, Manchester

The Geological Survey of Canada is issuing a valuable series of "Contributions to Canadian Palæontology" The fourth part of the first volume, by J F Whiteaves, has just been published It deals with the fossils of the Devonian rocks of the islands, shores, and immediate vicinity of Lakes Manitoba and Winnipegosis, and is well illustrated

The York School Natural History, Literary, and Polytechnic Society has issued its fifty ninth annual report Much genuine interest in science is evidently maintained among the members of this society by the part they take in its work The Natural History Club held in the course of the year twenty-three meetings, sixteen of which were occupied with the club's regular business of reporting and commenting on finds and observations

The first part of an elaborate "Topographische Anatomie des Pferdes," by W. Ellenberger and H Baum, has just been issued, the publisher being Paul Parey, Berlin

A new sclerometer, constructed by M Paul Jannetaz, was recently presented to the French Academy of Sciences. Like that invented by Seebeck, it measures the hardness of bodies defined as their resistance to scratching It consists essentially of a platform rendered horizontal by means of leveling screws, and furnished with various motions which enable the observer to place any part of the body whose hardness is to be determined underneath a vertical point This point is carried by an arm of a balance, which can be adjusted by a coarse and a fine movement, so as to bring the point and the body into contact without a shock The beam is provided with pans carrying the weights which produce the pressure At one extremity the beam carries a screw for horizontal adjustment, at the other a hollow bar to hold one of a set of points, such as copper or steel points of various angles, straight or curved, forming certain definite angles with the platform when mounted, or crystalline points clamped in metallic jaws A very light aluminium beam is used for bodies which are only tested with light weights As a rule the points trace a small circle on the body, which, when examined under the microscope, indicates the hardness of the substance in various directions Homogeneous bodies like metals need only be moved in one direction. The scratch is viewed by reflection, greater softness being indicated by greater breadth An interesting fact concerning the relative hardness of copper and zinc has been brought to light by means of this apparatus Most authors regard zinc as harder than copper If, however, the metals are examined in a sufficiently pure state, it appears that copper is the harder of the two This removes an exception to the rule that the harder the body the less its atomic volume.

In a paper communicated to the Royal Prussian Academy of Sciences (see also *Electrician*, vol. xxx. p. 660) Dr. Philipp Lenard gives an account of some interesting experiments on the rays given out by the kathode of a Geissler tube which produce phosphorescence. Thin metal plates being to a great extent transparent to these rays by

closing a small hole in the observing tube by a plate of aluminium 0 003 mm thick, it was possible to study their properties outside the tube It was found that the rays produce a slight luminosity in air, and when they fall on phosphorescent bodies, held near the window, cause the latter to shine with the same light they show when enclosed within the vacuum tube itself The brightness diminishes rapidly as the distance from the window increases, so that in air all glow ceases at about 6 cm On bringing a magnet near the tube so that the kathode rays no longer fall on the inner surface of the window, all phosphorescence ceases without the tube A quartz plate half a millimetre thick entirely stopped the rays, ordinary gold, copper, and aluminium leaf, however, allowed them to pass almost undiminished In air at the ordinary pressure these rays are not propagated in straight lines but are diffused, so that it is impossible to obtain a sharp shadow of a body placed between the window and the phosphorescent substance As these waves cannot be generated in a high vacuum it has been up to now impossible to say whether they are only propagated when matter is present By enclosing the observing tube in another, the author has shown that in the best vacuum attainable with a mercury pump, these waves are transmitted with as great facility as in air at the pressures ordinarily existing within Geissler tubes Different gases transmit the rays to very different extents, thus, with hydrogen at atmospheric pressure, phosphorescence is produced in a body placed at a distance of 20 cm. from the window These experiments seem to show that while for light of the smallest known wave length the matter behaves as if it completely filled the space it appears to occupy, in the case of these kathode rays even gases behave as non homogeneous media, and each separate molecule acts as an obstacle diffusing the rays

NOTES from the Marine Biological Station, Plymouth — Recent captures include the Polyclada *Eurylepta cornuta*, *Cycloporus papillosus* and *Leptoplana*, the Actinian *Zoanthus Couchii*, and the Opisthobranchs *Scaphander lignarius* and *Aegirus punctilucens* The sea has lately become increasingly richer in diatoms and floating algæ, esp *Coscinodiscus*, *Rhizosolenia* and the so-called "gelatinous alga" In the floating fauna the Dinoflagellate *Ceratium tripos* has been constantly plentiful throughout the winter, *Noctiluca* is very scarce Of the Hydroid medusæ, small *Obelia* are still abundant, medusæ of *Clytia Johnstoni* are generally present, and Forbes's *Thaumantias octona* has been again observed The Actinian larva *Arachnactis* occurs in most townettings Zoææ of *Porcellana* have slightly increased in number The Actinian *Bunodes verrucosa* (= *gemmacea*) is now breeding

THE additions to the Zoological Society's Gardens during the past week include a Leopard (*Felis pardus*) from India, presented by Admiral W B Kennedy, R N, F Z S, a Common Squirrel (*Sciurus vulgaris*) British, presented by Miss Edith Mackenzie, two Black Rats (*Mus rattus*) British, presented by Mr. Sydney Wedlock, a Panama Amazon (*Chrysotis panamensis*) from Panama, presented by Mrs Mackey, a European Pond Tortoise (*Emys europæa*) European, presented by Mast J F Harben; a Macaque Monkey (*Macacus cynomolgus*) from India, deposited, a Common Pintail (*Dafila acuta*) European, a Bell's Cinixys (*Cinixys belliana*), a Home's Cinixys (*Cinixys homeana*) from West Africa, purchased, a Mute Swan (*Cygnus olor*) European, received in exchange, three Coypus (*Myopotamus coypus*) born in the Gardens

OUR ASTRONOMICAL COLUMN

SOLAR OBSERVATIONS AT ROME —In the *Memorie degli Spettroscopisti Italiani* for March, Prof Tacchini communicates the solar observations made at the Royal College These observations refer to the 4th trimestre of 1892, and are given here somewhat in detail Taking prominences first, the numbers show a great falling off when compared with the preceding three months, thus for the northern and southern hemispheres the frequency of these phenomena for the three months was 81, 78, 61 for the former (sum 220) and 105, 138, 90, for the latter (sum 333) the foregoing trimestre giving 431 and 493 for each hemisphere The greatest frequencies took place in latitudes + 60° + 70° N and − 30° − 40° S, but the numbers indicate really two other maxima for each hemisphere, and they lie in the zones + 30° + 20° and 50° − 60°

The frequency of groups of faculæ recorded for both north and south latitudes are given as 100 and 132 respectively, the average for each month amounted to 37, but for the southern zones during October an increase to 20 above this average was noted, the greatest frequencies occurred in zones + 10° + 20° and − 20° − 30° In dealing with the spots their frequency may be generally stated to be about half that of the faculæ. The table gives 46 and 58 for the two zones, and in this case also the greatest disturbances seem to have occurred in the southern hemisphere during October, the numbers for the monthly records are, for the northern zones 18, 13 and 15, and for the southern 26, 12, and 20, the greatest frequencies occurring in latitudes + 10° + 20° N and − 20° − 30° S

Prof Tacchini, in addition to the above communication, describes in a short note a large protuberance observed on November 20 of last year, and gives 10 figures to illustrate the various forms which it successively assumed The height and velocity of ascent can be gathered from the few numbers below —

"		H	M
146 3	about	10	57
155 5	,,	11	22 5
188 8	,,	1	21
184 1	,,	1	58
186 4	,,	2	38
154 6	,,	2	52

PARALLAXES OF μ AND θ CASSIOPEIÆ —In No 5 of the contributions from the Observatory of Columbia College, New York, Mr Harold Jacoby presents us with the results he has obtained with regard to the parallaxes of μ and θ Cassiopeiæ, as deduced by him from an examination of the Rutherfurd photographic measures of the stars surrounding μ Cassiopeiæ. The negatives, which were twenty-eight in number, two impressions being on each plate, were made between July, 1870, and December, 1873, and as they were specially taken for parallax determinations, the observations were restricted to the months of July, January, and December The study of the parallax here made is based upon measures of distance only Each pair of stars was selected so as to differ approximately 180° in position angle with respect to μ Cassiopeiæ, and the scale value was determined for each pair, on each plate, in order to make the sum of the distances from μ constant By taking the difference of the same distances as the quantity from the variation of which the parallax should appear, "the excess of the parallax of the principal star over the mean of the parallaxes of the two comparison stars" is, satisfying certain conditions, finally obtained

The values for the parallaxes which he has obtained are—

Parallax of μ Cassiopeiæ	0″275 ± 0″024
,, ,, θ ,,	0 232 ± 0 067

On comparing the former of these values with the work of other observatories the discordances, he says, are large The Oxford photographic result was 0″ 036 ± 0″ 018, while the Rutherfurd plates gave 0″ 249 ± 0″ 045, the same pair of comparison stars being used in each case Struve from distant measures deduced the value 0″ 251 ± 0″ 075, and from position angles the value 0″ 425 ± 0″·072 "It is therefore plain that the photographic method of determining parallaxes cannot be regarded as free from systematic error"

FALL OF A METEORITE —A brief account of the fall of a meteorite at a place in South Dakota, 4 km south of Bath, on August 29 of last year, is given in the current number of *Prometheus*, No 183 It was observed about four o'clock in the afternoon, attention being first drawn to it by the sound of a series of explosions. As the observer looked upwards he saw a meteoritic stone flying through the air, leaving a trail of smoke behind it. On reaching the ground it plunged to a depth

of 40 cm, and was so hot that the observer was unable to put his hand on it. At the explosion of the meteor several small portions weighing from 30–60 gr were scattered, while the weight of the chief mass amounted to 22 kg. The description of the exterior says that it showed the general, smooth, black crust, while from the fracture it was noticed to be finely granulated; one could also see easily small particles of iron, which could without any difficulty be separated by pulverisation. Chemical analysis showed that nickel and cobalt was present in considerable quantities.

JAHRBUCH DER ASTRONOMIE UND GEOPHYSIK.—This volume, which is edited by Dr. Hermann J. Klein, contains a very interesting account and summary of the work done in various branches of astronomical science during the past year. Dunér's, Deslandres', Hale's, and Young's sun observations are referred to, while several other references to solar work are given. The numerous observations made with reference to the major and minor planets are here all brought together; Trouvelot's Venus observations, the opposition of Mars, and the recent discovery of Jupiter's fifth satellite being rather prominent. Under the heading of "The Moon" Wernik's enlargements, Boddiker's and Hartmann's researches and are referred to at some length. Comets, meteorites, and shooting stars also come in for a good share, and under the fixed stars, in which are included all variables, nebulæ, &c., are included references to the Nova in Auriga, stellar spectroscopic observations, motion in line of sight, &c.

THE OBSERVATORY.—From the cover of the *Observatory* one quite misses the familiar name of Dr. Common, in place of which are now inserted Messrs. T. Lewis and H. P. Hollis. In an editorial notice Mr. Turner says a few words to account for this perturbation, mentioning that it is owing to pressure of work, which has made it impossible for either of them to conduct the magazine. He concludes by saying, "It would be with the keenest satisfaction that we should return to the management of the magazine if the future should have that in store for us."

GEOGRAPHICAL NOTES

THE *Scottish Geographical Magazine* for April contains a paper of some value by Colonel Justin C. Ross on irrigation and agriculture in Egypt, giving the result of his experience as Director-General of Irrigation in that country. In consequence of the indisposition of Colonel Bailey the *Magazine* is now edited by Mr. W. A. Taylor, Librarian to the Royal Scottish Geographical Society, who has for several years had charge of the book reviews and geographical notes.

THE April number of the *Deutsche Rundschau fur Geographie* contains a coloured map of the density of population in Holland which illustrates in a manner very rare in continental map-work an ignorance of the first principles of map colouring. The objects of map colouring are two—one is to indicate the areas occupied by discontinuous and unlike conditions, such as countries, races of people, or geological formations. For this the colours have to be as strongly contrasted as possible and the map is necessarily and properly a patchwork. The other object is to show the distribution of a continuously varying quantity, like altitude, temperature, or rainfall, and in order to attain it the colours ought to merge one into the other so that the eye is carried from the lowest to the highest value by just perceptible gradations. The Austrian map referred to applies the first method to bring out the second result, each different density of population being coloured so as to contrast with the others, and to show no definite gradation from less to greater.

Globus states that the Russian Government, dissatisfied with the foreign sound of the names Dorpat and Dunaburg, have resolved to resume those towns Jurjew and Dwinsk respectively.

THE Paris Geographical Society held a special meeting in commemoration of the discoveries of Columbus on March 4, the four hundredth anniversary of his return from the first transatlantic voyage. A masterly address by M. Levasseur on the moral and material consequences of the discovery of America, and a paper by Dr. Hamy on the traces of Columbus in Spain and Italy were the principal features of the meeting.

SOME recent measurements in Russia, noticed by M. Venukoff in the last number of the *Comptes Rendus* are valuable as leading to some conclusions regarding the form of the geoid. Determinations of the value of the degree of longitude along the parallels of 47°30′ and 52° accord closely with Bessel's geoid (polar flattening $\frac{1}{300}$) and are widely divergent from Clarke's result of $\frac{1}{293}$.

THE AMIDE AND IMIDE OF SULPHURIC ACID

FURTHER details concerning these interesting substances are communicated by Dr. Traube of the laboratory of the Berlin University to the current number of the *Berichte*. It has long been surmised that an amide of sulphuric acid was capable of existence, and Regnault assumed that the product which he obtained by leading ammonia gas into a solution of sulphuryl dichloride in ethylene chloride consisted of that substance mixed with sal ammoniac. Dr. Traube has further investigated the reaction and has at length isolated not only sulphuryl diamide, $SO_2(NH_2)_2$, but also sulphuryl imide, SO_2NH, the imide of sulphuric acid, and has, moreover, prepared several metallic derivatives of each.

Sulphuryl Diamide

The most advantageous mode of preparing sulphuryl diamide consists in saturating a solution of sulphuryl dichloride, SO_2Cl_2, in chloroform with ammonia. It is necessary to dilute the sulphuryl dichloride with 15–20 times its volume of chloroform, and to maintain a low temperature by extraneous cooling in order that the reaction may be under complete control, and the ammonia gas must be carefully dried before being allowed to bubble through the liquid. The main reaction occurs in accordance with the following equation:—

$$SO_2Cl_2 + 4NH_3 = 2NH_4Cl + SO_2(NH_2)_2.$$

The products are gradually deposited in the form of a white solid, which, after the completion of the reaction, is agitated with water until the whole of it is dissolved. The ammoniacal aqueous solution is then separated from the chloroform, acidified with nitric acid, and the whole of the chlorine removed by the addition of silver nitrate. After removal of the silver chloride by filtration the acid solution is neutralised with alkali and silver nitrate again added, when a crystalline precipitate is obtained consisting of a silver derivative of sulphuryl diamide, $SO_2(NHAg)_2$, together with another silver compound, whose composition has not yet been definitely ascertained. In order to isolate the silver compound of sulphuryl diamide, the washed precipitate is decomposed with the calculated quantity of hydrochloric acid, and the resulting acid liquid carefully neutralised with ammonia; upon now adding silver nitrate only the silver compound of unknown and complex composition is deposited. The pure silver compound of sulphuryl diamide is finally deposited upon adding a further quantity of silver nitrate and sufficient ammonia to render the liquid strongly alkaline.

When the precipitated silver compound of sulphuryl diamide is decomposed with hydrochloric acid a feebly acid liquid is obtained, which, when evaporated to a syrup *in vacuo*, at a temperature not exceeding 40°, and afterwards allowed to stand *in vacuo* over oil of vitriol, gradually deposits large colourless crystals of pure sulphuryl diamide, $SO_2(NH_2)_2$.

Sulphuryl diamide is an extremely deliquescent substance. The crystals are rapidly dissolved by water, but are practically insoluble in organic solvents. They soften at 75° and melt at 81°. As the liquid cools, however, it exhibits the property of superfusion to a very marked extent, remaining liquid many degrees below its melting point. The moment, however, it is disturbed by contact with a sharp body, it instantly solidifies. When heated above its melting point sulphuryl diamide loses ammonia even below 100°; up to 250° no further decomposition than the loss of ammonia occurs, the residual compound being the sulphuryl imide to be presently described. Above 250° complete decomposition ensues with the evolution of acid fumes.

The aqueous solution of sulphuryl diamide reacts neutral to litmus and possesses a bitter taste. It yields no precipitates in acid solutions either with salts of barium or platinic chloride. On long boiling with acids, however, it is gradually converted into sulphuric acid and ammonia, and then yields the usual

precipitates for those substances with barium or platinic chloride Its behaviour with nitrous acid is interesting Upon adding to an acid solution of sulphuryl diamide a few drops of the solution of a nitrite nitrogen is at once evolved, in the cold, and sulphuric acid is formed

Sulphuryl diamide does not combine with acids Alkalies appear to be only capable of removing one amido group, converting the diamide into sulphaminic acid, $SO_2(NH_2)(OH)$

As described in the course of the preparation of sulphuryl diamide, ammonia precipitates from a solution mixed with silver nitrate a silver compound If the precipitate is allowed to remain in contact with the excess of the reagents for some time, it invariably yields numbers upon analysis which agree with the formula $SO_2(NHAg)_2$. If, however, it is at once separated, it is found to consist of a mixture of this salt with the salt $SO_2(NH_2)(NHAg)$

These silver compounds of sulphuryl diamide are amorphous, even after deposition from solution in hot water When dry they are white powders very slightly sensitive to light Upon heating to 200° they decompose with evolution of sulphur dioxide

Sulphuryl diamide likewise forms a compound with mercuric oxide when its solution is mixed with one of mercuric nitrate The composition of this precipitate, however, appears to vary with the degree of concentration of the solutions employed, and if chlorides are present a precipitate is only obtained with a very large excess of mercuric nitrate Mercuric chloride produces no precipitate at all

A somewhat similar lead compound is also formed when lead acetate is added to a moderately concentrated solution of sulphuryl diamide

Sulphuryl Imide

As previously mentioned, when sulphuryl diamide is heated for a considerable time above its melting-point it loses ammonia and becomes converted into sulphuryl imide

$$SO_2(NH_2)_2 = NH_3 + SO_2NH$$

The best temperature for the rapid production of sulphuryl imide is 200°-210 The evolution of ammonia at this temperature is very vigorous, occurring with much frothing, but after a time diminishes and finally ceases, the mass becoming eventually solid To purify it from impurities the solution in water is treated with a solution of silver nitrate when the silver compound of sulphuryl imide, SO_2NAg, is precipitated, and may be recrystallised in long acicular crystals, first from water slightly acidified with nitric acid, and finally from pure water

Upon decomposing the silver compound with the calculated quantity of dilute hydrochloric acid an aqueous solution of free sulphuryl imide is obtained, which reacts strongly acid, and liberates carbon dioxide from carbonates Upon evaporation, however, it decomposes, and deposits hydrogen ammonium sulphate Even evaporation *in vacuo* is sufficient to decompose it, so that crystals of the imide itself have not been obtained It exists, however, in the solid form, although somewhat contaminated with smaller quantities of other products, in the residue obtained by heating sulphuryl diamide as previously described

Salts of sulphuryl imide, however, are readily obtained, either by decomposition of the silver salt with metallic chlorides, or by the neutralisation of solutions of sulphuryl imide with metallic oxides or carbonates

The potassium salt, SO_2NK, was obtained in the form of well developed colourless crystals by adding a quantity of the silver salt to a hot solution of the calculated quantity of potassium chloride, removing the precipitated silver chloride by filtration, and evaporating the solution Both the solution and the salt are very stable, it requires long boiling with acids to convert it into sulphuric acid. When the dry salt is heated it decomposes with considerable violence and production of flame Nitrogen and sulphur dioxide escape, and potassium sulphate and sulphi e are left

The sodium salt, SO_2NNa, obtained by neutralising a solution of sulphuryl imide with caustic soda and subsequent evaporation, forms small crystals, which decompose upon heating in a manner similar to the crystals of the potassium salt

The ammonium salt, SO_2NNH_4, isomeric with sulphuryl diamide, was likewise obtained in colourless needles by neutralisation of the free imide with ammonia. It is interesting to note that this substance is not capable of being converted into its isomer by repeated crystallisation, but is partially so converted by rapidly heating it to its melting point over a small gas flame

Acicular crystals of a hydrated barium salt, $(SO_2N)_2Ba.2H_2O$, have been obtained by saturating a solution of the imide with barium carbonate and afterwards adding alcohol, also needles of a lead salt and a green amorphous copper salt

The acid character of sulphuryl imide, so different from the neutral nature of sulphuryl diamide, is thus seen to be quite conclusively established A E TUTTON

THE DENSITIES OF THE PRINCIPAL GASES[1]

IN former communications ("Roy Soc Proc," February, 1888, February, 1892) I have described the arrangements by which I determined the ratio of densities of oxygen and hydrogen (15 882) For the purpose of that work it was not necessary to know with precision the actual volume of gas weighed, nor even the pressure at which the containing vessel was filled But I was desirous before leaving the subject of ascertaining not merely the relative, but also the absolute, densities of the more important gases—that is, of comparing their weights with that of an equal volume of water To effect this it was necessary to weigh the globe used to contain the gases when charged with water, an operation not quite so simple as at first sight it appears And, further, in the corresponding work upon the gases a precise absolute specification is required of the temperature and pressure at which a filling takes place To render the former weighings available for this purpose, it would be necessary to determine the errors of the barometers then employed There would, perhaps, be no great difficulty in doing this, but I was of opinion that it would be an improvement to use a manometer in direct connection with the globe, without the intervention of the atmosphere With respect to temperature, also, it was thought better to avoid all further questions by surrounding the globe with ice, as in Regnault's original determinations.

The Manometer

The arrangements adopted for the measurement of pressure must be described in some detail, as they offer several points of novelty

The object in view was to avoid certain defects to which ordinary barometers are liable, when applied to absolute measurements Of these three especially may be formulated —

(*a*) It is difficult to be sure that the vacuum at the top of the mercury is suitable for the purpose

(*b*) No measurements of a length can be regarded as satisfactory in which different methods of reading are used for the two extremities

(*c*) There is necessarily some uncertainty due to irregular refraction by the walls of the tube The apparent level of the mercury may deviate from the real position

(*d*) To the above may be added that the accurate observation of the barometer, as used by Regnault and most of his successors, requires the use of a cathetometer, an expensive and not always satisfactory instrument

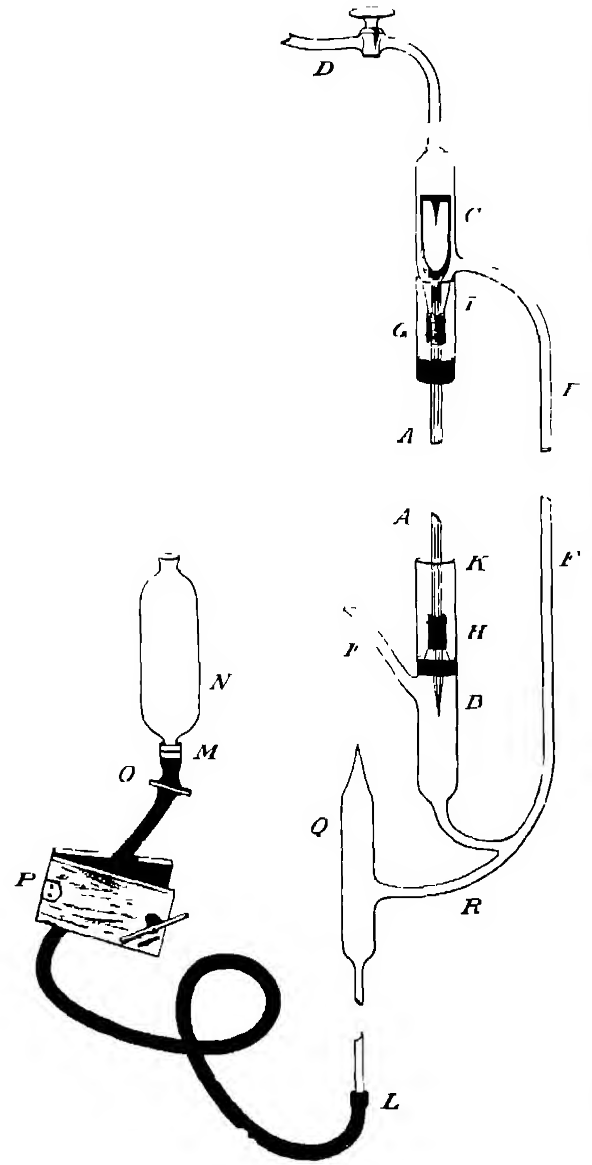
The guiding idea of the present apparatus is the actual application of a measuring rod to the upper and lower mercury surfaces, arranged so as to be vertically superposed The rod AA, fig 1, is of iron (7 mm. in diameter), pointed below B At the upper end, C, it divides at the level of the mercury into a sort of fork, and terminates in a point similar to that at B, and, like it, directed downwards. The coincidence of these points with their images reflected in the mercury surfaces, is observed with the aid of lenses of about 30 mm focus, held in position upon the wooden framework of the apparatus. It is, of course, independent of any irregular refraction which the tube may exercise The verticality of the line joining the points is tested without difficulty by a plumb-line

The upper and lower chambers C, B are formed from tubing of the same diameter (about 21 mm internal). The upper communicates through a tap, D, with the Toppler, by means of which a suitable vacuum can at any time be established and tested. In ordinary use, D stands permanently open, but its

[1] Abstract of a paper read by Lord Rayleigh before the Royal Society on March 23.

introduction was found useful in the preliminary arrangements and in testing for leaks. The connection between the lower chamber B and the vessel in which the pressure is to be verified takes place through a side tube, E.

The greater part of the column of mercury to which the pressure is due is contained in the connecting tube FF, of about 3 mm. internal diameter. The temperature is taken by a thermometer whose bulb is situated near the middle of FF. Towards the close of operations the more sensitive parts are protected by a packing of tow or cotton-wool, held in position between two wooden boards. The anterior board is provided



with a suitable glass window, through which the thermometer may be read.

It is an essential requirement of a manometer on the present plan that the measuring rod pass air-tight from the upper and lower chambers into the atmosphere. To effect this the glass tubing is drawn out until its internal diameter is not much greater than that of the rod. The joints are then made by short lengths of thick walled india-rubber H, G, wired on and drowned externally in mercury. The vessels for holding the mercury are shown at I, K.

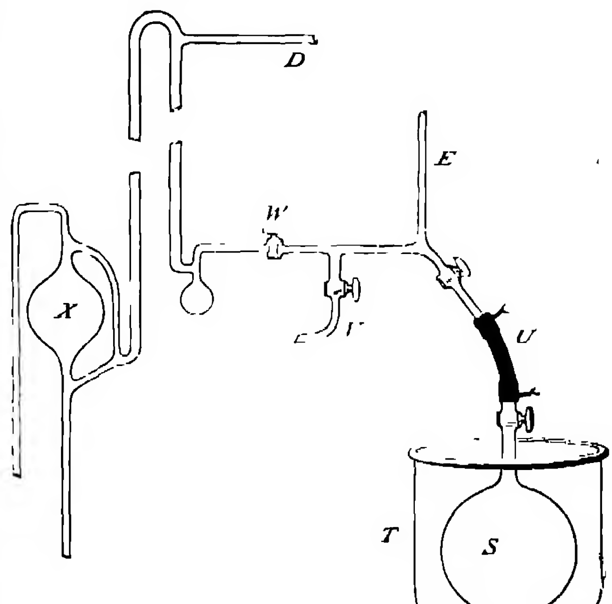
The distance between the points of the rod is determined under microscopes by comparison with a standard scale, before the apparatus is put together. As the rod is held only by the rubber connexions, there is no fear of its length being altered by stress.

The adjustment of the mercury (distilled in a vacuum) to the right level is effected by means of the tube of black rubber LM, terminating in the reservoir N. When the supply of mercury to the manometer is a little short of what is needed, the connexion with the reservoir is cut off by a pinch cock at O, and the fine adjustment is continued by squeezing the tube at P between a pair of hinged boards, gradually approximated by a screw. This plan, though apparently rough, worked perfectly, leaving nothing to be desired.

It remains to explain the object of the vessel shown at Q. In the early trials, when the rubber tube was connected directly to R, the gradual fouling of the mercury surface, which it seems impossible to avoid, threatened to interfere with the setting at B. By means of Q, the mercury can be discharged from the measuring chambers, and a fresh surface constituted at B as well as at C.

Connexions with Pump and Manometer.

Some of the details of the process of filling the globe with gas under standard conditions will be best described later under the head of the particular gas; but the general arrangement and



the connexions with the pump and the manometer are common to all. They are sketched in Fig. 2, in which S represents the globe, T the inverted bell-glass employed to contain the enveloping ice. The connexion with the rest of the apparatus is by a short tube U of thick rubber, carefully wired on. The tightness of these joints was always tested with the aid of the Toppler X, the tap V leading to the gas generating apparatus being closed. The side tube at D leads to the vacuum chamber of the manometer, while that at E leads to the pressure chamber B. The wash out of the tubes, and in some cases of the generator, was aided by the Toppler. When this operation was judged to be complete, V was again closed, and a good vacuum made in the parts still connected to the pump. W would then be closed, and the actual filling commenced by opening V, and finally the tap of the globe. The lower chamber of the manometer was now in connexion with the globe, and through a regulating tap (not shown) with the gas generating apparatus. By means of the Töppler, the vacuum in the manometer could be carried to any desired point. But with respect to this a remark must be made. It is a feature of the method employed[1] that the exhaustions of

[1] Due to von Jolly.

the globe are carried to such a point that the weight of the residual gas may be neglected, thus eliminating errors due to a second manometer reading There is no difficulty in attaining this result, but the delicacy of the Toppler employed as a gauge is so great that the residual gas still admits of tolerably accurate measurement Now in exhausting the head of the manometer it would be easy to carry the process to a point much in excess of what is necessary in the case of the globe, but there is evidently no advantage in so doing The best results will be obtained by carrying both exhaustions to the *same* degree of perfection

The Water Contents of the Globe

The globe being packed in finely-divided ice, was filled with boiled distilled water up to the level of the top of the channel through the plug of the tap, that is, being itself at 0°, was filled with water also at 0° Thus charged the globe had now to be weighed; but this was a matter of some difficulty, owing to the very small capacity available above the tap. At about 9° there would be a risk of overflow Of course the water could be retained by the addition of extra tubing, but this was a complication that it was desired to avoid In February, 1882, during a frost, an opportunity was found to effect the weighing in a cold cellar at a temperature ranging from 4° to 7° The weights required (on the same side of the balance as the globe and its supports) amounted to 0 1822 gram On the other side were other weights whose values did not require to be known so long as they remained unmoved during the whole series of operations Barometer (corrected) 758 9 mm, temperature 6° 3

A few days later the globe was discharged, dried, and replaced in the balance with tap open 1834 1701 grams had now to be associated with it in order to obtain equilibrium The difference,

$$1834\ 170 - 0\ 182 = 1833\ 988,$$

represents the weight of the water less that of the air displaced by it

It remains to estimate the actual weight of the air displaced by the water under the above mentioned atmospheric conditions It appears that, on this account, we are to add 2 314, thus obtaining

$$1836\ 30$$

as the weight of the water at 0° which fills the globe at 0°

A further small correction is required to take account of the fact that the usual standard density is that of water at 4 and not at 0° According to Broch (Everett's "C G S System of Units"), the factor required is 0 99988, so that we have

$$\frac{1836\ 30}{0\ 99988} = 1836\ 52$$

as the weight of water at 4° which would fill the globe at 0°

Air

Air drawn from outside (in the country) was passed through a solution of potash. On leaving the regulating tap it traversed tubes filled with fragments of potash, and a long length of phosphoric anhydride, followed by a filter of glass wool The arrangements beyond the regulating tap were the same for all the gases experimented upon.

In deducing the weight of the gas we compare each weighing "full" with the mean of the preceding and following weights "empty," except in the case of October 15, when there was no subsequent weighing empty The results are

September	27	2 37686
,,	29	2 37651
October	3	2 37653
,,	8	2·37646
,,	11	2·37668
,,	13	2 37679
,,	15	2·37647
Mean		. . . 2 37661

There is here no evidence of the variation in the density of air suspected by Regnault and v. Jolly

To allow for the contraction of the globe (No 14) when weighed empty, discussed in my former papers, we are to add 0 00056 to the apparent weight, so that the result for air becomes

$$2\ 37717$$

This is the weight of the contents at 0° and under the pressure defined by the manometer gauge at 15° of the thermometer The reduction to standard conditions is, for the present, postponed

Oxygen

This gas has been prepared by three distinct methods (*a*) from chlorates, (*b*) from permanganate of potash, (*c*) by electrolysis

In the first method mixed chlorates of potash and soda were employed, as recommended by Shenstone, the advantage lying in the readier fusibility Two sets of five fillings were effected with this oxygen. In the first set (May, 1892) the highest result was 2 6272, and the lowest 2 6266, mean 2·62691 In the second set (June, July, 1892) the highest result was 2 6273 and the lowest 2 6267, mean 2 62693

The second method (*b*) proved very convenient, the evolution of gas being under much better control than in the case of chlorates The recrystallised salt was heated in a Florence flask, the wash out, in this case also, being facilitated by a vacuum Three fillings gave satisfactory results, the highest being 2 6273, the lowest 2 6270, and the mean 2 62714 The gas was quite free from smell

By the third method I have not as many results as I could have wished, operations having been interrupted by the breakage of the electrolytic generator This was, however, of less importance, as I had evidence from former work that there is no material difference between the oxygen from chlorates and that obtained by electrolysis The gas was passed over hot copper, as detailed in previous papers The result of one filling, with the apparatus as here described, was 2 6271 To this may be added the result of two fillings obtained at an earlier stage of the work, when the head of the manometer was exhausted by an independent Sprengel pump, instead of by the Toppler The value then obtained was 2 6272 The results stand thus —

Electrolysis (2), May, 1892	2 6272
,, (1) ,,	2 6271
Chlorates (5), May, 1892	2 6269
,, (5), June, 1892	2 6269
Permanganate (3), January, 1893	2 6271
Mean	2 62704
Correction for contraction	0 00056
	2 62760

It will be seen that the agreement between the different methods is very good, the differences, such as they are, having all the appearance of being accidental Oxygen prepared by electrolysis is perhaps most in danger of being light (from contamination with hydrogen), and that from chlorates of being abnormally heavy

Nitrogen

This gas was prepared, in the usual manner, from air by removal of oxygen with heated copper Precautions are required, in the first place, to secure a sufficient action of the reduced copper, and secondly, as was shown by v Jolly, and later by Leduc, to avoid contamination with hydrogen which may be liberated from the copper I have followed the plan, recommended by v Jolly, of causing the gas to pass finally over a length of unreduced copper. The arrangements were as follows.—

Air drawn through solution of potash was deprived of its oxygen by reduced copper, contained in a tube of hard glass heated by a large flame It then traversed a U tube, in which was deposited most of the water of combustion The gas, practically free, as the event proved, from oxygen, was passed, as a further precaution, over a length of copper heated in a combustion furnace, then through strong sulphuric acid,[1] and afterwards back through the furnace over a length of oxide of copper It then passed on to the regulating tap, and thence through the remainder of the apparatus, as already described In no case

[1] There was no need for this, but the acid was in position for another purpose.

did the copper in the furnace, even at the end where the gas entered, show any sign of losing its metallic appearance

Three results, obtained in August, 1892, were —

August 8	2 31035
,, 10	2 31026
,, 15	2 31024
Mean	2 31028

To these may be added the results of two special experiments made to test the removal of hydrogen by the copper oxide For this purpose a small hydrogen generator, which could be set in action by closing an external contact, was included between the two tubes of reduced copper, the gas being caused to bubble through the electrolytic liquid The quantity of hydrogen liberated was calculated from the deflection of a galvanometer included in the circuit, and was sufficient, if retained, to alter the density very materially Care was taken that the small stream of hydrogen should be uniform during the whole time (about 2½ hours) occupied by the filling, but, as will be seen, the impurity was effectually removed by the copper oxide [1] Two experiments gave—

September 17	2 31012
,, 20	2 31027
Mean	2 31020

We may take as the number for nitrogen—

	2 31026
Correction for contraction	56
	2 31082

Although the subject is not yet ripe for discussion, I cannot omit to notice here that nitrogen prepared from ammonia, and expected to be pure, turned out to be decidedly lighter than the above When the oxygen of air is burned by excess of ammonia, the deficiency is about 1/1000th part [2] When oxygen is substituted for air, so that all (instead of about one-seventh part) of the nitrogen is derived from ammonia, the deficiency of weight may amount to ½ per cent It seems certain that the abnormal lightness cannot be explained by contamination with hydrogen, or with ammonia, or with water, and everything suggests that the explanation is to be sought in a dissociated state of the nitrogen itself Until the questions arising out of these observations are thoroughly cleared up, the above number for nitrogen must be received with a certain reserve But it has not been thought necessary, on this account, to delay the presentation of the present paper, more especially as the method employed in preparing the nitrogen for which the results are recorded is that used by previous experimenters

Reduction to Standard Pressure

The pressure to which the numbers so far given relate is that due to 762 511 mm of mercury at a temperature of 14° 85,[3] and under the gravity operative in my laboratory in latitude 51° 47′ In order to compare the results with those of other experimenters, it will be convenient to reduce them not only to 760 mm of mercury pressure at 0°, but also to the value of gravity at Paris.

The product of the three factors, corrective for length, for temperature, and for gravity, is 0 99914 Thus multiplied, the numbers are as follows —

Air	Oxygen	Nitrogen
2 37512	2 62534	2 30883

and these may now be compared with the water contents of the globe, viz. 1836 52

The densities of the various gases under standard conditions, referred to that of distilled water at 4°, are thus —

Air	Oxygen	Nitrogen
0 00129327	0 00142952	0 00125718

With regard to hydrogen, we may calculate its density by means of the ratio of densities of oxygen and hydrogen formerly given by me, viz 15 882 Hence

Hydrogen
0 000090009

The following table shows the results arrived at by various experimenters Von Jolly did not examine hydrogen The numbers are multiplied by 1000 so as to exhibit the weights in grams per litre —

	Air	Oxygen	Nitrogen	Hydrogen
Regnault, 1847	1 29319	1 42980	1 25617	0 08958
Corrected by Crafts	1 29349	1 43011	1 25647	0 08988
Von Jolly, 1880	1 29351	1 42939	1 25787	—
Ditto corrected.	1 29383	1 42971	1 25819	—
Leduc, 1891[1]	1 29330	1 42910	1 25709	0 08985
Rayleigh, 1893 .	1 29327	1 42952	1 25718	0 09001

The correction of Regnault by Crafts (*Comptes Rendus*, vol cvi, p 1664) represents allowance for the contraction of Regnault's globe when exhausted, but the data were not obtained from the identical globe used by Regnault In the fourth row I have introduced a similar correction to the results of von Jolly This is merely an estimate founded upon the probability that the proportional contraction would be about the same as in my own case and in that of M Leduc

In taking a mean we may omit the uncorrected numbers, and also that obtained by Regnault for nitrogen, as there is reason to suppose that his gas was contaminated with hydrogen Thus

Mean Numbers.

Air	Oxygen	Nitrogen	Hydrogen.
1 29347	1 42961	1 25749	0 08991

The evaluation of the densities as compared with water is exposed to many sources of error which do not affect the comparison of one gas with another It may, therefore, be instructive to exhibit the results of various workers referred to air as unity.

	Oxygen	Nitrogen	Hydrogen
Regnault (corrected)	1 10562	0 97138	0 06949
v Jolly (corrected)	1 10502	0 97245	—
Leduc	1 1050	0 9720	0 06947
Rayleigh	1 10535	0 97209	0 06960
Mean	1 10525	0 97218	0 06952

As usually happens in such cases, the concordance of the numbers obtained by various experimenters is not so good as might be expected from the work of each taken separately The most serious discrepancy is in the difficult case of hydrogen M Leduc suggests (*Comptes Rendus*, July, 1892) that my number is too high on account of penetration of air through the blow off tube (used to establish equilibrium of pressure with the atmosphere), which he reckons at 1 m long and 1 cm in diameter. In reality the length was about double, and the diameter one-half of these estimates, and the explanation is difficult to maintain, in view of the fact, recorded in my paper, that a prolongation of the time of contact from 4m to 30m had no appreciable ill effect. It must be admitted, however, that there is a certain presumption in favour of a lower number, unless it can be explained as due to an insufficient estimate for the correction for contraction On account of the doubt as to the appropriate value of this correction, no great weight can be assigned to Regnault's number for hydrogen If the atomic weight of oxygen be indeed 15 88, and the ratio of densities of oxygen and hydrogen be 15 90, as M Leduc makes them, we should have to accept a much higher number for the ratio of volumes than that (2 0002) resulting from the very elaborate measurements of Morley But while I write the information reaches me that Mr. A Scott's recent work upon the volume ratio leads him to just such a higher ratio, viz 2 00245, a number *a priori* more probable than 2 0002. Under the circumstances both the volume ratio and the density of hydrogen must be regarded as still uncertain to the 1/1000th part.

ELECTRICAL RAILWAYS.[1]

ONE of the most striking of the many new departures in the practical application of electrical science, which made the Paris Exhibition of 1881 memorable, was a short tramway laid

[1] Much larger quantities of hydrogen, sufficient to reduce the oxide over several centimetres, have been introduced without appreciably altering the weight of the gas.

[2] NATURE, vol xlvi p. 512.

[3] The thermometer employed with the manometer read 0° 15 too high.

[1] *Bulletin des Séances de la Société de Physique*

[2] Friday evening discourse delivered at the Royal Institution by Dr. Edward Hopkinson on February 24.

down, under the direction of the late Sir William Siemens, from the Palais de l'Industrie to the Place de la Concorde, upon which a tramcar worked by an electric motor plied up and down with great regularity and success during the period of the Exhibition Yet few of those who saw in this experiment the possibilities of a great future for a new mode of traction would have ventured to predict that within ten years' time, in the United States alone, over 5,000 electric cars would be in operation, travelling 50,000,000 miles annually, and carrying 250,000,000 passengers, or that electrical traction would have solved the problem of better communication in London and other large cities. Two years before the exhibition in Paris the late Dr Werner Siemens had exhibited at the Berlin Exhibition in 1879 an experimental electric tramway on a much smaller scale, and his firm had put down in 1881 the first permanent electric railway in the short length of line at Lichterfelde, near Berlin, which, I believe, is still at work In the same year Dr William Siemens undertook to work the tramway, then projected, between Portrush and Bushmills, in the north of Ireland, over six miles in length, by electric power, making use of the water power of the Bush River for the purpose, an undertaking which I had the advantage of carrying out under his direction It is no part of my object to night to follow further the history of electric traction, which is so recent that it is familiar to all, but, in alluding to these initial stages of its development, I have desired to recall that it was to the foresight and energy of Dr Werner and Dr William Siemens, and their skill in applying scientific knowledge to the uses of daily life, which gave the first impulse to the development of the new electrical power

The problem of electric traction may be naturally considered under three heads:—

(1) The production of the electrical power

(2) Its distribution along the line

(3) The reconversion of electrical into mechanical power, in the car motor or locomotive

The first of these here in England at any rate is dependent upon the economical production of steam power, although there are essential points of difference between the conditions under which steam power is required for electric traction purposes and for electric lighting But in Scotland and Ireland and in many countries abroad there is abundant water power, now only very partially utilised The Portrush line is worked in part by water and in part by steam power, but in the Bessbrook and Newry Tramway (of which there is a working model on the table) water power is exclusively used

A few experiments will show that the demand for power on the generating plant is greatest at the moment of starting the car or train, when in addition to the power required to overcome the frictional resistances power is also required to accelerate the velocity Thus, if instead of a single car there are a number of trains moving on the one system, and it so happens that several are starting together, the demand made upon the generating plant may at one moment be three or four times as great as that made a few seconds after This is shown in the diagrams which exhibit the variation of current supplied by the generators on the City and South London Railway, with eight trains running together, the readings being taken every ten seconds The maxima rise as high as double the mean, thus the generating plant must be capable of instantly responding to a demand double or even treble the average demand upon it

In electric lighting it is true there is not less variation between the maximum demand and the mean taken during the ordinary hours of lighting, but it is only in the event of sudden fog that the probable demand cannot be accurately gauged beforehand, and provided for by throwing more generators into action Thus in a lighting station each generator may be kept working approximately at its full load, and therefore under conditions of maximum economy, whereas in a traction station the whole plant must be kept ready to instantaneously respond to the maximum demands which may be made upon it, and must therefore necessarily work with a low load factor, and consequently with diminished economy So important is the influence on cost of production of the possible demand in relation to average demand, that the Corporation of Manchester under their order for electric supply, have decided upon the advice of their engineer to annually charge a customer £3 per quarter for each unit per hour of maximum supply which he may require, in addition to 2*d*. per unit for each unit actually consumed, *i.e.* for being ready to supply him with a certain amount of electrical power if required to do so, they charge an additional sum equivalent to the charge for its actual consumption for 1440 hours

In one respect water power has an economic advantage over steam power, because although steam engine and turbine alike work with greatly reduced efficiency at reduced loads, when the turbine gates are partially closed and the water restrained in the reservoir, it is not subject to loss of potential energy, whereas the energy of the steam held back by the valves of the engine suffers loss through radiation and condensation

At Bessbrook the turbine and generator dynamo combined yield 60 per cent of the energy of the water as electrical energy available for work on the line, but when the load is reduced to a third of the full load the efficiency is reduced to 33 per cent So on the City and South London line a generator engine and dynamo will yield, when working at their full load, 78 per cent of the indicated horse-power as useful electrical power, but at half load the efficiency falls to 65 per cent Notwithstanding these conditions the generator station of the City and South London line is producing electrical energy at a cost of 1 56*d* per Board of Trade unit, which is less than the annual average cost of production of any electric station in England, with the single exception of Bradford, which has the advantage both of cheap coal and cheap labour In output it is the largest of any Electric Generating Station in England, the total electrical energy delivered in 1892 being 1,250,000 Board of Trade units, the second on the list being the St James and Pall Mall with 1,186,826 units

Let us pass now to the consideration of the distribution of the electric power along the line I have equipped the three model tracks before you with three different kinds of conductors In two of them the rails of the permanent way, which are necessarily uninsulated, are made use of for the return current This plan, with I believe the almost single exception of the Buda Pesth Tramway, has been universally adopted with the object of saving the cost of a return conductor, but it is doubtful whether such an arrangement can be considered final, for it must necessarily create differences of potential in the earth, which already in some instances have had disturbing effects upon our observatories, or upon our telegraph and telephone systems It appears to be probable in the more or less distant future that the use of the earth for the passage of large current will be guarded by legislation, and that it will be reserved for the more delicate and widely extended operations of telegraphy and telephony These disturbances may of course be easily avoided by the use of an insulated conductor for the return circuit In the case of conductors which are in such a position that contact may be made from them to the ground through the body of a horse or some other animal coming into contact with them, there is another strong argument for an insulated return, as many animals, and notably horses, are far more sensitive to electric shock than man It is not perhaps well known, but still a fact, that a shock of 250 volts is quite sufficient to kill a horse almost instantaneously

The first model has a single overhead conductor with return by the rails, but in place of a single fishing rod collector or trolley to take the current from the overhead wire there are fixed on the car two rigid bars, one at each end, which slide along the under surface of the wire and make a rubbing contact against it This system, devised by Dr John Hopkinson, has the advantage that there is less difficulty in maintaining contact on uneven roads or on curves, and that the catenaries of the suspended wire may be hung with greater dip, and therefore with less tension Again, the double contact obviates the frequent breaks and consequent sparking of a single trolley system The second model shows the system adopted on the City and South London line, and more recently followed on the Liverpool Overhead line, of a conductor of channel steel, upon which collectors fixed to the locomotives make a sliding contact The third track shows an overhead system like the first, but with an insulated return in place of return by the rails

The characteristic feature of an electric motor is that it delivers us the mechanical power we require directly in the form of a couple about an axis instead of in the form of a rectilinear force, as is the case with steam, gas, or air engines, which must be reduced to a rotary form by connecting rod and crank Thus it is possible to sweep away all intermediate gear, and to arrive at once at the simplest of all forms of a traction motor, consisting of but one pair of wheels fixed on a single axle with the armature constructed directly upon it, with its magnets suspended from it and maintained in their position against the

magnetic forces acting upon them by their weight. Such a locomotive is shown in the third model before you. So far as I am aware, a locomotive of such simplicity as this has never been constructed for practical work, but on the City and South London line the armatures of the motors are placed directly on the axles and the magnets, suspended partly from the axles and partly from the frame.

The second model is an exact reproduction of the locomotives on the City and South London line, but with a different arrangement of motors. Here both armatures are included in the same magnetic circuit, and both magnets and armatures carried on the frame of the locomotive and not on the axles. The armatures are geared to the axles by diagonal connecting rods, the axle boxes being inclined, so that their rise and fall in the horn blocks is at right angles to the connecting rods. This design, which is due to the late Mr. Lange, of Messrs. Beyer, Peacock & Co., allows of the motor armature being placed on the floor level of the locomotive, and so more easily accessible.

This model will serve to show some of the characteristic features as well as some of the characteristic defects of an electric motor as such. But in order to show these clearly I may refer for a moment to the general theory of a motor. It is easily shown that in a series wound motor the couple or turning moment on the axle is a function of the current only, and independent of the speed and electro motive force. Again it follows from Ohm's law that the current passing through the motor multiplied by the resistance of the magnet and armature coils is equal to the difference between the electro-motive force at the terminals of the motor and the electro-motive force which would be generated by the motor, if it were working at the same speed as a generator of electricity, that is to say the difference between the electro motive force at the terminals and what is called the "back" or "counter" electro-motive force of the motor. Hence if the terminals of the motor be coupled direct to the line at the moment of starting when the motor is still at rest, the current will be very great and its power entirely absorbed in the coils of the armature and magnets, but the turning moment will then be a maximum. The motor then begins to move, part of the power being spent in overcoming frictional resistances and part in accelerating the train. A back electro-motive force is then set up, increasing as the speed increases, and causing the current to diminish until finally a position of equilibrium is established, when the speed is such that the back electro motive force together with the loss of potential in the coils of the motor is equal to the potential of the line. But in practice the mechanical strength of the motor, and the carrying power of its coils, as well as the limited current available from the generators makes it necessary to introduce resistances in circuit with the motor to throttle the current and to reduce it within proper limits. It is to this point I desire to draw attention, that in traction work when starting the motor resistances must be introduced, which, with the resistance of the motor itself, at the moment of starting, absorb the whole power of the current, reducing the efficiency of the motor to nil, and which continue to absorb a large percentage of the power, until the condition of equilibrium is established. This is the great defect in electric motors for traction work, and its importance can be shown very clearly by reference to the work done on the City and South London line. There the motors when working with their normal current have an efficiency of 90 per cent., but the actual all-round efficiency of the locomotives as a whole is 70 per cent. only, so that the loss in starting is equal to 20 per cent. of the whole power. Of course in some respects the City and South London line is exceptional in that a start is made every two or three minutes. Various devices have been suggested with a view to diminishing this waste of power in starting an electric motor, but none entirely meet the case. Thus if the locomotive or car has two motors, these can be coupled in series at the start, and subsequently thrown into parallel, thereby doubling the tractive force with a given current, or for the same tractive force reducing the loss of power by three-fourths. When through the increase of speed of the motor the back electro-motive force balances the electro-motive force of the line the speed can be increased by diminishing the magnetic field by reducing the effective coils on the magnets, but this device does not give any assistance at the lower speeds, as the magnets ought to be so wound as to be high on the characteristic curve, or nearly saturated, with the normal current, and it is therefore not possible to obtain any increased intensity of field, by increasing the convolutions of the magnet coils. If it were possible to use alternate current motors for traction work the difficulty could at once be met by introducing a transformer in the circuit, and placing the motor in its secondary. The effective convolutions of the secondary circuit on the transformer could then be varied as the speed increases in such wise that the electro motive force of the line is balanced by the back electro-motive force of the motor and the fall of potential due to the resistance of the motor coils, so avoiding all need for resistances.

The City and South London line has enabled experiments to be made on the efficiency of the railway system as a whole, taking into account the loss of power in the generators, on the line, and in the motors, and in the resistances of the locomotives. The loss in the line is about eleven per cent. of the power generated, and the efficiency of the locomotives as a whole is, as I have shown, 70 per cent.; thus the electrical efficiency of the entire system is 62 per cent. The trains weigh with full load of 100 passengers about forty tons, and the average speed between stations is 13.5 miles per hour. The cost of working, including all charges, during last half year was 7.1*d.* per train mile, of which 4.7*d.* represents the cost of production of the electric power, and 2.4*d.* the cost of utilising it on the locomotives. It is perhaps hardly a fair comparison to compare the cost of working such a line as the South London line with the cost of steam traction on other lines, inasmuch as steam could not possibly be used in the tunnels, only 10′ 6″ diameter, in which this line is constructed, but the comparison is not uninstructive. Take the Mersey Railway, where the gradients and nature of the traffic are similar. On the Mersey Railway the locomotives weigh about 70 tons, and the train, which is capable of carrying about 350 passengers, 150 tons. According to the published returns of the company the cost of locomotive power is 14*d.* per train mile, *i.e.* double the cost on the South London line, but for a train weighing between four and five times as much but capable of carrying only 3½ times the number of passengers; thus the cost of steam traction per ton mile of train is about half that per ton mile of train for electric traction. But it is not on the cost per ton mile that the success of a passenger line depends. The real basis of comparison is the cost per passenger mile, and here electric traction has great advantage over steam, as the dead weight of the electric motor is small compared with the dead weight of steam locomotives of the same power, and with electric motors the trains can be split up into smaller units at but slightly increased cost, so permitting a more frequent service. We cannot expect, therefore, that electric traction with our present knowledge will take the place of steam traction on our trunk lines; but it has its proper function in the working of the underground lines now projected for London, Paris, Berlin, and Brussels, and other large towns, and also I think on other urban lines, for example, on the Liverpool Overhead Railway, where trains of large carrying capacity are not required, but a frequent service is essential; and finally, also on those short lines, whether independent or branches of the great trunk lines where water power is available. When I undertook the construction of the Bessbrook line it was a condition that the cost of working should be less than the cost of working by steam, a condition which the first six months of working showed to be successfully fulfilled. When Messrs. Mather and Platt undertook the construction of the electric plant for the City and South London Railway, they guaranteed that the cost of traction for a service of 8247 miles per week as actually run should not exceed 6.3*d.* per train mile, exclusive of the drivers' wages. Their anticipations have been more than realised, the actual cost being 5.1*d.* per train mile only. There are, however, other projects both in America and on the continent for electric railways on which the special feature is to be an enormously high speed of travel, speeds of 150 and even 200 miles per hour being promised. With a steam locomotive, involving the reciprocating motion of the piston and connecting rod, such speeds are probably unattainable, but they may be realised in the purely rotary motion of an electric motor. But at such high speeds as these the power required to overcome the air resistance is of special consideration. Probably up to speeds of 750 miles per hour, or even to higher limits still, the ordinary law of air resistance holds good, as the rate of disturbance is still less than the velocity of waves in air, but above these limits we leave the regions of ordinary locomotion and enter rather into the field of projectiles. Assuming, however, that the ordinary laws of air resistance do hold good, I calculate that the power required to propel an ordinary train 200 feet long at 200 miles per hour against the

resistance of air alone, apart from the frictional resistances, would not be less than 1700 horse power Though there is nothing to prevent the construction of electric locomotives capable of developing this or even greater power, the strength of the materials at present at command will set a limit to the speeds which may be obtained

In order that the engineer may realise the imperfection of all his works, it is well for him to be constrained from time to time to contemplate the amount of energy involved in his final purpose compared with the energy of the coal with which he starts I have endeavoured to put before you to-night the losses that occur and the reasons for them, in some steps of the complex machine which constitutes an electric railway, so in conclusion I will draw your attention to the ultimate efficiency of the machine, starting with the coal and ending with the passenger carried through space The diagram on the wall, starting with the familiar 12,000,000 foot-pounds, the energy of a pound of coal, shows the loss in each step, supposing it made with the most economical appliances known to the engineer, first in the boiler, then in the steam engine, generator dynamo, conductors, locomotives, in the dead weight of the train, till finally we arrive at the energy expended on the passenger himself, which we find to be 133,000 foot pounds, or but little more than 1 per cent. of the energy with which we started It is true indeed that transportation is a more economical process than lighting with incandescent lamps, in which the final efficiency is about one-half per cent, but whether in lighting or in traction, when we consider that ninety nine parts are now wasted for one part saved, we may realise that the future has greater possibilities than anything accomplished in the past

HAIL STORMS[1]

SOME recent thunder and hail storms were so violent that they call for more than a passing notice, not only on account of their severity, but also because they are well marked phenomena in our weather The district in which they were most severe is that around Narrabri, and the weather map for the day indicated this district as one in which storms would probably manifest great intensity The places from which the best accounts have reached me are Narrabri, Avondale, thirty miles due north of Narrabri, and Tulcumbah, fifty seven miles south east of Narrabri

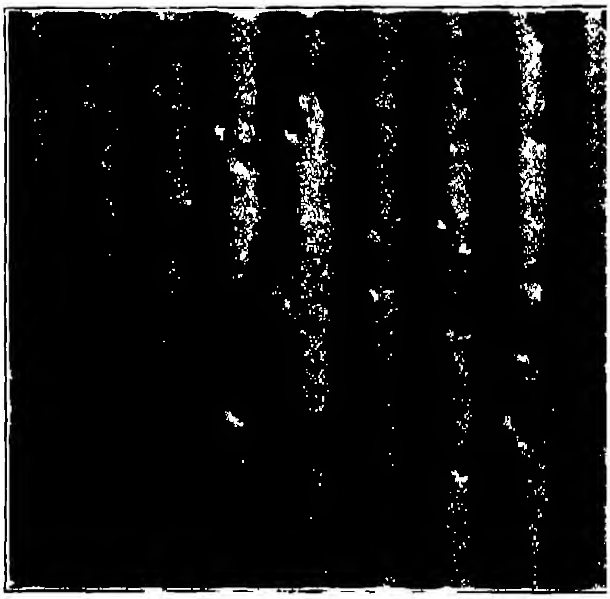
The Sydney weather chart at 9 a m. on October 13, the day of these storms, shows us that there was but little difference in pressure all over Australia To the west of the overland telegraph line it was slightly higher, over western New South Wales and Queensland lower, and higher again over the East Coast, in which the isobars clearly outline the area of relatively low pressure, and the kinks in them indicate disturbed conditions, local short lived storms, and before the day was over the inference from the state of pressure was fully justified, for storms of extreme violence occurred over the area, storms which swept down great forest trees two and three feet in diameter. What this means in wind velocity I am unable to say, the trees are eucalypts, and therefore the wood is hard and very strong, but they were treated as if they were reeds, and their strength was as nothing compared with the force of the wind

These storms are common enough, but owing to the sparse population they seldom pass over towns or dwellings In this instance such has been the case, and in the future as population increases similar cases must increase in number, for the storms are abundant, indeed these storms form a well marked feature of our summer weather. As a rule they are disconnected, and the most violent part of the wind covers but two hundred or three hundred yards wide, and travels along with great rapidity, leaving a narrow line of destruction in its wake

On the day in question heavy storms were reported at Goodooga, Armidale, two hundred and forty miles south east of Goodooga, and at Grafton one hundred miles north east of Armidale Storms which seem to have been quite disconnected, for the earliest time was at Grafton, and as a rule they come from the west, these are spoken of as severe storms, but were evidently not specially remarkable, nothing to compare with those in the Narrabri district to which I wish to direct your attention Unfortunately, data for determining the rate of progress is not available, although that as to the intensity of the storms is abundant I may mention that three days before these storms, that is on October 10, a similar storm passed over from Wilcannia to Sydney, a distance of four hundred and eighty miles, at the rate of fifty-five miles per hour, and I have before traced one over the same part of the colony, the rate being fifty seven miles per hour, but we have not traced a sufficient number to determine an average rate.

As to the velocity of the wind along the line of damage in these storms, we have no actual anemometer results, so far we have not had one which passed over one of the anemometers, but judging from the damage done to large and solid trees, two and even three feet in diameter, it cannot I think be less than one hundred and forty or one hundred and fifty miles per hour

We may now turn to the storms in the Narrabri district The storm reached Narrabri at 6 15 p m, and the postmaster reports that the storm which approached Narrabri from north west was accompanied by thunder and lightning, but no hail. The wind, however, seems to have been of hurricane violence, trees two feet in diameter were torn up by the roots, limbs twelve inches through were snapped off short, a brick factory completely ruined, roofs, sign boards, and everything that the wind could move went flying, in the language of the local newspaper, "substantial brick buildings came tumbling in all directions, the



Photograph of iron perforated by hail

air was full of iron tubs, galvanised iron, and tins of every description"

In the district south of Narrabri the storm was even more severe At Tulcumbah Station, fifty seven miles south-east from Narrabri, at 8 p m on October 13, a violent thunder and hail storm broke over the homestead. It lasted half an hour, and Mr A D Griffiths, my informant and manager of the station, says, "I measured some of the hailstones, six and a half inches in circumference, this was fifteen or twenty minutes after the storm, and I think I did not get the largest Next morning I found that nineteen sheep had been killed by the hail, also birds, kangaroo-rats, and other animals were found lying dead in all directions All the windows exposed to the storm were broken, and the galvanised iron roofing is dented from end to end, and many sheets cut through, in several cases the hailstones went through the iron, in one sheet I found thirty holes, and in another more than sixty The bark of the trees in the storm track was all battered by the hail, and the fences and buildings bore traces of the impact of these great lumps of ice The stones were generally triangular or conoidal in form, many having an uneven surface, which looked as if it had been formed from frozen drops of water collected into masses, others had an opaque snow-like centre, perhaps the majority were like this, the remainder being like clear ice. It was only the larger stones that were irregular as described, the smaller ones were generally rounded"

At Avondale, thirty miles north of Narrabri, my informant,

[1] Read by H C. Russell, F R.S before the Royal Society of N S. Wales, November 2, 1892

Mr S J. Dickson, says, "From the 9th to the 13th of October, the weather was unusually oppressive with threatening storms, and on the evening of the 13th a heavy storm was seen to be working up from the west accompanied by incessant lightning of every description, and about 8 p m. it broke over the homestead in all its fury, the wind was from south-west and of terrific force, and the rain and hail were very severe The hailstones were as large as hen-eggs, and in some of the paddocks, one particularly, it pounded the herbage completely out, so that not a vestige of it was left, although before the storm came on. it was from six to twelve inches high, and in other places strong variegated thistles three to four feet high were beaten down Trees some two feet thick, that the wind could not tear up by the roots, were snapped off short as if made of matchwood In the storm the hail killed birds innumerable, and even domestic fowls roosting on the trees were killed by it, and after the storm a large snake was found cut into two pieces by the hail, so at least it appeared On the open plain the hail laid four to six inches deep, and the whole country looked as if a heavy snowstorm had passed over it Trees in the track of the hail were completely denuded of leaves, and the bark knocked off tree trunks and limbs The storm wind carried away outstations, unroofed the hayshed, damaged the woolshed, and carried away two sides of the house-verandah, and the sheets of iron from it were found nearly half a mile (30 chains) away to the north east, round wall plates in the hayshed six to eight inches thick were broken to pieces, and the iron roofing on all the buildings was battered by the hail as if some one had pounded it with a hammer all over The storm track was only a mile to a mile and a half wide, at least the hail part Between 7 and 8 p m, as the storm came up, there seemed to be a white bow in the sky, like a white rainbow stretching from north to south I have seen heavy storms before, but I never wish to see another like this The shearers were completely terrified, and all say that they have never experienced a storm like it, in fact, it beggars description and can hardly be realised It was an experience that we shall remember as long as we live"

North of Narrabri, and especially between Narrabri and Avondale, the storms were very severe Midway between these places and at Terry hi hi and Berrigal Creek the wind worked great destruction in the forest How violent it was may be gathered from the fact that great trees twelve feet in circumference at three feet from the ground, were snapped off short ten feet above the ground, or entirely stripped of their limbs

SCIENTIFIC SERIAL

American Meteorological Journal, March —Exploration of the free air, by Prof M W Harrington The author considers that the conclusions to be drawn from weather maps are nearly exhausted, and that the reason of the imperfection of meteorology is the want of knowledge of what is going on in the free air Mountain observations give most important results, but they are still surface observations We know what goes on at the base of a cyclone, but not what occurs at the top Theories are deduced from cloud observations, but we lack actual knowledge of what is going on above, and the only means available at present is systematic balloon observations. Prof Harrington thinks that such observations should be provided for by funds from private sources —The general winds of the Atlantic Ocean, by Prof W M Davis The basis of this discussion is the "Sailing Directory of the Atlantic Ocean," published by the Deutsche Seewarte, and especially two generalised wind charts contained in the atlas accompanying that work The author classifies the winds as planetary (due to the earth's rotation and the influence of the sun), terrestrial (the annual migration of the wind belts north and south, and the seasonal variations of velocity and direction), including the interruptions of continents and mountain ranges —The colours of cloudy condensation, by Prof C Barus The author considers the problems connected with the condensation of water from moist air, and reviews the labours of Mr Aitken and Mr Bidwell with reference to the particles of an opaque steam-jet He also gives a minute description of the apparatus employed in his own investigations.

SOCIETIES AND ACADEMIES

LONDON.

Physical Society, March 24.—Prof A W. Rücker, F.R.S, President, in the chair.—Several excellent photographs of flying bullets and of the air waves produced by vibrating hammers, were exhibited, the originals of which had been taken by Prof Mach —A paper on the differential equation of electric flow was read by Mr T H Blakesley The object of the paper is to show that the ordinary mathematical expressions for electric flow fail to explain all known facts, and to point out that in order to interpret these facts certain properties of matter not usually recognised must be admitted The subject is treated both algebraically and geometrically, in the latter case the magnitudes being represented by the projections of the sides of a triangle revolving in its own plane on a fixed line in that plane Taking the ordinary differential equation for a simple circuit having resistance and self-induction, viz, $V - L\frac{dC}{dt} = RC$, it is shown that this takes no account of any energy except that spent in heating the conductor, and that where radiation into space is concerned, it is necessary to introduce another term λC, where λ is a quantity of the nature of resistance It is further pointed out that if work be done outside the circuit, the line which geometrically represents the induced E M F cannot be perpendicular to that indicating the current and "effective" E M F, the latter term being defined to mean the value of the quantity which is numerically equal to the product of the current into the resistance A magnetic phase lag must therefore exist The author also shows that a magnetic field induced in phase with the magnetic induction would not result in a loss of energy, and no hysteresis could exist Under the same circumstances there could be no radiation of energy from an alternating magnet A Leyden jar discharging through a circuit having self-induction is next considered Taking the ordinary premises, it is shown that no provision is there made for energy radiated into space, and that magnetic lag is necessary for the existence of such phenomena The differential equations for the variables in condenser discharges according to ordinary assumptions are shown to be of the same form, and the variables can be represented by the projection of the sides of a triangle which is simultaneously undergoing uniform rotation and linear logarithmic shrinking The rate of shrinking is the same as that of the radius vector of an equiangular spiral of characteristic angle β, where $\cos\beta = \sqrt{\frac{K}{L}}\frac{R}{2}$, K, L, and R representing capacity, self induction, and resistance respectively The equations and their consequences are considered at some length, and several important properties brought out To allow for radiated energy, R must be virtually increased from R to $R+\lambda$, and the total energy is divided between the circuit and the field in the ratio of R to λ If, therefore, the circumstances be such that λ is large compared with R, say by having high frequency, the heating of the circuit may only be a small part of the total energy In this direction the author thinks the true explanation of some of Tesla's experiments is to be found, the energy being expended chiefly in radiation and not in current through the experimenter's body Prof Perry thought the C^2R term would not represent the heating of the wire when the oscillations were rapid, owing to the distribution of current not being uniform over the section of the conductor. Maxwell had shown that certain throttling terms had to be considered In condenser discharges the complete equation would have many terms Prof O J Lodge said the best definition of R in such case was that derived from Joule's law rather than that of Ohms Frequency was very important in the radiation of energy, but even at ordinary frequencies of alternators some energy was radiated Referring to Tesla's experiments, he said the reason why no serious consequences followed, was that there was not much energy behind them High frequency might be instrumental in preventing injury, but this he thought remained to be proved Dr Sumpner pointed out that losses other than C^2R (R being the ordinary resistance of the conductor) had to be taken into account In some cases, such as transformers on open circuit, the effective resistance might be 1000 times that of the coil To discuss completely the problem taken up by Mr Blakesley, it would be necessary to take account of non-uniform distribution of current, both across and along the conductor, as well as the character of the magnetic and electric fields surrounding the circuit Mr. Swinburne thought there was a tendency to over-estimate the rate of high-frequency currents, for unless the coils of transformers were assumed geometrically coincident, calculations were difficult. Errors of hundreds per cent were quite possible. In Tesla's experiments no great power was involved, for the transformer could not give out any large power Mr. Blakesley, in reply, said the

term R was such that C^2R represented the whole waste loss in the conductor, whilst λ included everything wasted outside the conductor.—A paper on the viscosity of liquids, by Prof. J. Perry, F.R.S., assisted by J. Graham and C. W. Heath, was read by Prof. Perry. The viscosity was tested by suspending a hollow cylinder within an annular trough containing the liquid, and measuring the torque exerted on the cylinder when the trough rotated at various speeds about its axis. In the paper the equation of motion under the conditions of the experiment is discussed, the error introduced by assuming that the liquid moves in plane layers being shown to be about 0.5 per cent. By measuring the viscous torques exerted with different depths of liquid in the trough, the correction for the edge of the suspended cylinder was found to be 0.8 c.m. On plotting the results obtained with sperm oil at different temperatures and constant speed, a discontinuity was noticed about 40°. For a speed of nine revolutions a minute the viscosity (μ) could be very approximately calculated from the formula $\mu = 2.06 (\theta - 4.2)^{-.656}$ below 40° C. and $\mu = 21.67 (\theta - 4.2)^{-1.349}$ above 40° C., θ being the temperature. Experiments on the change of density of sperm oil with temperature, made by Mr. J. B. Knight, indicated a minimum density about 40°. Subsequent experiments with other samples had not confirmed these observations. The paper contains several tables of the results obtained in various experiments. Those performed at constant temperatures show that for slow speeds the torque is strictly proportional to speed, but afterwards increases more rapidly, probably owing to the critical speed having been exceeded. After concluding the paper Prof. Perry read a letter he had received from Prof. Osborne Reynolds on the subject, who doubted whether the true critical velocities had been reached in the experiments. In the particular arrangement employed, he would expect no critical velocity in the outer ring of liquid, whilst in the inner ring the motion would be unstable from the first. Mr. Rogers pointed out that experiments which corroborated those of Prof. Perry had been made by M. Couette and published in *Ann. de Chim. et de Phys.* [6] xxi.

Geological Society, March 22.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—On the jaw of a new carnivorous dinosaur from the Oxford clay of Peterborough, by R. Lydekker. The author describes a fragment of the left side of a lower jaw of a carnivorous dinosaur from the Oxford clay of Peterborough, indicating a new genus and species, which he names *Sarcolestes Leedsi*. Some remarks were made on this paper by the President and Prof. Seeley.—On a mammalian incisor from the Wealden of Hastings, by R. Lydekker. In this paper a small rodent-like tooth from the Wealden of Hastings, belonging to Sir John Evans, K.C.B., is described. It is probably the front tooth of one of the mammalian genera found in the Purbeck Beds, as may be gathered from American specimens. The reading of this paper was followed by a discussion, in which the President, Sir John Evans, Mr. C. Dawson, Mr. Oldfield Thomas, Dr. Forsyth-Major, Dr. H. Woodward, and the author took part.—On an intrusion of Muscovite biotite-gneiss in the south-eastern Highlands, and its accompanying thermo-metamorphism, by George Barrow, of the Geological Survey. (Communicated by permission of the Director-General of the Geological Survey.) The area to which this paper refers lies in the north-eastern part of Forfarshire, and is drained by the two Esks. The author first describes the distribution, mode of occurrence, and petrological characters of the intrusive masses. In the north-western portion of the area the intrusive rock is always a gneiss, and occurs in thin tongues which permeate the surrounding rocks. Towards the south-east these tongues amalgamate and form large masses, in which the foliation is less marked. Moreover, in this direction the large masses are often fringed with pegmatite, especially on their southern and eastern edges. Where the rock is a gneiss, it is composed of oligoclase, muscovite, biotite, and quartz, but contains no microcline. As the gneissose character becomes less marked, the oligoclase diminishes in amount, and microcline begins to appear, especially towards the margins of the masses. In the most south-easterly of these microcline is greatly in excess of oligoclase. The differences in structure and composition of these masses are believed by the author to be due to the straining off of the crystals of earlier consolidation during intrusion under great pressure. The still liquid potash-bearing portion of the magma was squeezed out and forced into every plane of weakness in the surrounding rocks, and that portion of it which contained the highest percentage of potash finally consolidated as pegmatite. Special attention is directed to the distribution of pegmatite. This rock is widely distributed in the Southern Highlands, and cuts across every known system of folding. It is consequently newer than any member of the metamorphic series. The surrounding metamorphic schists are next dealt with. These are remarkable for their highly crystalline condition, and also on account of the presence of many minerals known to occur in regions where thermo-metamorphism has taken place. The characters of the more important minerals are described in detail. The rocks of the metamorphic area become less and less crystalline as they are followed towards the Highland border. Three zones, characterised respectively by the minerals sillimanite, cyanite, and staurolite, have been roughly mapped. The more important rocks found in these zones are described in detail, and evidence is given to show that the boundaries between the zones do not in all cases coincide with the strike of the rocks. Thus, a thin bed of quartzite, which retains its character in consequence of the simplicity of its chemical composition, may be followed through all the zones; whereas the bed adjacent to it is in the outer zone a staurolite schist, in the intermediate zone a cyanite gneiss, and near the contact with the igneous rock a coarse sillimanite-gneiss. Evidence is given to show that the original rocks formed a sedimentary series. The phenomena are compared with those of other areas where thermo-metamorphism has taken place; and the conclusion is reached that the differences are of *degree* rather than of *kind*. The special features of the area in question are attributed to the depth at which the change was produced. The paper is illustrated by a map of the district and a table of original analyses. This paper gave rise to a discussion, in which the president, Prof. Judd, Mr. Rutley, General McMahon, Dr. Hicks, Mr. Marr, Dr. Du Riche Preller, Mr. Teall, and the author took part.

Zoological Society, March 28.—Sir W. H. Flower, K.C.B., LL.D., F.R.S., President, in the chair.—A report was read, drawn up by Mr. A. Thomson, the Society's head-keeper, on the insects bred in the insect-house during the past season.—A communication was read from Mr. Herbert Druce, giving an account of some new species of Lepidoptera Heterocera, chiefly from Central and South America.—Mr. F. E. Beddard, F.R.S., read a paper on the brain of the African elephant. The author gave reasons for disagreeing with some of the conclusions of Dr. Krueg, but confirmed others. The outline is more like that of the carnivorous than the ungulate brain, but the principal furrows appear to be arranged on a plan characteristic of the elephantidæ.—Mr. W. T. Blanford showed that the various names hitherto employed in systematic works for the bird called by Jerdon the Himalayan cuckoo (*Cuculus himalayanus*, *C. striatus*, and *C. intermedius*) belonged to other species. He also gave reasons for not adopting S. Müller's *C. canoroides*, and accepted the term *C. saturatus*, Hodgson, as the correct scientific name.—A communication was read from Mr. F. M. Woodward, entitled "Further observations on the genitalia of British earthworms." This paper chiefly dealt with supplementary gonads which were found to be much more common than had been supposed; in one specimen an hermaphrodite gland was discovered in addition to testes and ovaries.

Entomological Society, March 29.—Henry John Elwes, President, in the chair.—Mr. G. C. Champion exhibited a living specimen of a luminous species of *Pyrophorus*, which had been found in an orchid house in Dorking. It was supposed to have emerged from the roots of a species of *Cattleya* from Colombia.—Mr. A. H. Jones exhibited living full-grown larvæ of *Charaxes jasius*, found by Mr. Frederic Raine, at Hyères, feeding on *Arbutus unedo*.—Surgeon-Captain Manders exhibited a series of *Lycæna theophrastus* from Rawal Pindi, showing climatal variations, the rainy-season form being of darker coloration, and larger than that occurring in the dry season. The ground colour of the former on the under surface was markedly white with deep black striæ; in the latter form the ground colour was distinctly reddish, and the marking reduced to reddish lines. He said that the latter form had been described as *L. alteratus*.—Mr. S. G. C. Russell exhibited a beautiful variety of *Argynnis selene*, taken near Fleet, Hants; two varieties of *A. selene* from Abbot's Wood, Sussex; typical specimens of *A. selene* and *A. euphrosyne* for comparison; and

a remarkable variety of *Pieris napi* from Woking —Mr C. J Gahan exhibited a microscopic preparation of the antenna of the larva of a beetle (*Pterostichus*), for the purpose of demonstrating the sensory nature of the so-called "appendix" of the antenna. Since he wrote a note describing this structure, a short time ago, he found that Prof Beauregard had already suggested its sensory character, and was inclined to believe that it was an auditory organ —Mr H Goss exhibited a specimen of *Trogus lapidator*, Grav, believed to have been bred from a larva of *Papilio machaon*, taken in Norfolk by Major General Carden Mr Goss stated that he sent the specimen to the Rev T A Marshall, who said it was a well-known parasite of *P machaon* on the Continent, but not proved to exist in the United Kingdom —Mr F Merrifield said he knew this parasite, and had bred several specimens of it from pupæ of *P machaon* received from Spain —Colonel Swinhoe read a paper, entitled "The Lepidoptera of the Khasia Hills Part I" A long and interesting discussion ensued, in which Mr Elwes, Mr Hampson, Colonel Swinhoe and others took part —Mr W Bartlett Calvert communicated a paper entitled "New Chilian Lepidoptera"—Mr J W Shipp communicated a paper entitled "On a New Species of the Genus *Phalacrognathus*"

PARIS

Academy of Sciences, April 4 —M Lœwy in the chair —On the construction of the chart of the heavens, numerical application of the method of attaching neighbouring negatives, by M Maurice Lœwy —Remarks on M Joubin's note relating to the measurement of large differences of phase in white light, by M A Cornu —On the approximate representation of experimental functions between given limits, by M Vallier —On the benzeneazocyanacetic ethers and their analogues, by MM A. Haller and E Brancovici —Measurement of the parallel of 47° 30′ in Russia, by M Venukoff The parallel was measured from the meridian of Kichinev, near the Roumanian frontier, to that of Astrakhan, on the Lower Volga, the difference of longitude being 19° 11′ 55″ 11 The measurements gave 1,446,462 m for the length of the arc, or 75,336 m per degree of longitude But this mean value is not everywhere attained Between Rostov on the-Don and Sarepta the geodetic arc exceeds the astronomical one by 15″ 26, whilst between Sarepta and Astrakhan the astronomical arc is the larger by 9″ 82 This deviation shows a remarkable agreement with that obtained in the measurement of the 52nd parallel and indicates that the plains of Eastern Russia are formed according to the same geometrical law over a vast area A comparison of the results for the two arcs, with reference to the length of the meridian measured from the North Cape to Dorpat and the Lower Danube, indicates a polar depression of 1 in 299 65, which agrees closely with that found by Bessel for Germany in 1841 (1 in 299 26), but differs from that of Clarke (1 in 293 46) —Condensation experiments of the acetylcyanacetic acids with the phenols, by M A Held.—Synthesis of erythrite, by M. G Griner —Action of temperature upon the rotatory power of liquids, by M. A Aignan Reasoning from the fact that the oxide of isobutylamyl presents a rotatory power which changes its sign at −30°, M. Colson has concluded that "chemical constitution does not appear to be the preponderating factor in the value or the sign of the rotatory power." But the fact referred to can be explained as the effect of the mixture of a negative and a positive rotating substance respectively A mixture of essence of terebenthine (left-handed) and camphor (right-handed) was dissolved in benzene, and observed through the 20 cm. tube of the polarimeter in different kinds of light This mixture changed from negative to positive at a temperature between 61° and 73°C for red light, between 13° and 33° C. for yellow light, and was positive for all the temperatures for green light, the angle of rotation being 2° 24′ at 13°, and 6° 43′ at 90° C. To explain M Colson's observation, it is not even necessary to assume that the oxide contains two substances of rotatory powers of different signs It suffices to admit, as has been done in the case of solutions of tartaric acid, that the molecules of isobutylamyl are susceptible of polymerisation in the liquid state, so that the sign of the rotatory power characterising the molecule of the substance is that observed at the higher temperatures —Neolithic village of the Roche-au-Diable, near Tesnières, canton of Lorez-le-Bocage (Seine-et-Marne), by M. Armand Viré In the course of excavations in the valley of Lunain a village was discovered of a type not met with up to now It consists of a series of ground-works of square huts touching each other, and arranged in a line nearly east and west, forming a very regular street At the end was a sort of square enclosure of stone, measuring about 2 5 by 3 m, with a door towards the south Inside it presented a circular cavity, 30 cm in diameter and 20 cm deep, which still appeared to contain ashes, and whose clay walls were baked to a depth of about 4 cm. Similar hearths have been found among the Kabyles of Algiers. Near this structure was another, of circular form, built of rough blocks of limestone and sandstone, with a triangular door built of two enormous blocks of sandstone, joining at the top, and leaving a space of 50 cm at the bottom This hut also showed traces of cooking operations A little further on came a series of seven similar huts, followed by two larger ones without hearths, and finally two more like the first The total length of the village was 114 m All the masonry consisted of blocks of limestone or sandstone, cemented with clay A large number of stone and flint implements was found, including half a dozen sandstone hatchets, polished or prepared for polishing The village is, curiously enough, situated at the very bottom of the valley

BOOKS AND PAMPHLETS RECEIVED

BOOKS.—Exercises in Euclid W Weeks (Macmillan).—Electrical Tables and Memoranda S P Thompson and E Thomas (Spon)—Popular Lectures on Scientific Subjects H von Helmholtz, 2 vols new edition, translated by E Atkinson (Longmans).—Aids to Biology J W Williams (Baillière)—Statics and Dynamics E Geldard (Longmans)—Map of River Basins C F De Rance (Manchester J E Cornish)—Telephone Lines and their Properties W J Hopkins (Longmans)—The Birds of Derbyshire F B Whitlock (Bemrose).—Theory of Functions of a Complex Variable Dr A R Forsyth (Cambridge University Press).—Theory of Structures and Strength of Materials H T Bovey (K Paul)—Die Thermodynamik in der Chemie J J Van Laar (Leipzig, Engelmann)—Polarisation Rotatoire G Foussereau (Paris, G Carré) Traité Pratique d'Analyse Chimique et de Recherches Toxicologiques G Guérin (Paris, G Carré).—Forest Tithes, &c A Son of the Marshes (Smith, Elder)—Technology for Schools J Hassell (Blackie)—A Practical Treatise on Bridge Construction, 2 vols T C Fidler (Griffin)—The Steam Engine, 2 vols D K Clark (Blackie)

PAMPHLETS —Sulla Distribuzione del Potenziale Nell'Aria Rarefatta percorsa dalla Corrente Elettrica Prof A Righi (Bologna)—The Fundamental Theorems of Analysis Generalised for Space Prof A Macfarlane (Boston).—The Imaginary of Algebra Prof A Macfarlane (Salem)—Australian Museum, Sydney, Catalogue of Australian Mammals, &c (Sydney).—Catalogue of the Michigan Mining School, Houghton, Michigan 1891–92 (Houghton)

CONTENTS.

THURSDAY, APRIL 20, 1893

THE NEW UNIVERSITY FOR LONDON

THE long procession of witnesses which for months past has been defiling before the "Gresham University Commission" has at length come to an end. The Commissioners are now, we suppose, engaged in constructing a scheme for the constitution of the University. Their manner of performing the first portion of their task has been open to criticism. More may be heard hereafter of the extraordinary refusal to furnish the witnesses with copies of their own evidence, and of the still more remarkable fact that, though the majority were denied copies of what they themselves had said, exceptions were made in the case of certain favoured persons who were allowed to see and to contradict the evidence of others.

While the Commission has been sitting several schemes for the constitution of the new University have been proposed. In spite of certain important differences there is one most important point on which they are generally in accord. It is not too much to say that—with no more exceptions than are necessary to prove the rule—every one interested in the future development of the higher education in London agrees that there should be but one university in the metropolis, and that it should not (as was proposed in the discredited Gresham scheme) be a loose federation of competing colleges. It cannot be too strongly urged that the object of a university is the promotion and the diffusion of learning, not the aggrandisement of educational institutions. Every student in London who can pass the prescribed examinations can at present obtain a degree. No change in existing arrangements need be made unless it can be shown by some other method students could be attracted in greater numbers, or could be turned out at the end of their university careers with a greater mastery of the branches of knowledge which they have studied. These ends will not be attained by giving to the existing colleges the right to agree among themselves as to the conditions on which degrees are to be bestowed, and leaving the existing university as a rival whom they will immediately be tempted to undersell. If public money were bestowed on such a university it would merely be scrambled for by the constituent colleges, and would be spent in a rivalry in which the minimum advantage to learning would be produced by the maximum waste of funds.

If London is to have a University worthy of the name, if Parliament, the City Companies, and the London County Council are to provide it with the means absolutely necessary for its proper equipment, the University must be endowed with powers which will enable it to fashion the Colleges to meet the needs of London. It must be freed from, not fettered and hampered by, the necessity of maintaining in precisely their present form arrangements which are themselves in large measure the result of the religious animosities of fifty years ago.

But while this fundamental fact must in every way be insisted on, it would, of course, be absurd to attempt to compel the governing bodies of existing institutions to surrender all their rights off hand, or to treat as hostile men who have been doing their best for the public good amid great difficulties and with too little public sympathy. We cannot, therefore, but hope that the Commission may recommend, and the Colleges accept, some such plan as that recently proposed by the Professorial Association.

In this scheme a praiseworthy attempt has been made to combine a rigid insistance on the conditions necessary for the future success of the University, with a due regard for the susceptibilities of the Colleges out of which it will in part be constituted. It is proposed that the Governing Body shall consist of the Chancellor and the Vice Chancellor, and twenty-five Professors (each of whom shall be elected annually by the Professors of a definite group of cognate subjects), together with fourteen members nominated by the Crown, four members nominated by its Corporation and the London County Council, three representatives of Convocation, and four members, not being teachers in the University nominated by the Governing Body itself.

The last provision would enable the Court—as the Governing Body is called—to give temporary or permanent representation to public or semi-public bodies which it might be desirable to attach to the University. It is also proposed that the arrangements between the University and the existing colleges shall be negociated by a Statutory Commission with very wide powers, subject always to the condition that every Professor of the University, wherever he may teach, shall be appointed and paid by the University. To this Commission is entrusted the task of selecting in the first instance the fourteen members of the Court, whose successors will be nominated by the Crown. The choice is to be made "from among the existing members of the Senate of the University of London, and from members of the governing bodies of those colleges which may be incorporated, in such proportion as may seem advisable to the Commission, having regard to the importance of the vested interests involved, and to the magnitude of the educational resources which may be placed by each at the disposal of the new University. These initial appointments are to last for ten years, and at the end of ten years, or in the event of vacancy through death or resignation, the appointments are to be made by the Crown." Subject to the general control of the Court the Professors of the University are to have charge of all purely educational matters.

The colleges named as those which it is desirable to bring into connection with the University are (in alphabetical order) Bedford College, the Central Institution of the City and Guilds Institute, Gresham College, King's College, the Medical Schools, the Royal College of Science, and University College, while there are other institutions, especially those giving instruction in Fine Arts and in Law, with which it may be possible for the University to establish relations. It is also proposed that the University should have the power to appoint or to recognise teachers giving instruction of a more or less academic character at institutions or colleges, the objects

or the standing of which render complete incorporation with the University undesirable, and to institute "University Extension" lectures, always, however, subject to the condition that the teaching functions of the University are to be confined to the metropolitan area The examinations of the existing University of London would of course be carried on, so that in this part of its work the University would maintain its connection with all parts of the kingdom, and indeed of the empire

In all these points the suggestions of the Association appear to us to be eminently practical It is hopeless to expect a solution of the problem to which every one will agree The first desideratum is to secure the establishment of a new non-federal teaching University, and then to give a statutory commission the power to make bargains with the existing colleges, which must either assent to reasonable terms or be left outside the University altogether If any Governing Body consents to a close incorporation with the University it will secure representation on the Court both from among its lay members and its Professors When the University is fairly started the Crown will select persons who are or are not connected with the Colleges as may seem desirable The Medical Schools will be free to make terms with the Statutory Commission or to remain independent as they please Of course the Commission ought to be as strong as possible, and much will depend on it, but with the suggested constitution it would be impossible to make the University a federation It would be independent of and superior to the Colleges It would be powerful and important enough to bulk large even in London, and to attract help both from the State and the Municipality

COMPARATIVE GEOLOGY

Text Book of Comparative Geology By E Kayser, Ph D, Professor of Geology in the University of Marburg Translated and edited by Philip Lake, M A, F G S, late Harkness Scholar in the University of Cambridge With 596 Illustrations (73 plates and 70 figures in the text) (London Swan Sonnenschein New York Macmillan and Co, 1893)

AMONG works dealing with stratigraphical or historical geology, Dr E Kayser's "Lehrbuch der geologischen Formationskunde" holds a deservedly high place The account given in this work of the several geological systems, as displayed in Germany, is very full and complete; and the comparisons of the German strata with their equivalents in other parts of Europe are for the most part judicious and accurate A very striking and admirable feature of the book is its wealth of illustration, carefully selected specimens of the characteristic fossils of the several formations, are figured in such a way as to be clearly recognisable, and there is probably no text-book of the kind in which the number of forms thus represented is anything like so great

We cannot but think that Mr Lake has rendered a great service to geological students in this country by translating Dr. Kayser's admirable text-book, and for the general manner in which he has performed his task we have nothing but praise When a detailed examination of the book is made, however, it is impossible not to be struck with a certain inequality of treatment on the part of the editor and as we sincerely hope this excellent book may reach a second edition, it may be well to call attention to points in which it is certainly susceptible of improvement

There are two ways in which a teacher of geology in any particular country may advantageously introduce his students to the comparative study of the several formations He may, in the first instance, describe the formation as displayed in an area where his students can make direct acquaintance with it, and then proceed to point out the resemblances and differences presented by the various foreign equivalents of the formation, and there is certainly much to be said in favour of thus making geology "begin at home" But, inasmuch as the several systems of strata are very unequally developed in different areas, there is often a very obvious advantage in following a different plan If the district in which the most perfect exhibition of a system of strata can be studied be selected as the *type*, and all other areas be directly compared with this typical representation of the system, it is evident that a more satisfactory account of a formation can thus be given in a limited space than is possible by the other method

Now as regards the Palæozoic formations, we think that Mr Lake has been very happy in the methods he has adopted In the case of the Cambrian, Ordovician, Silurian, and Carboniferous systems, he has commenced with an account of their development in the British Islands The Devonian and Permian are, however, differently dealt with, the type of the first being sought in the Eifel and of the second in Central Germany Nothing could be better for the purpose aimed at than this blending of the two different methods of treatment to which we have referred

In his preface the author acknowledges the assistance received from Mr Marr and Prof Lebour in preparing the account of the Palæozoic rocks, and every one must be satisfied with the general accuracy and fulness of treatment of the British strata and their equivalents, so far as the great Palæozoic systems are concerned.

The most serious criticism which we have to offer with respect to this earlier portion of the work is as regards the limits adopted for the Cambrian Mr Lake divides this system into three portions, characterised by the *Olenellus*, the *Paradoxides*, and the *Olenus* fauna respectively, he nevertheless takes away from the Cambrian the Tremadoc beds, in which *Olenus* is so abundant, and makes them the base of the Ordovician We think that, in a work intended for English students, it would have been better to have followed the practice which has hitherto prevailed in this country, and to have included the Tremadoc in the Cambrian, giving a reference to Dr Kayser's views in a footnote

We also find in the preface an admission that "additions are most numerous in the first half of the work, while in the latter half the greatness of the subject and the limits of space have made themselves more severely felt" In the account of the Jurassic and Cretaceous strata there are not a few important facts with respect to the British representatives of those systems that are altogether omitted, while there is, we think, a dispropor

tionate amount of space given to some foreign equivalents. It is when we come to the Tertiary strata, however, that we are most painfully impressed by the inadequacy of the treatment of some very essential matters. The British Eocenes have about half a page devoted to them; there is no mention of the Hampshire Basin as distinct from that of London; and the table of strata given is neither that of one basin nor the other, but an awkward combination of beds from both. The English Oligocene is dismissed in about a dozen lines, and no mention is made of the rich and varied marine fauna of the New Forest. About the same amount of space is devoted to the Pliocene of East Anglia (that of the South Downs and Cornwall not being even mentioned), while the highly developed Pliocene of Belgium has assigned to it only a single line.

We make these remarks, not with any desire to find fault, but in order to call the author's attention to the fact that, in its present state, the work would be almost useless to an English student, unless he used it in conjunction with another geological text book, in which the British formations had received more adequate treatment. If the more vigorous editing, which has made the first part of this book so excellent, were applied to the latter half of the volume, we should then have an almost perfect work, and one which would find a place in every scientific library.

With all its faults, however, we have a text-book of stratigraphical geology which is superior to all its predecessors in respect to its illustrations, and its thoroughness. The copious index is of the greatest value, though the work would be improved by some additions to the references and the substitution in all cases of citations of original memoirs in the place of works giving information at second hand.

The plan of treatment of the several geological systems is excellent. The historical account of the establishment of the particular division and grouping of the strata is followed by sketches of the development of the system in the chief European areas, concluding in certain cases with shorter notices of some of the extra-European equivalents. This account of the stratigraphy of the system is followed by an admirable sketch of its palæontology.

There are two portions of the book which, to make the work suitable as a manual for English students, require to be greatly modified, if not altogether rewritten. These are the chapters relating to the Archæan and the "Diluvium" respectively. We can readily understand that the editor would shrink from so drastic a remedy as we suggest, and yet the views expressed in the book before us, upon the oldest and youngest of the formations respectively, are so entirely at variance with those which the beginner is likely to hear from any recognised teacher of geology in this country, that it is scarcely fair to students to allow them to stand in their present form. In the same way the uncompromising statements concerning the difference between the eruptive rocks associated with the tertiary and those of older geological epochs require serious qualification. If the editor felt that he could not, in fairness to the original author, make the necessary omissions or alterations in the text, he might have appended notes in which the attention of the student is called to statements that are at variance with the instruction he would ordinarily receive in this country.

Although we have felt it to be our duty to call attention to certain imperfections and blemishes in this book, we must repeat our verdict concerning its general excellence, and the hope that an opportunity will soon be afforded to its editor of preparing a second edition, in which these imperfections and blemishes may be removed.

THE BALTIC SHIP-CANAL

Der Nord-Ostsee Kanal. Von C. Beseke. (Kiel and Leipsic: Lipsius and Tischer, 1893.)

FOREMOST among the engineering works of the latter part of the nineteenth century must assuredly be placed the magnificent maritime canals, which afford such conspicuous evidence of industrial skill and enterprise; and of these great works few will yield in point of size and importance to the new sea-way between the North Sea and the Baltic, the history and progress of which is so ably described by Herr Beseke in the present volume.

The idea of such a canal has been under consideration for five centuries, and one of the most interesting chapters in the book is that which enumerates no less than sixteen schemes which have from time to time been propounded for the accomplishment of this difficult problem. These different projects are rendered all the more intelligible by means of a sketch map, indicating the various lines proposed, the majority of which, having their origin in the estuary of the Elbe, passed transversely across the Schleswig-Holstein peninsula to points in the vicinity of Kiel or Lubeck.

The inception of the present undertaking dates from October 19, 1883, when the Chancellor of State was directed by Imperial rescript to report upon the execution of a canal from Kiel to the mouth of the Elbe. The plans, prepared in conformity with this decree, were adopted, with trifling modifications, on March 16, 1886, the execution of the works being entrusted to a State Commission in July of the same year, and the first stone was laid by the Emperor William I. with an imposing ceremony on June 3, 1887.

The total length of the projected canal is about 61 English miles, the width at the water-line is 197 feet, and at the bottom, at the toe of the slopes, 72 feet; the total depth is nearly 28 feet. It is shown by means of a diagram that not only will two of the largest Baltic merchant vessels pass one another without difficulty, but also that there is room for a vessel of this type to give way to one of the finest ironclads of the German navy, such as the *König Wilhelm*, with a displacement of 9757 tons. Special passing stations have, however, also been arranged at intervals, similar to those on the Suez Canal.

The cost of the works was originally estimated at £7,800,000, which provides for 77,400,000 cubic metres of excavation, and all requisite contractors' plant and materials, entrance locks, bridges, and harbour works, as also for the forts needed to protect the western approach to the canal.

A most curious chapter is that which deals with the provision made for the conduct of the enterprise, and for the housing and accommodation of the large staff of workpeople engaged therein. The sub-contractors for

the various sections into which the works were divided—15 in number—had, under conditions carefully specified, to construct barracks for the staff of workers The canteen arrangements were all carefully thought out, and the prices of food were regulated by fixed tariffs The sizes of dormitories were prescribed, hospitals and laundries have to be provided, and all the sanitary arrangements appear to be most complete

It was a condition of their engagement that the workpeople should be at least seventeen years of age, no Socialists or Anarchists might be employed, and all drunken and dissolute persons were liable to instant dismissal Some of the regulations appear slightly autocratic, but doubtless with a population of from 6000 to 8000 persons brought together from all parts of Germany, such as was to be found on certain of the sections, it was necessary to insist upon a very severe discipline We are assured by the author that hitherto these rules have worked satisfactorily A detailed account is given of the four bridges required for the railway crossings, also of the numerous ferries and of the massive constructions needed to form the entrance locks of the canal at either end The water-level of the canal is almost coincident with that of the Baltic So that on 340 days in the year the sluices can remain open, and the lock-gates into the Elbe can be opened daily at certain states of the tide, the water in the canal is to be at one uniform level throughout

In consequence of the advanced state of the works it seems probable that the undertaking may be formally opened for traffic at the period originally contemplated, in the summer of 1895 Steamers will be permitted to propel themselves at a mean speed of about six miles an hour, and sailing vessels and barges will be towed in train through the canal by steam-tugs provided for this purpose

Herr Beseke presents us with most exhaustive statistics showing the saving in time caused by the use of the canal as contrasted with the dangerous passage round the coast of Denmark, and a wreck chart of the entrance of the Baltic serves as an effective object-lesson of the value to navigation of this new sea-way

In the concluding chapters we find most ample details of the volume of Baltic commerce and of the tonnage engaged therein, both in the form of steamers and sailing vessels, and excellent diagrams and charts have been specially prepared by the author to render these facts readily intelligible to the public Nor does Herr Beseke omit to treat of the industrial value of these works and of their importance to the Fatherland, both from the military and naval aspects, in fact their political significance is shown to be enormous

The volume contains a mass of well-digested information upon an undertaking concerning which but little has hitherto been heard in this country, but which is destined to exert a powerful influence upon the commerce of the states bordering upon the Baltic

OUR BOOK SHELF.

Laws and Properties of Matter. By R T Glazebrook, M A, F R S. (London. Kegan Paul, Trench, Trubner and Co, 1893)

This is the latest addition to the manuals on "Modern Science" which are appearing under the direction of Sir John Lubbock It is concerned with the meaning of the terms applied to matter, and with the principal properties which matter possesses, and contains chapters upon units of measurement, force and motion, work and energy, the forms of matter and of energy, and upon the properties of solids, liquids, and gases

The book is an excellent introduction to the study of the physical properties of substances, and meets the main difficulty of the beginner by supplying him with sound ideas on the ground-work of his subject It is indeed a matter for regret that there are so few similar books on other branches of science

Although the properties discussed are almost entirely mechanical or physical, the author occasionally touches upon the subject matter of chemistry, and here the chemical reader may perhaps be puzzled to find the term "molecule" applied in cases where he has been taught to use the term "atom" The molecular weights given on p 184, for example, are the ordinary atomic weights of the chemist It is impossible, however, to correctly discuss even such chemical phenomena as are given in the book, without employing the conception of atom as well as that of molecule Thus on p 183 it is stated that "by adding to each molecule of carbonic oxide a second molecule of oxygen we get carbonic acid" This conclusion is not in harmony with Avogadro's hypothesis, for carbonic oxide unites with half its volume of oxygen to form carbonic acid

The value 411 is much higher than those recently obtained for the critical temperature of water On p 19 "dynes in a given mass" should be "dynes in a given weight" The formulæ on pp 164 and 180 are not correctly printed J W R

The Partition of Africa By J Scott Keltie (London Edward Stanford, 1893)

The author of this book does not wish it to be regarded as a contribution either to the geography of Africa or to the history of African exploration His object has been to present "a brief connected narrative of the remarkable events which, during the last eight years, have led to the partition of the bulk of Africa among certain of the powers of Europe" In carrying out this purpose, Mr Keltie displays wide knowledge, sound judgment, and an admirable power of lucid and effective exposition The details of his narrative do not come within the scope of Nature, but we may note that in his occasional references to the scientific aspects of the subject he invariably gives evidence of a thorough grasp of the principles which can alone be of vital service in the study of geography This is especially true of a luminous and interesting chapter on "the economic value of Africa" The importance of the work is greatly increased by a large number of carefully-selected and well-executed maps

Forest Tithes, and other Studies from Nature By a Son of the Marshes Edited by J A. Owen (London Smith, Elder, and Co, 1893)

By "forest tithes" are meant the quantities of food secured at the expense of rural folk by wild creatures of the moorlands The subject is an attractive one, and in dealing with it the author of this little volume presents many bright and lively sketches of animal life The essays on other subjects are in their own way not less pleasant They all display an ardent love of nature and a remarkable power of minute and accurate observation—qualities which have won for "a Son of the Marshes" a place of his own among the popular writers of the day Some of the articles have already appeared in various publications, others are now printed for the first time

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE *No notice is taken of anonymous communications]*

Locusts at Great Elevations

THE following account of the occurrence of swarms of locusts at great elevations in the Himalaya, and these stripping birch trees, is from a privately printed record of an expedition to the north east of Kinchinjunga, in 1891, by Mr White, the British resident in Sikkim That flights of locusts are carried from the plains of India up to great heights in the Himalaya is a well-known fact, but not, I think, in the numbers nor with the results to birch or other forest trees here recorded

The Camp, April J D HOOKER

"On July 19, 1891, I crossed the Lunglala Pass, 17,400 feet On the Pass I saw the locusts that had infested Darjeeling, for the first time, though subsequently I saw them as high as 18,000 feet, where they were dying in the snow It will be remembered that this was the year of the great plague of locusts in Malta I heard that they had penetrated even into Tibet On the 21st I came down as far as Tangu, 12,750 feet, where the locusts were in swarms and dying in thousands The only plants they seemed to care about were the birches, and these they stripped bare "

The Sandgate Landslip

AS I have just returned from Folkestone, and have had opportunities for observing the recent "landslip" at Sandgate, perhaps a note on it may be of some interest to readers of NATURE, as I do not think the explanation suggested by Mr Blake in NATURE (vol xlvii p 467) is altogether applicable to the present instance

So far as I could see from a careful examination of the exposures, there is no trace of any movement of the solid rocks of the cliff, as these are nowhere exposed in the fissures that have been formed by the earth movements, and my impression from all that I saw is that the "slip" has been entirely confined to the débris which has accumulated in past ages against the flank of the escarpment On referring to the four types of Bergstürze or landslips described by Prof A Heim, of Zurich, some years ago in a monograph, which was summarised (with additions) by myself in the *Geological Magazine* (Decade II, vol x p 160 *et seq*), it is not difficult to identify the Sandgate incident with the first class of such phenomena, to which Prof Heim gives the name "Schuttrutschung", that is to say, a *slide* or *push* of an accumulation of débris (Schutt) Such accumulations often in mountain regions occur as lateral moraines or as talus, and in my paper on the origin of valley lakes (*Quar Jour Geol Soc*, vol xxxix, February, 1883) I have attempted to show how such masses play an important part in the formation of some lakes The Sandgate phenomenon I take to be no more than a magnified instance of what occurs in many a clayey railway cutting as railway-engineers know too well There seems to be no occasion for importing the notion of "faulting" of the rocks themselves into the question Still less rational is the notion that vibrations due to the blowing-up of one or two ships lately had anything to do with the catastrophe The most elementary principles of mechanics explain it completely

A mass of rock fragments and clayey material, such as may constitute a "scree," acquires in time a certain amount of coherency from the oxidation of the irony constituents, or from the solution and redeposition of carbonate of lime (where the materials are calcareous) by carbonated atmospheric waters percolating the mass, or from both of these causes If the mass is fairly drained internally it may retain its stable condition for any length of time, and be mistaken for a part of the solid geotectony of the district, though in cases where the materials are largely composed of decomposable silicates, it is evident that there is a tendency for the proportion of the fine slippery clay-material in the mass to increase. The consequence may be (and often is) that there is a tendency in the whole mass to settle down under the force of gravitation, and so a slow preliminary differential movement often goes on for years, before some new factor is introduced to precipitate the disaster There can scarcely be any doubt that the new factor in this case was the excessive rainfall of last February, and the want of sufficient under draining to carry away the water, which entered the mass of partly compacted débris from above A small lateral valley parallel with the general line of the escarpment had no doubt served as a catchment agent for much of this water This supposition is borne out by the facts (1) that further to the east, where a land drain was laid some years ago, the mass below it remained stable, (2) that above the western end of the "slip" the military hospital suffered no damage, the stability of its base being doubtless due to the complete under draining of the site which, as my kind friend and host Colonel Cranmer Byng informed me, was carried out before the hospital was built It is probable, however, that at the point of maximum movement the springs from the beds which form the plateau above had much to do with the water-logging and consequent diminution of the internal friction of the debris which moved, and that the action of those springs was exceptional or excessive in the early part of this year, owing to the rise of the water line in the ground at the back of the escarpment

I have talked the matter over with Mr Topley, who is an expert on all matters of Wealden stratigraphy, and he agrees generally with me as to the real nature of the phenomenon There is one obvious and only preventive against its recurrence

Wellington College, Berks, April 15 A IRVING

"Roche's Limit"

I MUST thank your correspondent G R for correcting my carelessness in giving Roche's limit round the sun as about a tenth of the earth's distance, instead of about a ninetieth as it really is

If R is the radius and D the density of a spherical planet, and d the density of the tidally disturbed and infinitesimal satellite, moving in a circular orbit so as always to present the same face to the planet, then the distance at which the satellite is on the point of being broken up by the tidal forces is $2.44 \mathrm{R} \times (\mathrm{D}/d)^{\frac{1}{3}}$ [1] This is Roche's limit, and the formula is correctly stated by G R

The mean density of Jupiter is about one third greater than that of water, and it does not seem unreasonable to suppose that the density of the fifth satellite may be as low as 2 This would bring the limit to 2 13 R

Any plausible hypothesis as to the density of the stones forming Saturn's rings will no doubt bring the limit somewhat inside the outer edge of the rings

I must plead guilty to not having made these numerical estimates whilst writing my review of Mr See's paper However, it still seems to me that the coincidences which I there noted are very remarkable

The simple illustration by which G R obtains a fair approximation to Roche's limit is very interesting

The satellite is replaced by two small spheres of density d and radius r, touching one another, in line with the large sphere of density D and radius R Suppose that when the point of contact is distant c from the centre of the large sphere, the small spheres are on the point of being pulled apart, then c is the approximation to Roche's limit G R 's condition is that the excess of the attraction of the large sphere on the nearer small one above the attraction on the further one is equal to the attraction between the small ones In algebraical language this becomes

$$\tfrac{4}{3}\pi \mathrm{D}\mathrm{R}^3 \, \tfrac{4}{3}\pi d r^3 \left\{ \frac{1}{(c-r)^2} - \frac{1}{(c+r)^2} \right\} = (\tfrac{4}{3}\pi d r^3)^2 \, \frac{1}{4r^2}$$

Whence

$$\frac{(c^2 - r^2)^2}{c} = 16\mathrm{R}^3 \, \frac{\mathrm{D}}{d}$$

Treating r as very small we have $c = 2.52 \mathrm{R} \times (\mathrm{D}/d)^{\frac{1}{3}}$

If the spheres r are not very small, if $\mathrm{D} = d$, and if R be taken as unit of length, the equation for c becomes

$$c^4 - 2c^2r^2 - 16c + r^4 = 0$$

This quartic determines the approximate limit when the satellite is not infinitely small

I shall now use this equation to find what size we must attri-

[1] "La figure d'une masse fluide soumise à l'attraction d'un point éloigné " E Roche *Acad des Sci de Montpelier*, vol i (1847 50), p 243

bute to the small spheres, so that all three spheres may touch one another. They touch when $c = 1 + 2r$, whence we get

$$9r^4 + 24r^3 + 22r^2 - 24r - 15 = 0,$$

the solution of which is ·85078.

Hence if the smaller spheres have their radii ·85078 of the large one, they are all three in contact, and there is no pressure between the small ones, when they revolve with proper orbital angular velocity. Now the analogue of this solution in Roche's problem is very interesting. The problem is to find the relative sizes of planet and satellite, so that where the satellite is in limiting equilibrium the two bodies shall just touch. The solution will give a fair approximation to that hour glass figure of equilibrium of rotating fluid, which I have treated otherwise in a paper in the Philosophical Transactions (vol. clxxviii. A., p. 379). The solution would be improved, although complicated, by allowing the larger body to be also deformed.

Unfortunately the solution requires the tabulation of several functions depending on elliptic integrals. Roche made, but did not publish, tables of certain integrals which he used for obtaining his results. It appears that the problem to which I refer did not occur to him.

Some years ago I began the computations necessary for this solution, but as it appeared to be a much more laborious task than I had anticipated, I have put the work aside until I should find leisure to attack the problem again. G. H. DARWIN.

April 10.

The Afterglows and Bishop's Ring.

I AGREE with your correspondents (pp. 101 and 127) that there has been a marked increase in the amount of dust in the upper regions of the atmosphere within the last few months, as evidenced by sky phenomena.

I did not notice the sunset of November 27, and it was not till the next morning I observed any increase in the dust phenomena here. About sunrise on the 28th "Bishop's Ring" was very conspicuous for the first time for a considerable period, as also were the whitish wisps in and near it, very similar to those forming such a noticeable feature of the Krakatão sunsets; but I have never again seen them so small and definite as when those sunsets first took place. The sunset of that day (November 28) was a magnificent and striking one, with a very deep pink glow. On the 30th there was a somewhat definite bright segment below the rosy glow, at first a dull buff, and then orange. This segment was a very striking feature of the earlier Krakatão sunsets, but I have rarely seen it since till that day. I noticed it again on December 4. The wisps continued to be very conspicuous up to December 13, after which date they gradually grew less so, and have now disappeared altogether.

After the middle of December I was travelling in Portugal, the Canaries, and Spain. The segment was invisible—or at any rate not a noticeable feature—after December 19 to January 30; but most of the time I was not favourably situated for seeing it on account of hills. From the last mentioned date to February 11 (during which time I was in the neighbourhood of the Straits of Gibraltar) the sunsets—generally on a cloudless sky—were very striking, and almost nightly the orange segment was very bright and definite, though I think not quite so definite in outline as in the Krakatão sunsets, but it reminded me much of them. As I had not been in that locality before, I do not know whether such sunsets are common there, or whether the phenomena were due entirely to a general accession of dust.

Since returning to England on February 14, the segment has sometimes been visible, though much less striking than in Spain.

"Bishop's Ring" still continues very conspicuous about sunset. I have not seen it of late years when the sun has had any considerable altitude, except on the 18th ult., from 1.30 to 3.30 p.m., I was then in Teesdale at from 1300 to 1700 feet above sea-level; it was quite plain when the sun was behind a cloud, and visible even with the sun free from clouds. It has never ceased to be visible at about sunrise and sunset since November, 1883, although at times very faint. Has it always occurred when the sun is near the horizon, and is it only because attention was called to it by its remarkable vividness at the time of the Krakatão sunsets that one has been able to see it ever since, though never before? Unlike Mr. S. E. Bishop I always see a certain amount of red in the outer margin; though in the late accession to its conspicuousness the red has been very dull, rather to be called dull brown than red. This has also been the case at times before.

One other feature of the Krakatão sunsets has occasionally been visible of late in this country, namely, the second pink glow in the western sky. This was much more striking in Teneriffe, though still much fainter than in the Krakatão sunsets.

It would appear that if this dust is the same as that seen at Honolulu, it took six weeks to get from there to Dublin and Sunderland, while the Krakatão dust took two months in reaching the south of England from Honolulu.

Sunderland, April 10. T. W. BACKHOUSE.

Thunderstorms and Auroral Phenomena.

I AM residing in tropical Queensland, lat. 21° S., and consequently am not likely to see any auroral phenomena, particularly in the middle of our hot and rainy season; but last night between 8 and 9 p.m. there occurred the following remarkable appearances, which were seen by me and several others.

There was a sharp thunderstorm with incessant lightning visible on the southern horizon, occupying a width of 10° and an altitude of from 5° to 10° above the horizon, probably from 80 to 100 miles off.

But for the distant thunderclouds the sky was clear and starlight, with a few light cirrhus clouds drifting before the north wind.

I was sitting on the lawn watching the distant flashes, when suddenly a patch or cloud of rosy light—5° to 6° in diameter—rose up from above the thunderstorm and mounted upwards, disappearing at an elevation of from 40°-45°. There were about twenty to twenty five of these patches in the course of half an hour, sometimes three or four in quick succession; they took from one to two seconds to mount, and were not associated with any particular flash; the rosy colour contrasted strangely with the silvery light of Nubecula Major just above. There were also occasional streamers, sometimes bifurcated, of 2° in breadth, which shot up in the same way as the auroral streamers, which I have seen both in the arctic and antarctic zones.

Auroral phenomena are known to be electrical manifestations, but here were the same phenomena exhibited in connection with a thunderstorm in the tropics. Thinking this phase of electrical action worthy of note, I send you this account and enclose my card. J. EWEN DAVIDSON.

Branscombe, Mackay, Queensland, February 5th.

P.S.—The thunderstorm, patches of light, and streamers were distinctly *connected*; it was not a case of an ordinary aurora, with a thunderstorm interposed.

Fossil Floras and Climate.

SIR WILLIAM DAWSON demonstrates that the plants of the cretaceous and tertiary series of Canada prove that the temperature of Greenland during the tertiary period was mild but not subtropical. That is sufficiently extraordinary, but geologists prefer, with strange inconsistency, the more astonishing contrast between Heer's arctic miocene palms and the glacial period. The fact is that these floras, comprising a few large leaved evergreens and relatively tender ferns and coniferæ, are not normal in such high latitudes, but confined to localities which might have been stations on the north coast of a warm Atlantic Ocean. Therefore they perhaps require nothing more prodigious than the circulation of a gulf stream in an Atlantic isolated from the Arctic Ocean, a probable state of things at that time. At all events tertiary plants collected from near the Equator negative any generally enhanced temperature.

This applies solely to the tertiary period, when many actually living species of plants were in existence. As we recede in time species become more strange and extinct, and likely to mislead. No wise person would define, for instance, from surviving cycads the climatic conditions they may have endured when as common and widely diffused as blackberries are to-day. Even estimates based on such a group as Gleichenia may be quite inapplicable when they sustained the *rôle* now usurped by the bracken.

Sir William Dawson is aware that with even the best preserved fossil leaves, and with access to the most complete herbaria in the world, half-a dozen different conclusions may be come to in

succession, while single and imperfect specimens are mere pitfalls. No imperfect or indistinct leaves, unless they possess exceptional characters, should be named, since however faithfully described or figured, they are simply confusing.

J. STARKIE GARDNER.

WILD SPAIN.[1]

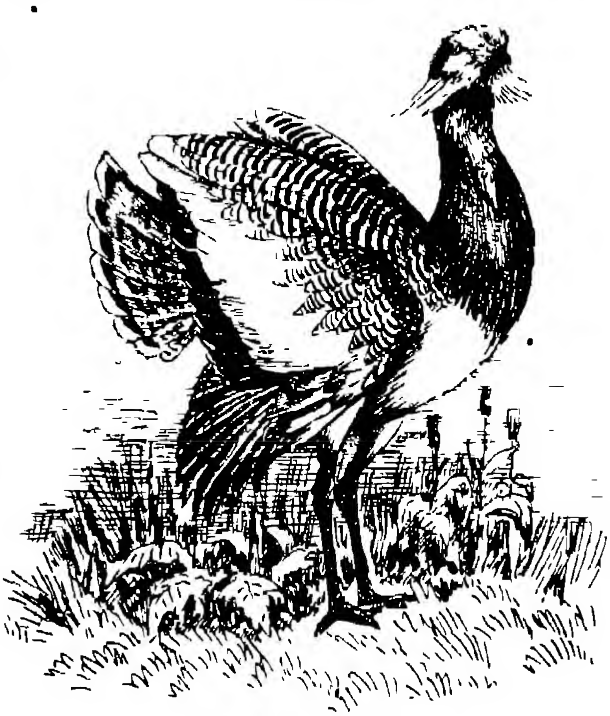
THERE seems to be no limit in these days to the demand for books on popular natural history, especially when they combine a certain amount of science with a sporting element. The present volume, in which the authors endeavour to describe Spain from "a point of view hitherto almost unoccupied, that of the sportsman-naturalist," excellently illustrated as it is, will, no doubt, attract a host of readers, for it deserves to do so. One of the joint authors, Mr. Abel Chapman, is already known to us as a writer on the bird-life of the Scotch Borders, and as an ornithologist who has laboured very successfully on the birds of Spain. His coadjutor, Mr. Walter Buck, who is resident at Jerez, has long devoted himself to the exploration of the lower valley of the Guadalquivir and the bordering Sierras—the most interesting districts of the whole peninsula.

Although the larger mammals of Spain are by no means neglected, and even such extraneous subjects as corn, wine, oil, brigands and gypsies are cursorily treated of, "Wild Life in Spain" is emphatically a "bird book." After their digressions on other points the authors return to their feathered favourites with a zest which shows that the study of the bird life of the peninsula, combined no doubt with an ardent love of "la chasse," was the primary object of their wanderings.

In the fauna of Wild Spain the abundance of the larger birds of prey forms a very prominent feature, and several chapters are well devoted to this part of the subject. Almost all the finest and largest Raptors of the European ornis are to be met with in Spain. To the ornithologist, who in these latter days may search the greater part of "Wild Britain" without finding anything more exciting than a stray kestrel or a fugitive sparrowhawk, this superabundance of the larger Falconidæ must prove a great attraction. Eagle shooting, which would be a fearful crime in England, is allowable, if not praiseworthy, in the Spanish peninsula, and even an occasional vulture may be killed without much harm being done. Moreover Spain is fortunate in possessing an eagle of its own, called by modern naturalists *Aquila adalberti*, which is in fact a local form of the Imperial eagle of South-eastern Europe. But the Adalbert's eagle is remarkable as showing several successive stages of plumage which do not appear to occur in its near ally. On these we have much information in the present volume from actual experience, which seems to prove that the Spanish Imperial eagle breeds indiscriminately in its youthful and adult liveries, birds in fully adult plumage having been found paired with others in the younger forms of dress. Besides eight or nine eagles two large vultures are abundant in the south of Spain, and the celebrated Lammergeier of the Alps known to the Andalucians by the appropriate name of "*Quebranta huesos*" or "bone-snatcher" is likewise still to be met with. How the eyries of this giant bird, situated in the mountains eastward of Jerez were visited and ransacked is told to us in two attractive chapters. As the breeding-season of the Lammergeier begins in January, when the Sierras are still under snow and the weather is inclined to be severe, such an expedition is by no means free from inconveniences.

Even in wild Spain, we regret to say, the Lammergeier is yearly decreasing in numbers. "A decade ago they were fairly numerous in the vast area of rock mountains which stretch between Granada and Jaen. To-day a week may be spent in that district without even so much as a distant view of this grand bird. The reason is unquestionably the use of poison, which is laid out broadcast by the goat-herds for the special benefit of wolves, but which is equally fatal to the Lammergeiers."

Another leading feature in the Spanish ornis is the Great Bustard, still abundant in Andalucia "on those vast stretches of silent corn-lands which form its home." "Big days with bustard," the various modes of its *chasse* and the principal features of its life are well described in "Wild Spain." It is curious that the authors do not seem to have been able to ascertain positively whether this bird is monogamous or polygamous. Even during the pairing season each band of bustards is composed of mixed sexes, the females preponderating, until the latter skulk off to perform the duties of incubation, and leave the males all together in separate packs. Bustard shooting must indeed be glorious sport. Oh, that Salisbury



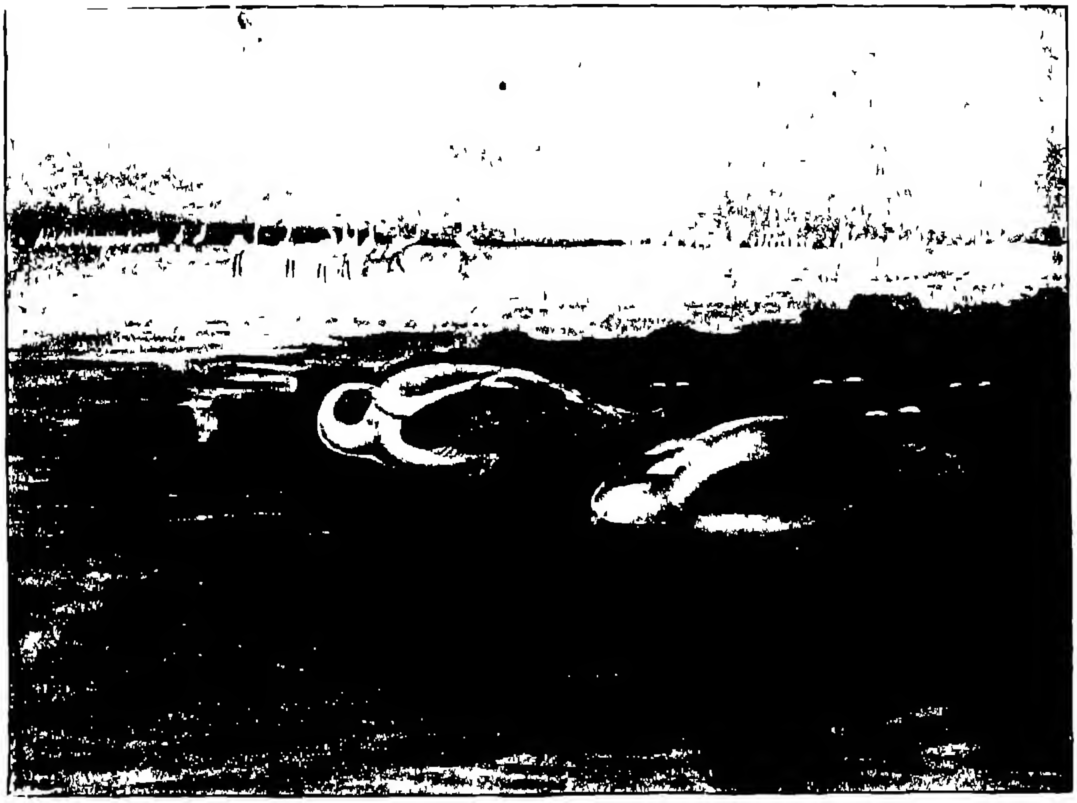
Male Great Bustard, showing off

Plain could be restocked with this now nearly extinct (English) bird!

Next to the bustard the flamingo is perhaps one of the most attractive objects to the explorer of the wilds of Andalucia. In some seasons flamingoes visit the marismas in enormous flocks, in other years they are extremely scarce. In 1883 Mr. Chapman found them abundant in the month of April, and searched the country over a large area systematically, in the hope of finding their breeding-places. The exact fashion in which this bird sits upon its nest had long been a matter of controversy, and it was hoped that this interesting point might now be definitely settled. But in April all efforts were unsuccessful—it was evident the birds had not yet begun to breed—and a smart attack of ague was the only result of splashing about from day to day in the mud and water, with a fierce sun beating down upon the ornithologist's head. In May, however, during an

[1] "Wild Spain (España agreste), Records of Sport with Rifle, Rod and Gun, Natural History and Exploration." By Abel Chapman, F.Z.S., and Walter J. Buck, C.M.Z.S. of Jerez. With 174 Illustrations, mostly by the author. (London: Gurney and Jackson, 1893.)

exploration of certain bird-islets lying off the shore of the marisma, success was at length obtained On a low mud-island was found a "perfect mass of nests," and scattered round the main colony were numerous single nests raised above the water level From a distance of about seventy yards the sitting birds were observed most distinctly "The long red legs doubled under their bodies, the knees (*scribe*, heels) projecting as far as or beyond the tail, and their graceful necks neatly curled away among their back-feathers, with the heads resting on their breasts—all these points were unmistakable" The problem was thus solved, for it had been asserted by previous authorities that the sitting flamingo, unlike other birds, straddles across its elevated nest, leaving its long legs dangling down on each side! It is only fair, however, to add that the true



Flamingoes on their Nests.

mode of the incubation of the flamingo has also been witnessed since, in the case of the North American species (*Phœnicopterus roseus*), by Sir Henry Blake, in the West Indian island of Abaco (see *Nineteenth Century*, December, 1887) Sir Henry has fully confirmed the accuracy of Mr Chapman's observations

Another curious discovery which we owe to the energy of Mr Chapman is the existence of wild camels living and breeding in the "Bœtican Wilderness" The statement that camels were roaming about and reproducing their species in Europe at first met with much unbelief and even ridicule. There can be no doubt, however, on the subject The camels were introduced from the Canaries in 1833, and for some years used as beasts of burden in the province of Cadiz At the present time some stray descendants of these camels live and flourish in the marisma in a "wholly wild state," and are "practically ownerless"

Did space permit, we could well give further "elegant extracts" from this interesting volume, which is replete with information on the inhabitants of "Wild Spain," and their manners and customs The numerous plates and smaller illustrations in the text are mostly excellent, and add greatly to the attractions of the work. We might, however, wonder that greater accuracy has not been secured as regards the spelling of some of the scientific names, especially when we are told that Mr Howard Saunders's experienced eye has "gone through the proof-sheets For example, *Haliaetus* is misprinted "*Haliaeetus*," *Aedon*, "*Ædon*," and *Rhopalocera*, "*Rhodopalocera*" Nor is it correct to call an Arabian camel (*Camelus dromedarius*) a "Bactrian" (*i e C bactrianus*) It is also now well known that the ichneumon of Spain is the same as the Algerian and Egyptian species (*i e Herpestes ichneumon*) It should therefore be no longer called *Herpestes widdringtoni*

NOTES

THE conditions under which the total solar eclipse on Sunday was observed seem, on the whole, to have been favourable According to a telegram from Ceara, the clouds at Para Cura – where the British expedition in charge of Mr. A Taylor was stationed—were heavy before contact, but afterwards dispersed, leaving a clear space for observation during totality The photographs were believed to be satisfactory The eclipse was seen at Bathurst, in West Africa, "in perfectly clear

weather," and no doubt was entertained there that the British expedition under Prof Thorpe, at Fundium, on the Salum River, had been equally fortunate M Bigourdan, one of the astronomers sent by the Paris Observatory to observe the eclipse in Senegal, has telegraphed to M Tisserand, the Director "Foggy sky, observed the four contacts, Vulcan not seen" Prof Pickering has telegraphed to the *New York Herald* that the atmospheric conditions prevailing at Mina Bronces during the solar eclipse were perfect, and that the results of his observations were very satisfactory He observed four streamers proceeding from the corona, two of which stretched over a distance of more than 435,000 miles Several dark rifts were also visible extending directly westward from the moon's limb to the utmost limit of the corona Several solar prominences attained great distinctness and brilliancy During the eclipse the surface of the moon appeared almost of an inky blackness, by contrast with the dazzling brightness of the inner corona The observations showed very conclusively that the present condition of the sun is one of great disturbance The corona was whitish rather than red in tint Many satisfactory photographs were taken

THE first Royal Society soirée of the present season will be held at Burlington House on Wednesday, May 10

THE International Sanitary Conference closed its proceedings on Friday last with the signing of a provisional convention by the representatives of Germany, Austria Hungary, Belgium, France, Italy, Luxembourg, Montenegro, the Netherlands, Russia, and Switzerland The delegates of the other Powers accepted the convention *ad referendum* The ratification is to take place in Berlin within six months According to the Berlin correspondent of the *Times*, the convention is divided into two chief sections The first contains the international preventive measures to be taken against cholera as regards passenger and goods traffic, as well as regulations for obviating a dislocation of trade in case of an epidemic The second section deals with the question of sanitation at the mouths of the Danube

A COMPLIMENTARY dinner was given by the Royal Meteorological Society, at Limmer's Hotel, on Saturday evening last, to Mr Henry Perigal, in celebration of his 92nd birthday, and of the completion of forty years' service as treasurer A number of friends from other societies with which Mr Perigal is connected also joined in the dinner The President, Dr C Theodore Williams, in proposing the toast of the evening, gave some interesting particulars of the Perigal family, tracing their history back to some time before the Norman Conquest The family have been remarkable for longevity Mr. Perigal's father, who was 99¼ years of age when he died, was one of thirteen children, nine of whom attained respectively their 64th, 67th, 77th, 80th, 88th, 90th, 94th, 97th, and 100th year —the last five averaging 93 years 100 days Their father and mother died in 1824, the former being nearly 90 and the latter upwards of 80 years of age Mr Henry Perigal was the eldest of six children, one of whom lived to the age of 85, and the youngest, Mr. Frederick Perigal, now in his 82nd year, was present at the dinner Mr Perigal briefly responded to the toast, thanking all present for their congratulations and kind wishes

THE "Universitas Jurievensis," formerly known as Dorpat University, celebrated the centenary of the birth of the astronomer, Wilhelmus Struve, who was a professor in the University, on Saturday last, the 15th inst, by an oration delivered in the large hall of the Institution

THE Council of the Marine Biological Association has decided that in future a table in the Plymouth Laboratory may be rented for a single week, at a cost of thirty shillings It is hoped that advantage will be taken of this arrangement in the shorter vacations The other charges (£5 for a month, £25 for six months, £40 for a year) remain the same

THE Council of the Durham College of Science have addressed to the governors and other friends of the institution an urgent appeal for the means of relieving the college from its financial difficulties During the last three or four years the college income has nearly balanced the expenditure, but this has been brought about only "by the teaching staff placing the financial interests of the institution in front of their own, sometimes going the length of surrendering their fees when it has not been obvious how they were to be paid out of the funds available, and in many cases providing, at their own expense, apparatus or assistance which, under ordinary circumstances, should have been supplied by the college" This is very creditable to the teaching staff, but it is absurd that such sacrifices should have to be made by the officers of an institution established and maintained for the benefit of the people of a great and wealthy district When the facts about the matter are generally known, the authorities of the college ought to have little difficulty in obtaining what funds may be necessary for the full development of its work

ANOTHER terrible earthquake occurred in Zante at seven o'clock on Monday morning It was even more violent than the earthquake by which so much damage was done in February Other shocks were afterwards felt The town of Zante was almost destroyed, the church of St Dionysius, the theatre, and the prefecture being among the buildings now in ruins According to the accounts telegraphed on Tuesday, seventeen persons were killed in the town, and many injured The villages in the island have not generally suffered so severely, but one village, Gaetani, has been totally destroyed, and there has been some loss of life A correspondent of the *Times*, telegraphing from Patras, says that at the time of the principal shock the sea receded several feet from the shore, and that a severe shock was felt at Patras, at Pyrgos, and on the western shore of the Peloponnesus

DURING the past week several depressions have traversed the extreme northern parts of our islands and Scandinavia, causing unsettled weather in those parts, which on Sunday extended southwards, and on the following day disturbed weather became fairly general over the United Kingdom The rainfall in Ireland and Scotland was somewhat heavy, but in the southern districts the fall was slight, and at several stations no rain fell In the neighbourhood of London the drought had lasted thirty days, a period which has been unparalleled at any season of the year during the last half century The day temperatures have varied considerably in different parts, the maxima on several days exceeding 60° and even reaching 67° in the midland and south eastern districts, while in the north they have ranged from 40° to 50° Sharp frosts have occurred during several nights, the readings on the 14th being from 5° to 8° below the freezing point in the shade over central England, and falling to 19° on the ground On Monday an anticyclone lay over the North Sea, again bringing fine weather to the south eastern portion of England, but on the following day depressions were approaching our north west coasts, and a gale was blowing in the extreme north, while the general conditions were of a more unsettled type than for some considerable time past During the week ended the 15th inst. there was a considerable decrease in bright sunshine, but still it exceeded the mean in nearly all districts.

THE Maryland State Weather Service publishes a monthly report in connection with the U S Weather Bureau That for March contains an interesting article by Prof. W B

Clark, of the Johns Hopkins University, on the surface configuration of Maryland The state is divided into three districts the Appalachian Region, the Piedmont Plateau, and the Coastal Plain The inland border of the Coastal Plain marks the head of navigation, above which the inclinations of the valleys rise more steeply This boundary is called the "Fall line", along it the larger cities of the Atlantic seaboard have grown up, and it marks out the leading highways of trade which connect the north and south The prolongation of these three regions through other states is pointed out, and attention is directed to their importance as affecting temperature, rainfall, and the direction of the winds

THE Berlin Academy has recently made the following grants — £50 to Dr Wulf, of Schwerin, for prosecution of his crystallographic researches, £30 to Prof Taschenberg, of Halle, for publication of his *Bibliotheca zoologica*, £50 to Dr Herz, of Vienna, for carrying further the reduction of the observations at the Kuffner Astronomical Observatory, £175 to Prof Selenka, of Erlangen, for a journey to Borneo and Malacca to investigate the development of apes, and especially the orang, and £25 to Prof Keibel, of Freiburg, for his researches on the development history of the pig

THE relations of the universities to the county councils in respect to technical education will be discussed to day and to morrow at a conference which will meet at Cambridge in accordance with arrangements made by the Cambridge University Extension Syndicate The conference will be attended by representatives of county councils and universities, and by other persons interested in the subject Cambridge has during the last year provided courses of lectures on various scientific subjects coming within the scope of the Technical Instruction Acts for eleven County Councils as well as for the technical education committees of other local authorities A large part of the work done has consisted of simple scientific teaching in villages and small towns, and the attempt thus to bring the universities into closer relation with rural districts has naturally led to results of considerable interest and novelty The results of such work and the most effective way of making progress in the future will be among the subjects discussed at the conference Another item will be the scheme for systematic instruction in agricultural science at the university, devised by Prof Liveing and others in cooperation with several of the county councils

THE Cambridge University Extension authorities have already announced as part of the programme of their summer meeting to be held in Cambridge next autumn five courses of practical work in science in the university laboratories and museums, the subjects selected being chemistry, electricity, botany, physiology, and geology As, however, the date of the summer meeting, July 29 to August 26, is too early for many teachers in elementary schools whose holidays fall during harvest time, arrangements have also been made for two courses in agricultural chemistry, specially adapted to meet the requirements of teachers sent with scholarships by their respective county councils Each course will extend from August 25 to September 12 inclusive, and will thus include sixteen working days, on each of which several hours' work in the university laboratory will be provided One course—conducted by Mr Fenton, one of the university demonstrators—is intended for students who have done little or no laboratory work, but have acquired a knowledge of theoretical chemistry, and will be similar to the course given last year and attended by about 120 county council scholars The other course—conducted by Mr R H. Adie, one of the Cambridge Extension lecturers—will be more advanced in character, and will be adapted to students who went through last year's course with credit, or have done similar work elsewhere Accommodation for 120 students can be provided at these two courses

LAST month a stone, which is valued at 17,000 rupees, was discovered at the Burma ruby mines According to the *Pioneer Mail*, this is the most valuable ruby which has come to light for some considerable time past

M ÉDOUARD BRANLY gives a further account of his experiments on the loss of the electrical charge of bodies in diffuse light and in darkness, in this week's *Comptes Rendus* He finds that a disc of polished aluminium, if it is experimented on a few days after being polished, behaves like most other metals, *i e* it slowly loses its charge, and the loss is approximately equal for the two kinds of electricity and independent of the kind of light to which it is exposed If the disc has been freshly polished, however, even in diffuse light the loss is rapid, and is only slightly diminished by surrounding it by orange glass, thus showing the loss not to be due, to any great extent, to the rays at the more refrangible end of the spectrum

IN the current number of the *American Journal of Science* there is a paper by Mr I Pupin describing a method of obtaining alternating currents of constant and easily determined frequency For this purpose he uses a small transformer, whose primary circuit contains an interrupter of peculiar design This consists of a stiff brass wire, stretched between the pole pieces of two permanent horse shoe magnets, and carrying at its middle point a short amalgamated copper wire At every vibration this copper wire dips into a mercury cup and closes the circuit of a battery, the repulsion between the current in the wire and the magnets serving to keep up the vibrations The tension, which can be adjusted without stopping the vibrations, is altered until the wire is in unison with a tuning-fork of known pitch In order to diminish the intensity of the harmonics which are present when the current is interrupted in this way, the primary of the transformer is joined in series with another coil, having a movable iron core, and in parallel with a condenser of variable capacity The capacity and self induction of the circuit are by these means altered till the natural period of the circuit corresponds with the fundamental of the wire The attainment of this condition is shown by the sparking at the break being a minimum Under these circumstances the circuit acts as a resonator, and selects from the complex E M F that harmonic with which it is in resonance, and strengthens it

FOR some considerable time continuous records have been kept at Greenwich Observatory of the earth currents along two lines approximately at right angles However, since the South London Electric Railway has been working, the records, except during a few hours of the night when the trains do not run, have been so disturbed as to be quite valueless These disturbances show to what an extent the current, when there is no insulated return, strays, as the railway is nowhere within four miles of the Observatory In order to continue the earth current records and if possible trace their connection with the disturbances of the earth's magnetism, Prof Mascart has had two earth-current lines fitted with continuous recording galvanometers, placed in the Parc Saint-Maur Observatory, and has so selected his lines that one runs exactly north and south, and the other east and west In addition to the above a continuous record is kept of the currents passing in an aerial circuit, which is at all parts insulated from the earth

IN the course of some investigations necessitating the elimination of small variations of atmospheric pressure, Dr. Carlo del Lungo constructed what appears to be a highly sensitive mercury barometer As described in the *Rivista Scientifico-Industriale*, it consists of a vertical tube of 20 mm. bore and about a metre long, bent round at the bottom in the ordinary way, but having the open end closed by a steel cap screwed on to an iron collar attached to the tube. A long

capillary tube of 1 mm bore is attached at right angles to the main tube a little above the bend, ending in an open vessel The amount of mercury is so adjusted that there is a free meniscus about the middle of the capillary tube Any slight increase in atmospheric pressure will then cause the main column to rise, and the necessary mercury will be withdrawn from the capillary A fall of pressure will be indicated by a forward movement of the meniscus in the horizontal tube Thus the rise and fall of the mercury in the main tube is exaggerated in the ratio of the sections of the tubes, in this case 400 : 1 Hence it is possible to observe a variation of $\frac{1}{100}$ mm Should the variation of the pressure be so large as to drive the meniscus out of the tube altogether, it can be brought back by screwing the steel cylinder up or down In spite of the errors introduced by variations of temperature and the faults due to capillary adhesion, variation of sectional area of the tube, and impurities in the mercury and the glass, the instrument appears to be well adapted to the observation of small fluctuations of pressure, such as the diurnal variation and the small and rapid oscillations peculiar to windy days On one such occasion an amplitude of two or three centimetres was obtained in the course of two hours, during which an ordinary barometer remained perfectly steady, and a Richard barograph showed only a faintly waved line

IF we may accept literally Sir Edward Braddon's glowing descriptions of gardens in Tasmania, that island ought to be the paradise of horticulturists Speaking the other day before the Indian section of the Society of Arts, he said of the garden he himself cultivated there for ten years "All the year through that garden had its charms of colour and perfume to lavish upon me, always there were life and growth in progress, and new delights unfolding themselves out of nature's bounteous lap" His monster pelargoniums, that stood from 3 to 4½ feet high, and had a circumference of 9 to 27 feet, were sources of increasing pride and pleasure to him, as they were of successive glories of flower As for his fruit trees and vegetable garden, they yielded a never-failing supply of food for the table that in England, purchased of the greengrocer, would have cost about £100 a year "Many another garden like unto mine is there," said Sir Edward, "in Tasmania and New Zealand, gardens in which all the fruits and flowers of the temperate zone flourish abundantly, and in which it is possible for a European to work all the year round without fear of sunstroke or frostbite" These panegyrics were uttered in the course of an address in which the speaker tried to persuade Anglo-Indians that after their term of service in the East they would find it pleasanter and more profitable to settle somewhere in Australasia than to return to England The address is an interesting one, and may be read—with the discussion to which it gave rise—in the current number of the *Journal of the Society of Arts*

THE Hornsey Local Board, Highgate, has set a good example to other Local Boards by organising an excellent museum of modern sanitary appliances About two years ago it occurred to the Board that it might be well to bring together some specimens of the most improved fittings for the guidance of builders and others. Accordingly a suitable room was erected, and manufacturers were invited to send examples of their manufactures. In order to ensure the permanence of the museum it was stipulated that all articles deposited should become the property of the Board, and thus an important collection—which now occupies seven rooms—has been gradually formed. It is open free to the public on week days, and a good catalogue of the contents of the museum has just been issued.

MR. ROBERT SERVICE, of Maxwelltown, writing in the new number of *The Annals of Scottish Natural History*, says it is somewhat surprising, considering the untold myriads of voles that have overrun the sheep pastures in southern Scotland for a year or two past, that so few variations in colour have been reported He himself has not seen any noteworthy aberration among those he has observed in peregrinating through their haunts, but the shepherds have reported an occasional pied example. Mr Service has, however, a very strong impression that the "hill voles" are decidedly of a more smoky tint than those to be found in the lower lands among the hedges and plantations The latter seem to develop a much ruddier colour on the fur along the back, and the general tone of gray seems much brighter than that of the voles that have ravaged the upland pastures

MR THOMAS STEEL continues in the *Victorian Naturalist* for February his remarks on some zoological gardens he has visited The collection at Rundwick Park, Sydney, contains some very fair specimens of various kinds, especially among the large carnivora and the monkeys, but he thinks a visitor from abroad would be disappointed in the small number of indigenous animals Melbourne and Adelaide seem to be better off in this respect Of the Melbourne Gardens, as compared with those he has visited elsewhere, he has a high opinion Nowhere has he seen more attention given to the rational housing and to the comfort of the animals

OPPONENTS of the doctrine of evolution have often tried to support their view of the subject by reference to the supposed sudden appearance of metaspermic plants in the rocks of the Cretaceous period In the *American Naturalist* for April Mr Conway McMillan deals with this point in an article on "the probable physiognomy of the Cretaceous plant population" He undertakes to show, first, that the appearance of Cretaceous metaspermic plants is proved, by the fossils, not to have been sudden, but gradual, and consequently, in Cretaceous time, the general preponderance of plant population was strongly coniferous, fern and cycadean, and second, that the conditions of Cretaceous time were such that the new and scattered metaspermic plants were placed under circumstances similar to those in which to-day variation is most rapid and plasticity is greatest for each species and even for every individual.

SOME interesting notes on alligator shooting in Trinidad are contributed by Mr S Devenish to the February number of the *Trinidad Field Naturalist's Club Magazine* In Trinidad it is commonly believed that if any one attempts to touch an alligator's nest, he runs great risk of being attacked by the mother alligator, who is always on the watch to defend her progeny While surveying on the left bank of the Caroni, Mr Devenish came once upon one of these curious constructions, and so frightened were his eight men at his going to examine and demolish it, that they all ran away to a distance of at least twenty yards, warning him of the danger of the "Maman Caiman," which was sure to attack him However, having beside his bowie knife at his side, his cutlass in hand, he prepared for defence, and quietly demolished with perfect immunity the large nest, in which he found a number of eggs Of these a few were blown for his collection, and the rest left to hatch near a little fountain in his garden. After a few days the hatching took place, and it was as curious as interesting, says Mr Devenish, "to see the little alligators, still adhering to the shells by their umbilical cords, briskly showing fight when approached, dragging the shell behind them and rushing with open jaws at anything presented to them and madly biting it"

THE Royal Dublin Society has published in its Proceedings a list of some of the Rotifera of Ireland, by Miss L. S. Glascott. The list is the result of research carried on from May to October in 1891. The number of rare and new species obtained during this short period seems to indicate that the

Rotifera are well represented in Ireland, and Miss Glascott has been induced to issue her list in the hope that it may lead other observers to study the group

DR. JOHN STRUTHERS contributes to the current number of the *Journal of Anatomy and Physiology* an important paper on the rudimentary hind limb of a great fin-whale (*Balænoptera musculus*) in comparison with those of the humpback whale and the Greenland right-whale His object is to determine the interpretation which should be given to the occurrence of a part apparently so rudimentary as a thigh bone of about the size of a pigeon's egg in a great whale He decides that the presence of the bone in fin-whales cannot be accounted for from the point of view of function, and that the bone must be regarded only as "a vestige" In the course of his inquiry Dr Struthers has had occasion to note the need for caution in the attempt to find a functional explanation of the presence of rudimentary structures "In endeavouring," he says, "to assign uses to rudimentary structures, we have to keep in view that such parts may in reality serve no purpose of functional utility, may be meaningless except as the products of decreasing heredity or as the incidents of variability, and that the parts attached to such structures may be but remnants, or may be adaptations acquired amid the surrounding activities"

THE purification of water more especially for drinking purposes has assumed quite a different character since the introduction and application of the bacteriological methods now in vogue Novel processes have in consequence been devised, whilst those already in use have received an altogether new interpretation In two recently published papers further contributions are made to both these aspects of the subject V and A Babes, in "Ueber ein Verfahren keimfreies Wasser zu gewinnen" (*Centralblatt für Bakteriologie*, July 30, 1892), describe a series of experiments which they have conducted on the removal of micro-organisms in water by means of alum Some years ago Leeds made some investigations on this subject, and showed that by the addition of one-half grain of alum to a gallon of water the number of microbes in fifteen drops was reduced from 8100 to 80 This material has, moreover, been employed for the purification of water on a large scale in America, the amount used varying according to the water, from one half to six grains per gallon of water In the above paper the authors record the use of very much larger quantities of alum than Leeds, and in all cases after agitating the water with this material, they obtained an absolutely sterile liquid, although the water contained originally as many as 1200 microbes in about twenty-five drops The number of bacteria in the sediment of a water shaken up with alum was also investigated, and was found to contain but a mere fraction of the organisms originally present In the second paper, "Reinigung des Wassers durch Sedimentirung" (*Centralblatt für Bakteriologie*, February 8, 1893), Percy Frankland details some further investigations he has recently made on the purification of water by sedimentation This author conducted a series of experiments some years ago on the removal of micro-organisms from water by means of agitation with different solid particles, both in the laboratory and as practically carried out during the softening of water by means of lime in Clark's process In the present investigations attention is directed to the bacterial purification which takes place during the storeage of water on the large scale in reservoirs. The following experiment may be cited, showing the nature of the results obtained —The Thames water before flowing into the reservoirs of one of the London water companies contained 1437 microbes per c c. (about 25 drops); on passing out of the first reservoir there were 318 present, whilst after passing through the second reservoir only 177 were present in the c.c Both Frank and Schlatter, the former for the river Spree, and the latter for the river Limmat at Zurich, have pointed out the reduction in the number of bacteria which is exhibited in the course of a river's flow, and the above results show clearly how important a factor is sedimentation in this process of purification

A FULL report of the second session of the International Congress of Experimental Psychology, held in London in 1892, has been published by Messrs Williams and Norgate

A LITTLE book which seems likely to be of good service to young students of geometry has been published by Messrs Macmillan and Co It is called "Exercises in Euclid, Graduated and Systematized," and is by Mr William Weeks, lecturer on geometry, St Luke's Training College, Exeter The examples are grouped in sets, each set bearing upon, and serving to impress, some fundamental fact or principle which is stated in larger type at the head of it Thus the object of the book is to build up the pupil's knowledge, and to develop in him gradually the power to grapple successfully with difficult deductions

SOME remarkably interesting illustrations of the zoological results obtained by the naturalists on board H M Indian marine surveying steamer *Investigator* are being published They consist of plates with brief explanations of the figures We have received Part I of "Fishes," by A Alcock, and Part I of "Crustaceans," by J Wood Mason In the former there are seven plates, in the latter, five

"A DAKOTA ENGLISH DICTIONARY" has been published by the U S Department of the Interior It is an enlarged and improved version of a work prepared by a missionary, the Rev S R Riggs, and published by the Smithsonian Institution in 1852 Mr Riggs died in 1883, but had been able to get the new edition of his dictionary ready for the press The task of editing his materials has been fulfilled by Mr J O Dorsey, who has made a special study of the Siouan language, including the Dakota, since 1871

A NEW mode of preparing hyponitrous acid, $H_2N_2O_2$, eminently suitable for demonstrating the existence of this interesting lowest acid of nitrogen in the lecture room, is described by Dr Wilhelm Wislicenus in the current number of the *Berichte* It will doubtless be remembered that hyponitrous acid was first prepared in the year 1871 by Divers, by reducing nitrates with sodium amalgam Zorn subsequently showed that the molecular composition of the acid was most probably represented by the double formula $H_2N_2O_2$ He prepared the ethyl salt and found it to be a substance suitable for a determination of vapour density, the numbers obtained upon making a series of such vapour density determinations indicated that its molecular composition was $(C_2H_5)_2N_2O_2$ Several years ago Victor Meyer described an interesting reaction of hydroxylamine, NH_2OH He showed that nitrous acid and hydroxylamine mutually decompose each other with production of water and nitrous oxide gas $NH_2OH + HNO_2 = 2H_2O + N_2O$ It was further shown that when concentrated solutions of hydroxylamine sulphate and sodium nitrite are mixed a rise of temperature and a violent evolution of nitrous oxide occur Dr Wislicenus now shows that even very dilute solutions of sodium nitrite and hydroxylamine hydrochloride although cooled by ice slowly evolve nitrous oxide, eventually suffering complete mutual decomposition The explanation of these reactions between hydroxylamine and nitrous acid has hitherto been unknown It is now shown to be due to the fact that hyponitrous acid is produced as an unstable intermediate product.

$$NH_2 OH + NO OH = HO.N N OH + H_2O.$$

It is a well-known fact that hyponitrous acid readily breaks up into nitrous oxide and water, hence the explanation of Victor

Meyer's reaction is at once apparent To prove the fact Dr Wislicenus shows that the silver salt of hyponitrous acid may actually be obtained from the solution at a certain stage of the reaction, and the experiment forms the best method yet described of demonstrating the formation and properties of hyponitrous acid There is always a considerable amount of hyponitrous acid present in the slowly-effervescing liquid obtained by mixing solutions of hydroxylamine sulphate and sodium nitrite at the ordinary temperature Much more, however, is present for a few minutes when the liquid is warmed to 50–60° At this temperature the decomposition is sufficiently rapid to cause somewhat energetic effervescence, but by the immediate addition of a solution of silver nitrate the greater portion of the hyponitrous acid can be fixed and precipitated in the form of the bright yellow stable silver salt, $Ag_2N_2O_2$ The yield of the finely divided precipitate is about ten grams for every hundred grams of hydroxylamine

WHEN it is desired to demonstrate this mode of formation of hyponitrous acid upon the lecture table, solutions of about three grams of hydroxylamine sulphate and the equivalent quantity of sodium nitrite are previously and separately prepared The total amount of solvent water should not exceed two hundred cubic centimetres When the time arrives to perform the experiment the two solutions are mixed and a little of the resulting liquid immediately decanted into a test glass, silver nitrate solution added, and the fact pointed out that the resulting precipitate of nitrite and sulphate of silver is white The vessel containing the main quantity of the liquid is then transferred to a water bath warmed to 50°, when a rapid evolution of gas at once commences The issuing gas may rapidly be shown to answer to the properties of nitrous oxide by inserting a glowing splint, and almost immediately silver nitrate solution should be added to the liquid, when the beautiful bright yellow silver salt of hyponitrous acid is precipitated

NOTES from the Marine Biological Laboratory, Plymouth — Last week's captures include the Polychæta *Hyalinœcia tubicola* and *Amblyosyllis* (*Gattiola*) *spectabilis*, the Mollusca *Ovula patula* and *Loligo media* (136 mm in length of mantle !), the Decapod Crustacea *Nika edulis*, *Ebalia Pennantii* and *Cranchii*, and the Tunicata *Clavelina lepadiformis*, *Archidistoma aggregatum* and *Perophora Listeri* The "gelatinous alga" has now entirely replaced *Halosphæra viridis*, and both spherical and elongated forms are being taken in the townets in great profusion A single specimen of the Cladoceran *Podon*, carrying embryos, has been taken for the first time this year Among the many animals now breeding, the following have not previously been noticed: the Cephalopod *Loligo media*, the Leptostracan *Nebalia bipes*, the Schizopod *Macromysis flexuosa* (= *chamæleon*), the Macrura *Pandalus brevirostris* and *Hippolyte Cranchii*, and the Brachyuran *Porcellana longicornis* The *Glaucothoë* stage of *Pagurus* has also been taken

THE additions to the Zoological Society's Gardens during the past week include a Black-bellied Weaver Bird (*Euplectes afer*), a Pin-tailed Whydah Bird (*Vidua principalis*), an Orange-cheeked Waxbill (*Estrelda melpoda*), two Common Waxbills (*Estrelda cinerea*) from West Africa, two Amaduvade Finches (*Estrelda amandava*), two Indian Silver bills (*Munia malabarica*) from India, presented by Miss Herring; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr H. H Forsayth, four Red-backed Buzzards (*Buteo erythronotus*) from the Falkland Islands, two presented by Dr. Dale, and two presented by Mr Vere Packe, three Upland Geese (*Bernicla magellanica*) from Patagonia, presented by Sir Roger T Goldsworthy, a Herring Gull (*Larus argentatus*) British, presented by Mr Thomas Owen, an Alexandrine Parrakeet (*Palæornis alexandri*) from India, presented by Mr S Hulme, a Banded tailed Tree Snake (*Ahætulla liocercus*), a — Snake (*Dipsas cenchoa*) from Trinidad, presented by Messrs Mole and Urich, six Green Tree-frogs (*Hyla arborea*) European presented by the Rev Clifford D Fothergill, a Moorish Toad (*Bufo mauritanica*) from Tunis, a Banded tailed Tree Snake (*Ahætulla liocercus*) from Trinidad, deposited, two Red Oven Birds (*Furnarius rufus*), a Melancholy Tyrant (*Tyrannus melancholicus*) from the Argentine Republic, a white eyebrowed Wood Swallow (*Artamus superciliosus*) from New South Wales, six Edible Frogs (*Rana esculenta*) European, purchased, a Gayal (*Bibos frontalis*, ♂) born in the Gardens

OUR ASTRONOMICAL COLUMN

THE PHOTOGRAPHIC CHART OF THE HEAVENS —M Lœwy in *Comptes Rendus* (No 13) for March 27 adds a few more words with regard to the scheme which he has suggested for determining the coordinates of the centres of the clichés Without such a method as his, or at any rate one that has for its object the same end (that is, of shortening the work), it seems that the work of determining the positions of the chief stars will extend over some period With 22,054 plates covering 169 cm and corresponding to a portion of the sky 4° 7 square the average number of stars up to the eleventh magnitude is estimated as 250 Now it is not necessarily certain that on all of these plates there will be stars whose positions are accurately known, and further, even if accurate places had once been obtained, our knowledge of their proper motions is not considered advanced enough to apply them in such an instance as this Only the two following ways, then, seem to be left —(1) To observe afresh with our meridian circles as many (say six) stars as will appear on each cliché and deduce their positions (thus eliminating proper motion), or (2) to adopt a system of triangulation, assuming we know the places of some of the more important position stars M Lœwy's method is based on the latter, in which he groups the clichés together, for instance, the first grouping would contain as many as sixteen square degrees, but the second, third, &c, would cover just twice this number With regard to "le problème du rattachement" he says, "Malgré tous les soins pris pour exécuter les photographies dans des conditions toujours semblables, il est impossible que les coordonnées mesurées sur deux clichés voisins soient immédiatement et rigoureusement comparable Chacun d'eux, en effet, représente la projection d'une portion de la sphère céleste sur un plan déterminé, et les plans de projection relatifs à deux plaques voisines sont inclinés l'un sur l'autre d'un certain angle Les poses ont pu être effectuées à des époques très différentes, on ne saurait donc s'attendre à ce que la situation des plaques par rapport à l'axe de la lunette, l'orientation l'échelle des mesures soient identiques dans les deux cas Par suite il est nécessaire de faire subir aux grandeurs mesurées certaines corrections, si l'on veut qu'elles constituent un système unique et homogène de coordonnées" In his first memoir M Lœwy has already given the formulæ, &c, for reduction, and in the one to which we refer below he gives us an application of his method

In *Comptes Rendus* for April 4 (No 14) M Lœwy states the results that he has obtained in applying his method of determining the coordinates of the stars on the clichés for the Photographic Chart As it would be impossible to give an idea of this computation without entering into the subject at some length, it seems best that we should leave it quite alone and refer our readers to the journal itself, from which he will get full information Suffice it for us to say that in the different methods of "raccordement" based on twenty six well determined positions, the probable error of the equatorial coordinates amounts nearly to ±0" 1, but "comme il faut encore admettre les erreurs réelles plus fortes qui les valeurs théoriques calculées, il devient évident que le degré d'exactitude obtenu, bien que suffisant, est loin d'être exagéré"

CATALOGUE OF SOUTHERN STAR MAGNITUDES —In vol xii no 1 of the *Memoirs of the American Academy of Arts and Sciences* will be found the results in catalogue form of Mr Edwin Sawyer's determinations of the magnitudes of southern stars from 0° to − 30° Declination to the 7th magnitude inclusive

The general plan was to observe every star three times, and out of the total number of stars in the catalogue (3415) 289 stars were observed less than this number of times, while 1048, 491, and 194 stars were observed four, five, and six times respectively, and the rest seven times or more. The various differences of brightness were estimated by Argelander's method of step-estimations, each sequence comprising ten, five, or twenty stars according to the number of stars in the vicinity observed. Commencing in the year 1882, Mr. Sawyer says that nearly half of the whole work was done in that time, an opera glass being extensively used for fainter sequences, such as those in which the stars were of the 6th or fainter magnitude a field glass was employed. During the years 1883 and 1885 the observations, as he tells us, were wholly discontinued, "owing to the injury to the eyes from the trying nature of the work." In the method of reduction the magnitudes were deduced by plotting out the sequences, graphically using the *Uranometria Argentina* magnitudes as ordinates, and the observed differences of brightness, expressed in steps, as abscissas. The arrangement of the catalogue itself is as follows:—The columns give successively the catalogue current number of the star, U.A. catalogue number, constellation, Right Ascensions and Declinations for mean equinox 1875.0, number of observations, mean magnitude deduced, U.A. magnitude, and the three last the separate dates of the observations and magnitudes.

Comparing the average differences between the magnitudes here assigned and those given by Gould, it is found that $\pm 0.088m$ about represents it, while the average error of a single determination, assuring equal degree of precision and including besides accidental errors, the effect of systematic difference is given as $\pm 0.059m$.

While the work was in hand eight variables were discovered, which were as follows:—U Ophiuchi (1881), U Ceti (1885), U Aquilæ and Y Sagittarii (1886), R Canis Majoris (1887), Y Ophiuchi and W Hydræ (1888), and (?) Leporis (1891), and in addition several large discordances were noticed in many values obtained (the catalogue number of these are here given), rendering these stars worthy of special attention. The volume concludes with notes, in which several suspicious cases of variables, &c., are recorded.

A NEW TABLE OF STANDARD WAVE-LENGTHS.—Under this title Prof. H. A. Rowland contributes to *Astronomy and Astro-physics* for April (No. 114) the new measurements of several metallic lines to be used as standards. The actual measures were made by Mr. L. E. Jewell, the probable error of one setting amounting to 1 part of 5,000,000 of the wave-length, and the reductions of the reading by Prof. Rowland himself. The measurements were obtained with a new machine, supplied with a screw specially made after Prof. Rowland's process. The standard wave-length of D used was the mean of the determinations of Angstrom, Muller and Kempf, Kurlbaum, Pierce, and Bell, and was 5896.156, different weights being given to these separate values. This value was utilised in six different ways, and the resulting table of wave-lengths from 2100 to 7700 was obtained, the accuracy of which might, as he says, be estimated as follows:—"Distribute less than $\frac{1}{100}$ division of Angstrom properly throughout the table as a correction, and it will be perfect within the limits 2400 and 7000."

METEOR SHOWERS.—Among the principal meteor showers for the current year, a list of which is given in the *Companion to the Observatory*, the following two occur this week, the former of which is described by Denning as "one of the most brilliant showers." The radiant points are:—

Date	Radiant α	Radiant δ	Meteors
April 20	270°	+ 33°	Swift
,, 25	272°	+ 21°	Swift, short

WOLSINGHAM OBSERVATORY, CIRCULAR NO. 35.—A plate taken with the Compton 8-inch photo-telescope, April 11, compared with a photo by Max Wolf, 1891, shows that the two stars

Es-Birm 545 18h. 28.9m. + 36° 55′ (1900)
,, 561 18h. 39.4m. 36° 52′ ,,

are var., the photo differences being approximately 9·1, 11·4, 8·8, 10·2.

GEOGRAPHICAL NOTES.

LETTERS dated March 9 have been received from the Antarctic whaling vessels confirming and extending the brief telegraphic information already published. The ships did not proceed farther south than 67° latitude, and discovered no signs of the existence of the Greenland whale, although whales of several other species were common, and there were great numbers of grampuses. In default of whaling, the energy of the crews was devoted to sealing, and the four vessels secured between them about 16,000 skins and a full cargo of oil. The seals were of several varieties, but until the return of the ships their species cannot be determined, nor their commercial value known. The weather throughout the whole stay in Antarctic waters was severe, and the formation of ice compelled the vessels to return at an earlier date than was at first intended. Flat icebergs of enormous size were seen, one being reported as fifty miles in length. The facilities afforded for scientific work were disappointing.

THE Delcommune expedition (p. 474) has returned to Europe, and M. Delcommune was received with great enthusiasm in Brussels. The expedition, together with the others sent out by the Katanga Company, has to a large extent completed the work of Livingstone and his successors in the Congo Basin, and in the main confirms the accepted geography of the region. One point of some interest which has been established is that the Lake Lanji, marked from Arab reports at the junction of the Lukuga and the Lualaba, has no existence.

THE new number of *Petermann's Mitteilungen* contains a short paper by Prof. Krummel on recent Russian oceanographical work in the north Pacific. This is accompanied by a map of the salinity of the surface water, which extends, and in a general way confirms, Mr. Buchanan's map founded on the *Challenger* work. The centre of maximum salinity lies between 20° and 30° N., and has its centre about 170° W. A tongue of considerably fresher water stretches nearly across the ocean, about 10° N. and sweeps round the coasts of America and Asia. The diminution of salinity northward is very interesting, the curves of equal salinity sweeping through Bering Sea without regard to the line of Aleutian Islands, thus showing that so far as regards surface water, Bering Sea is simply part of the Pacific ocean, standing in very marked contrast to the Sea of Okhotsk, a fact of some interest during the present international controversy.

MR. T. H. HATTON-RICHARDS read a paper on British New Guinea at the last meeting of the Royal Colonial Institute. While giving an account of the climate discouraging to would-be white settlers, Mr. Richards describes the native Papuans from personal experience as a fine race, possessing a keen sense of justice, and most laborious and successful as agriculturists.

RECENT INNOVATIONS IN VECTOR THEORY.[1]

OF late years there has arisen a clique of vector analysts who refuse to admit the quaternion to the glorious company of vectors. Their high priest is Prof. Willard Gibbs. His reasons for developing a vector analysis devoid of the quaternion are given with tolerable fullness in NATURE, vol. xliii. p. 511. His own vector analysis is presented in a pamphlet, "Elements of Vector Analysis, arranged for the Use of Students in Physics, not Published" (1881–84). Mr. Oliver Heaviside, in a series of papers published recently in the *Electrician* and in an elaborate memoir in the *Philosophical Transactions*, supports some of Gibbs's contentions and cannot say hard enough things about the quaternion as a quantity which no physicist wants. Prof. Macfarlane, of Texas University, has added to the literature of the subject, and without altogether agreeing with Gibbs takes umbrage at a most fundamental principle of quaternions and developes a pseudo-quaternionic system of vector algebra which is non-associative in its products!

Between the years 1846–52, just at the time when Hamilton was developing the quaternion calculus, a series of papers was published by the Rev. M. O'Brien, Professor in King's College, London. The system developed by O'Brien is essentially that

[1] Abstract of a paper by Prof. C. G. Knott, read before the Royal Society of Edinburgh, on Monday, December 19, 1892.

advocated by Gibbs and Heaviside. Two products of vectors are defined, which correspond to Hamilton's $V\alpha\beta$ and $-S\alpha\beta$, and applications are given of the linear and vector function and of the operator $\alpha\partial_1 + \beta\partial_2 + \gamma\partial_3$ which somewhat resembles the quaternion ∇.

The broad argument advanced by Gibbs in his letter to NATURE is that, in comparison with the quantities $V\alpha\beta$ and $S\gamma V\alpha\beta$, which symbolise an area and a volume which "are the very foundations of geometry," anything that can be urged in favour of the quaternion product or quotient as a "*fundamental* notion in vector analysis" is "trivial or artificial." These are brave words. Let us examine them by considering what is the purpose of a vector analysis. Clearly such a calculus is intended to show forth the properties of vectors in a form suitable for use.

Having formed the conception of a vector, we have next to find what relations exist between any two vectors. We have to compare one with another, and this we may do by taking either their difference or their ratio. The geometry of displacements and velocities suggests the well known addition theorem—

$$\alpha + \delta = \beta$$

in which by adding the vector δ we pass from the vector α to the vector β.

But this method is not more fundamental geometrically than the other method which gives us the quaternion. When we wish to compare two lengths a and b, we divide the one by the other. We form the quotient a/b, and this quotient is defined as the factor which changes b into a. Now a vector is a directed length. By an obvious generalisation, therefore, we compare two vectors by taking their quotient and by defining this quotient α/β as the factor which changes the vector β into the vector α. This is the germ out of which the whole of vector analysis naturally grows. A more fundamental conception it is hardly possible to make. Yet Gibbs calls it trivial and artificial! Far more fundamental, we are told, are the conceptions of a vector bounded area and a vector bounded volume, whose bounding vectors may have an infinity of values. Or take the more general case of a body strained homogeneously. The relative vector of any two of its points passes into its new position by a process which is a combination of stretching and turning. A simpler and more complete description cannot be imagined. It is perfectly symbolised by the quaternion with its tensor and versor factors. And *this* is trivial and artificial—as trivial, say, as the versor operation which every one performs when estimating the time that must be allowed to catch a train.

Another argument advanced by Willard Gibbs is in the paragraph beginning "How much more deeply rooted in the nature of things are the functions $S\alpha\beta$ and $V\alpha\beta$ than any which depend on the definition of a quaternion, will appear in a strong light if we try to extend our formulæ to space of four or more dimensions." To elucidate the "nature of things" by an appeal to the fourth dimension—to solve the Irish question by a discussion of social life in Mars—it is a grand conception, worthy of the scorner of the trivial and artificial quaternion of three dimensions. Further on we are told that there "must be vectors in such a space", that is, space of four or more dimensions. True, and if there be vectors, must there not be operations for changing one vector into another?

"Vectors must be treated vectorially" is a high-sounding phrase uttered by Prof. Henrici and Mr. Heaviside. What does it mean? On the same sapient principle, I suppose, scalars must be treated scalarially, rotors rotorially, algebra algebraically, geometry geometrically. That is to say the remark is a very loose statement of a truism, or it is profound nonsense. Strictly speaking, to treat vectorially is to treat after the manner of vectors, or to treat *as vectors do*.

Now what does a vector do? Prof. Gibbs, the prince of vector purists, says on page 6 of his pamphlet that "the effect of the skew [or vector] multiplication by α [any unit vector] upon vectors in a plane perpendicular to α is simply to rotate them all 90° in that plane." Hence a vector *is* a versor. To which Mr. Heaviside in fierce denunciation: "In a given equation [in quaternion vector analysis] one vector may be a vector and another a quaternion. *Or the same vector in one and the same equation may be a vector in one place and a quaternion* (versor or turner) in another. This amalgamation of the vectorial and quaternionic functions is very puzzling. *You never know how things may turn out.*" Puzzling? Then must Heaviside find his own system as puzzling as any. For when he writes the vector product $ij=k$, he is simply acting on j by i or on i by j, and turning it through a right angle. It is impossible to get rid of this versorial effect of a vector. It stares you in the face from the very beginning.

A very sore grievance with Heaviside and Macfarlane—although Gibbs cautiously steers clear of the whole question—is that Hamilton puts i^2, j^2, k^2, each equal to negative unity, with the consequence that $S\alpha\beta$ is equal to $-ab\cos\theta$, where a and b are the lengths of α and β, and θ the angle between them. This putting the square of a vector equal to *minus* the square of its length vexes their souls mightily. It is so "unnatural," so troublesome.

Now Prof. Kelland, in Kelland and Tait's "Introduction to Quaternions," chap. iii., shows that if we assume, as do Heaviside and Macfarlane, the cyclic relations

$$ij = k = -ji, \quad jk = i = -kj, \quad ki = j = -ik,$$

and if in addition we desire an *associative* algebra, then *of necessity* we must have $i^2 = j^2 = k^2 = -1$. If then, following these O'Brienites, we put what they consider to be so much simpler and more natural, namely, $i^2 = j^2 = k^2 = +1$, we get a non associative algebra of appalling complexity, which in the long run gives us no more than the associative quaternion algebra.

Heaviside apparently is unaware of the non-associative beauties of his system, which he believes "to represent what the physicist wants," for he says, much to the credit of the *Philosophical Transactions*, that his system (which is demonstrably *not* quaternions) is "simply the elements of quaternions without the quaternions, with the notation simplified to the uttermost, and with the very inconvenient *minus* sign before scalar products done away with" (*Phil. Trans.*, vol. clxxxiii. 1892, p. 428).

We have seen how perfectly natural is the geometric conception of a quaternion as the quotient of two vectors, and the quaternion product is as simply conceived of as the operator $(\alpha\beta)$ which turns the vector β^{-1} into α. Space considerations quickly lead us to consider quaternions which rotate a given vector through a right angle. If we take two such right or quadrantal quaternions I I' and operate severally on the vector α that is perpendicular to the axes of both, it is easy to show that

$$I\alpha + I'\alpha = (I + I')\alpha$$

gives a right quaternion $(I + I')$ bearing to I and I' the same relation which would exist were I and I' vectors. That is, right or quadrantal quaternions are added and subtracted according to the recognised rules for vector addition and subtraction, which so far be it noted, are all we know about vectors. Hence in combinations other than addition and subtraction we may treat vectors as quadrantal quaternions, exactly as Gibbs, Heaviside, and Macfarlane do, although in a half hearted fashion.

It remains now to consider wherein the systems advocated by these vector analysts improve upon Hamilton's. Do they give us anything of value not contained in quaternions?

Prof. Gibbs, having objected *in toto* to the quaternion product $\alpha\beta$, is for consistency's sake bound to object to Hamilton's selective principle of notation. His own notation is very similar in appearance to O'Brien's of old. He defines two products, the *direct* product $(\alpha . \beta)$ and the *skew* product $(\alpha \times \beta)$. The direct product is Grassmann's inner product or Hamilton's $-S\alpha\beta$, and the skew product is $V\alpha\beta$, so called probably because it has a value only when α and β are skew, or inclined to one another. Now there is a serious objection at the very outset to such a form as $\alpha \times \beta$ for the vector product of α and β. There corresponds to it no quotient amenable to symbolic treatment. The reason is, of course, that $\alpha \times \beta$ is not a complete product. Given the quaternion equation $\alpha\beta = q$, any one quantity is uniquely determined if the other two are given. But it is impossible, in spite of the suggestiveness of the form, to throw Prof. Gibbs's $\alpha \times \beta = \gamma$ into any such shape as $\alpha = \gamma \div \beta$. The point is that Hamilton's notation does not even suggest the possibility of such a transformation. It is certainly inexpedient, to say the least, to use a notation strongly resembling that for multiplication of ordinary algebraic quantities, but having no corresponding *process* by which either factor can be carried over as a generalised divisor to the other side of the equation.

One peculiar perplexity of Hamilton's notation arises from the fact that S and V are thrown out in bold relief from amongst the small Greek letters used for vectors and the small

Roman letters used for quaternions and scalars. A glance tells us what kind of quantity we have to deal with before we are called upon to inquire into its composition. There is no such eye-catching virtue in Gibbs's notation, and Heaviside largely destroys the contrast between the quantities and selective symbols by using capital letters for all. In print the vectors are made heavy and stand out prominently enough. But a vector analysis is a thing *to be used*, and with pencil or pen or chalk on a blackboard it is hopeless to prevent confusion between A and **A**. In suggesting a suffix notation for manuscript, Heaviside unconsciously condemns his own system. Two conditions for a good notation are (1) an *unmistakable* difference between *easily written* symbols for scalar and vector quantities, (2) the scalar and vector parts of products and quotients thrown out in clear relief. This second is quite as important as the first condition. So far, Hamilton's notation easily holds its own.

A very important symbol of operation is the Nabla, ∇, which may be defined in the form $\alpha\partial_1 + \beta\partial_2 + \gamma\partial_3$, where $\partial_1\partial_2\partial_3$ are space-differentiations along the mutually rectangular directions of the unit vectors $\alpha\beta\gamma$. Since Heaviside and Macfarlane make $\alpha^2\beta^2\gamma^2$ each equal to $+1$, they find that $\nabla^2 u$, where u is any scalar, is $d^2u/dx^2 + d^2u/dy^2 + d^2u/dz^2$. The real $\nabla^2 u$ is *minus* this quantity. When ∇^2 acts on a vector, Heaviside boldly defines $\nabla^2\omega$ as having the same significance, but Macfarlane, rejoicing in his non-associative algebra, finds that $\nabla(\nabla\omega)$ is quite a different quantity from $(\nabla\nabla)\omega$. The net result attained by this tinkering of the signs is to get a pseudo nabla non-associative with itself!

Gibbs moves more cannily. He defines separately the quantities ∇u, $\nabla \times \omega$, $\nabla . \omega$, and $\nabla . \nabla\omega$, which mean the same things as the quaternion quantities ∇u, $V\nabla\omega$, $-S\nabla\omega$, and $-\nabla^2\omega$. [In quaternions there is one definition of ∇, and everything else follows.] But even with these four definitions (all of which are properties somewhat distorted of the real Nabla) Gibbs finds his system lacking in flexibility. He has, so to speak, to lubricate its joints by pouring in the definitions of four other functions with as many new symbols. One of these is the Potential, the others are called the Newtonian, Laplacian, and Maxwellian. They are symbolised thus—Pot, New, Lap, Max. Their meanings will be evident when they are exhibited in quaternion form. Thus, as is well known,

$$\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}\right) \text{Pot } u = -4\pi u,$$

from which at once

$$\nabla^2 \text{ Pot } u = +4\pi u$$

or

$$\text{Pot } u = 4\pi\nabla^{-2}u$$

Similarly, if ω is a vector quantity,

$$\text{Pot } \omega = 4\pi\nabla^{-2}\omega$$

Then we have

$$\text{New } u = \nabla \text{ Pot } u = 4\pi\nabla^{-1}u$$

$$\text{Lap } \omega = V\nabla \text{ Pot } \omega = 4\pi V\nabla^{-1}\omega$$

$$-\text{ Max } \omega = S\nabla \text{ Pot } \omega = 4\pi S\nabla^{-1}\omega$$

Now, Prof. Gibbs gives a good many equations connecting these functions and their various derivatives, equations which in quaternions are *identities* involving the *very simplest* transformations. But there is no such simplicity and flexibility in Gibbs's analysis. For example, he takes eight distinct steps to prove two equations, which are special cases of

$$\nabla^{-2}\nabla^2 u = u!$$

Another of his *theorems*, namely,

$$4\pi \text{ Pot } \omega = \text{Lap Lap } \omega - \text{New Max } \omega$$

is simply the quaternion *identity*

$$4\pi\nabla^{-2}\omega = 4\pi\nabla^{-1}\nabla^{-1}\omega$$
$$= 4\pi\nabla^{-1}V\nabla^{-1}\omega + 4\pi\nabla^{-1}S\nabla^{-1}\omega.$$

Similarly the equation

$$4\pi \text{ Pot } u = -\text{ Max New } u$$

is a travesty of

$$4\pi\nabla^{-2}u = 4\pi\nabla^{-1}\nabla^{-1}u!$$

These extremely simple quaternion transformations cannot be obtained with the operator used by Gibbs. Hence the necessity he is under to introduce his Pot, New, Lap, Max, which are merely inverse quaternion operators.

Gibbs's system of dyadics, which Heaviside regards with such high admiration, differs from Hamilton's treatment of the linear and vector function simply by virtue of its notation. In his letter to NATURE he gives reasons why this notation is preferable to the recognised quaternion notation. As developed in the pamphlet, the theory of the dyadic goes over much the same ground as is traversed in the last chapter of Kelland and Tait's "Introduction to Quaternions." With the exception of a few of those lexicon products, for which Prof. Gibbs has such an affection,[1] there is nothing of real value added to our knowledge of the linear and vector function. As usual, the path is littered with definition after definition. Thus the *direct product*[2] of two dyads (indicated by a dot) is defined by the equation $\{\alpha\beta\} . \{\gamma\delta\} = \beta . \gamma\alpha\delta$. Quaternions gives at once

$$\phi\psi\rho = \alpha S\beta(\gamma S\delta\rho) + \&c. = \alpha S\delta\rho S\beta\gamma + \&c.$$

Then there follow the definitions of the *skew* products of ϕ and ρ, thus—

$$\phi \times \rho = \alpha\lambda \times \rho + \beta\mu \times \rho + \gamma\nu \times \rho$$

$$\rho \times \phi = \rho \times \alpha\lambda + \rho \times \beta\mu + \rho \times \gamma\nu$$

These are not quantities but operators. To see what they mean let them operate on some vector σ. Then we find

$$\phi \times \rho . \sigma = \alpha S\lambda\rho\sigma + \quad = \phi V\rho\sigma$$

$$\rho \times \phi . \sigma = V\rho\alpha S\lambda\sigma + \quad = V\rho\phi\sigma$$

The first is simply $\phi\varpi$, the old thing! The second is a well-known and important quantity in the theory of the linear and vector function. It is interesting to note, as bearing upon the *intelligibility* of the notation, that Heaviside, who dotes so on the dyadic, writes $\phi \times \rho$ in the form $V\phi\rho$, so that he makes

$$\phi V\rho\sigma = -V\sigma\phi\rho!!$$

As one example of our *gain* in following Gibbs's notation, take his dyadic identity—

$$\psi . \{\rho \times \phi\} = \{\psi \times \rho\} . \phi,$$

on which the comment is that "the braces cannot be omitted without ambiguity." The quaternion expression is $\psi V\rho\phi\sigma$, where there is no chance of ambiguity, where everything is perfectly straightforward, and where there is much greater compactness in form. It seems to me that this last equation given by Gibbs condemns his whole principle of notation. It shows that one use of connecting symbols is to obscure the significance of a transformation.

A beautiful example of virtually giving back with the left hand what he has taken away with the right is furnished on p. 42 of Gibbs's pamphlet. He writes "On this account we may regard the dyad as the most general form of product of two vectors. We shall call it the indeterminate product." And then he shows how to obtain a vector and a scalar "from a dyadic by insertion of the sign of skew or direct multiplication."

This is exquisite. From the *operator* $\alpha\lambda + \beta\mu + \gamma\nu$, he forms—heedless of his high toned scorn for the quaternion product—the conception of the sum of three similar though more general products, but quiets his conscience by calling them *indeterminate!* This sum of products then becomes by simple insertion of dots and crosses the vector

$$\phi_\times = \alpha \times \lambda + \beta \times \mu + \gamma \times \nu,$$

and the scalar

$$\phi_s = \alpha . \lambda + \beta . \mu + \gamma . \nu$$

Why, we naturally ask, is this *indeterminate* product welcomed where the *quaternion* product is spurned?

The truth is the quaternion, or something like it, has to come in, and in it most assuredly does come when Gibbs proceeds to treat the versor in dyadic form. The expression $\{2\beta\beta - I\} . \{2\alpha\alpha - I\}$ represents in Gibbs's notation the quaternion operator

$$\beta\alpha(\quad)\alpha\beta, \text{ or more simply } q(\quad)q^{-1}$$

The I is called an *idemfactor* and is simply unity.

There is something almost naive in the way in which Heaviside introduces the dyadic as if nothing like it was to be found

[1] We are surprised that so much etymological erudition should accept such a monstrosity as parallelOpiped.

[2] Gibbs calls the quantity $\phi . \sigma$ (which is simply Hamilton's $\phi\sigma$) the direct product of the dyadic ϕ and the vector σ. The direct product of two vectors is $\alpha . \beta$, and this Heaviside calls the scalar product. Similarly translating the Gibbsian dialect, he speaks of $\phi\sigma$ as being the "scalar product of the dyadic and the vector"—and gets a scalar product equal to a vector! This "is most tolerable and not to be endured."

in either Hamilton or Tait The truth is it is all there Hamilton showed long ago that if

$$\phi\rho = \alpha S\lambda\rho + \beta S\mu\rho + \gamma S\nu\rho,$$

then

$$\phi^{-1}\rho = \lambda_1 S\alpha_1\rho + \mu_1 S\beta_1\rho + \nu_1 S\gamma_1\rho,$$

where

$$\alpha_1 S\alpha\beta\gamma = V\beta\gamma, \&c, \ \lambda_1 S\lambda\mu\nu = V\mu\nu, \&c$$

Now Heaviside fusses greatly over this method of inverting ϕ, and any reader of § 172 ("Electromagnetic Theory," in the *Electrician*), would infer that the invention of the name dyadic suggestion this demonstration which Hamilton and Tait had somehow missed in their development of "the very clumsy way" of expressing $\phi^{-1}\rho$ in terms of ρ, $\phi\rho$, and $\phi^2\rho$ But the whole thing is given in Hamilton's "Elements" (p 438, equation xxvii), and in Tait's "Quaternions" (p 89, second edition, p 123, third edition) I would also refer to § 174 of Tait's third edition (§ 162 of the second), a comparison of which with Heaviside's tall talk in the *Electrician* of November 18, 1892 (§ 171), will show that, on the most lenient hypothesis available, our self appointed critic of Tait's methods has never really read Tait's "Quaternions"

All through his system Prof Gibbs has refused to consider the complete product of two vectors He has used the form $\alpha\beta$ to mean a "dyad" or operator of the form $\alpha S\beta$ or $\beta S\alpha$ What, then, can he mean us to understand by the equations—

$$\iint d\sigma\omega = \iiint dv\nabla\omega \quad ((2) \text{ of } \S\ 164),$$

and

$$\int d\rho\omega = \iint d\sigma \times \nabla\omega \quad ((2) \text{ of } \S\ 165)$$

In quaternion notation the last would be written

$$\int d\rho\omega = \iint V(d\sigma\nabla)\omega$$

Both equations are quite correct if and only if $d\sigma\omega$, $d\rho\omega$, and $\nabla\omega$ are taken in their quaternion meaning of *quantities* But Gibbs has wilfully cut himself adrift from this interpretation How, then, does he interpret these equations?

The chief arguments of the paper may be briefly summarised thus —

(1) It is maintained that the quaternion is as fundamental a geometrical conception as any that Prof Gibbs has named

(2) In every vector analysis so far developed, the versorial character of vectors in product combinations is implied if not explicitly stated

(3) This being so, it follows as a *natural* consequence that the square of a unit vector is equal to negative unity

(4) The *assumption* that the square of a unit vector is positive unity leads to an algebra whose characteristic quantities are non-associative, and whose ∇ is not the real efficient *Nabla* of quaternions.

(5) The invention of new names and new notations has added practically nothing of importance to what we have already learned from quaternions

EXPERIMENTAL MEDICINE[1]

THIS volume is the fourth number of this remarkable publication, and will prove of surpassing interest to the bacteriologist, physiologist, and physician, chiefly on account of the first paper which it contains[2]

In 1877 Dr N V Eck invented an operation by which it was possible to alter the circulation in such a manner that the blood flowed from the portal vein into the inferior vena cava without passing through the liver He succeeded in establishing an artificial opening between these veins in several dogs, and then tied the portal vein near the liver, unfortunately, only one dog lived for any length of time (two and a half months), and, owing to an accident, Dr Eck was unable to control the result by post-mortem examination The operation has now been repeated at the St Petersburg Institute, and it has been found that in successful cases the blood passed entirely from the portal vein into the inferior vena cava

The animals which successfully resisted this severe operation showed no alteration in the appetite, though after a period of ten days or so their temper underwent marked changes Although perfectly docile before the operation, they now became bad tempered, bit everything that came in their way, and showed undue excitement on trifling provocation The animals became weak, and their gait ataxic, whilst the sensory apparatus was also greatly disturbed, as they often became blind, and appeared to lose all sensation of pain In a further stage convulsions and coma supervened, though the animals occasionally recovered perfectly after a time, many of them died when the first attack of excitement and convulsions occurred, or succumbed to subsequent attacks, although, on the whole, the latter rarely proved fatal The temperature showed no changes attributable to the veinous fistula, but the weight generally diminished until death supervened, although, in animals which recovered it reached, or even exceeded, the original weight The appetite was good, though capricious, but a distinct relation was found to exist between the state of the alimentary canal and the attacks of excitement before mentioned The animals which absolutely refused to eat meat remained free from the attacks, while the "crises" invariably occurred in the dogs that ate meat voraciously It is a remarkable fact that many of them learnt by experience that meat was bad for them, and declined to take it

Some dogs recovered perfectly, and at the postmortem it was found that a collateral circulation had been set up, so that the portal blood again circulated through the liver

It would appear from further observations that these symptoms are due to the toxic action of the products of the transformation of nitrogenous food, the liver being unable to convert them into urea and uric acid Carbamic acid was found in the urine of these animals, and carbamate of sodium or calcium, when introduced into a healthy animal's stomach, produced exactly the same symptoms as the fistula above described On the other hand, it was found impossible to poison healthy dogs with the same salt, provided the setting free of carbamic acid was prevented by the simultaneous introduction of carbonate of soda into the stomach, while the introduction of both salts gave rise to all the symptoms of carbamic acid poisoning, when the circulation through the liver had been interrupted The authors conclude, therefore, that the carbamates formed during digestion in passing through the liver are transformed into a harmless substance, and that this substance is most probably urea

In some cases the experimenters removed the entire liver, but the animals never lived more than six hours, and fell at once into a comatose state, followed by convulsions, tetanus, and death through arrest of the respiration Similar results were obtained by establishing a veinous fistula in the first place and tying the hepatic artery afterwards

According to Messrs Hahn and Nencki, who performed the chemical part of these observations, the reaction of the urine remained normal until one of the attacks of excitement set in, when it became alkaline If the hepatic artery were tied at the same time, the urine contained a little albumin and hæmaglobin, together with small quantities of urobilin and biliary pigment, provided the gall bladder had not been emptied before the operation The quantity of urea was always greatly lessened if the hepatic artery were also tied, or the greater part of the liver removed The relation of the nitrogen in urea to the total quantity of nitrogen excreted was much smaller than normal, being only 77 per cent instead of 89 per cent On the other hand, the uric acid in the urine ultimately increased in quantity, even when the hepatic artery was not tied, although the total quantity of nitrogen excreted was not greater than normal, the increase in the uric acid corresponding to the setting in of the convulsions With regard to the ammonia contained in urine, the authors have come to the following conclusions —(1) Eck's operation, combined with the ligature of the hepatic artery, causes in dogs an increase in the excretion of ammonia. In some cases this increase is relative only with regard to the nitrogen of urea or the total nitrogen, whereas in other cases it is absolute and this absolute incre[illegible] takes place when the animals survive the operation for t[illegible]y hours at least; (2) the secretion of ammonia increases rapidly in animals which have been subjected to Eck's operation as soon as the first symptoms set in

In a further series of researches the authors showed that car

[1] "Archives des Sciences biologiques publiées par l'Institut impérial de médecine expérimentale à St Pétersbourg," vol i no. 4

[2] "La fistule d'Eck de la veine cave inférieure et de la veine porte, et ses conséquences pour l'organisme, par MM. les Drs. M Hahn, V. Massen, M Nencki, et J Pawlow"

bamic acid is present in the urine of a normal animal, and increases after Eck's operation It would be interesting therefore to compare these facts with what we know of the increase of ammonia in pathological states of the liver in man The liver, however, is not the only place where urea is formed, for the urea never completely disappeared in any of these experiments, and it is well known that in sharks which live seventy hours after the removal of the liver, the urea in the muscles does not diminish after the operation

Such are the chief new facts we have met with in this interesting memoir, and it is certain that these investigations open up a new field for further researches The other papers[1] contained in this volume call for little comment, they relate chiefly to the digestive and putrefactive processes taking place in the human intestinal tract

It will be seen, however, that this fourth number sustains the well earned reputation of the three first ones, and that the archives deserve to take their place among the chief scientific journals which made their first appearance in the year 1892

STEAM ENGINE TRIALS

A PAPER on the last series of steam engine trials undertaken by the late Mr P W Willans was read at the meeting of the Institution of Civil Engineers on April 11

The paper dealt with an extensive series of condensing trials made with a 40 I H P Willans Central Valve Engine These were intended to form a sequel to the investigations described in the author's papers, entitled "Economy Trials of a Non-condensing Steam Engine, Simple, Compound, and Triple," read before the Institution in 1888 and 1889 The principal objects in undertaking these trials were—(1) To ascertain the initial condensation in the first cylinder, and to trace the behaviour of the steam in the succeeding cylinders, when working as a compound or triple expansion engine, (2) To observe the effect of speed of rotation, area of exposed surface, and range of temperature, upon the initial condensation, and upon economy generally, (3) To ascertain the percentage of the theoretical mean pressure actually obtained, (4) To ascertain the ratio of the work done by each pound of steam to the theoretical work due from it, (5) To determine the consumption of steam at all loads, and under various conditions.

The consumption of steam was determined by discharging the condensed water from the exhaust into a tank carried by a weigh bridge, and observing the intervals of time required for fixed weights of water to run in By this method, a continual watch was kept on the performance of the engine during the whole trial, and any disturbing cause was immediately detected, leaky steam pipe joints did not affect the result, and the length of the trial might be much reduced Special experiments, made to ascertain whether any addition was necessary to cover leakage in the engine and exhaust-pipe, showed that this leakage was slight

The method of determining the theoretical work due from one pound of saturated steam when discharging into a condenser was next considered, and it was shown that the thermal efficiency of a condensing engine must of necessity be less than that of a non-condensing engine, owing to the greater proportionate size of the "toe" of the diagram cut off for practical reasons In the non-condensing trials the best number of expansions was computed from the approximate formula $p^8 v^7$ = constant, but for the condensing trials the error in this could not be neglected The best ratio of expansion and mean pressure were therefore calculated for adiabatic expansion, by Mr. Macfarlane Gray's $\theta \phi$ diagram, combined with a volume curve Altogether sixty-two trials were made under various conditions of speed, steam pressure, load, and ratio of expansion, as well as with the engine working simple, compound, and triple, and the results were embodied in the tables accompanying the paper

One of the principal deductions from these experiments was the "straight-line" law of steam-consumption, and it was shown by diagrams that the *total* water for the horse-power corresponding to any mean pressure P, was W + K P, where W was the water which would be used by the engine at zero mean pressure (through initial condensation, radiation and conduction), supposing it were frictionless, and K was the water per hour required to produce each pound of mean pressure These factors were shown to vary with the conditions under which the engine was working

Eighteen of the trials were planned to assist in determining the law connecting initial condensation with revolutions, and it was found that in the high pressure cylinder at high mean pressures the total condensation per unit of time was directly proportional to the square root of the number of revolutions per unit of time As the mean pressure was diminished, the condensation became more and more nearly constant at all speeds, and finally, at low mean pressures, the law appeared to be reversed For the low-pressure cylinder, the law was modified

The important question of the changing proportions of steam and water present during the expansive part of the stroke was investigated by the $\theta \phi$ diagram The matter was first examined theoretically by considering the effect of a thin liner of infinitely conducting matter, and a curve was drawn on the $\theta \phi$ diagram showing the rate at which the steam initially condensed in warming up the liner from the exhaust to the initial temperature was re-evaporated as the expansion proceeded The actual re evaporation, as obtained by measurement of the indicator cards was compared with this theoretical re evaporation, the difference measuring the delay in the return of the heat from the liner to the steam The losses due to conduction and radiation, to passage through ports, and to incomplete expansion, could also be shown on the $\theta \phi$ diagram

The question of the economical advantage of reducing the power by automatic cut off *versus* throttling was discussed Broadly, the result was that the gain by varying the expansion was large for a simple engine, moderate for a compound engine, and, for a triple engine, almost inappreciable It further appeared that the gain at high speeds was greater than at low speeds

A few trials made with the cylinders steam jacketed showed a slight gain, but further experiments were required to show whether the gain was likely to be worth the extra trouble and expense involved

The missing steam at cut off varied in the trials to even a greater extent than it did in the non condensing trials—the amount being much affected by the range of temperature, the density of the steam, and by other conditions

It appeared that, under all circumstances, the triple-condensing engine showed an advantage over the compound in regard to steam consumption, but that, except for very large engines, the compound-transfer engine was probably the best for pressures below 150 lbs (absolute) pressure per square inch

ETHNOLOGICAL OBSERVATIONS IN AUSTRALIA

SOME time ago Mr R Etheridge, jun, carried on a series of geological and ethnological investigations in the valley of the Wollondilly River, at its junction with the Nattai River, New South Wales, and in the latest number of the "Records of the Australian Museum" (vol ii No 4) he gives an interesting account of the various facts he had occasion to study The following is the greater part of the passage in which he records his ethnological observations.—

The aborigines of the Wollondilly and Nattai Valleys, must, from local accounts, have existed in considerable numbers, and are now only represented by interments, carved trees, wizards' hands, and charcoal drawings in rock shelters along the precipitous escarpments

The first objects investigated under this head were the "Hands on the Rock." The "rock" consists of a huge mass of Hawkesbury Sandstone, about seventeen feet in breadth and length, hollowed out on the side overlooking the river to the extent of six feet. It is perched on the side of a gentle rise from the Wollondilly, having rolled from the higher ground above, and alongside the track from the Nattai Junction to Cox's River, in the immediate south-west corner of the Parish Werriberri. The cavernous front of the rock is fifteen feet

[1] "On the Putrefactive Processes in the Large Intestine of Man and on the Microbes Causing Them," by M Lumfc. "On the Micro-organisms in the Organs of Choleraic Patients" by M L. de Rekowski. "Contributions to the Study of Chemical Processes in the Intestines of Man," by M. [illegible]owski

broad, and twelve feet high On the back wall are depicted a number of red hands, both right and left Under the principal hands are four white curved bands, resembling boomerangs or ribs, the whole of the hands being relieved, as is usually the case with these representations, by light splash work The hand marks in this shelter differ, however, from any I have seen before by an unquestionably previous preparation of the rock surface for their reception by incising the surface to the shape of each hand, thus leaving a slightly raised margin around each I have recently given (Records Geol Survey, N S Wales, 1892, iii Pt 1 p 34) an epitome of our knowledge of these hand imprints, their method of preparation, and supposed significance sufficiently full to render any further reference unnecessary at present The colour red, amongst black races, was the symbol of evil (Fraser, Journ R Soc, N S Wales for 1882 [1883], xvi p 213)

Mr Maurice Hayes, of Queahgong, informed me that he has known the rock for the past fifty years, and that the imprints have not altered in the least He found it difficult to obtain trustworthy information from the aborigines regarding them, they expressed ignorance, but ultimately gave him to understand that the "hands were the imprints of those of their Deity when on earth"

The large alluvial flats in this neighbourhood, along the Wollondilly, were, I was informed, great gathering grounds for the various tribes from many miles round, even those of Goulburn and Shoalhaven participating

On a spur overlooking one of these green expanses, known as Gorman's Flat, immediately at the junction of the Wollondilly and Nattai Rivers, we investigated an interment, thirty years old, indicated by a single carved tree, but the device has, I regret to say been wantonly destroyed This grave is known to be that of "Jimmy Aremoy," or "Blackman's Billy," of the local tribe, and called in the aboriginal dialect *Ah-re moy*, and was covered by a small mound at the foot of a small tree, forty-seven feet north of the carved tree, and had been surrounded by a sapling fence After removing the mound and superincumbent soil, we found the grave had been filled with boulders and large pieces of rock to the depth of four feet six inches, whilst under this was a layer of split timber and bark On removing this we found the skeleton well wrapt in what had once been an old coat, a blanket, and an opossum rug The skeleton was doubled up in the usual manner, the arms drawn up to the breast, and the legs against the abdomen, placed on the right side, and facing the south-east

Not the least interesting fact was the variety of articles placed with the deceased, according to aboriginal custom Loose in the superincumbent earth we found an ingenious conversion of a piece of forked iron into a probable spear-head, a pointed stick, and some loose pieces of timber Underneath the skeleton in various positions there occurred an old comb in two pieces, a thimble, a large iron spoon, the blade of another spoon, a small bullet mould, handle and portion of the tin plate work of an old "quart pot" or "billy can," fragment of a clay tobacco pipe-stem, top of an old metal powder or shot case, containing shot and a few shirt buttons, and last, but by no means the least curious, a castor oil bottle, still containing what seems to be a portion of the oil—this was placed directly under the head

A little below the junction of the rivers we viewed the burial place of a "Chief" of the late local tribe, the interment having taken place about fifteen years ago It lies contiguous to one of three marked trees placed in a triangle, the longest side or base of the latter being half a chain in length, and bearing north west and south east The trees are still erect, although the carvings are more or less obliterated by bush fires, but they seem to have been chiefly in zig zag lines, and of course cut with an iron tomahawk The heavy rain prevailing at the time deterred us from investigating this burial

This concluded our investigations in Burragorang proper, but on returning to Thirlmere, we diverted our course near Vanderville, across the Werriberri Creek to "The Hermitage," the estate of Mr W G Hayes, parish of Burragorang, county of Camden. Through the kindness of Mr Hayes we were allowed to examine a much more extensive burial ground than either of the preceding Here, on a small plateau above and to the east of the Waterfall Creek, a branch of the Werriberri, and behind, or to the south of the homestead, are four graves of various sizes distinguished by four carved trees, more or less in a state of dilapidation There does not appear to have been any geometrical form of arrangement assumed in the placing of these graves, unless it be a roughly rhomboidal one We expected, from current report, to find five graves here, but four only rewarded our efforts Three of the graves and three carved trees are more or less in a north-west and south east line Starting at the north west corner, the figures on a She oak (*Casuarina*) have been partially obliterated, ten feet from this is the first grave, and fourteen feet from the latter is another carved She-oak, now lying on the ground and much decayed Fifty one feet still further on occurs the largest grave, and at another fifty-one feet the third ornamented tree, a dead gum still standing but much burnt by bush fires, and bearing an extraordinary figure Between the last grave and this tree, and deviating somewhat from the straight line in the third interment, at right-angles to the original starting point, and fifty four feet from it at right angles, is the fourth carved tree, also a dead gum, bearing figures At right angles to this again, and distant sixty four feet, is the fourth grave, apparently without any indicating tree near it We did not investigate the contents of these graves owing to want of time

I am not acquainted with any systematic account of Australian carved trees, in fact little seems to have been collectively written about them, and very few representations figured Probably some of the earliest illustrations are those by Oxley, Sturt, and "W R G" presumed to be from the context of his writings, Mr Surveyor W R Govett, of Govett's Leap fame Oxley discovered a grave on the Lachlan, consisting of a semicircular mound, with two trees overlooking it, barked and carved in a simple manner (Journ Two Expeds Interior N S Wales, 1820, p 139, plate) These carvings consisted of herring bone on the one tree, and well marked curved although simple lines on the other The explorer Sturt noticed an oblong grave beyond Taylor's Rivulet, Macquarie River, around which the trees were "fancifully carved on the inner side," one with a figure of a heart (Two Expeds Interior S Austr, 1834, i, p 14) The anonymous author (W R G) describes an occurrence of this kind at Mount Wayo, County Argyle, in the following words —"The trees all round the tomb were marked in various peculiar ways, some with zig zags and stripes, and pieces of bark otherwise cut" (Saturday Mag 1836, ix, No 279, p 184) A Mr Macdonald states that the aborigines of the Page and Isis, tributaries of the Hunter River, carve serpentine lines on two trees to the north west of each grave (Journ Anthrop Inst Gt Brit and Ireland, 1878, vii, p 256)

The figures are either composed of right lines or curves, more commonly the former, but a few instances have been recorded of natural objects, such as the outline of an Emu's foot, seen by Leichhardt on a gum tree in the Gulf Country (Journ Overland Exped Moreton Bay to Port Essington, 1847, p 356) One thing is self-evident, such carvings possessed a dual if not a triple significance We have already seen the employment of them to indicate an interment, presumably acting the part of a tombstone, for it is believed by some that the figures on a tree in each case correspond to those on the inner side of deceased's 'possum rug, the *mombarai*, or "drawing," which Fraser thinks was distinctive in each family, or a peculiar modification of the tribal *mombarai* (Journ R. Soc N S Wales for 1892 [1893], xvi, p 201) So far as I can gather, such devices invariably indicated the last resting place of a male. Mr E. M Curr states ("The Australian Race, 1886," ii, p 433) that the Breeaba Tribe, at the head-waters of the Burdekin River, North Queensland, employed marked trees to commemorate a battle He figures a tree from the banks of the Diamantina, barked and marked by a series of close, irregularly super-imposed notches, like those made by a black when climbing a tree These, however, can hardly be compared to carvings.

According to Mr J Henderson, Dr John Fraser, Mr A W Howitt, and Mr Macdonald previously mentioned, Bora Grounds are also embellished with carved trees The first named describes ("Obs Colonies of N S Wales and V D Land,' 1832, p 145, pl 3) the approach to one of these initiation places at Wellington as through "a long, straight avenue of trees, extending for about a mile, and these were carved on each side with various devices . At the lower extremity of this, a narrow pathway turned off towards the left, and soon terminated in a circle." Mr. Henderson further remarks that the fact of the use of this place for Bora purposes was communicated to him by the then headman of the tribe. Dr. Fraser says (Journ R Soc N S. Wales for 1882 [1883] xvi, p 205) that the Gringai Tribe, one of the northern N S Welsh tribes, clear two circular enclosures, one within the other, for their Bora, and that the trees

growing around the smaller circle are carved "with curious emblematical devices and figures", whilst Mr MacDonald informs us that on the Bora ground of the Page and Isis River Natives, as many as a hundred and twenty marked trees occur round about (Journ Anthrop Inst Gt Brit Ireland, 1878, vii, p 256) Confirmation is further afforded by Mr W O Hodgkinson, who saw a Bora ground on the Macleay River with "trees minutely tatooed, and carved to such a considerable altitude that he could not help feeling astonished at the labour bestowed on the work" (Smyth, "Aborigines of Victoria, 1878," i, p 292)

If, as previously stated, according to current report, the designs on the trees be the same as those on the 'possum rugs, the transfer of them to the trees surrounding a grave must have had some important and lasting meaning to the survivors The figures on the rug may have indicated some degree of ownership, a crest, coat of arms, or monogram, as it were, and in such a case the reproduction on the trees surrounding a grave may be looked upon as an identification of the deceased Henderson speaks of the tree carvings as symbols "A symbol is afterwards carved upon the nearest tree which seems to indicate the particular tribe to which the individual may have belonged" ("Obs Colonies of N S Wales and V D Land, 1832," p 149) Or had they a deeper esoteric meaning, one only known to the learned men of the tribe? Smyth states ("Aborigines of Victoria, 1878," i, p 288) that the figures on the inner sides of the 'possum rugs "were the same as those on their weapons, namely, the herring bone, chevron, and saltier" How easily these same devices can be traced, in a general way, both on the carved trees and some of the wooden weapons, is amply shown by many of the excellent figures given in Smyth's work. This painstaking author, in briefly dealing—too briefly, in fact—with this interesting subject, says (*Ibid* p 286 The italics are mine) "The natives of the Murray and the Darling, and those in other parts adjacent, carved on the trees near the tombs of deceased warriors *strange figures having meanings no doubt intelligible to all the tribes* in the vast area watered by these rivers" By the Kamilarai (T Honery, Journ Anthrop Inst Gt Brit and Ireland, 1878, vii, p 254) they were regarded as "memorials of the dead

It is much to be regretted that before the last remnant of this fast disappearing race has passed away, a translation, or at any rate an explanation of these matters, cannot be obtained

SCIENTIFIC SERIALS

American Journal of Science, April —Distance of the stars by Doppler's principle, by G W Colles, Jun This principle may be applied to the calculation of the distances of stars in the manner suggested by Fox Talbot and discussed by Prof Rambaut If the velocity of a component of a binary star be measured spectroscopically when it is moving in the line of sight, and its orbit be studied by means of the micrometer, the velocity at any point of the orbit, and hence also the size of the orbit, may be determined This, divided by its angular magnitude, gives the distance of the system From theoretical considerations the author calculates the ratio of the mean velocity across the line of sight of a large number of stars distributed equally over the celestial sphere to their mean velocity along the line of sight, and finds this ratio to be $\frac{\pi}{2}$ He then shows that the mean distance of all these stars will be approximately arrived at by multiplying this ratio by the sum of the observed velocities in the line of sight, and dividing by the sum of the observed corresponding angular velocities Calculating from observations of ninety-five stars in the northern hemisphere, a mean distance of 150 9 light years is obtained, or, taking Vogel's observations only, 80 5 light years —The radiation and absorption of heat by leaves, by Alfred Goldsborough Mayer Two leaves of the same species of plant were each glued upon one of the polished tin sides of a Leslie cube. One of the leaves was then painted over with dead-black, and the cube was filled with water kept at 40° C. The radiation from the two leaves was measured by means of a thermopile It was found that almost all the leaves radiated as well as lampblack The effect of a thin film of dew was to reduce the radiation to 78 per cent, and to 66 per cent. if the dew stood out in beads upon the surface The absorption of dark heat rays by leaves interposed as a diaphragm was found to be highly selective A single elm leaf transmitted 20 per cent of the radiant heat. A second leaf transmitted 78 per cent of this, and a third over 83 per cent of that transmitted by the second Wild cherry leaves transmitted 9 per cent, and chicory 4 per cent more heat when their chlorophyll was abstracted by ether or alcohol —Also papers by Messrs H L Wheeler, W P Headden, W H Melville, J F Kemp, E A Smith, R T Hill, M I Pupin, F A Gooch, and P E Browning

The most important article in the *Botanical Gazette* for December, 1892, is the one to which we have already alluded, in which Mr R Thaxter proposes the establishment of a new order of Schizomycetes with the name Myxobacteriaceæ In that and the following numbers (January—March, 1893) Prof D H Campbell gives his account, most of which we have reprinted, of his visit to the Hawaiian Islands, Mr G W Martin completes his description of the development of the flower and embryo-sac in *Aster and Solidago*, Mr F D Maxwell gives a comparative study of the roots of Ranunculaceæ, in which he makes three types of structure on the basis of the changes which take place through secondary growth Mr A Schneider has a note on the influence of anæsthetics on the transpiration of plants, he finds that both this function and the vitality of protoplasm are both retarded by the action of ether, the protoplasm being finally killed Prof J E Humphrey gives a full account of the life history of *Monilia fructigena*, a parasitic fungus which causes great destruction of pears and stone fruit in America In an article on non parasitic bacteria in vegetable tissue Mr H L Russell sums up his conclusion that vegetable, like animal tissues, are normally free from micro organisms, but that in healthy vegetable tissues many species of bacteria are able to exist for a not inconsiderable length of time We have also articles describing new species of flowering plants discovered on the American continent, and a *résumé* of the botanical papers read at the New Orleans meeting of the American Association for the Advancement of Science

In the numbers of the *Journal of Botany* from January to April the articles of most general interest, in addition to the continuation of others already noticed, are —A list of the Mycetozoa of South Beds and North Herts, by Mr Jas Saunders, Dr M T Masters, on some cases of inversion, in which he gives illustrations of the reversal of the normal relative position of organs or of elements of tissues, a provisional list of the marine algæ of the Cape of Good Hope, by Miss E S Barton, a list of the mosses of Guernsey, by Mr E D Marquand, notes on Scotch freshwater algæ, by Mr W West, in which two new species are described, notes on the British species of *Campylopus*, a genus of Musci, by Mr H N Dixon Under the head of "Laboratory Notes," Mr S Le M Moore describes the best way of making Millon's reagent, a new way of demonstrating continuity of protoplasm (Millon's fluid); and the action of cold Millon's fluid on iron-greening tannins, and on cell walls giving proteid reactions

SOCIETIES AND ACADEMIES

London

Royal Society, February 2 —"A New Portable Miner's Safety-lamp, with Hydrogen attachment for delicate Gas-testing, with exact Measurements of Flame cap indications furnished by this and by other Testing lamps." By Prof Frank Clowes, D Sc (Lond), University College, Nottingham

The author, availing himself of his "test-chamber," already described in the Proc Roy Soc vols l li has examined the indications of fire damp furnished by the different safety-lamps at present in use for testing purposes These lamps include the ordinary oil lamp, the Pieler alcohol lamp, the Ashworth benzoline lamp, and the hydrogen-oil lamp, recently devised by the author

The introduction of a standard hydrogen gas testing flame into an ordinary oil safety lamp was first effected by the author, and was described by him in the papers referred to above But it has now been brought into a far more convenient and portable form, the most recent development of the lamp is described and explained by illustrations in the present paper The hydrogen gas is stored in a little pocket steel cylinder, under about 100 atmospheres pressure this can be immediately attached to the safety-lamp when required, and can be made to furnish a standard 10 millimetre hydrogen flame which will burn continuously for forty minutes from the cylinder-supply. The hydrogen is kindled from the oil-flame, without opening the

lamp and proves to be equal in delicacy and accuracy of testing to Liveing's indicator and other forms of apparatus of precision at present in use The lamp presents the great advantage of serving at once for lighting, for ordinary gas testing by the oil flame, and for most accurate and delicate testing by means of the hydrogen flame

The paper gives full statements of the results of the flame cap measurements of the new lamp, and of the lamps mentioned above

The general conclusions to be drawn from these measurements, and from experience derived from working with the different lamps, are the following —

(1) The indications of the Pieler lamp begin at the lowest limit of 0 25 per cent, but quickly become too great to be utilised The thread-like tip extending above the flame for several inches in pure air must not be mistaken for a cap, but it is scarcely distinguishable from the cap given by 0 25 per cent of gas

This lamp suffers under the disadvantage that much of the feeble light of the caps is lost by the obstruction of the gauze the gauze also frequently presents a bright reflecting surface behind the flame, and this renders the observation of the cap impossible All the other lamps in use are free from these interferences due to the gauze, and if their glasses are blackened behind internally by smoking them with a taper they become well suited for the observation of caps

(2) The Ashworth benzoline lamp begins its indications doubtfully at 0 5 per cent, the cap thus produced being more distinct, but not greater in height, than the mantle of the flame seen in gas free air

But starting with certainty with an indication of 1 per cent, it gives strikingly regular indications up to 6 per cent, and even higher percentages may be read off in a lamp with a long glass

(3) The standard 10 mm hydrogen flame gives distinct indications from 0 25 to 3 per cent, the cap then becomes too high for measurement in the lamp, but by reducing the flame to 5 mm, cap readings may be taken up to 6 per cent of gas

The lower indications may similarly be increased by raising the flame to 15 mm

(4) The oil flame produced by unmixed colza oil gives no indications with percentages below 2 With 1 per cent of gas the flame from colza mixed with an equal volume of petroleum (water white) produces an apparent cap, which, though somewhat more intense than the natural mantle seen in gas-free air, is only equal to this mantle in dimensions, and might easily be mistaken for it

The oil flame, when it is reduced until it just loses its luminous tip, however, gives distinct indications from 3 to 6 per cent

The largest indications are produced by drawing down the flame *in the presence of the gas*, until a cap of maximum size is obtained

A carefully regulated oil flame may, therefore, conveniently supplement the hydrogen flame for the indication of gas varying from 3 to 6 per cent, and in the new hydrogen lamp this will be found to be a convenient method to adopt

The use of colza alone in the oil lamp is very inconvenient for gas testing: the wick quickly chars and hardens on the top, and cannot then be reduced without danger of extinction, it can never be obtained satisfactorily in a non luminous condition. The admixture with petroleum obviates these difficulties

The use of the hydrogen flame for gas-testing has been proposed, but has never been hitherto carried into practice in an ordinary safety lamp Careful comparison proves this flame to be superior to the alcohol flame and to all other flames at present suggested Its indications have never been carefully observed and measured before, they are carefully summarised in the present paper

It will be readily understood that the main advantages resulting from the use of the hydrogen flame are the following:—

(1) The flame is non luminous, whatever its dimensions may be, and therefore does not interfere with the perception of the cap.

(2) The flame can always be adjusted at once to standard height and maintained at that height sufficiently long for the completion of the test, whereas other testing flames are constantly varying in dimensions, and most of them cannot be set to standard size at all with any certainty

Thus a colza petroleum flame exposed in air containing a low percentage of gas when twice adjusted gave caps of 8 and of 20 mm The reduced oil flame often fell so quickly that cap-readings with low percentages of gas could not be taken at all

(3) The caps produced over the hydrogen flame are larger than those produced by any flame of corresponding size

(4) The size of the hydrogen flame can therefore be so far reduced as to enable it to be used in an ordinary safety lamp

The size of the flame may further be suitably varied so as to increase or decrease the height of the cap and thus either increase the delicacy of the test or extend its range

(5) The hydrogen flame shows no trace of mantle or cap in air free from gas, it resembles the Pieler flame in showing only a slender thread above its apex The colza-petroleum and the benzoline flames show pale mantles in gas-free air, which may be easily mistaken for a small percentage of gas

(6) The standard hydrogen flame burns vigorously, it is of fair size, and cannot be extinguished by accident, whereas the reduced flames ordinarily used in testing burn feebly and are readily lost

(7) Hydrogen is supplied pure and of practically invariable composition, whereas oil and alcohol are apt to vary much in composition, and therefore to give flames whose indications vary with the sample of liquid which is being burnt

It should be noted that the hydrogen flame is set to standard size *in the presence of the gas*, and therefore yields accurate indications in any atmosphere in which the test is made

The paper gives full descriptions of the method pursued for obtaining accurate flame cap measurements in this research The indications furnished by the new lamp in air containing coal gas and water-gas are also tabulated, and it is shown that these gases are readily detected when present in small proportions in the air, and their amount is accurately determined The lamp shows equal delicacy and accuracy in the detection and estimation of petroleum vapour in the air.

When used for the detection of fire damp the amount of fine coal dust ordinarily present in the air of the mine caused no interference with the test The lamp had been proved by use in the coal-mine to be thoroughly practical and easy in its application to gas testing

February 16 —"Further Experiments on the Action of Light on *Bacillus anthracis*" IV By H Marshall Ward, D Sc, F R S, Professor of Botany, Royal Indian Engineering College, Coopers Hill

The author has continued his experiments, proving that the light of a winter sun and that of the electric arc rapidly destroy the life of the spores of the anthrax bacillus, and showing that the bactericidal action is really direct, and not due to elevation of temperature, or to any indirect poisoning or starving process incident on changes in the food materials The evidence goes to prove that the effect is chiefly if not entirely due to the rays of higher refrangibility in the blue-violet of the spectrum

The experiments have been continued with special reference to these latter points, and confirm the general conclusions in every detail Not only so, but the further results prove that the inhibitory and deadly effects of direct insolation are not confined to *Bacillus anthracis*, but also extend to other bacteria and even to the Fungi; and throw some light on several problems which have presented themselves during previous investigations

Experiments with Coloured Screens of Various Kinds

The author described experiments made during December to February with coloured screens of various kinds, premising that the methods employed in preparing and exposing the plates, &c., have been the same as those referred to in the previous communication

The results show that when plates are exposed for equal periods behind screens transmitting blue and violet rays, and behind screens which cut off those rays, the spores on the former are killed, whereas no bactericidal action occurs on the latter.

Experiments with Spores and Food Material on Separate Plates.

In order to test still further the accuracy of previous conclusions, that the bactericidal action of the sunlight is direct,

and not due to secondary effects, owing to changes in the food material, the following modifications of the experiments were carried out, and yielded most important and conclusive proofs that the *action of the rays of light is direct on the spores*, and not due to secondary actions owing to changes in the food materials

Two plates, for instance, of dried spores only are made, and two of agar only, all as before Then one plate of each kind is exposed to the light, and the others are kept in the dark

After exposure, the stiff and moist film of *non exposed* agar is removed from its own plate, and *superposed on the exposed film of dried spores in situ* Reciprocally, the film of *exposed* agar is *removed*, and *superposed on the non exposed film of dried spores*

This prevents any wash or displacement, and ensures at the same time that the agar shall present in contact with the spores that face which was next the source of light

So far no appreciable effect on the agar has been observed, though the dried spores exposed for an equal period are killed in abundance, as shown by the figure which comes out on culture

Preliminary Results with the Spores of Fungi

Results substantially the same as the above are obtainable with other *Schizomycetes*, but it was interesting to see whether anything of kind occurs with the spores of true Fungi The time of year has, for many reasons, been unfavourable for very numerous experiments, but the results so far are extremely encouraging, and should give a stimulus to close inquiry into the whole subject

The following species have been examined —*Penicillium crustaceum*, *Aspergillus glaucus*, *Botrytis cinerea*, *Chalara mycoderma*, *Oidium lactis*, *Nectria cinnabarina*, *Mucor racemosus*, *Saccharomyces pyriformis*, and a "*Stysanus*" conidial form met with some months ago as a saprophyte on *Pandanus*

On making agar and gelatine plates of these as before, positive results were obtained with *Oidium* (5 cases), *Chalara* (1 case), *Saccharomyces* (4 cases), *Stysanus* (2 cases), and negative results with *Aspergillus* (5 cases), *Penicillium* (2 cases), *Mucor* (2 cases), *Nectria* (4 cases), and *Botrytis* (2 cases)

It seems worth noting that, in all the forms which have given a positive result right off, the spores, as seen in masses, are either hyaline and colourless, or, in the case of the *Stysanus*, with a faint tinge of buff, whereas those which gave negative results are either of some very pronounced colour, as *Aspergillus*, *Penicillium*, and *Nectria*, or (*Mucor* and *Botrytis*) of a dull, yellow brown hue

After some theoretical considerations, some practical bearings of the results are thus referred to —

The establishment of the fact of the bactericidal and fungicidal action of light, dating from Downes and Blunt to now, enables us to see much more clearly into the causes of several phenomena known to practical agriculturists, foresters, hygienists, &c

It helps to explain, for example, why the soil of a forest should not be exposed to the sun, a dogma long taught in schools, it will also effect our way of regarding bare fallows It has already been shown how important is its bearing on the purification of rivers, and the reasoning obviously applies to dwellings, towns, &c The author regards it as probably explaining many discrepancies in the cultures of Schizomycetes and Fungi in our laboratories, and as having a very important bearing indeed on the spreading of plant epidemics in dull weather in the summer, and no doubt this applies to other cases

That sunshine has something to do with the rarity of bacterial diseases in plants now seems quite as probable as the currently accepted view that the acid nature of the latter accounts for the fact

If that part of the chlorophyll which absorbs the blue-violet is a screen to prevent the destruction of easily oxidisable bodies, as they are formed in the chloroplasts, we may reconcile several old experimental discrepancies—*e g* the behaviour of plants under bichromate and cupric oxide screens

The author concludes from his experiments, and from numerous other considerations given in the paper, that the colours of spores, pollen grains, &c, are of the nature of colour screens, and is led to put forward the following hypothesis :—

No plant exposes a reserve store of fatty food materials to the danger of prolonged or intense insolations without a protective colour screen, calculated to cut out at least the blue violet rays, as these rays would otherwise destroy the reserve substance by prolonging its rapid oxidation

"Studies in the Morphology of Spore producing Members Preliminary Statement on the Equisetaceæ and Psilotaceæ" II By F O Bower, D Sc, F.R S, Regius Professor of Botany in the University of Glasgow

Still maintaining the same general views as were put forward in my preliminary statement on the Lycopodinæ and Ophioglossaceæ (Roy. Soc Proc, vol. l p 265), I have now investigated other types from among the Vascular Cryptogams as regards the development of their spore-producing members

Taking first the Equisetaceæ, the development of the sporangia has been closely followed by Goebel, I find it, however, difficult to accept his conclusions as to the hypodermal origin of the archesporium On following the early phases of development in *Eq arvense*, the sporangium is found to be eusporangiate, but the essential parts of the sporangium may be traced in origin to a single superficial cell, the cells adjoining this laterally contributing only to form the lateral portions of the wall The first division of this cell is periclinal *the inner resulting cell forms only a part of the sporogenous tissue*, the outer cell undergoes further segmentation, first by anticlinal, then by periclinal, walls, and *the inner cells thus produced are added to the sporogenous tissue, and take part in spore formation* The archesporium of *Eq arvense* is thus shown to be not of hypodermal origin in the strict sense, the same appears to be the case in *Eq limosum* Similar additions to the sporogenous tissue by early periclinal division of superficial cells is commonly to be seen in *Isoetes*, and occasional cases, which are difficult to explain in any other way, have been observed in some species of *Lycopodium* It would thus appear that Goebel's generalisation, that in all the Vascular Cryptogams which he investigated a hypodermal archesporium exists, cannot be retained in the strict sense The tapetum is derived from the series of cells immediately surrounding the sporogenous mass, it is, however, to be carefully distinguished from certain cells of the sporogenous mass, which also undergo an early disorganisation, for about one-third of the cells of the sporogenous mass do not form spores, but serve physiologically as a diffused tapetum, yielding up their substance to nourish the other young developing spores

The synangia of the Psilotaceæ have given rise to voluminous discussions *Tmesipteris* being the genus with the simpler structure, it may be described first In their earliest stages of development, as lateral outgrowths from the axis, the sporangiophores are not readily distinguishable from the foliage leaves in form or structure, while they occupy a similar position upon the axis The first appearance of a synangium is as an upgrowth of superficial cells of the adaxial face of the sporangiophore, immediately below its apex, meanwhile the cells of the abaxial side also grow strongly, while the apex itself does not grow so rapidly, so that the organic apex is soon sunk in a groove between these stronger growths The superficial cells which are to form the synangium undergo periclinal and anticlinal divisions, to form about four layers of cells All the cells of this tissue are at first very similar to one another, but later two sporogenous masses become differentiated, they are not, however, clearly defined while young from the sterile tissue which forms the partition of the synangium, or from the wall From the arrangement of the cells of these sporogenous masses it seems not improbable that each mass may be referable in origin to a single cell, but this has not been proved to be constantly the case All the cells of the sporogenous tissue do not arrive at maturity, but here, as in *Equisetum*, a considerable number, serving as a diffused tapetum, become disorganised without forming spores There is no clearly defined tapetum in *Tmesipteris* The leaf lobes begin to be formed almost simultaneously with the synangium, and appear as lateral growths immediately below the apex of the sporangiophore, their further development presents no characters of special note

The synangium of *Psilotum* originates in essentially a similar manner, being formed from the upper surface of the sporangiophore, immediately below its apex

On the ground of the observations of internal development, of which the above are the essential features, I agree with the conclusion of Solms that the whole sporangiophore of the Psilotaceæ is of foliar nature, and that the synangium is a growth from its upper surface.

In *Lepidodendron* the sporangium is very large, it is narrow and elongated in a radial direction, extending a considerable distance along the upper surface of the leaf I have already communicated to the Society the fact that trabeculæ extend in *Lepidodendron* from the base of the sporangium far up into the mass of

spores, and have compared these with the trabeculæ in the sporangium of *Isoetes* Neither of these sporangia are, however, completely partitioned I now suggest that comparatively slight modification of the condition in *Lepidodendron* would produce the state of things seen in *Tmesipteris* if the sterile trabeculæ of *Lepidodendron* were consolidated into a transverse septum, and the apical growth of the sporophyll arrested and taken up by two lateral lobes, the result would be such as is seen in *Tmesipteris* This is not a mere imaginative suggestion it proceeds from the observed fact that the septum in *Tmesipteris* is indistinguishable at first from the sporogenous masses It may further be noted, in connection with the above comparison between *Lepidodendron* and *Tmesipteris*, that the vascular tissues of some of the former appear to correspond more closely to those of *Tmesipteris* than to any other living plant

Looking at the whole plants of the Psilotaceæ from the point of view above indicated, they are to be regarded as lax strobili, bearing sporangiophores (sporophylls) of rather complex structure Branching, which is rare in *Tmesipteris*, is common in *Psilotum*, and is to be compared with the branching of the strobilus in many species of *Lycopodium* In both there are irregularly alternating sterile and fertile zones, not unlike those of some species of *Lycopodium*; at the limits of these arrested sporangia are frequently found It is not difficult to imagine how such plants as the Psilotaceæ may have originated from some strobiloid type, not unlike that of the genus *Lycopodium*.

March 23 — "The Absolute Thermal Conductivities of Copper and Iron" By R Wallace Stewart, B Sc (London), Assistant Lecturer and Demonstrator in Physics, University College, Bangor Communicated by Lord Kelvin, P R S

The experiments described in the paper were undertaken with the object of determining the thermal conductivity at different temperatures of iron, and, in particular, of pure, electrolytically deposited copper

The method adopted was that due to Forbes, but the thermo-electric method of determining temperature was employed, and the bar was protected from currents of air and external radiation by surrounding it by a trough of sheet zinc

The iron bar used was a square ⅞ inch bar of ordinary wrought iron, the copper bar was a round ½ inch bar of pure electrolytic copper

The variation of the specific heat of iron with the temperature was determined by Bunsen's calorimeter, for the specific heat of copper the result given by Bède was taken

The range of temperature over which the observations extended was from 15° C to about 220° C

The final results obtained are indicated by the formulæ given below, and tend to show that for both copper and iron the conductivity decreases with rise of temperature

Results for Iron in C G S Units

Diffusivity, κ, at t° C is given by—

$$\kappa_t = 0\ 208\ (1 - 0\ 001751t),$$

and the absolute thermal conductivity, k, by—

$$k_t = 0\ 172\ (1 - 0\ 0011t)$$

Results for Copper in C.G S Units

Diffusivity, κ, at t° C is given by—

$$\text{I}\quad \kappa_t = 1\ 370\ (1 - 0\ 00125t)$$
$$\text{II}\quad \kappa_t = 1\ 391\ (1 - 0\ 00120t)$$

The mean of these results is taken as—

$$\kappa_t = 1\ 38\ (1 - 0\ 0012t),$$

and the value of the absolute conductivity, k, is then given by—

$$k_t = 1\ 10\ (1 - 0\ 00053t)$$

A table is given at the end of the paper showing the emissive power of the surface of each bar at temperatures between 20° C and 200° C

Linnean Society, April 6 —Prof Stewart, President, in the chair —The President took occasion to refer to the great loss which botanical science had sustained by the death, on April 4, of Prof Alphonse de Candolle of Geneva, an announcement which was received with profound regret. Prof de Candolle was the senior foreign member of this Society, having been elected in May 1850, and was the recipient of the Society's Gold Medal in 1889 —Mr Clement Reid exhibited and made some remarks upon the fruit of a South European Maple (*Acer monspessulanum*) from an interglacial deposit on the Hampshire coast.—Mr R. Lloyd Præger, who was present as a visitor, exhibited some rare British plants from the co Armagh, and gave an account of their local distribution — A paper was then read by Mr W B Hemsley on a collection of plants from the region of Lhassa, made by Surgeon Captain Thorold in 1891, and a further collection from the Kuenlun plains made by Captain Picot in 1892 Some of the more interesting plants were exhibited, and critical remarks were offered by Messrs C B Clarke, J G Baker, and Dr Stapf —Dr H C Sorby gave a demonstration with the oxyhydrogen lantern and exhibited a number of slides which he had prepared of small marine organisms, many of them extremely beautiful, mounted transparently so as to show the internal structure

Entomological Society, April 12 —Mr Frederic Merrifield, Vice President, in the chair —Sir John T Dillwyn Llewelyn, Bart, exhibited a number of specimens of Lepidoptera, Coleoptera, and Hymenoptera, all caught in Glamorganshire The Lepidoptera included two remarkable varieties of *Vanessa io*, both obtained from the same brood of larvæ from which the usual eye like spots in the hind wings were absent, varieties of *Arctia menthastri*, a long series of melanic and other forms of *Boarmia repandata* and *Tephrosia crepuscularia*, and bleached forms of *Geometra papilionaria* The Coleoptera included specimens of *Prionus coriarius*, *Pyrochroa coccinea*, *Otiorhynchus sulcatus*, and *Astynomus ædilis*, a large species of Longicornia, which Sir John Llewelyn stated had been handed to him by colliers, who obtained them from the wooden props used in the coal mines, made out of timber imported from the Baltic Mr Merrifield, Dr Sharp, F R S, and Mr Stevens made some remarks on the specimens —Sir John T D Llewelyn inquired whether the name of the moth which had a sufficiently long proboscis to fertilise the large Madagascan species of Orchis, *Angræcum sesquipedale*, was known Mr. C O Waterhouse stated that the collections received at the British Museum from Madagascar had been examined with the view to the discovery of the species, but up to the present it had not been identified —Mr H Goss exhibited, for Mr Frank W P Dennis, of Bahia, Brazil, several nests of Trap door Spiders, containing living specimens of the spider, and read a communication from Mr Dennis on the subject Several photographs of the nests and the spiders were also exhibited It was stated that Mr. Dennis had found these nests at Bahia in one spot only in a cocoa nut grove close by the sea —Mr McLachlan, F R S, read a paper entitled "On species of Chrysopa observed in the Eastern Pyrenees, together with descriptions of, and notes on, new or little-known Palæarctic forms of the genus" The author stated that the species referred to in this paper had been observed by him in the Eastern Pyrenees, in July, 1886, when staying with Mons René Oberthur After describing the nature of the district, and its capabilities from an entomological point of view, the paper concluded with descriptions of certain new palæarctic species of the genus Dr Sharp, who said that he was acquainted with the district, and Mr. Merrifield made some remarks on the paper

PARIS

Academy of Sciences, April 10 —M Lœwy in the chair —The deaths were announced of Vice-Amiral Pâris and M Alphonse de Candolle —On the extinction of torrents and the replanting of the highlands, by M P Demontzey A report on the work done since 1883 towards securing the south of France from its periodical inundation by mountain torrents —On the loss of electric charge in diffused light and in darkness, by M Édouard Branly —Dynamo-electric machinery with compound excitation, by M Paul Hoho If a curve be constructed showing how the magnetic excitation of a dynamo electric machine ought to vary in order that the E M F may remain constant, or may vary according to a given law, it is possible to contrive an excitation such that, if it be also expressed by a curve, the latter will cut the former in any number of points required Between these points of intersection the two curves nearly coincide Hence it is possible to produce currents which, between certain limits, do not vary with the speed of the engine. This has been practically realised by means of two separate exciter circuits —On anomalous dispersion, by M Salvator Bloch —General conditions to be fulfilled by registering instruments or indicators, problem of integral synchronisation, by M A. Blondel. All the instruments in question consist essentially of a movable piece (needle, pencil, membrane, or mirror) susceptible of rectilinear or circular displacement under the simultaneous influence of a

force proportional to the physical quantity to be measured, an opposing force sensibly proportional to the displacement, the inertia of the moving parts, and the damping force, usually proportional to the velocity. The desideratum is that the periodic motion of the moving piece should follow a law as closely approaching that of the phenomenon as possible, so that the deflection may at any instant depart as little as possible from a value equal to the ratio of the force to be measured and the opposing force. This the inventor of the "oscillograph" calls the problem of integral synchronisation, from its analogy to that of simple synchronisation investigated by M. Cornu.—An expression is given for the value below which the damping effect, though made as small as possible, should not be allowed to fall.—On the volatility of manganese, by M. S. Jordan.—Determination of atomic weights by the limit method, by Mr. G. Hinrichs.—On nitrogenised copper, by MM. Paul Sabatier and J. B. Senderens. Several metals, when newly prepared by means of reduction of their oxides by hydrogen, are able to fix a large quantity of nitrogen peroxide in the cold. The resulting compounds have been termed nitrogenised metals (*métaux nitrés*). In the case of copper, a quantitative analysis of the compound has led to the formula Cu_2NO_2, which corresponds to the fixation upon the metallic surface of the copper of about 1000 times its volume of peroxide at 30° C.—On the isomerism of the amido benzoic acids, by M. Oechsner de Coninck.—On phtalocyanacetic ether, by P. Th. Muller.—On transpiration in herbaceous grafts, by M. Lucien Daniel.—Exploration of the higher atmosphere, experiment of March 21, 1893, by M. Gustave Hermite. The balloon carrying the registering instruments was constructed of triple gold beater's skin varnished, its volume being 113 cubic metres. The total weight of the apparatus carried was 17 kgr., including an automatic distributor of inquiry cards, working by a fuse. The ascensional force was 65 kgr., giving a vertical velocity of 8 or 9m. per second. The average velocity of descent was 2.4m., so that the instruments did not suffer. The balloon ascended at 12h. 25m. from Paris Vaugirard, and landed at Chanvres (Yonne) at 7h. 11m. p.m. The lowest pressure registered was 103 mm., or less than one seventh of an atmosphere, which corresponds to a height of about 16,000 m. The lowest temperature recorded was −51° C. at 12,500 m., after which the curves of temperature and pressure were interrupted by the freezing of the recording ink. Subsequently, however, the intense solar radiation seems to have thawed the ink, so that the barometric record was taken up again at 16,000 m. and the thermometric curve at −21° C. The fuse ceased to burn after some time, probably owing to the lack of oxygen. The balloon could be followed with the naked eye for three-quarters of an hour, within which it attained its highest altitude. It was white, and brightly illuminated by the sun.—Odoriferous power of chloroform, bromoform, and iodoform, by M. Jacques Passy.—Observations on a series of new forms of snow, collected at very low temperatures, by M. Gustave Nordenskiold.

BERLIN

Physiological Society, March 17.—Prof. du Bois Reymond, President, in the chair.—In the discussion which ensued on the communication made at the last meeting of the society, Prof. Zuntz gave the data as to the daily consumption of proteid and fat by the fasting man Cetti, as also the heat produced by their oxidation, from which it appeared that the heat production during his fast was constant.—Prof. Behring gave an account of his further experiments with preventive serum. A portion was mixed with a slight excess of tetanus virus; mice died after inoculation with the mixture. When heated to 65° C. the virus became inert, but not so the serum, thus proving that the respective substances had not exerted any chemical action each on the other. A further new and important fact observed was that tetanus virus—that is, the products of metabolism of tetanus bacilli—made inert by heating to 65° acts preventively towards tetanus infection. Hence the facts known to hold good as to the action of tuberculin in tuberculosis now appear to hold good with regard to tetanus, and should be further investigated in the case of other acute diseases, such as diphtheria, typhus, and cholera.—Dr. Lewy Dorn gave a full description of his experiments on the question of whether the formation of sweat is the result of a filtrational process. By calculating the capacity of the sweat-glands, and the volume of the sweat-drops secreted, he came to the conclusion that a true new formation of sweat could only be assumed with certainty after a fourfold and copious secretion had taken place. When he now subjected the foot of a cat to an air pressure far exceeding that of the blood, secretion of sweat was observed on stimulation of the sciatic nerve. On the other hand, when the foot was subjected to a considerably reduced (negative) air pressure, no formation of sweat was observed. Both these facts are opposed to the filtrational theory of sweat-secretion. Varnishing the skin did not prevent the secretion of sweat resulting from stimulation of nerves or administration of pilocarpine.

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PAMPHLETS.—Bibliography of the Athapascan Languages: J. C. Pilling (Washington).—A List of some of the Rotifera of Ireland: M. Glascott (Dublin).

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CONTENTS.

THURSDAY, APRIL 27, 1893

DYNAMICS IN NUBIBUS

Waterdale Researches, Fresh Light on Dynamics By "Waterdale" (London Chapman and Hall, 1892)

WHEN St Paul tried to convince the Athenians that they were mistaken in their philosophy, he probably spoke to them in Greek instead of expecting them to learn Hebrew "Waterdale" is trying to convince nineteenth century philosophers that it is possible to invent mechanism by which he can attain "the undoubted theoretical possibility of *perpetual motion*," and he does not take the trouble of learning the language of those whom he desires to convince, but insists that they must learn his language, simply because he *professes* to have invented a possible explanation of gravity He acknowledges that his work would require at least a month's hard work to comprehend, and taunts the scientific world for not gladly spending this time in refuting what most of them have already spent weeks on—namely, refuting the very ingenious inventions of cranks, who think to cheat nature in the dark by some roundabout way of doing what simple considerations show to be impossible A good month's work to teach him! Let him pay somebody with a reputation whose time is probably worth twelve hundred a year, say a month's time, one hundred pounds, to explain and convince him of the impossibility of his mechanical arrangement It would take more than a month, however If human experience is worth much it proves that there is very little use in trying to convince people with missions whether they are right or whether they are wrong And fortunately so, for, if they are right they will ultimately prevail, and if they are wrong after all they generally do more good than harm by interesting the world in something outside and better than the selfish interests of individuals

"Waterdale" attributes a good deal of importance to this mechanism He says in his preface "Let the scientific reader, I would ask, take the trouble first to go through these calculations, and he will then have some idea as to whether the rest of the book is worthy or not of careful perusal." In the body of the work he invents a very complicated hydrodynamic machine to effect his purpose He there refers to the very much simpler arrangement described in the appendix, and says "Unless the possibility" (of perpetual motion) "is admissible, then I must confess that the theory of equal real ponderosity to all matter can *never* be accepted." He acknowledges at the same time "that with full knowledge of the liability to error when dealing with the action of forces," all he can reasonably do is to ask "that . . . pure mathematics be once more applied to the subject." All the same, he asserts that "no disproof can be, or has up to the present been given." "There is no speculation about this, but simple fact, if calculation by figures can be accepted to be true" There are so many things touched on in the work that do not seem in any way necessarily connected with the question of "equal real ponderosity," that it is desirable to show how much interest "Waterdale" feels in this part of his theory in order to justify the paying of any serious attention to what can, on general principles, be so easily disproved It would certainly not be worth while investigating the question in a scientific journal in order to convince the author of the paradox He could only be convinced by very painstaking and judicious personal interviews of his error and of the unimportance of this question of equal real ponderosities. It would hardly be worth while investigating the question merely because "Waterdale" attributes importance to it, but it is worth while doing so because others may attribute importance to it, and still more so because "Waterdale's" mechanism is interesting and involves a principle that is intimately connected with the second law of thermodynamics, Boltzmann's hypothesis, and a lot of recondite questions which are puzzling the scientific world, so that it is not much wonder that even a clever and ingenious person should get involved in its meshes, especially when that person is involved in a "mission"

The general idea involved in "Waterdale's" mechanism is as follows—Suppose a large body (he objects to the word "mass") M and a small one m, and a spring or other means by which kinetic energy can be given to the bodies If the spring exert a constant force F through a space s_1, it would communicate a velocity V_1 to $(M + m)$, given by the equation—

$$Fs_1 = \tfrac{1}{2}(M + m)V_1^2$$

If now it work through a distance s_2 it will increase this velocity to V_2, when

$$Fs_2 = \tfrac{1}{2}(M + m)(V_2^2 - V_1^2)$$

So far all is plain sailing But we may proceed in another way We may let the spring work against m alone, and then by suitable mechanism use m's kinetic energy to make the combined system $M + m$ move In this way we might expect to give m a velocity v_1, such that $Fs_1 = \frac{1}{2}mv_1^2$, and when this energy was spent on the two bodies $M + m$, they would acquire a velocity V_1 the same as before, given by $\frac{1}{2}mv_1^2 = \frac{1}{2}(M + m)V_1^2$ Now comes an important assumption, that if the *relative* velocity of m and M be equal to v_1, then by proper mechanism it must always be possible to *increase* M's velocity by V_1, while m's velocity is being reduced to V_1.

Suppose now m_1, moving with velocity V_1, we act upon m by means of the force F, again through the distance s_2 we have for its final velocity v_2—

$$Fs_2 = \tfrac{1}{2}m(v_2^2 - V_1^2).$$

Hence the relative velocity of M and m is $v_2 - V_1$. By choosing $s_2 = 3s_1$, we can arrange that $V_2 = 2V_1$, as it simplifies the further argument In this case

$$v_2^2 - V_1^2 = 3v_1^2 \text{ or } v_2^2 = 3v_1^2 + V_1^2,$$

$$\therefore v_2 = \sqrt{3v_1^2 + V_1^2},$$

and the relative velocity

$$v_2 - V_1 = \sqrt{3v_1^2 + V_1^2} - V_1,$$

which may be much greater than v_1, if v_1 be much greater than V_1, *i.e.* if m be much smaller than M This shows that the *relative* velocity after the second blow may be much greater than after the first, even though the two blows were so chosen as that if applied directly to the combined body they would produce equal increments of velocity in that body Assuming then that a given *relative* velocity can always

produce a given *increase* of velocity in the combined system, it appears by our assumption that, as the *relative* velocity is much greater after the second blow given to m than after the first, the *increase* of velocity of the system produced by this indirect method of applying the second blow will be much greater than by the first, and consequently much greater than the velocity that could be given to the system by applying the blow directly By reducing the system to its otherwise produced velocity V_2, we could obtain a certain amount of energy, and then repeat the process *ad infinitum*, thus obtaining a continual supply of energy

An investigator without a mission would be led by this curious result to assume that there must be some mistake in his arguments, and "Waterdale" evidently has some lurking doubts He sees that it is impossible in the simple case of bodies having only one direction of velocity Impact can never reduce two bodies of a system to move with the same velocity *and* conserve energy We cannot have momentum and energy both conserved Unless M = o we cannot have

$$mv_1 = (M + m)V_1$$
$$\tfrac{1}{2}mv_1^2 = \tfrac{1}{2}(M + m)V_1^2$$

In order to divide the energy $\tfrac{1}{2}mv_1^2$ between the two bodies and reduce them both to a common velocity, we require a *third body*, and then what becomes of the principle that seemed so plausible, that the increased velocity that m could impart to M depended on their *relative* velocity only? "Waterdale" sees the hitch all right in the simple case, and consequently, in order to cheat nature by inventing a complicated case in which he hopes that she will get as muddled as himself, he interposes bent channels, a third and fourth body to receive the blows, springy arms to absorb energy, and smooth surfaces to divert the motion He evidently has some doubts about all this, for, notwithstanding his assertion that "Appendix II is a mechanical demonstration to prove that by the principle of *velocity* of force, a saving in mechanical work, . can be effected," and that "there is no speculation about this, but simple fact," yet he gives only a series of suggestions and vague estimates as *unspeculative proofs*, that the energy spent in bending his springs, in jumping his bodies about, and so forth, is negligible, while in reality it is an important part of his system That it is so necessarily is proved conclusively by the impossible result he obtains by neglecting it This is the really interesting principle in the whole matter, that it is not possible to give energy to a system of bodies by giving a series of impulses to some particles of it, to be transmitted to the rest of the system by actions within the system without some part of the energy being spent on internal motions in the system. It is here that the example touches upon the second law of thermodynamics, Boltzmann's hypothesis, and so forth In order to minimise the effects of these internal vibrations, &c., "Waterdale" argues thus "Loss No. 2" (giving rise to internal vibrations of his system) "if it arises" (he himself shows that it would, though he overlooks a more important loss), "would be of the nature of internally asserted work." . . . "This loss of work could not be great, for we see by the diagram that the span of work already done when the ball arrives at o is small compared with what it has to do" Notwithstanding his profession of calculating everything he does not calculate here, nor does he calculate with what velocity the ball would rebound after it hit the body B, which ultimately stops it, in fact he omits this important question altogether, and goes to the "third factor, the bending of the arm of the system," which he goes on to say, *without calculation*, "can be almost neglected if we take the tension of elasticity of the arm to be small" "I should say that one-eighth internal loss of work would certainly more than cover everything" This blessed "I should say!" Is it thus that "Waterdale" gives "a mechanical demonstration to prove . . a saving in mechanical work"? "There is no speculation about this"! It is "simple fact, if calculation by figures can be accepted as true" Most people would agree that "if calculation by figures can be accepted as true" the velocity that could be given by *any* mechanism to the system indirectly could not be greater than what would give it kinetic energy corresponding to the work supplied If "Waterdale" will apply a system of levers, springs, &c, acting on the fixed bodies of his system, so as to reduce all the bodies to relative rest, and thereby gives up as hopeless the task of inventing some method by which he can by internal actions alone transfer kinetic energy from one body of a system to the whole of the system without wasting any of it in internal kinetic or potential energy, then he will see how he has to give up the apparently legitimate assumption that the velocity one body of a system can give to the whole system by being itself reduced to relative rest depends *only* on the *relative* velocity of the body and the rest of the system He will see that it depends also on the velocity of his system relative to those supposed fixed bodies he will require as fulcrums for the mechanism required to transfer the energy of the one body to the rest of the system He sees that something is required to keep his wedge moving forward He arranges "that the wedge is supported by a following force . during this part." The amount of work required he without calculation *assumes* to be small, and he is probably right here, but it is only one of several losses that he does not *calculate*, and there are others, such as the conditions of impact at the end of the flight of m, that he does not even notice, though this is the very first that should strike a person investigating the subject after he had clearly seen, as "Waterdale" appears to do, that it is here, in the laws of impacts, that the simple case of velocity in one direction and direct impacts fails. It is interesting how cases of this kind illustrate the warming of a gas by compression, the vibrations produced in a bell when struck, and other such cases where energy is given to one part of a dynamical system for this part to distribute amongst the whole, and also how it illustrates the way in which the amount of this internal energy depends on the mobility of the part originally moved. Of course it is all plain enough when the subject is attacked by means of general principles of conservation of energy and momentum, but when the interactions of the different parts of the system are individually considered and the mind distracted by the complexity of the problem, there is real danger that what is important may be overlooked as trivial, as has been done by "Waterdale." He is not to

be blamed for this, but he is to be blamed for putting forward as a proof in which "there is no speculation," as a "simple fact, if calculation by figures can be accepted as true," an investigation in which he acknowledges that he estimates this, that, and the other without calculation

And after all, what does he require all this elaborate attempt to cheat nature by complex mechanisms for? Simply because he does not understand fully the position of scientific men in respect of the word "mass," and because he has some *à priori* difficulties in his own mind as to how atoms of different masses can require equal quantities of heat to warm them through equal ranges of temperature. He *says* that scientific men say that *because* a cube of gold weighs seven times as much as a cube of aluminium, "it is therefore taken to comprise seven times the quantity of matter, *ergo* it possesses seven times the attractive force, and falls with equal acceleration, *ergo* also it requires seven times the force or work to move it" Now this is a gross libel on scientific men That it requires seven times the force to move a cube of gold that is required in the same time to generate the same velocity in an equal cube of aluminium is a matter of experience, and is the only reason why it is said that the mass of the gold is seven times as great as the mass of the aluminium, and this is said because the statement is only using the word mass in accordance with the definition of the word That there is *therefore* seven times the quantity of matter is really no question of *therefore*, for the statement is again merely a definition of the term "quantity of matter," which is, in its scientific use, only another name for mass Now come questions about gravity, and as no satisfactory explanation of gravity (*pace* Le Sage, Tolver Preston, Osborne Reynolds, "Waterdale," and a host of other theorisers upon this interesting subject) has yet been propounded, no scientific person can rightly say that a body attracts seven times as much as another *because* it has seven times the mass or quantity of matter, for until we know the cause of the attraction we have no right to say that it is *because* of this or that. Hence there is no *therefore* at all put forward by scientific men between "seven times the quantity of matter," "or mass," and "seven times as heavy," or "seven times the attractive force" That a body with seven times the mass of another does as a matter of fact weigh seven times as much is a matter of experience, but that it does so *because* it has seven times the mass is a mere conjecture, and that it is so held by scientific men is proved by attempts having been made to prove by experiment that weight is proportional to mass, and even to find whether weight varies with the direction of the axis of a crystal, &c "Waterdale" objects to supposing the elementary atoms bulk for bulk to be of equal density, because "we should have to place the atoms in a light substance too far apart," a fairly good reason for investigating the question though not for deciding it. On the other hand he objects to supposing "each atom to be more or less porous—a very incredible hypothesis"—for reasons depending on specific heats to which he evidently attaches some weight, as he harps upon it more than once. Why he should think it so incredible that the atoms may be porous does not clearly appear, for his own atoms, as described in the book, are eminently porous, and it is upon their porosity that his whole explanation of their behaviour to force, and his application of his principle of "velocity of force," and his theories of light and electricity and chemical action and adhesion all depend He would probably reply that he does not want them *so* porous as all that, though this hardly justifies the epithet "incredible" in respect of a hypothesis he himself holds Anyway, his serious reason for disbelieving in the unequal masses, or, as he calls it, ponderosities, of atoms is the difficulty he has in seeing how equal quantities of heat can raise unequal masses through equal ranges of temperature His difficulty rests upon his imagination that he understands fully what the wisest men would probably say they did not understand at all fully, namely, on what property of the atoms of a body temperature depends He discusses the matter pretty carefully. He says "How are we to account for the apparent fact that the work of a quantity of heat which is equal to raising weight, 1 of water 1° of temperature—or, in other words, to accelerate, it is to be inferred, the vibrative motion of the whole of its parts in the degree corresponding to one more degree of heat—will be also equal to giving equal acceleration to the entire parts of 8 784 and 30 816, respectively, more matter in the cases of iron and gold?" He here assumes that equal increments of temperature correspond to equal increments of "acceleration" of the atoms This, if it means anything, is not true, and it is not *à priori* at all likely Take another place, where he says, " . The fact that a given quantity of imparted heat raised a *really* heavy atom to the same temperature as it would a *really* lighter atom, would indicate that equal temperatures were marked by a slow motion of heavy wedges in respect of a heavy atom, and by a quick motion of light wedges in respect to light atoms"

"Although the same quantity of heat might thus be imparted to the two atoms, it is reasonable to infer that the intensity of the heat, as made apparent to our senses, would not in the two cases be identical" " It is reasonable to infer," on the other hand, that there is some hitch in an argument that depends to any important degree upon such a form of expression as "it is reasonable to infer" Is it not, on the other hand, most reasonable to infer that the blow given by a light body moving quickly would be very much the same as by a heavy body moving more slowly, and that, consequently, the "intensity of heat," as he calls it, would feel the same? In any case a very cursory study of the kinetic theory of gases would point out how there is certainly no incongruity or incredibility, but quite the reverse, in the notion that equal quantities of heat do make light atoms move rapidly and heavy ones slowly, and that, notwithstanding their different atomic velocities, the temperatures of two bodies may be the same. There is no real difficulty in supposing that it requires thirty times as much heat to raise the temperature of water as is required to raise an equal mass of gold through the same range of temperature, if we bear clearly in mind the very complex structure of both water and gold, and all that has to be done by the heat in each case, and at the same time recollect how very little we know of the conditions that determine when two bodies are at the same temperature, *i.e.* that

determine that on the whole no energy shall flow from one to the other when placed in contact or radiating to one another

There are many other matters treated of in the book, but if one were to take "Waterdale" at his word and judge "whether the rest of the book is worthy or not of careful perusal" by one's experience of Appendix II and its supposed proof, nobody would read another word, and unless one had a great deal of leisure to devote to speculative conjectures, or were well paid for it, there does not seem much inducement to wade very carefully through it. "Waterdale" professes to explain gravitation by a sort of hotch-potch of Bjerknes' sound wave attractions and Osborne Reynolds's theory founded on dilatancy He seems to think that any attempt to explain gravitation is very remarkable "The author would have thought that when the unusual occurrence of the publication of a work announcing the discovery of gravity and other original theories as important arises, that the scientific world would display sufficient interest in the subject as to read and examine the arguments, although the work might be by an unknown pen" "Waterdale" seems ignorant of the fact that the scientific world has been inundated with theories of gravity and other original theories To mention only a few of the better known ones, there are Le Sage's corpuscular theory, worked out very carefully by Mr Tolver Preston and Mr George Forbes. Others founded on wave motion and fluid flow, such as Bjerknes has popularized, and which Mr Karl Pearson has devoted so much ingenuity to, though he takes refuge in nondynamical suggestions, such as a fourth dimension, which might just as well be introduced as a region in which a convenient series of strings existed to hold atoms together without any action at all going on in our stupid tridimensional space What the difference is between such a theory and the good old hypothesis of inherent qualities seems difficult to discover Then there is the suggestion that every atom is connected to every other by means of vortex filaments, though how the poor things work when they get tangled is rather a difficulty here Finally, there is Osborne Reynolds's interesting theory founded on dilatancy, which very possibly has a future before it, especially if we consider that the ether is probably full of vortices, and that vortices cannot cut one another These theories almost all suffer from the apparently incurable defect to which "Waterdale's" is also liable, that they give a rate of propagation of gravity comparable with that of light Parents are proverbially partial to their children, and "Waterdale" probably will cherish his suggestions as very valuable, notwithstanding this and other serious objections The confident way in which, after pages of suggestions as to what might happen, he states that a current from right to left will produce one effect, while one from left to right will not neutralise it is quite refreshing, but is not an attractive investigation to those who are accustomed to call nothing a proof that is not founded upon something better than suggestions. That gravity is propagated with such amazing rapidity as it seems to show that it must be an action of the medium to whose *structure* the electromagnetic properties of the ether are due. Such actions are known to exist in a perfect liquid, and it is natural to attribute gravity to such actions. The reasons for attributing great velocity of propagation to gravity are not apparently very well known The difficulty is owing to the component of the force at right angles to the radius vector that would come in, owing to the aberration of the force, and which would cause an acceleration of areas of planets This might be partly neutralized by a resisting medium, but hardly completely, especially in the case of comets, because the resisting force would be tangential to the path, while the aberration component would be at right angles to the radius vector. It is possible, by assuming an increase of force due to velocity of approach and a decrease due to recession, to get over this latter difficulty, but even then it is hard to explain the persistent rotation of the earth when the surface is *not moving freely* as a projectile, and when consequently the supposed exact balance between gravitational acceleration and resistance of medium does not hold Even then there is the possible suggestion that cohesional and other forces, being similarly propagated in time, would prevent any possible effect being produced by the resisting medium, and so matters return to much as they were at first, and no final answer be given to the questions, "Is gravity propagated in time?" "Does the ether offer resistance to motion?" It remains much in the same position as the question of the motion of the ether at the surface of the earth

"Waterdale" and others seem to think that *fluidity* necessarily implies that a medium is divisible into hard or soft particles No ordinary mind is forced to this conclusion Most minds look upon water, for instance, as a perfectly continuous medium, any part of which can flow past any other part with perfect freedom Hardness, softness and so forth may require structure, but mere fluidity does not Again, "Waterdale" and others seem to imagine that elasticity essentially involves the *compressibility* of the elastic body *i e* that it must consist of atoms that are themselves compressible "Waterdale" himself invents a structure for an atom that resists *deformation* without its constituents being themselves compressible, and the existence of vortex rings shows how a perfect liquid can have a real elasticity to deformation given to a part of it by giving it motion without any part being composed of particles, or any part of it being at all compressible

The rest of "Waterdale's Researches" concern suggestions as to how cohesion, chemical action, light, electricity, &c, may at some future time be explicable by the structure he proposes for the ether, which is to all intents and purposes the same as Osborne Reynolds already has suggested, a whole collection of absolutely hard bodies of different sizes, or, as "Waterdale" suggests, spheres of two different sizes There is considerable cleverness displayed in the way he has reasoned out for himself such a well-known theorem as that a body moving in a perfect liquid will behave as if its mass were increased, but the labour bestowed upon such a well-known theorem does not entice the reader to try and follow the vague suggestions that follow, and that are much the same as have been over and over again given to show how *every* theory as to the nature of the ether explains a lot of things which can on the face of them be explained by *any* ether through which bodies can move, and upon which they exert pressures. Mixed

up with these plausible suggestions are such things as hypothetical whirls of ether within the solar system that seem, to say the least of them, to require some elucidation as to how comets go through them in every sort of direction without any sensible action of the whirl on the comet

A person who has brought forth, after enormous labour of thought, a series of theorems concerning the universe, and who is not very familiar with the equally carefully thought-out suggestions of others naturally looks with more favour upon his own children than upon those of others, but, if he is reasonable, and in a reasonable mood, he will not be surprised nor even distressed, because those who look at all these children with critical eyes see very serious defects in all of them, and feel very confident that without great changes no one of them can possibly grow into a second Newton

VERTEBRATE BIOLOGY

Text book of Biology By H G Wells, B Sc Lond, F Z S With an Introduction by G B Howes, F L S, F Z S, Assistant Professor of Zoology, Royal College of Science, London Part I Vertebrata (London W B Clive and Co, University Correspondence College Press)

MR WELLS'S book is avowedly written mainly for the purpose of helping solitary workers to pass the Intermediate Science examination of the University of London, and it would therefore be unfair to criticise it from a wider point of view The scope for originality in such a work is naturally somewhat limited, but it is a pleasant surprise to come across one which is far above the average as regards soundness of treatment and method The author not only possesses a practical knowledge of the greater part of the subject he deals with, but also evidently takes pleasure in it for its own sake, and has a healthy dislike of "that chaotic and breathless cramming of terms misunderstood, tabulated statements, formulated 'tips,' and lists of names, in which so many students, in spite of advice, waste their youth." He states that "the marked proclivity of the average schoolmaster for mere book-work has put such a stamp on study that, in nine cases out of ten, a student, unless he is expressly instructed to the contrary, will go to the tortuous, and possibly inexact, description of a book for a knowledge of things that lie at his very finger-tips" (p. 31); and again, on p. 125, that "it is seeing and thinking much more than reading, which will enable" the student "to clothe the bare terms and phrases of embryology with coherent knowledge" Throughout the book the importance of actual observation is insisted upon.

The present part deals with the Rabbit, Frog, Dog-fish, and Amphioxus, and includes an account of the development of these animals and of the theory of evolution, as well as a number of questions, most of which have been set at the examinations of the London University The morphological portions are, on the whole good and clearly written, and a fair amount of physiology is also introduced A syllabus of practical work is given at the end: this would in many respects bear amplifying. The student is not warned that his time will be wasted if he wanders off the direct path of the examination syllabus; and on the contrary, points of general biological interest are referred to here and there, and these go far to show what a good many of our elementary text-books do not —viz. that the London University syllabus, "as at present constituted," affords "considerable scope for efficient biological study" The student, moreover, is told that this "little book is the merest beginning in zoology," and the last paragraph, on p 131, indicates the aspect of mind with which the author regards his subject

Twenty-four folding sheets of sketches are inserted in the text, but the figures are, on the whole, exceedingly rough, and though many of them may be found useful as guides, we feel that the student would do better to postpone drawing until his dissections are made, or even copy some of the numerous good figures to be found elsewhere, than to "copy and recopy" these sketches first, as advised by the author

Numerous inaccuracies and awkward expressions occur, only a few of which can be here mentioned. The terms superior and inferior, as applied to the great veins, are likely to confuse a beginner after reading the definition of the regions of the body given on p 3 "Metabolism" and "metaboly" occur even in consecutive sentences on p 23 Peristaltic movement is said to move the food "forward" (p 41) It is stated that the thyroid is similar in structure to the thymus and to "botryoidal tissue" in general (p 26), and that the epithelium of the villi, with its striated border, "is usually spoken of as leading towards "ciliated" epithelium (p 22) It is misleading to say that "a tarsus (tarsalia) *equals* the carpus," and that the vomer of the dog is paired (pp 38 and 76) As the term "Chordata" is adopted on p 96, it is unfortunate that the student is told on p 60 that vertebrata occur in which cartilage is absent, and that Amphioxus possesses the "essential vertebrate features," is "*twisted*, as it were," and that its "vertebral column is devoid of vertebræ" it is, moreover, inadvisable to use the term "hyoidean" with regard to this animal. On p 61 "classes" and "orders" are used in a correct and an incorrect sense in the same sentence. The expression, "carotid gland" requires a better explanation on p 67. The morphology of the cardinals, azygos, and post-caval is incompletely explained (pp 87, 120, and 124) Several serious mistakes are made with regard to the homologies of the urinogenital apparatus (*cf*, *e.g.* pp 92 and 114) Misprints are also fairly abundant throughout.

Most of these faults are, however, such as can be remedied in a future edition, and the book will, we think, serve the purpose for which it was written very satisfactorily W N P

OUR BOOK SHELF.

Pflanzenleben. Von Anton Kerner von Marilaun. Band II. Geschichte der Pflanzen (Leipzig und Wien Bibliographisches Institut.)

THE first volume of this excellent book was reviewed in NATURE, vol. xxxix p. 507 The present volume, which completes the work, treats of the "history of plants," by which is meant their *development*, in the widest sense, including both ontogeny and phylogeny. The former subject ("origin of descendants") occupies the first 480 pages, while the remainder is devoted to the "history of species."

It is not proposed to enter into any detailed criticism of this volume Some idea of the scope of the work was given in the former notice; we are glad to hear that an English translation is in preparation, and when this appears a further opportunity will be given for a general account of the whole In point of interest the second volume is fully equal to the first, there is, however, perhaps more room for adverse criticism of certain parts Speaking quite generally it may be said that while the "biology," or natural history of the subject is admirable, the morphology is on the whole rather weak The former, however, is the more important for the general reader, for whom the book is intended

The account of reproduction begins with the asexual organs of propagation, including spores, buds, and gemmæ This is succeeded by the much more extensive section on reproduction by fruits, including all sexual processes The great value of this part lies in the extremely full, and in many respects original, treatment of the fascinating subject of the pollination of flowering plants, to which nearly 300 pages are devoted Special stress is laid here on the phenomena of *geitonogamy*, or the crossing of different flowers on the same inflorescence, and of *autogamy*, or self-fertilisation of hermaphrodite flowers The whole account is of the greatest possible interest, and familiar as the subject has now become, innumerable fresh points of view are opened up

The second part of the volume is on the history of species, including the whole subject of variation Changes produced by external agencies, such as parasitic fungi, and gall-forming insects, form the subjects of special sections

As regards the origin of new species, the author, like Prof Weismann, attributes the greatest importance to sexual reproduction, and especially to cross-fertilisation He occupies a peculiar position in so far as he believes that hybridisation has played an important part in nature as a source of new forms

This second part of vol ii includes classification, and a fairly full account is given of all the important groups of plants, each cohort, or "Stamm," receiving separate treatment

Sections on the distribution of species, and on their extinction, conclude the book

A really good index is added, which will be a great boon to all who wish to make use of the vast store of facts which the book contains The illustrations, consisting of twenty coloured plates and 1547 figures in the text, reach the same high standard as those of the previous volume

To the book as a whole the highest praise must be given No such popular account of the natural history of plants has appeared before The publication of an English version will be anticipated with great interest

D H S.

Bibliografia Medica Italiana By P Giacosa, Prof straord. di Materia Medica e Chimica fisiologica all' Università di Torino (Torino-Roma L Roux e C, 1893)

This work is a collection of abstracts of the chief papers bearing on the medical sciences published by various Italian authors during the year 1892 Prof. Giacosa has been aided in his work by several experts, whose names are a sufficient guarantee for the accuracy of the abstracts, such as Profs Marcassi of Palermo, Maggiora of Modena, and Sperino of Torino. The medical reading public is familiar with the excellent *Jahrberichte* and *Centralblatter* published in Germany, which deals chiefly, though not exclusively, with scientific papers by German authors. There has been a great want of similar publications of Italian work, and Prof. Giacosa's "Bibliografia" is a welcome addition to medical literature. In it will be found abstracts of all the chief Italian papers published in 1892 on parasites and helminthology (zoology), physiology, biological chemistry, pharmacology, histology, human and pathological anatomy, bacteriology and hygiene. The abstracts are done by experts in the particular subject, are short but clear and intelligible, and have the advantage of not being critical

The Evolution of Decorative Art By Henry Balfour, M A, F Z S (London Percival and Co., 1893.)

It is remarkable that in these days, when the question of "origins' holds a place of commanding importance in almost every department of investigation, comparatively little should have been done to trace the evolution of art back to what Mr Balfour calls "its very simplest beginning" Mr Balfour does not, of course, undertake to present in this small book anything like a complete view of the subject His aim is merely to indicate some of the main conclusions to which he has been led by his own researches He finds in early art three distinct stages—(1) adaptive, the appreciation of curious or decorative effects occurring in nature or as accidents in manufacture, and the slight increasing of the same by artificial means in order to augment their peculiar character or enhance their value as ornaments, (2) creative, the artificial production of similar effects where these do not occur (imitation or copying), (3) variative, gradual metamorphosis of designs by unconscious and conscious variation Mr Balfour brings out admirably the significance of these stages, and it is scarcely necessary to say that the Pitt Rivers collection, of which he is curator, provides him with ample means for the clear and effective exposition and illustration of his ideas

LETTERS TO THE EDITOR

The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications*]

Palæontological Discovery in Australia

Many readers of Nature will learn with interest that I have this day received a telegram from Prof Stirling, of the University of Adelaide, as follows —

"Made discovery immense deposit fossil remains excavated several nearly complete skeletons Diprotodon besides two thousand bones also large Struthious bird giant Wombat particulars letter"

I need scarcely add that I shall await with impatience the promised particulars of this discovery, which may prove to be one of great importance Alfred Newton.

Magdalene College, Cambridge, April 21

An International Zoological Record

It is much to be regretted that the praiseworthy agitation of this subject, opened by Mr Minchin (Nature, vol xlvi p. 367), has not been continued. There cannot be the slightest doubt of the desirability of such a reform Possibly the reason why the letters of Mr Minchin and Mr Bathers (*ib* p. 416) have not aroused more interest lies in the fact that they both wrote as recorders. They showed the absurd burdens that the actual system imposes upon the recorders; but they left somewhat in the background the advantages which the great world of zoologists could receive.

However this may be, it is certain that the rank and file of investigators of the present day are supporting an utterly unnecessary burden, and one from which they ardently desire to be freed. Any one who desires to test the sentiment has only to make inquiries among those of his acquaintance. Having myself agitated in this quiet way a method of reform that had occurred to me nearly two years ago, I can hardly doubt that the concourse of opinion is strong enough to effect a radical change, if only concerted action can be taken.

Mr. Minchin and Mr. Bathers have pointed out that the

recorders at present do the same work many times over, and suggest a plan by which it can be avoided. The salient feature lies in separating the duties of recorder and bibliographer, and in having the entire mechanical work *done once* for all concerned in the preparation of the record. The plan is an admirable one, but why thus restrict the blessings of a competent bibliographer? The scheme to which I have alluded in the preceding paragraph simply substitutes a *bibliographical bureau* for the bibliographer, a feature necessitated by the additional duties imposed upon it.

The business of recording a publication according to the latter plan may be referred to *three stages*. Let me suppose the bureau constituted at a centre such as the British Museum, and show its working. The *first stage* of recording is conducted wholly by the central bureau, with such aids from outside as might be found expedient. [I refer to assistants in other countries. In the case of Russia it would be at first probably necessary, although in general to be avoided as far as possible.] In the first place the bureau would make complete lists of all zoological papers as they are published. At intervals of a week, or of two weeks, these lists would be given to the press and printed successively in two forms. One would constitute a pamphlet similar to the bibliographical part of the *Zoolog. Anzeig.*, but would give all the titles *promptly*. The other form in which the list would be printed would have the titles widely spaced, would be printed on strong, stout paper, and would appear in sheets, leaving one side blank. These sheets could then be cut up at will into slips of uniform size and shape to serve further bibliographical elaboration. During the printing of the slips it would have been the duty of the bibliographer to have sorted the titles carefully, and, in the case of larger works and works with ill characterised contents, it would further have been his duty to have ascertained the *topics* dealt with, so that at the end of the period he would be able to *sort and classify* the 150 titles, which appear at present weekly.

Thereupon the second stage of recording would be begun. Each reviewer would receive at once slips indicating the papers concerning him, together with a page number in the case in which his topic is only incidentally dealt with. Thus the mechanical labour of the reviewer would be reduced to a minimum. Not merely, however, the reviewers could be thus informed, but *also any specialist whose field of work sufficiently* coincided with one of the divisions of the Record to induce him to subscribe to the series. Thus, for example, a worker on the development of the vertebrate nervous system would find his wants admirably met. The second stage of recording would be carried on wholly by the reviewers, who, however, in addition to writing reviews as at present, would also index the topics of the paper in a more detailed way than would be possible for the bibliographer in his first hasty survey; or this work might be left to the bibliographer, who, in what I have called the third stage, collates the reviews which have been returned to him. The reviewer should also note any incidental observations of interest to other reviewers which the bibliographer may have overlooked.

In stage 3 the bibliographical bureau becomes a bureau of publication, and it is believed that with such an organisation the Record for the year could be very promptly issued. At the same time, however, the bureau would be able, by the use of the slips at its disposal, to embody the indexes furnished by the reviewers (or, possibly better, made out by the bibliographer from their abstracts) in a permanent slip index, which would grow with the years and become a record of inestimable value. This part of the plan alone, I see, has been independently advocated by Mr. Cockerell (NATURE, vol. xlvi. p. 442), but, inasmuch as he overlooked the indefinite multiplication made possible by the use of printed slips, he failed to note the highest use which the bureau can serve. To my mind this consists in *informing the individual investigator of every work which concerns his specialty* by sending him the proper slips.

The value of such a service can hardly be exaggerated. It relieves the individual of endless labour; it gives a completeness to his knowledge of the literature that no individual endeavour could attain; and finally, it saves him the annoyance which indefinite titles occasion him in using the ordinary means of seeking for papers relating to his subject. So long as a fundamental observation on the development of the Wolffian Duct can be published under the title, "Observations on the Lymph," so long as the bulletins announce "Contributions to the Development of the Vertebrates," we have no right to expect authors to have a full mastery of their subject, unless they can receive aid from a central bureau such as I have described.

The expense of maintaining at several points a complete index, such as that in the bibliographical bureau, is not such as to make it infeasible, and I fancy it would be done in several zoological centres. The labour of the bureau would probably assume considerable proportions, but, inasmuch as it would in each case save much more of the scattered and oft-repeated labour of individuals, it would be quite self supporting. For the perfect working of the scheme it is important that authors should send "extras" to the bibliographer. Mr. Bathers suggests that they would gladly do this if there were only one asking for them instead of a number, as is now the case. Here Mr. Bathers again writes as a recorder. I was unaware that papers were desired, and would not know even where to send a copy. With the scheme I have proposed, also those who now unintentionally withhold their papers would contribute them, for the organisation would at least be well known.

Respecting further details, there is no occasion of bringing these forward now. I may simply add that I have had opportunity of seeing paper slip catalogues in use in a very large scale in the Government service in Russia, and learned that they gave excellent satisfaction. It may be also of interest to any who may further concern themselves with this subject that the present volume of zoological publication is not far from 2000 pages weekly.

I have made inquiries among many of my friends in different countries in respect to their interest in such a plan as I here propose, and it has received such endorsement that I cannot doubt that it affords a remedy for a real evil. I am well aware that such a plan needs to be much modified, but I submit it in this form. I have already a long list of persons and institutions who have promised to subscribe to the slips, could they be obtained at a reasonable price, among others of librarians, who would use them to save copying in making out the "card catalogues" in vogue in America. This support was obtained when the scheme was but little elaborated, and when there was almost no prospect of success. I am confident that were the undertaking once begun the support would be very great. It needs organised action such as the various scientific bodies can give it. Let the British Association appoint a committee and invite others to join them in forming an International Commission, or let them respond should the call come to them. Let all considerations of national pride be set aside. Surely England, with her enormous library and museum facilities, will receive her share.

Leipzig, Germany, April 16. HERBERT H. FIELD.

Lion-tiger and Tiger-lion Hybrids

SINCE the date of my previous communication on the above subject (see NATURE, p. 390) I have had some correspondence with Mr. John Atkins, son of Mr. Thomas Atkins, the result of which has been not only to clear up several discrepancies which I pointed out as occurring in the previously published accounts by Sir Wm. Jardine and Mr. Griffiths, but moreover it enables me to present for the first time a detailed account of what, so far as I can ascertain, are the only authenticated cases of the interbreeding of a lion and tigress. I am aware of the classical references to the reputed breeding of the leopard and lioness, but that part of the subject I do not propose to discuss now. In the first place I should state that the proprietor of the menagerie, when the first hybrids were seen, was Mr. Thomas Atkins, not "F." or "J. Atkins" as quoted previously. Mr. John Atkins came into possession later on. The parents of the hybrids were the same all through for ten years, from 1824 to 1833, during which period six litters were born. The lion was bred in Mr. Atkins's menagerie from a Barbary lion and a Senegal lioness. The tigress was born in the Marquis of Hastings's collection in Calcutta, and was purchased when about eighteen months old by Mr. T. Atkins from a captain, to whom she had been given by the Marquis. Being of the same age as the lion, she was placed together with him in the same cage, and two years afterwards she proved to be in cub.

The following statement regarding the successive litters has been revised by Mr. John Atkins, and as he has preserved notes of the facts which are recorded, they may be accepted as authentic. I need hardly add that but for his ready and full response to my queries this account could not have been written.

First Litter.—Born October 24, 1824, at Windsor, two males

and one female Reared by terrier bitch, all died within a year They were exhibited to King George IV at the Royal Cottage, Windsor, on November 1, 1824

Second Litter —Born April 22, 1825, at Clapham Common, there were three cubs, sexes not recorded Reared by the mother, as also were all the subsequent litters They only lived a short time.

Third Litter.—Born December 31, 1826 or '27, at Edinburgh, one male and two females As stated in the previous paper, the year is given as 1827 in the handbill of the menagerie from which I quoted, and the other references seem to sup port that date, but Mr John Atkins says it is given as 1826 in a printed catalogue in his possession

Fourth Litter —Born October 2, 1828, at Windsor, one male and two females

Fifth Litter —Born May, 1831, at Kensington, three cubs, sexes not recorded. They were shown to the Queen, then Princess Victoria, and to the Duchess of Kent The whole group performed in a specially constructed cage at Astley's Amphitheatre, and in 1832 were taken by Mr Atkins for a tour in Ireland To a separate account of this tour reference has been made in my previous paper

Sixth Litter —Born July 19, 1833, at the Zoological Gardens, Liverpool, one male and two females One, the male, lived for ten years in the gardens The young male lion tigers when about three years old had a short mane something like that of an Asiatic lion, the stripes became very indistinct at that age

Mr Atkins informs me that there is a badly stuffed specimen of one cub which was about a year old in the Museum at Salisbury, and from Mr Harmer's letter (see NATURE, p. 413) there is one also in Cambridge

From the account quoted by him it would seem improbable that that particular specimen, had it survived, could have bred As a matter of fact I learn from Mr Atkins that none of them ever did breed, though he does not know of any reason why they should not have done so

Mr Atkins thinks that the cubs of the earlier litters died from over-feeding, when he adopted a different treatment he had no difficulty in rearing them

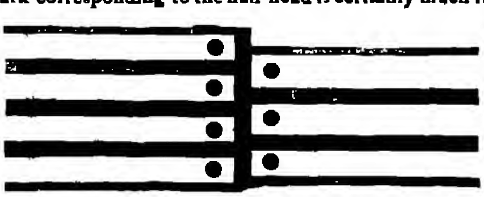
In my previous paper, in the quotation from Griffiths, the word "superfineness" should read "superficies"

This record, it may be noted, while correcting some errors in the previously published accounts, also extends over a period subsequent to all of them. V BALL

Science and Art Museum, Dublin, April 15

Soot-figures on Ceilings

As the subject of dust-images was recently considered in some interesting letters in NATURE, I wish to record an example of a soot-image which was far more detailed and remarkable than any I have yet seen. The example is to be found on the ceiling of the billiard room in the Golf Club House at Felixstowe Abundant soot has been deposited above the lamps by which the table is lighted, and this is distributed so as to map out on the ceiling not only the outline of the joists, but that of the laths and even of the nails by which the ends of the latter are secured. The mark corresponding to the nail-head is certainly much larger



than the latter I made rom memory a rough sketch of the appearance, which is reproduced in the accompanying woodcut. I may be mistaken in the position of some of the light and dark shades. If the example is as new to others as it was to me it would be interesting to have a photograph of the ceiling before it is again whitewashed. E. B. POULTON.

Oxford, April 17.

THIS phenomenon is often observed, though not often so clearly as in the case noticed by Mr Poulton. It is due to the same cause as produces the dust-free space seen rising from hot bodies in illuminated smoky air, viz. a peculiar Crookesian (or rather Osborne Reynoldsian) bombardment of sufficiently small dust-particles, in the direction of decreasing temperature, by the extra energy of the gas-molecules on one side See papers by myself and the late Mr Clark in NATURE (especially July 26, 1883, April 24, 1884, vol xxix p 417, and January 22, 1885), and in Phil Mag, 1884, Proc. R I, &c, also by Mr Aitken, Trans. R S. Edin, 1884. And see the remarkable theoretical paper by Prof Osborne Reynolds on "Dimensional Properties of Gases," Phil Trans, 1879

Dust gets bombarded out of hot air on to all colder surfaces The details of this effect are specially given by Mr Aitken in NATURE, vol xxix. p 322 The badly-conducting plaster of a ceiling is no doubt fully heated by contact with the air below except in places where the conducting power of wood or iron keeps it comparatively cool, hence the picking-out of the pattern Solid deposit from warm air on to cool surfaces can occur without any actual smoke, *e.g* It can be noticed above incandescent lamps OLIVER LODGE

The Use of Ants to Aphides and Coccidæ

I HAVE just had an opportunity of seeing Dr. Romanes' interesting work, "Darwin, and after Darwin," and find therein (p 292) the production of honey-dew by Aphides adduced as a difficulty in the way of the Darwinian theory I have not paid any particular attention to Aphides, but have lately been much interested in the allied Coccidæ, which, since they produce a similar fluid attracting ants, may be considered to offer a parallel instance Both Coccidæ and Aphides suffer from many predaceous and parasitic enemies, and there seems to be no doubt that the presence of numerous ants serves to ward these off, and is consequently beneficial There is an interesting Coccid, *Icerya rosæ*, which I find on Prosopis here, and on more than one occasion I have been unable to collect specimens without being stung by the ants At the present moment some of these Iceryæ are enjoying life, which would certainly have perished at my hands, but for the inconvenience presented by the numbers of stinging ants

Belt and Forel have also written on the protection of Coccidæ by ants ("Naturalist in Nicaragua," and *Bull Soc Vaud.*, 1876) Maskell has given an account of the honey-dew organ of Coccidæ, from which it appears that it is something more than a mere organ for the excretion of waste products This author also figures some of the fungi which grow on honey dew and it may well be that these also serve to prevent the attacks of enemies When, as we sometimes see in Jamaica, the leaves appear to be coated with soot (*Antennaria robbinsii* is the fungus), it cannot be so convenient for coccinellid larvæ, Chrysopa larvæ, &c., to crawl about on them in search of Coccidæ.

Jamaica, April 3 T. D A COCKERELL.

Blind Animals in Caves

IN his last letter (p 537) Mr J T Cunningham states that the "early stages" of the European Proteus have not yet been obtained This assertion is incorrect In 1888 and 1889 the oviposition and development have been described by E Zeller (*Zool Anz.*, 1888, No 290, and *Jahresh Ver. Naturk Wurtt*, xlv, 1889, p 131, plate iii), who gives a coloured figure of the larva, and particularly refers to the development of the eyes. As early as 1831 (Oken's "Isis," 1831, p 501) Michahelles remarked that the eyes in young specimens are more distinct and somewhat larger than in the adult G. A. BOULENGER

OBSERVATIONS IN THE WEST INDIES.[1]

HERE we are back at Nassau for the third time, and thinking you might be interested to hear of my cruises, I send you a short sketch of our trip The first time we left Nassau we entered the Bahama Bank at Douglass Channel and crossed the bank to North Eleuthera, where we examined the "Glass Window" and the northern extremity of Eleuthera, we then sailed along the west shore of the island close enough to get a good view of its characteristics as far as Rock Harbour at the

[1] A letter from Alexander Agassiz to J D. Dana, dated Steam Yacht *Wild Duck*, Nassau, March, 1893. Printed in the *American Journal of Science* for April, and communicated to NATURE by the author.

southern end We steamed out into Exuma Sound through the Powell Channel and round the southern end of Eleuthera to little San Salvador, and the north-west end of Cat Island, where are the highest hills of the Bahamas. We then skirted Cat Island along its western face, rounded the southern extremity and made for Riding Rocks on the Western side of Watling's Island We circumnavigated Watling, passed over to Rum Cay, then to northern part of Long Island, visiting Clarence Harbour, next we crossed to Fortune Island, and passed to the east side near the northern end of the island on the Crooked Island Bank. From there we crossed to Caicos Bank, crossing that bank from French Cay to Long Island, passed by Cockburn Harbour and ended our eastern route at Turks Island, from there we shaped our course to Santiago de Cuba to coal and provision the yacht We were fortunate enough to strike Cape Maysi a short time after daylight, and I thus had a capital chance to observe the magnificent elevated terraces (coral reefs) which skirt the whole of the southern shore of Cuba from Cape Maysi to Cape Cruz and make so prominent a part of the landscape as seen from the sea We were never more than three miles from shore and had ample opportunity to trace the course of some of the terraces as far as Santiago, and to note the great changes in the aspect of the shores as we passed westward due to the greater denudation and erosion of the limestone hills and terraces to the west of Cape Maysi, which seems to be the only point where five terraces are distinctly to be seen The height of the hills east of Pt Caleta, where the terraces are most clearly defined, I should estimate at 900 to 1000 feet, though the hills behind the terraces, which judging from their faces are also limestone, reach a somewhat greater height, perhaps 1100 to 1200 feet

After coaling at Santiago de Cuba we visited Inagua, and next steamed to Hogstey Reef, a regular horseshoe-shaped atoll with two small cays at the western entrance There we passed three days studying the atoll This to me was an entirely novel experience, to be at anchor in 3 fathoms of water 45 miles from any land with water 900 fathoms within three miles outside, surrounded by a wall of heavy breakers pounding upon the narrow annular reef which sheltered us I made some soundings in the lagoon and on the slope of reef outside From there we returned to Crooked Island Bank to the westward of which I also made some soundings to determine the slope of the Bank We next again visited Long Island, taking in the southern and northern ends which I had not examined From there we passed to Great Exuma, stopping at Great Exuma Harbour and sounding into deep water on our way out to Conch Cut when we sailed west crossing the Bank to Green Cay From there we made the southward face of New Providence, and before going into Nassau Harbour made some trials in deep water in the Tongue of the Ocean with the *Tanner* deep-sea townet in 100 and 300 fathoms, depth being 700 fathoms—after which we returned to Nassau I had on board a Tanner sounding machine kindly loaned me for this trip by Colonel McDonald of the Fish Commission, and some deep-sea thermometers were also kindly supplied by him and by Prof Mendenhall, the superintendent of the U S Coast Survey. I supplied myself with a number of Tanner deep-sea townets and with a supply of dredge and of townets and carried on board a Yale and Towne patent winch for winding the wire rope which I used in my dredging and towing in deep water. The yacht was provided with a steam capstan and by increasing its diameter with lagging we found no difficulty in hauling in our wire rope at the rate of 8 min. to 100 fathoms. I carried 600 fathoms of steel wire dredging rope with me of the same dimensions which I had used on the *Blake* and which has also been adopted on the *Albatross*. During our second cruise we steamed from Nassau for Harvey Cay crossing the Bank from north to south to Flamingo Cay, and then to Great Ragged Cay, from which we took our departure for Baracoa. At Baracoa I hoped to be able to ascend the Yunque, unfortunately I had to give up my trip owing to the desperate condition of the roads. From Baracoa we steamed close to the shores to the westward, touching at Port Banes, Port Padre, Cay Confites, Sagua, Cape Frances, Cardenas, Matanzas, and finally ending at Havana. This trip was a continuation of the observations we made on the south coast of Cuba and enabled me to trace the gradual disappearance of the terraces from Baracoa to Nuevitas, and their reappearance from Matanzas to Havana, from the same causes which evidently influenced their state of preservation from Cape Maysi west. I also got a pretty clear idea of the mode of formation of the fine harbours found on the northern coast of Cuba to the eastward of Nuevitas, and of the mode of formation of the extensive systems of cays reaching from Nuevitas to Cardenas and which find their parallel on the south coast of Cuba from Cape Cruz to Cape Corrientes After refitting at Havana we left for Nassau Both on going into Havana and on leaving we spent the greater part of a day in towing with the Tanner net I thought I could not select a better spot for finally settling the vertical distribution of pelagic life than off Havana which is in deep water—900 fathoms —close to land, on the track of a great oceanic current, the Gulf Stream, noted for the mass of pelagic life it carries along its course We towed in 100, 150, 250, and 300 fathoms and on the surface at or near the same locality, and I have found nothing to cause me to change the views which I expressed in my preliminary reports of the *Albatross* expedition of 1891 Nowhere did I find anything which was not at some time found also at the surface At 100 fathoms the amount of animal life was much less than in the belt from 100 fathoms to the surface At 150 fathoms there was still less and at 250 fathoms and 300 fathoms the closed part of the Tanner contained *nothing*. At each one of these depths we towed fully as long as was required to bring the net to the surface again. Thus we insured before the messenger was sent to close the lower part of the bar as long a pull through water as the open part of the net would have to travel till it reached the surface, giving the fauna of a horizontal column of water at 100, 150, 250, and 300 fathoms of the same or greater length than the vertical column to the surface for comparison of their respective richness. From Havana we steamed to Cay Sal Bank, visited Cay Sal, Double-headed Shot Cays, Anguila Islands, and then crossed over to the Great Bank to the west of Andros Island. The bottom of this bank is of a most uniform level, 3 and 3½ fathoms for miles and then very gradually sloping to the west shore of Andros, so that we had to anchor nearly six miles from the "Wide Opening" of the central part of Andros which we visited. The bottom consists of a white marl, resembling when brought up in the dredge newly mixed plaster of Paris, and having about its consistency just as it begins to set This same bottom extends to the shore; and the land itself, which is low where we went on shore not more than 10 to 15 inches above high-water mark, is made up of the same material, which feels under foot as if one were treading upon a sheet of soft india rubber, of course on shore the marl is drier and has the consistency of very thick dough It appears to be made up of the same material as the æolian rocks of the rest of the Bahamas, only that it has become thoroughly saturated with salt water, and in that condition it crumbles readily and is then triturated into a fine impalpable powder almost like deep sea ooze which covers the bottom of the immense bank to the west of Andros. After leaving Andros we crossed the bank again to Orange Cay and followed the eastern edge of the Gulf Stream to see Riding Rocks, Gun Cay, and the Beminis. We then passed to Great Isaac, where we saw some huge

masses of æolian rocks which had been thrown up along the slope of the cay about 80 feet from high-water mark to a height of 20 feet One of these masses was 15′ 6″ × 11″ × 6′ We then kept on to Great Stirrup Cay coasting along the Berry Cays, crossed over to Morgan's Bluff, on eastward of Andros down to Mastic Point on the same Sound, and then returned to Nassau

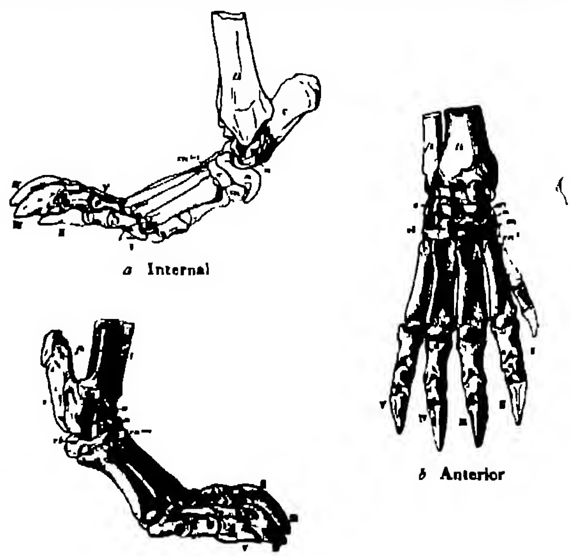
The islands of the Bahamas (as far as Turks Island) are all of æolian origin They were formed at a time when the Banks up to the 10-fathom line must have been practically one huge irregularly shaped mass of low land, from the beaches of which successive ranges of low hills, such as we still find in New Providence, must have originated After the islands were thus raised there was an extensive gradual subsidence which can be estimated at about 300 feet, and during this subsidence the sea has little by little eaten away the æolian lands, leaving only here and there narrow strips of land in the shape of the present islands Inagua and Little Inagua are still in the original condition in which I imagine such banks as the Crooked Island Banks, Caicos Banks, and other parts of the Bahamas to have been, while the process of disintegration going on at the western side of Andros shows still a broad island which will in time leave only the narrow eastern strip of higher land (æolian hills) on the western edge of the tongue of the ocean Such is the structure also of Salt Cay Bank which owes its present shape to the same conditions as those which have given the Bahamas their present configuration My reason for assigning a subsidence of 300 feet is the depth of some of the deep holes which have been surveyed on the bank and which I take to be submarine blow-holes or caverns formed in the æolian limestone of the Bahama hills when they were at a greater elevation than now This subsidence explains satisfactorily the cause of the present configuration of the Bahamas, but teaches us nothing in regard to the substratum upon which the Bahamas were built The present reefs form indeed but an insignificant part of the topography of the islands and have taken only a secondary part in filling here and there a bight or a cove with more modern reef rock, thrown up against the shores so as to form a coral reef beach such as we find in the Florida Reef I have steamed now nearly 3300 miles among the Bahamas, visiting all the more important points and have made an extensive collection of the rocks of the group

I hoped to have made also a larger number of deep soundings than I have been able to take, unfortunately the trades were unusually heavy during the greater part of my visit to the Bahamas, greatly interfering with such work on a vessel no larger than the *Wild Duck*—127 feet on the water line For the same reason the number of deep-water pelagic hauls was also much smaller than I hoped to make, as in a heavy sea the apparatus would have been greatly endangered It is a very different thing to work at sea in a small yacht like the *Wild Duck* or in such vessels as the *Blake* and the *Albatross* of large size and fitted up with every possible requirement for deep sea work The *Wild Duck*, on the other hand, was admirably adapted for cruising on the Bahama Banks, her light draught enabling her to go to every point of interest and to cross and recross the banks where a larger vessel could not follow I am under the greatest obligations to my friend Mr. John M Forbes for having so kindly placed his yacht at my disposal for this exploration, and I hope soon after my return to Cambridge to publish more in detail the results of this examination of the structure of the Bahamas

ARTIONYX—A CLAWED ARTIODACTYLE.

If any further evidence were needed to disprove Cuvier's famous generalisation, it is found in the recently discovered hind foot of Artionyx. In this foot each of the digits with all the phalanges are modified very much as in the primitive bears, and combined with metatarsals and an ankle joint almost identical with those of the pigs The termination of the limb in claws would have led Cuvier to predict that the whole skeleton and the dentition was of a clawed or carnivorous type, whereas in this animal we find the foot alone belongs to two types as widely separated as can be, and the probabilities are that the skeleton and teeth are also mixed in character

The foot of Artionyx was found last summer by the American Museum party under Dr Wortman, in the same beds with the remarkable Protoceras recently described in NATURE It belonged to an animal about the size of a peccary The terminal claws were first exposed, and although found uncleft, they at once suggested a reference to Chalicotherium, for which the party was keeping a sharp look-out, but a further removal of the matrix showed a pes of an entirely distinct character In the foot of *Chalicotherium magnum* of the Upper Miocene of France we find three toes, thus odd in number, but not strictly perissodactyle, for the largest is



a Internal

b Anterior

c External

Right hind foot of *Artionyx gaudryi*.

not the median but the outer toe Above the toes is an ankle joint of a modified perissodactyle type, that is, the astragalus is grooved upon its tibial side, and flattened where it rests upon the navicular The navicular and cuneiforms are also flattened, so that the foot must have been placed somewhat at an angle with the leg, as it is in the Sloths In Artionyx, on the other hand, there are five digits; the first, or thumb, was a dew-claw, very much shorter than the rest, the remaining four, as shown in *b* of the figure, are nearly symmetrically placed in pairs on either side of the median line, precisely as in the Artiodactyla. This has suggested the name of the animal, its even-numbered toes terminating in claws. Above these elements we have a coalescence of the outer and middle cuneiforms as in many Artiodactyla. The cuboid, navicular, astragalus, and calcaneum, are also modified precisely as in the artiodactyles. The fibula comes down upon the heel bone, and there is the characteristic double hinge. The tibia is strongly interlocked on the outer side of the astragalus. The three accompanying cuts exhibit the peculiar features of this foot; the side views showing that the animal was digitigrade like the cats, and not plantigrade like the bears, although the claws were more of the bear than the cat type.

The discovery of this foot is one of those complete surprises which render palæontological research so fascinating. The existence of such a type was not even suspected, for nothing at all similar has ever been found before. We were daily expecting to find remains of Chalicotherium in the Lower Miocene of America, but no one could have anticipated the complete counterpart in foot structure which this animal exhibits. Of course it will remain an open question whether Artionyx is actually related to the other type until we procure more of its skeleton, and especially of its teeth. This discovery seems to support Cope's opinion that Chalicotherium represents a distinct order—the Ancylopoda, including animals of an ungulate type of skeleton, with unguiculate phalanges. The writer has recently suggested that this order may have been given off from the most primitive hoofed mammals, the Condylarthra, at a period when they still exhibited many of the characters of their clawed ancestors. If this supposition is correct, and Artionyx proves to be a member of the Ancylopoda, it will very possibly present a unique double parallelism with the subdivisions of the Ungulata, Chalicotherium representing an odd-clawed division—the Perissonychia, and Artionyx an even-clawed division—the Artionychia—these divisions being parallel with the perissodactyle and artiodactyle ungulates. This is advanced as a provisional hypothesis, pending the discovery of additional remains.

HENRY F. OSBORN

THE HODGKINS FUND PRIZES

In October, 1891, Thomas George Hodgkins, Esq., of Setauket, New York, made a donation to the Smithsonian Institution, the income from a part of which was to be devoted "to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man."

With the intent of furthering the donor's wishes, the Smithsonian Institution now announces the following prizes to be awarded on or after July 1, 1894, should satisfactory papers be offered in competition:—

1. A prize of 10,000 dollars for a treatise embodying some new and important discovery in regard to the nature or properties of atmospheric air. These properties may be considered in their bearing upon any or all of the sciences—*e.g.* not only in regard to meteorology, but in connection with hygiene, or with any department whatever of biological or physical knowledge.

2. A prize of 2000 dollars for the most satisfactory essay upon (A) the known properties of atmospheric air considered in their relationships to research in every department of natural science, and the importance of a study of the atmosphere considered in view of these relationships; (B) the proper direction of future research in connection with the imperfections of our knowledge of atmospheric air, and of the connections of that knowledge with other sciences. The essay, as a whole, should tend to indicate the path best calculated to lead to worthy results in connection with the future administration of the Hodgkins foundation.

3. A prize of 1000 dollars for the best popular treatise upon atmospheric air, its properties and relationships (including those to hygiene, physical and mental). This essay need not exceed 20,000 words in length; it should be written in simple language, and be suitable for publication for popular instruction.

4. A medal will be established, under the name of "The Hodgkins Medal of the Smithsonian Institution," which will be awarded annually or biennially, for important contributions to our knowledge of the nature and properties of atmospheric air, or for practical applications of our existing knowledge of them to the welfare of mankind. This medal will be of gold, and will be accompanied by a duplicate impression in silver or bronze.

The treatises may be written in English, French, German, or Italian, and should be sent to the secretary of the Smithsonian Institution, Washington, before July 1, 1894, except those in competition for the first prize, the sending of which may be delayed until December 31, 1894.

The papers will be examined and prizes awarded by a committee to be appointed as follows:—One member by the secretary of the Smithsonian Institution, one member by the President of the National Academy of Sciences, one by the President *pro tempore* of the American Association for the Advancement of Science, and the committee will act together with the Secretary of the Smithsonian Institution as member *ex officio*. The right is reserved to award no prize if, in the judgment of the committee, no contribution is offered of sufficient merit to warrant an award. An advisory committee of not more than three European men of science may be added at the discretion of the Committee of Award.

If no disposition be made of the first prize at the time now announced, the Institution may continue it until a later date, should it be made evident that important investigations relative to its object are in progress, the results of which it is intended to offer in competition for the prize. The Smithsonian Institution reserves the right to limit or modify the conditions for this prize after December 1, 1894, should it be found necessary. Should any of the minor prizes not be awarded to papers sent in before July 1, 1894, the said prizes will be withdrawn from competition.

A principal motive for offering these prizes is to call attention to the Hodgkins Fund and the purposes for which it exists, and accordingly this circular is sent to the principal universities and to all learned societies known to the Institution, as well as to representative men of science in every nation. Suggestions and recommendations in regard to the most effective application of this fund are invited.

It is probable that special grants of money may be made to specialists engaged in original investigation upon atmospheric air and its properties. Applications for grants of this nature should have the indorsement of some recognised academy of sciences or other institution of learning, and should be accompanied by evidences of the capacity of the applicant in the form of at least one memoir already published by him based upon original investigation.

To prevent misapprehension of the founder's wishes it is repeated that the discoveries or applications proper to be brought to the consideration of the Committee of Award may be in the field of any science or any art without restriction, provided only that they have to do with "the nature and properties of atmospheric air in connection with the welfare of man."

Information of any kind desired by persons intending to become competitors will be furnished on application.

All communications in regard to the Hodgkins Fund, the Hodgkins Prizes, the Hodgkins Medals, and the Hodgkins Fund Publications, or applications for grants of money, should be addressed to S. P. Langley, Secretary of the Smithsonian Institution, Washington, U.S.A.

S. P. LANGLEY,
Secretary of the Smithsonian Institution.

Washington, March 31, 1893.

THE SOLAR ECLIPSE.

The telegrams relating to the total solar eclipse of April 16 indicate that the observations at the various centres were carried on under very favourable conditions. The Senegal party—which will be home next week—was

evidently remarkably successful Prof Thorpe, who was in charge of this expedition, sent to Lord Kelvin the following telegram —"April 19, 1893 Thorpe to President Royal Society, Burlington House, London. Eclipse successfully observed at Fundium Position good, weather fine, very slight haze Slit spectroscope good, but mainly prominence lines, calcium and hydrogen seen projected on moon Thirty prismatic camera photographs, eighteen excellent, mainly prominence lines; corona lines doubtful Ten coronograph pictures, six very good Photometric work successful, twenty comparisons with equatorial, eleven with integrating apparatus Deslandres and Colculesco also observed at Fundium, with good results No word from Bigourdan at Joal Health of expedition good. Blonde leaves for Teneriffe to-morrow —Thorpe"

With regard to the work of the same expedition, a correspondent of the *Times* telegraphed from Bathurst on April 19.—"The solar eclipse was successfully observed at Fundium, Senegal The weather was fine, with only a very slight haze The results of the slit spectroscope were good Thirty prismatic camera photographs were taken, eighteen of which are excellent, while of ten coronograph pictures six are very good The photometric work was successful, and twenty comparisons were taken with the equatorial and eleven with the integrating apparatus The French astronomers, MM Deslandres and Colculesco also made observations at Fundium with good results. The health of the expedition is excellent."

Last week we gave the substance of a telegram regarding Prof Pickering's observations at Minasaris The *New York Herald* has published a telegram from Valparaiso, containing the following supplementary information as to Prof. Pickering's work —"The sunlight changed during the period of totality and presented a pale yellow hue A faint chill was perceptible in the air The photographic results with the differential spectroscope give twenty lines in the solar atmosphere at a time of 34 seconds previous to totality Two rays of light were seen issuing from the cusps, their terminal points corresponding to the horns of the new moon The cusps were in violent motion The corona showed a conical structure with a network of fine filaments visible to the naked eye Four light streamers from the corona were noticeable, and seven prominences were observed, which latter were estimated to attain a height of 80,000 miles. The integrating spectroscope showed one red, one yellow, and one blue line and two green lines in the corona. The prominences were well photographed"

The following is a Reuter's telegram from San Francisco, relating to the work of the American expedition to Chili.—"Prof Holden, the director of the Lick Observatory, has received a telegram from Prof Schaebele, the leader of the American expedition to Chili, stating that his observation of the sun's total eclipse was successful. The drawings of the corona made a year ago by Prof Schaebele were found to be a true representation of the corona actually visible in the present eclipse. Fifty photographs were secured by means of the three telescopes used by the observers One of these gave an image of the sun 4 in in diameter, and the corona covered a plate 18 by 22 in."

NOTES

ALL the most essential arrangements have now been made for the Nottingham meeting of the British Association. The first general meeting will be held on Wednesday, September 13, at 8 p.m., when Sir Archibald Geikie will resign the chair, and Dr. J. S. Burdon Sanderson will assume the presidency and deliver an address On Thursday evening, September 14, there will be a soirée; on Friday evening a discourse will be delivered by Prof Arthur Smithells on "flame"; on Monday evening Prof. Victor Horsley will deliver a discourse "on the discovery of the physiology of the nervous system"; on Tuesday evening there will be another soirée, and on Wednesday afternoon, September 20, the concluding general meeting will be held Excursions to places of interest in the neighbourhood of Nottingham will be made on the afternoon of Saturday, September 16, and on Thursday, September 21 The following will be the presidents of sections:—A (Mathematical and Physical Science), Prof R. B Clifton, F.R.S., B (Chemistry and Mineralogy), Prof J E. Reynolds, F R.S; C (Geology), Mr. J J H. Teall, F R S., D (Biology), Rev. H B. Tristram, F R.S, E (Geography), Mr H Seebohm, F (Economic Science and Statistics), Prof J S. Nicholson, G (Mechanical Science), Mr Jeremiah Head, H (Anthropology), Dr. Robert Munro

THE Chemical Society will hold on Friday, May 5, a Hofmann Memorial Meeting Addresses will be delivered by Lord Playfair, Sir F. A Abel, and Dr W H Perkin

THE annual dinner of the Royal Geographical Society will take place on Saturday, May 13, at the Whitehall Rooms, Hôtel Métropole, Sir Mountstuart E Grant Duff in the chair

AT the recent Graduation Ceremony of the University of St. Andrews the honorary degree of LL.D. was conferred on Prof. Henry E Armstrong, Ph D, F R.S., in recognition of his eminent services to organic chemistry.

ON Thursday, May 4, the forty-first anniversary of the election of the Secretary of the Institution of Civil Engineers as an Associate, the first "James Forrest" lecture will be delivered by Dr W Anderson, F R S, the subject being "The Interdependence of Abstract Science and Engineering"

THE City and Guilds of London Institute has forwarded to county councils throughout the kingdom, and to the secretaries of technical schools in connection with the Institute, a circular letter indicating various ways in which it has improved and enlarged the scope of its technological examinations. Among the alterations may be mentioned the addition of practical tests in photography, boot and shoe manufacture, goldsmiths' work, mechanical engineering, and other subjects; the subdivision of many subjects into sections to suit the requirements of different branches of the same trade, and the addition of examinations in such subjects as manual training and dressmaking. After careful consideration of the difficult questions involved in the organisation, for the first time, of a system of inspection of technical classes, the Committee of the Institute have adopted a scheme, and are prepared to receive applications from county councils or school committees for the inspection of classes in technical (other than agricultural) subjects, and also for special reports on the results of the examination of the students of separate classes registered under the Institute.

IT has been resolved by the Council of the Zoological Society of London to award the Society's Silver Medal to Donald Cameron, of Lochiel, and John Peter Grant, of Rothiemurchus, in recognition of the efforts they have made to protect the Osprey (*Pandion haliaëtus*) in Scotland. The osprey, formerly common in many parts of the British Islands, has become so rare of late years that it is stated that only three pairs of this bird have been known to breed in this country for some years past.

THE hon. secretaries of the Australasian Association for the Advancement of Science are sending out invitations to the leading scientific societies in Europe drawing attention to the meeting of the Association, which will be held in Adelaide, commencing on September 25 next. Sydney, Melbourne, Christchurch, and Hobart are the places in which the previous meetings of the Association have been held. The meeting in

Adelaide will be presided over by Prof Ralph Tate, of the University in that city

THE late Admiral Marquis Ricci of Genoa, formerly Minister of Marine of the Kingdom of Italy, has left a large sum, estimated to amount to about three million lire (£120,000) to the authorities of his native city, for the purpose of founding a Scientific Institution It is believed that this is likely to be devoted to a new site and building for the Museo Civico of Genoa, an Institution which, under the directorship of the Marquis G Doria, has, as is well known to all naturalists, carried on splendid work in zoology for many years We are sure that no better object could be selected for the appropriation of this munificent donation.

MR G W LICHTENTHALER, who died lately at San Francisco, bequeathed to the Illinois Wesleyan University at Bloomington—where he had lived during most of his life—his very valuable natural history collection. It includes from 6000 to 8000 species of shells, 1000 species of marine algæ, and 500 species of ferns, besides thousands of duplicates Mr Lichtenthaler also bequeathed 500 dollars to put the collection in suitable shape for preservation

IN connexion with the International Congress of Medicine and Hygiene, to be held in Rome next September, there will be an exhibition opened (from September 15 to October 15) for apparatus, plans, materials, models, &c, relating to the following. Research in biology, therapeutics and hygiene, medical practice, improvement of the soil, sanitation and hygienic service of towns, hygiene of the interior of public and private buildings, individual hygiene, the health of workpeople, hydrology and balneo-therapeutics, &c Diplomas and medals will be awarded For information on the subject application is to be made to the President, Prof L. Pagliani, Minister of the Interior, Rome

A NEW scientific society has been organised in Washington, called "The Geological Society of Washington" There are already more than a hundred members. The object of the society is the presentation of short notes on work in progress rather than the reading of elaborate papers At the first meeting Major J W. Powell, director of the U S Geological Survey, presided, and papers were read by Mr H W. Turner, on the structure of the gold belt of the Sierra Nevada, and by Mr. S F Emmons on the geological distribution of ore deposits in the United States.

THE disturbed weather conditions referred to in our last issue resulted in a few thunder showers only, more particularly in the southern districts, accompanied by slight rain at some stations. With these exceptions and some local fogs, brilliant weather has been experienced throughout the whole of the United Kingdom. The temperature in the southern and midland districts has been much above the average, a considerable increase set in on the 17th inst., the maximum in London reaching 70°, and since that time some remarkably high readings have been recorded On the 20th the thermometer over the inland counties ranged from 80° to 84°, while at Yarmouth it read 30° lower, and for several days the difference between these neighbouring districts has been very considerable. In the night of the 22nd a sharp thunderstorm occurred over South Devonshire, accompanied by a local rainfall amounting to nearly three-quarters of an inch, and another storm, with slight rain, occurred at Holyhead in the night of Monday, 24th; but in the early part of the present week the conditions were anti-cyclonic over a great part of the country, and the weather was very dry. The *Weekly Weather Report* of the 22nd instant states that rainfall was upon the whole less than the mean in all the wheat-producing districts and in the south-west of England, while in Ireland and the west of Scotland there was a slight excess. Bright sunshine was less prevalent than for some weeks past; the percentage of possible duration ranged from 24 in the east of Scotland to 58 in the south of England.

THE meteorological authorities in the United States are doing their utmost to utilise weather forecasts by adopting various means for their wide and rapid dissemination The *American Meteorological Journal* for April contains accounts of two methods recently inaugurated in New England. From September 12 to October 1, 1892, an electric search light placed on Mount Washington was used for flashing forecast signals over the surrounding country Reports received from persons in the vicinity show that the plan was quite successful, and the flashes were reported to have been seen at a distance of eighty miles It is intended to resume this novel method next summer The local forecast official at Boston sends out three hundred printed copies of forecasts daily by rail The bulletins are distributed from the trains, and posted immediately on receipt in the various railway stations in neat frames provided for the purpose by the Weather Bureau. In this way the forecasts are brought before the public in as short a time as possible

PROF J. MARK BALDWIN, of the University of Toronto, has accepted the Stuart Professorship of Psychology in the Princeton University, and will begin work there in September *Science* says that a suite of rooms has been set apart in North College for experimental psychology, and that a liberal appropriation has been made for its equipment.

MR. W. DE MORGAN, in accordance with the request of the Egyptian Ministry of Public Instruction, has been making experiments at Cairo with Egyptian clays with a view to determine whether it would be possible to use them for the production of glazed earthenware A correspondent of the *Times* at Cairo says that after about eight weeks' work Mr de Morgan considers that, whilst the production of porcelain and white earthenware is quite out of the question, there exist abundant materials for other descriptions of pottery, especially white majolica, similar to delft or della Robbia ware. But the cost of fuel is a stumbling-block. Mr de Morgan, says the correspondent, considers that nothing can exceed the skill of the native throwers, who, with the most simple contrivances, produce far better results than the European workmen with elaborate apparatus

IN his report for 1892 Dr Trimen, the director of the Royal Botanic Gardens, Ceylon refers to the fact that of every 100 lbs of tea consumed in England during the year 84 lbs were of British growth, viz. 53 in India and 31 in Ceylon, only 16 lbs being the produce of China There was an increase of nearly 2,000,000 lbs in the direct export of Ceylon tea to Australia, viz. 5,166,154 lbs against 3,210,598 lbs in 1891, and Dr Trimen thinks that the costly advertisement at the forthcoming Exhibition in Chicago may reasonably be expected to lead to a large sale in the future in America. Ceylon, he says, urgently needs this, for while there is no reason to fear any drawback to continued success as far as cultivation and manufacture are concerned, there is a real danger of over-production, and its consideration as a possibility, by no means remote, induces him earnestly to recommend those concerned to devote some portions of their land to other cultivations. In the low-country especially much caution should be exercised in opening further land in tea estates. One result of the enormous development of the tea industry in the island is unfortunate The industry so overshadows all other cultivations that there is now little room for trial or experiment with smaller products on estates, and not much stimulus to investigate them in the Botanic Gardens.

A COMMITTEE called the School Gradation Committee is at present being formed, the object of which, according to the

Times, is to promote the systematic and consecutive gradation of schools and universities, and to supplement the valuable work of recent years in respect of technical instruction by an effort to bring all effective schools and colleges, whether special ised or not, within a comprehensive national scheme It is thought that this "may be most economically done, with the *minimum* of interference, centralisation, and narrowing uniformity, by the recognition and encouragement of existing effective schools, and by using available resources under local control mainly to facilitate the ascent of pupils from lower to higher grades" Among the members of the committee are Sir H. Roscoe, Sir P Magnus, Prof R. C Jebb, Prof Max Muller, and Prof. H Sidgwick.

To determine the light refraction of liquid oxygen, Herren Olszewski, and Witkowski (Cracow Academy) have lately made use of total reflection The liquid was held in a metallic case having windows, and a number of protective envelopes Into it dipped a double plate formed of two plane glass plates, with an air layer of 0 006 mm between, which could be turned from without through a given angle Monochromatic light was introduced, and the refraction of the liquid determined by means of the bright interference-fringes observed with the netting of the telescope at the borders of the field of total reflection The relative index of refraction was found to be 1 2232, and the absolute coefficient 1 2235 (Dewar and Liveing, with the prism method, obtained 1 2236) The same authors sought also to determine light-absorption, using for the liquid a protected tube closed below with a glass plate, while another tube with terminal glass plates, dipped in the liquid above, and could be screwed up or down A ray of light was sent through from below, and passing through various thicknesses of liquid (according to the position of the inner tube) was reflected in a spectral photometer, and compared with a direct ray For the spectral region of most intense absorption of the green yellow (between $\lambda = 577$ and $\lambda = 570$), values between 84 and 89 per cent were obtained for the light passing through 1 mm thickness of oxygen, for the red absorption band 88

THE question of the purity of ice consumed for alimentary purposes in Paris has been lately before the Conseil de Salubrité de la Seine (*Rev Sci*) This ice is of two sorts, manufactured and collected. The production of artificial ice is about 27,000 tons a year, and of the "crop" of natural ice, the lac Daumesnil at Vincennes yields about one-half (12,000 to 15,000 tons a year) The price of the manufactured ice is eighteen to twenty francs a ton, that of the collected ice three to four francs The demand in Paris is not wholly met from those two sources, and there is some ice imported from Sweden and Norway, which is, naturally, dearer than the ice from lakes, &c., in France Now the lake Daumesnil just referred to is polluted on the one hand by the entrance of a sewer, and on the other by an artificial stream from the plateau of Gravelle; this stream traverses the Bois de Vincennes, and in the fine season receives all sorts of impurities from its banks. It is a question, therefore, of interdicting the collection of ice from this lake The sewer it appears, might be suppressed, but the Administration cannot touch the stream. It is proposed to limit the use of ice from sources like this lake to applications in which the ice is not brought into direct contact with the liquids or solids to be cooled, and that when such contact takes place (as in cooling drinks) artificial ice alone should be used, got exclusively from spring water, or river water sterilised by heat

THE Agricultural Department of New South Wales has been making a series of interesting and useful inquiries as to the plants most visited by bees in the various districts of the colony. Some of the results are set forth in the February number of the Department's *Gazette* It has been clearly proved that the flora of Australia includes honey-producing trees, shrubs, and plants of a high standard of excellence, the honey produced by bees in the near neighbourhood of the forest being of the finest quality, and having few (if any) faults While a gum-tree is in bloom the bee will pass over the most tempting plant in a garden and wing its way to the borders of the bush, but, on the other hand, a field of maize in tassel is a source of the greatest pleasure to the busy little workers, who swarm in countless numbers, collecting the pollen so necessary for their wants The plants which next seem to have the greatest attraction are the fruit-trees, familiarly called summer fruits Clover (both white and red) yields a large quantity of first rate honey, and bees kept at places where clover grows never fail to visit the modest flowers of the plant, dandelion, also, is a valuable honey-yielding flower, and is noted in all districts from Albury to Tenterfield As to the size and colour of the flowers most affected by the bees, much diversity of opinion exists among apiarists, and in the face of the very conflicting replies, the *Gazette* thinks it would be vain to try to determine what coloured flowers are most attractive

IT is not, perhaps, generally known that the largest wine-growing district in Germany is Alsace-Lorraine. According to a report forwarded to his Government by the French consular agent at Frankfort, while the Wiesbaden regency has only 7,300 acres planted with vines which in 1890 yielded 1,644,040 gallons, the Coblenz regency 18,950 acres, giving 3,755,220 gallons, that of Treves 8,980 acres, giving 1,832,400 gallons, Alsace-Lorraine alone contains 75,640 acres, the production of which in 1890 was 16,999,000 gallons (6,429,740 gallons in 1891), a production which is chiefly consumed in the country itself According to the same authority (whose report is summarised in the current number of the Board of Trade Journal) the average annual production of wine in the whole world during the five years from 1886 to 1890 is estimated at 2,811,600,000 gallons In this production Italy figures for 690,008,000 gallons, Spain for 657,250,000 gallons, and France for 606,562,000 gallons, that is to say these three countries supply two-thirds of the total quantity produced Germany, with an average annual production of 51,705,610 gallons, only occupies the tenth place among wine-growing countries The value of some of her wines partly compensates her, however, for the relatively small quantity of her annual crop

THE Imperial Forest School at Dehra Dun seems to be exercising a remarkably wholesome influence on the native students who attend its classes Addressing the students at the recent annual distribution of certificates and prizes, Sir E C Buck, secretary to the Government of India in the Revenue and Agricultural Department, said that the school had been a signal success in the widest sense. The student who passed through a technical school was usually fitted only for the technical profession which he was taught at the technical school But the Dehra School teaching was of such a broad and useful character that he believed its students, that is, the students who passed out of it successfully, would be more fit for any kind of work requiring originality and practical treatment than the students of any school or college in India. It was the only important educational institution in India in which the student was taught more in the field and in the museum than in the lecture room; in fact in which he was taught how to observe, and how to draw conclusions from observation. The consequence had been that the only signal instances which had, to his knowledge, occurred of original research leading to position and useful results being accomplished by natives of India, had been those in which such results had been produced by ex-students of the Debra School. Only recently the Government of India had been obliged to close apprenticeships attached to the Geological Department, because natives of India

could not be found qualified for original research It was not that natives of India had not in them the necessary qualifications; it was that the power lay undeveloped in them, and had not been brought out by a training in habits of observation

MESSRS. SWAN SONNENSCHEIN and Co have in the press and will shortly publish a work by Dr Edward Berdoe, entitled "The Healing Art," a popular history of the origin and growth of medicine in all ages and countries

AT a recent meeting of the Société Française de Physique M Janet gave an account of his experiments on electric oscillations of medium frequency (about 10,000 per sec) The arrangement he employs is as follows —A battery of accumulators furnishes a current which passes through a high resistance CD and a low resistance AB placed in series The ends of AB are joined to the plates of a condenser and also to the extremities of a circuit AHB The latter consists of a coil of self induction L and resistance $\frac{R}{2}$ joined in series with an equal non-inductive resistance. The quantities RL and the capacity of the condenser are so chosen that when the circuit is broken at AB oscillations are set up in the condenser circuit By means of an interrupter, closely resembling that used by Mouton in his work on the discharge of a condenser, the differences of potential e_1 and e_2 at the extremities of the inductive and non-inductive resistances are determined at different times after the breaking of the primary circuit, and the values plotted on a curve as functions of the interval after the break If ι is the current in the circuit AHB at any instant then the first curve gives the value of $\frac{R}{2}\iota + L\frac{d\iota}{dt}$, and the second that of $\frac{R}{2}\iota$, so that $L\frac{d\iota}{dt}$ is equal to the difference of the ordinates The value of $\frac{R}{2}\frac{d\iota}{dt}$ can be obtained from the second curve, so that if the self-induction is constant during an oscillation the ratio of these two quantities will be constant. This is found to be so, the value of L deduced from the curves being constant and also independent of the capacity of the condenser and of the electromotive force employed in the primary circuit The author has also obtained from his observations the value at each instant of the difference of potential V between the plates of the condenser (a mica one) and of the charge Q, and he finds that the quotient $\frac{Q}{V}$, representing the capacity of the condenser, is greater for decreasing than for increasing values of V. The shape of the curves obtained recall those Ewing has found in the case of the magnetisation of iron, and indicate a kind of hysteresis or viscosity in the dielectric.

THE problem of obtaining a well-defined and trustworthy standard for the intensity of a source of light can hardly be said to be completely solved Violle proposed as a unit the amount of light radiated by one square centimetre of molten platinum at the moment of solidification. But in order to keep the platinum absolutely pure, and its surface clean and smooth, it would be necessary to melt large quantities of the metal in an electric furnace. Siemens proposed platinum foil at the instant of melting, but a series of 500 meltings gave deviations of 10 per cent. in spite of the greatest precautions, mainly on account of the tearing of the foil on melting. According to a report recently presented to the Reichstag, the physicists of the Imperial Physico-Technical Institute at Berlin have been endeavouring to make Siemens' unit available for practical purposes by fixing the temperature of the platinum in some manner independent of its melting point. It was found that at any given temperature the ratio of the total radiation to that transmitted by a layer of water of a certain thickness was constant within 2 per cent. for plates of platinum of different thicknesses and from different sources. To measure the amounts of radiation a very delicate bolometer was constructed. A piece of platinum foil was welded on to a piece of silver foil of ten times its thickness, after which the combination was rolled between copper rollers down to a thickness of $\frac{1}{100}$ mm It was then cut in a dividing machine so as to form a long continuous strip of 1 mm breadth within a small area. Four such strips were mounted in a frame, and freed from silver by etching with acid, thus leaving strips $\frac{1}{1000}$ mm. thick When tested, the bolometer was found to be extremely satisfactory The Institute is at present engaged on determining the absorptive action of water and of the quartz vessel containing it Further important questions are those regarding the effect of impurities in the platinum and the kind and duration of incandescence, questions which must be answered before the method can be regarded as thoroughly practical.

AMIDOPHOSPHORIC ACID, PO $NH_2.(OH)_2$, the primary amine of orthophosphoric acid, has been isolated by Mr H N Stokes, and its properties and those of several well crystallising salts are described by him in the March number of the *American Chemical Journal*. It has hitherto been found impossible to obtain this substance owing to the extreme difficulty of regulating the decomposition by water or acids of the products obtained by the action of ammonia on pentachloride or oxychloride of phosphorus It has now been obtained, however, by employing, instead of the two latter compounds, the ethers of phosphoric acid The most advantageous method is to dissolve the chloride of diphenylphosphoric acid, PO $Cl(OC_6H_5)_2$, in alcohol and to react upon it with alcoholic ammonia, when a beautifully crystalline substance, diphenylamidophosphate, PO $NH_2(OC_6H_5)_2$, is at once formed This diphenyl ether of amidophosphoric acid yields an alkaline salt of amidophosphoric acid upon saponification with caustic potash or soda, upon converting this into the lead salt, decomposing the latter with sulphuretted hydrogen, and precipitating with alcohol, the free acid is obtained in the form of fine microscopic crystals In the actual preparation it is not necessary to first isolate the chloride of diphenylphosphoric acid It is only necessary to boil one molecular equivalent of phosphorus oxychloride with two molecular equivalents of phenol in a flask attached to a reflux condenser until no further evolution of hydrochloric acid occurs the product contains, along with other derivatives, the chloro-diphenyl ether required The liquid only requires to be diluted with alcohol, when the alcoholic ammonia may be directly added and the crystals of the amido diphenyl ether precipitated Diphenylamidophosphate is a comparatively stable substance melting at 148° and resolidifying to a mass of crystals. The crystals are readily converted into acid potassium or sodium amido phosphate by means of a concentrated solution of caustic potash or soda, the reaction is very energetic and is complete in ten minutes Upon acidification with ice-cold acetic acid and addition of alcohol, the acid salt is precipitated. Acid potassium amidophosphate, $PO\begin{cases}NH_2\\OK\\OH\end{cases}$, crystallises in six-rayed stars or rhombohedra, the neutral salt is extremely soluble in water and is very difficult to obtain crystallised. The acid sodium salt usually forms small hexagonal crystals, and the neutral sodium salt also crystallises well and, unlike the potassium salt, is not deliquescent. The lead salt is obtained in the form of a precipitate, consisting of groups of radiating plates, upon adding a solution of lead acetate to a solution of the acid potassium salt. In order to obtain the free acid from it, the crystals are suspended in iced water and a current of sulphuretted hydrogen allowed to bubble through. The filtrate from the sulphide of lead may then be allowed to fall directly into alcohol when the crystals of amidophosphoric acid are at once deposited.

AMIDOPHOSPHORIC ACID crystallises in tabular or short prismatic crystals which are insoluble in alcohol, but readily soluble in water, to which they impart a sweetish taste. The solution is readily distinguished from phosphoric acid inasmuch as it yields no precipitate with silver nitrate. It evolves no ammonia upon treatment with caustic alkalies, but merely forms the salt of the alkali metal. The solution slowly decomposes into ammonium phosphate. The solutions of the acid and neutral salts of the alkaline metals yield many corresponding acid and neutral amidophosphates of other metals by double decomposition with soluble salts of those metals.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include *Phoronis hippocrepia*, the Actinian *Corynactis viridis*, and the Foraminiferan *Haliphysema*. In the floating fauna the Cœlenterate element remains unchanged; the larvæ of the Nemertine *Cephalothrix* have made their first appearance for the year; the number of Polychæte larvæ and of Cirrhipede *Nauplii* has become considerably smaller; the later stages of various Decapod Crustacea (*Megalopa*, *Mysis*-stages) have appreciably increased in numbers; and minute young *Oikopleura* now occur in considerable quantity. The "gelatinous alga" and *Rhizoselenia* are extremely abundant. The Hydroid *Tubularia bellis*, the Gastropod *Nassa reticulata*, and the Decapod Crustacea *Pagurus lævis*, *Galathea squamifera*, *Porcellana platycheles* and *Pilumnus hirtellus* are now breeding.

THE additions to the Zoological Society's Gardens during the past week include an Orang Outang (*Simia satyrus*, ♂) from Borneo, presented by Mr. Thomas Workman; a Spotted Ichneumon (*Herpestes nepalensis*) from India, presented by Lady Blake; a Raven (*Corvus corax*) British, presented by Lady Rose; a Peregrine Falcon (*Falco peregrinus*) British, presented by the Old Hawking Club; a Greek Tortoise (*Testudo græca*) European, presented by Mrs. Alcock; a Martineta Tinamou (*Calodromas elegans*) from Argentina, three Spotted-sided Finches (*Amadina lathami*) from Australia, purchased; a Panama Amazon (*Chrysotis panamensis*) from Panama, received in exchange; six Indian Wild Swine (*Sus cristatus*), four Barbary Mice (*Mus barbarus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN

LARGE TELESCOPES.—Much has been written during the last few months with reference to the usefulness or non-usefulness of large telescopes. That the verdict is given in favour of the former is not at all surprising, for are we not far away from the limit, if there be one, beyond which larger instruments will be available? Dr. Common has many times pointed out the practicability of constructing large reflectors (his five-foot being a good example of the type of instrument he could enlarge), while the Lick instrument, the work of the Clarks, is really only a beginning of what will be done in large telescope building. For refractors it has many times been urged that the increase in size of lenses involves such a thickness that much light is thereby lost by absorption. M. Alvan G. Clark, with reference to this particular point, says a few words in *Astronomy and Astrophysics* for April, in which he points out that such is not the case. Greater aperture means greater light grasping power, and as it is quite unnecessary to considerably increase the thickness of the lens, the former predominates over the latter. With the forty-inch discs, he says, only a combined thickness of four inches is required, and with lenses of an object-glass of even six feet aperture a combined thickness of only six inches would be necessary. It is pleasing to hear through him that a steady improvement is being made in manufacture of glass, and that the present discs are *infinitely* superior to the early ones, and "who knows," as Mr. Clark says, "how soon still more transparent glass may be at hand."

SPECTRUM OF β LYRÆ.—The extreme interest that lies in this variable, especially for spectroscopists, makes it a subject of keen research, and the important observations made by Prof. Keeler with the great Lick refractor, and contributed to the number of *Astronomy and Astrophysics* for April, will be the more eagerly read. The observations were undertaken with the intention of connecting possible changes in the spectrum of the star with its period of light variability. After plotting a number of observations on the light curve of the star, the recorded appearances of the spectrum "were in some degree contradictory," although certain results were obtained, but they were left incomplete, owing to Prof. Keeler's withdrawal from the observatory. The results may be briefly stated as follows:—

(1) Bright hydrogen lines C and F, bright D_3 line and dark D lines are always visible with the Lick refractor. Certain fainter bright lines are absent only at principal minimum.

(2) Light variations due to changes in brightness of continuous spectrum.

(3) Bright lines brightest when continuous spectrum brightest.

(4) Bright lines broad and diffuse, particularly when star at maximum. D lines very hazy, so that components are hardly distinguishable.

(5) No really remarkable changes in the appearance of the spectrum took place during greater part of period. Observations show no relation between spectral changes and secondary minimum of the star.

(6) Most remarkable changes at principal minimum. "The bright lines became dimmer and perhaps sharper. The fainter bright lines disappear. The D lines become darker. Strong absorption lines appear on the more refrangible side of certain bright lines in the green, the separation of the dark and bright lines being at least five tenth-metres. Other bright lines are perhaps similarly affected. A narrow dark line appears above the D_3 line at the same time. Shortly before the first maximum is reached the dark lines disappear."

Prof. Keeler adds that the method of observation he adopted was only capable of allowing him to observe a "part of a much more complex series of changes" which no doubt takes place.

SOCIÉTÉ ASTRONOMIQUE DE FRANCE.—In the *Bulletin* of this society for 1892, the sixth year since its foundation, several articles of importance will be found to be scattered throughout its numerous pages. Of these we may refer our readers to some selenographic studies by MM. Gaudibert, Flammarion, and Antoniadi, examination of recent studies of Jupiter by M. Flammarion, and M. Edouard Fouléré's graphical method of determining the co-ordinates of solar spots. The valuable observations made by M. E.-L. Trouvelot on the planets Venus and Mercury, a full account of which has been given in these columns (NATURE, vol. xlvi. p. 468), will also be found here, together with a discourse by M. F. Tisserand on the movement of the moon, with reference to ancient eclipses. Among other communications M. Schmoll gives a summary, with tables, of the solar spots observed during the year 1891, M. Guillaume describes his observations on the surface and rings of Saturn, and MM. Quenisset and Trouvelot contribute their observations on planets and remarkable solar protuberances respectively. A simple method of determining the positions of solar spots, and of measuring their displacements, is treated by Dr. Huette, while M. Bruguière gives a most interesting account of M. Lippmann's work on photography in colours, and M. Plavinel on the coming (now past) eclipse of the sun.

WOLSINGHAM CIRCULAR, NO. 34.—With reference to the contents of the Wolsingham Circular, which we recently gave, Dr. Kreutz, in *Astronomische Nachrichten*, says:—"The first star, Esp.-Birm. 180, is certainly given by Chandler as (2258) Aurigæ in his list of probable variable stars A. J. 216; see also *Astronomische Nachrichten*, 2764, p. 63, No. 2. The second star is evidently identical with B.D. + 57° 727 = A. G. Hels. 3032. Position for 1900: 3h. 23m. 23s., + 58° 9'.0. The original magnitudes of the Hels. zones are: 9.1m. (February 15, 1872), and 9.0m. (February 15, 1873).

ASTRONOMICAL JOURNAL PRIZES.—The judges appointed by the editor of the *Astronomical Journal* say a few words in the current number (No. 293) with reference to some general considerations connected with the presenting or withholding of the awards. For comet observations, allowance for optical qualities of telescopes will to a certain extent be made; relative freedom from systematic peculiarities of observation will be regarded "as a mark of excellence. Even more important than the nominal or apparent precision in other respects." For individual precision of observations, freedom from large or abnormal errors

would be of the first importance In orbit computation the judges will regard with special attention care exercised in revision of published observation, ingenuity displayed in searching out and evaluating systematic errors, completeness and soundness of discussion, ability shown in indicating probable limits of uncertainty in adopted elements, &c With regard to variable stars, enough has already been said, but the judges remark that definite reductions cannot of course be expected, as from the nature of the case many years must elapse

GEOGRAPHICAL NOTES

THE Hon G N Curzon, M P, read a paper on his recent journey in Indo-China at the meeting of the Royal Geographical Society on Monday The whole region, he pointed out, is dominated by its great rivers, and may be divided into the mountain district of the north cleft by vast gorges, and the low plains of the south mainly composed of alluvial deposits, where the coast lands are steadily encroaching on the sea In the seventh century Tongking, now 60 miles inland, was on the coast A very remarkable feature which gives to parts of the coast a beauty comparable with that of the Inland Sea of Japan is a broken belt of limestone cut into curious flat-topped sections of all sizes, and perforated by the sea or rivers with many fantastic caverns and tunnels The masses of caverned rock rise to a height of from 50 to 500 feet, and are best seen in the Bay of Along in Tongking In Annam Mr Curzon travelled to Hué by the "Mandarin's Road," a track which is carried over several cols by some skilful engineering in the form of rock staircases Throughout Annam the traveller is much confused by the number of names applied indiscriminately to each village, and the maps hitherto constructed by the French officials are far from satisfactory The people of Annam have the submissiveness without the nerveless apathy of the Hindu, and as craftsmen they are industrious and artistic Coal is abundant, some seams being more than 180 feet thick at Haton, on the Bay of Along Hué is a city of great interest, being beautifully situated and near a number of magnificent ancient tombs Cambodia or Cambogia, as Mr Curzon prefers to spell the name, is of interest, mainly on account of its ruins, the number and character of which make a long stay desirable, if the traveller would do justice to his opportunities

THE newly published report of the Bengal census reveals the interesting fact that there is a steady transference of population from the most densely to the more thinly peopled parts of the province, the former prejudice against leaving the native village having apparently vanished Mohammedanism is increasing rapidly in Bengal, and the custom of widow marriage amongst Hindus has become common These facts are significant of progress

THE supremacy of the great ports of Europe as entrepôts for the trade of the world is rapidly becoming a thing of the past Two recent instances of independent action on the part of the colonies are of more than local importance One is the establishment of a line of steamers trading direct from New York to Cape Town, another the commencement of a regular service of fast steamers from Vancouver to Sydney, N.S W.

A COMMUNICATION was lately made to the Paris Geographical Society on the strength of a statement in a Russian newspaper, describing a curious mountain group in Podolia. This is said to rise abruptly from the plain with a grandly rugged crest composed of a broken circular rim surrounding a crater-like depression. The whole mass is composed of limestone, in which fossil corals abound, and the inference drawn is that this is, in fact, a full-sized fossil tertiary atoll The name of the mountain is given as Miodoborski, but it is called Toltra by the natives.

AT a general meeting of the Royal Geographical Society called by the requisition of a few Fellows who objected to the action of the Council in the manner of admitting women to the Fellowship of the Society, it was proposed to frame a bye-law restricting the privileges of lady Fellows, and rendering them incapable of serving on the Council or in any office in the Society. The question whether ladies should be admitted at all was voted upon after a somewhat heated discussion, and it was decided by 147 to 105 that women should not be admitted as Fellows of the Society. This decision was entirely unforeseen; it is a retrograde step which, we feel sure, will be disapproved and regretted by the majority of the Society.

THE Royal Medals of the Royal Geographical Society have been awarded to Mr F C Selous for his travels in Africa, and to Mr W. W Rockhill for his journeys in Tibet The Gill Memorial was awarded to Mr H C Forbes, and the Cuthbert Peek Grant to Mr Charles Hose for his travels in Sarawak Major Powell, Washington, Prof Ratzel, Leipzig, and M Vivien de St. Martin, Paris, were elected honorary corresponding members of the society.

INSTITUTION OF MECHANICAL ENGINEERS

ON the evenings of Thursday and Friday last week, April 20 and 21, an ordinary general meeting of the Institution of Mechanical Engineers was held in the theatre of the Institution of Civil Engineers, by permission of the Council of the latter body There were three papers on the Agenda, but only two were read, namely, Mr Dean's paper on copper plates for locomotives, and the second report of the Alloys Research Committee, the author of which was Prof W C Roberts-Austen, C B, F R S Our readers will remember that the first report of the Alloys Research Committee was read, and discussed at the October meeting of 1891, and an abstract of it appeared on page 22 of our 45th volume A large part of the first report was taken up by the consideration of the effect of various alloys on gold, and it will be remembered that the author was somewhat sharply criticised for the course he had taken in framing his report, gold being a metal not used by engineers, at least for constructive purposes This second report carries the matter further, and it is possible now to appreciate Prof Roberts-Austen's reasons for taking the course he did. In opening the subject he referred again to the "periodic law" of Newland and Mendeleeff, and upon it he based a large part of his reasoning in the first report The researches of Raoult Van't Hoff, and Arrhenius, led to the view that the molecules of small quantities of elements, distributed through a mass of a solvent, retain their individuality The work of Heycock and Neville (and also the experiments described in the author's previous report) point to the conclusion that the added elements may retain their freedom when they are present in much larger quantities than 0 2 per cent, which is the amount of added matter the Committee usually dealt with in their researches The point raised was whether the added element does, or does not, remain free in the mass of the solvent, and as the author pointed out, it is a vital one in limiting the scope of the inquiry

If the added element enters into combination with the solvent its individuality will be changed, and it might be that the mechanical properties of the metallic mass would mainly depend on the degree of fusibility of the compound formed If the concentration of the solution is such that a fraction of the dissolved body alone remains isolated, the influence of the volume of the added elements, will evidently be disturbed, as this influence is supposed to be exerted only by a single constituent of the mixture, whilst the mechanical properties of a solidified mixture are functions of both constituents, in the favourable circumstances where the solvent is not started by the added element, and where the law of atomic volumes is applicable A metal is seldom homogeneous and is more often formed of rounded polyhedral grains, and the cohesion in the interior of a grain differs from the adherence between the neighbouring grains The law of atomic volumes cannot apply, the report pointed out, to the adherence of the grains, that being regulated by other causes, such as the rate of cooling and pressure, and whether a compound be formed, which solders the grains together Arguing from these facts, the author pointed out that an attempt to prove the nature of the influence of atomic volumes by mechanical tests only led to anomalies, and more or less grave irregularities being encountered The investigation was not, however, limited to mechanical tests, independently of which it had been shown that the influence of impurity on the molecular transformation in iron, studied by Osmond, may be shown in several ways. Transformation may be assisted by the presence of impurity, the temperature at which they occur may be altered, or the molecular changes may even be entirely prevented by the presence of elements which behave in strict accordance with the law of atomic volumes. The author referred to the remarkable series of experiments recently made by E. Warburg and F. Tegetmeier, which would seem to demonstrate the possibility of producing eventually a degree of porosity in vitreous bodies, which will admit the passage of elements having comparatively small atomic volumes, while other elements, having larger atomic volumes, are strained off, thus occasioning

a mechanical sifting of the elements. In making these experiments, a cup like receptacle was used, which had a vertical partition of sheet glass placed in it, so that the cup was divided into two parts by the glass. Sodium amalgam was placed on one side and pure mercury on the other, the whole was then heated to a temperature of 200° C, at which the glass became slightly conducting. By the aid of a battery, the sodium atoms of the sodium silicate were set in motion, and after 30 hours it was found that a considerable quantity of sodium, amounting to 0.05 gramme, had passed into the mercury which was originally pure. A corresponding amount of sodium had been lost by the amalgam, but the glass had exactly preserved its original weight and clearness. The glass was partly composed of neutral molecules of sodium silicate, together with free molecules both of sodium (base) and of the acid, and of the free sodium capable of being transported under the influence of the electric current. When Tegelmeier replaced the sodium amalgam by lithium amalgam and repeated the experiment, the sodium of the glass passed as before into the originally pure mercury, and the glass became opaque on the side touching the lithium amalgam, but after a time the opacity extended right through the thickness of the glass, and the metallic lithium began to accumulate in the previously pure mercury. It is not possible thus to chase out all the sodium present in the glass, but the free sodium atoms are replaced by those of lithium. Analysis showed that the glass originally contained 2.4 per cent. of potassium and 13.1 per cent. of sodium, but after the experiment, while retaining the same percentage of potassium, it had only 4.3 per cent. of lithium, and only 5.3 per cent. of sodium. The glass in which lithium had thus replaced part of the sodium was very tender, opaque, and friable. The conclusion to be drawn is that the atoms of lithium, having an atomic weight of 7, and an atomic volume of 15.98, can pass along the tracks, or molecular galleries left in the glass by the sodium atoms, the atomic weight and volume of which are 23 and 16.04 respectively. When a metal of superior atomic weight and volume to sodium was substituted for the lithium—such as potassium, with atomic weight 39 and atomic volume 24—it was found not possible to chase out the sodium, the new atoms being too big to pass along through the spaces where the sodium had been. We are thus confronted with a molecular porosity which can in a sense be gauged, and the mechanical influence of the volume of the atom is made evident. Proceeding to the details of the experiments made by the committee, the influence of impurities on copper was next referred to. The question was raised whether normal copper can be made to assume an allotropic state, analogous to that in which there is reason to believe iron can exist, and if so are the properties of normal and of allotropic copper as widely different from each other as those of the distinct varieties of certain well-known non-metallic elements. The point is one of considerable interest, and Prof. Roberts Austen seems to have little doubt that copper can be prepared by electrolytic deposition, in an allotropic state, in which the density of the metal is from 8.0 to 8.2 as compared with 8.92, which is that of normal copper. The effect of mechanical and thermal treatment upon copper was then referred to, and some interesting figures were given, showing how different may be the properties of a metal chemically pure, for instance, rods of very pure electrolytic copper, all the same sample, but variously treated, broke under stresses varying between 8.219 tons and 18,750 tons to the square inch, the former being the tensile strength of cast rods, and the latter of cast rods worked and not annealed, whilst cast rods carefully worked, and annealed gave a tensile strength of 18.259 per square inch. The experiments show a difficulty in determining a standard tenacity for copper.

The effects of arsenic, bismuth, and nickel upon copper afforded one of the most interesting parts of the investigation, and from the engineer's point of view an extremely important section of the series of experiments. It has been too often accepted as a matter of fact that pure copper is the best that can be used for engineering purposes, and specifications are generally framed to this effect. The Research Committee, however, show that the metal may be, and frequently is, as a matter of practical fact, too pure for the purpose, thus, it has been found that a very fair percentage of arsenic improves the copper used in fire boxes of locomotives. It is well known that of old these parts of the boiler lasted for a much longer period of time than they do in the present day. In fact, as Mr. Tomlinson, an old railway engineer, said in the discussion, they used to expect to get half a million miles of running out of a copper fire box, whereas about half that distance is all that is obtained in the present day. This he attributes to the effect of electrical matters upon engineering practice. The electricians insist on their copper being absolutely pure, and that has raised the standard, so that now the copper smelters get all the impurities out of the metal, whereas in old times a considerable percentage of alloy, especially arsenic, was present. Antimony appears to behave like arsenic, and when present in proper proportion greatly strengthens the copper. Bismuth, on the other hand, renders copper singularly weak. With 0.1 per cent. of bismuth a sample of copper was too brittle to work, and had at the ordinary temperature a tenacity of 18,000 tons to the square inch, but at a higher temperature the fall in tenacity was very rapid, and there was practically no elongation. The prejudicial effects of bismuth did not seem to disappear, even though but a trace were present. In one test of a singularly pure copper, containing only 0.002 per cent. of bismuth, although the metal was strong and worked well, the elongation was very small. The variation in the effect of arsenic and antimony on the one hand, and of bismuth on the other, is of considerable interest, for according to the classification of Mendeleeff, arsenic, antimony, and bismuth all belong to the same family, of which nitrogen is a type. The atomic volume of bismuth—20.9—is, however, higher than that of arsenic—13.2, or of antimony—17.9, and therefore, according to the principle laid down by Prof. Roberts-Austen, bismuth ought to diminish the tenacity of copper, of which the atomic volume is only 7.1. But in accordance with this reasoning the influence of arsenic and antimony should be exerted in the same direction, even though in a less degree. The author has turned his attention to this matter, and has already been conducting a series of experiments which have extended over nearly twelve months. The investigations are, we believe, not yet complete, but the results will be given subsequently. A diagram was, however, exhibited at the meeting, in which curves were shown, illustrating the behaviour of various alloys of copper and bismuth during cooling, and the wholly unexpected fact was revealed that the copper passed below the freezing point before it actually became solid. On each curve there was a second or lower point of solidification, which occurred at a constant temperature in all the alloys, and was very close to the melting point of bismuth itself. The existence of this second point was very evident, even when the copper contained only one per cent. of bismuth, and this fact goes far to explain the peculiar action of bismuth on copper. It would appear that whether very poor or very rich in bismuth, the alloy of copper may be a portion of bismuth, containing perhaps a little copper, always remains fluid until the temperature of the mass has fallen to 260° C, which is the point at which bismuth itself solidifies. The presence, Prof. Roberts Austen stated, of a fluid constituent in an alloy long after the mass itself had become solid, is doubtless the determining cause which enables the metal to assume a highly crystalline, and consequently an intensely brittle structure. So far as he was aware the cause of the peculiar behaviour of bismuth could not have been revealed by any other method of investigation than the one adopted. In connection with this point, a fact brought forward during the discussion by Mr. Gowland, is of interest. In the course of his metallurgical work at the Japan mint, he had brought before him a large number of bars of silver for the purpose of coining, but they were so brittle that it was impossible to work them at all. On investigation he found that there was an appreciable quantity of bismuth in the silver. The structure was coarsely crystalline, and though the whole mass was so hard and brittle, the crystals themselves were very ductile. The conclusion he came to at the time was that the crystals of silver had become separated, as it were, by a film of bismuth. The fact bears out the correctness of Prof. Roberts-Austen's mode of reasoning. Judging from their polished surfaces, the alloys of copper rich in bismuth are to all appearances as coherent as the alloys of copper and tin, which have great strength. The report gives some interesting particulars of the effect of pressure. The passage of iron from one allotropic modification to another is accompanied not only by a change of heat capacity, but also by a change of volume. This matter was referred to in the previous report, but the author gave some further interesting particulars of experiments carried out by compressing a piece of steel in a hydraulic press, in order to obtain recalescence at a lower temperature than would be the case if the

pressure were not applied In one case a cylindrical piece of steel, 1" long and ⅝" in diameter, was bored through two thirds of its length by a hole $\frac{1}{16}$" in diameter, in which a thermal junction was placed. The mass was heated to 1000° C, and it was found that without the application of pressure recalescence occurred at 650° C, but when a load of 9 tons per square inch was applied, recalescence occurred at 620° C, and was comparatively feeble. The experiment, it need hardly be said, is one very difficult to make, and could only be done by those having command of special apparatus Other experiments were carried out, the result showing that the recalescence point is lowered by pressure, but it was found that the lowering was not affected, unless the load was applied at a temperature well above that at which recalescence takes place Experiments were made with Newton's alloy of bismuth, lead, and tin, the full results of which will be published at some future time In considering the whole scope of the report, the author said that it might be asked what evidence had been gathered as to the mode of action of added elements, and whether it appeared that the atomic volume of the added element had a dominating influence on the mechanical properties of the mass in which it is hidden? The true action of an added element, the author pointed out, may readily be masked by its action as a deoxidiser Notwithstanding these difficulties, it is undoubtedly proved that bismuth, potassium, and tellurium, all of which have atomic volumes, greatly lower the tenacity of copper Arsenic, which has a larger atomic value (13 2) than copper (7 1) confers strength on copper, but it is very certain that the limit of elasticity, and the ductility of a metal are greatly influenced by the presence of an element with large atomic volumes This fact may be of more molecular significance than the diminution of tenacity, to which, for the sake of simplicity, attention was mainly directed, when the early experiments on gold were made

In the discussion which followed the reading of the paper a number of speakers took part The most important contribution was that of Dr Watson, of the Broughton Copper Company, who brought forward some practical experience to reinforce the deductions of the author Mr Arnold, of the Technical Schools, Cambridge, read a very long manuscript, which it would be rash on our part to attempt to abstract, and which we cannot afford the space to give in full Mr Hadfield, of Sheffield, questioned the accuracy of the beta form of iron theory promulgated by Osmond and adopted by the author The point is one of considerable importance, but requires a wide field for its discussion

On the whole it cannot be doubted that the report is a most valuable contribution to the scientific knowledge at the command of the engineer, and were the attention called to the action of bismuth on copper its sole result, the labours of the committee would not be without warrant

The summer meeting of the institution will be held this year at Middlesborough on August 1 and three following days

CONIFERS.[1]

THIS is a bulky volume of nearly 600 pages, and contains a vast amount of information. If the Royal Horticultural Society had published nothing but this since 1891 they would have amply satisfied those who are interested in conifers, and have keenly felt the want of such a book of reference as the one now under notice Some of the papers published in the report could have been omitted without loss, but on the whole the editors have done their work well In the preface they say, in sending out this memorial of the Conifer Conference, 1891, "we would draw attention to the fact that it contains far more than a mere verbal report of the conference, Dr Maxwell T. Masters, F.R.S., and Prof Carl Hansen, of Copenhagen, having promised at the time to recast their notes more fully This they have done most kindly, and with infinite labour and research, but not without some little expenditure of time, the final sheets of MS. having only come into our hands in July, and the corrections extending up to September 29

"The names adopted by Dr Masters and Prof Hansen may, of course, be relied upon as representing the latest decisions of botanical science in England and on the continent of Europe respectively, though future research may necessitate some still further slight alterations. However, the hitherto inextricably confused nomenclature of conifers may safely be described as settling down upon the lines adopted in this volume by these two eminent authorities, who, although not yet in absolute agreement, will be found to approach very nearly"

The list of conifers and taxads, by Dr Masters, is by far the most important contribution to the nomenclature and synonymy of conifers which has appeared since the publication of Parlatore's monograph in De Candolle's "Prodromus" in 1868, it is much more complete than Beissner's "Handbuch der Coniferen-Benennung," and the more recent "Handbuch der Nadelholzkunde," of the same author There seems no reason to doubt that Dr Masters's list will be used and followed by English systematists generally Dr Masters, in drawing up the list of genera, follows Bentham and Hooker's "Genera Plantarum" as the standard authority A few deviations from it have, however, been made in accordance with more recently obtained knowledge Pseudolarix is accorded generic rank (and not united with Larix, as in the "Genera Plantarum," whose authors had not seen male flowers), Keteleeria too, after a careful study of living material, has been separated from Abies and reinstated as a genus—Dr Masters's studies having on these points proved the justice and accuracy of Carrière's views The Chilian Prumnopitys is restored to generic rank, and separated from Podocarpus, with which it was united by Bentham and Hooker

The Pinetum Danicum of Prof Carl Hansen is unsatisfactory, and its omission from the report would have been desirable It is a somewhat ambitious performance, but in bulk is very largely made up of extracts from books and periodicals Many of the records are certainly useless, for instance, under *Pinus longifolia*, it is stated "one plant, however, exposed out of doors does not appear to have suffered", this Indian species is tropical in its requirements, and as it will not grow out of doors even in the south of England, it is in the highest degree improbable that it would, even under the most favourable conditions, exist in the open air in Denmark A curious mistake occurs on p 372, where the Viennese botanist, Prof Gunther Beck, Ritter von Mannagetta, figures as Prof Gunther, Knight of Beck von Managetta. On p 330 Prof Hansen remarks under Prumnopitys that its wood is much valued by "ebonists" He probably means cabinetmakers (ébenistes) *Tsuga hookeriana* and *T pattoniana* are kept up as distinct species by Hansen, but Prof C S Sargent, who is familiar with the two forms in their native habitats, has no hesitation in regarding them as specifically identical Hansen accords generic rank to Biota, Thuyopsis, and Chamæcyparis, the first and second being merged into Thuya, and the third into Cupressus by Dr Masters It is rather annoying to find the obsolete geographical expression "New Holland" constantly used by Hansen. New Holland and South-east Victoria are given as the native countries of one species

The coniferæ of Japan, by H J Veitch, is a valuable paper. From it we learn the somewhat startling fact that, in proportion to the area of the country, the flora of Japan contains more coniferous species than that of any other country in the world. Japan boasts of forty one species and thirteen genera, whereas in the whole of Europe there are but eighteen species and seven genera

A D Webster, "Conifers for Economic Planting" Mr Webster is a practical forester of wide experience, and he considers that out of all the conifers cultivated in Britain only sixteen can be utilised in an economic sense, or for truly profitable planting These are the larch, silver fir, Corsican pine, Douglas fir, *Pinus Strobus*, Scotch fir, *Thuya gigantea*, Spruce fir, Austrian pine, *Pinus Pinaster*, *Abies nordmanniana*, *Sequoia sempervirens*, *Cupressus macrocarpa* (or, as Mr Webster calls it, *C lambertiana*), *Cedrus atlantica*, *Pinus rigida*, and *Cupressus lawsoniana* The order in which these names are given represent the relative value of the trees as timber producers. Under each heading Mr. Webster gives valuable data as to rates of growth under different conditions as regards soil, elevation, &c.

In a compact paper of thirteen pages Mr. W Somerville gives a very good *résumé* of the present state of our knowledge of the quality of coniferous timber as affected by sylvicultural treatment Mr Somerville's remarks are sure to be perused with profit by landowners and foresters.

Mr. D. F. Mackenzie, on the timber of exotic conifers: uses and comparative value, contributes much valuable information Taking the value of Scotch fir timber at 100, the author calculates that of *Cupressus macrocarpa* at 190 and that of *C lambertiana* at 283; as these two names represent one and

[1] Report of the Conifer Conference, 1891 (issued November, 1892).

the same species, the widely different results are probably due to the trees furnishing the timber having been grown under different conditions Mr Mackenzie mentions a curious fact "observed in the working of the various pine timbers I have named. It was found that the wood of pines having three leaves in a sheath was, as a rule, much harder than those having only two, whilst all those having five leaves in a sheath were uniformly soft, and when dressed had a silky appearance So general is this characteristic that one could almost at once tell to what class a certain plank of pine timber belonged." These observations we do not remember to have seen previously recorded

"The Diseases of Conifers" Although in German there is a literature of considerable extent on this subject, the publications in English are few. Prof Marshall Ward is a very careful and competent observer, and his contribution to the report is of great value both to the man of science and to the practical forester

Mr W F H Blandford's insects injurious to conifers is an excellent *résumé* of all that is known up to date of the life history of the various insect pests, which have been noted as injurious to conifers How important this subject is may be judged by the destruction wrought by the larvæ of *Liparis monacha* between 1853 and 1868 in East Prussia, Poland, and Russia, where the spruce was killed over an area of 7000 square German miles A similar instance is that afforded in 1890 in the Bavarian forests by the same destructive insect, the loss caused by this to the revenue being estimated at £40,000 Those, however, who, like the writer of these notes, travelled over the districts affected during the ravages of the larvæ, would realise much more vividly the gravity of the attack than others could from a mere perusal of statistics

Not the least valuable portions of the report are the statistics of conifers in the British Islands, and the value in the British Islands of introduced conifers, by Mr Malcolm Dunn These statistics represent an enormous amount of energy and perseverance on the part of the compiler The tabulated forms give particulars from a large number of places in the British Islands, and deal with the soil, altitude, age of trees, their height, girth, &c The list of conifers and largest specimens, also by Mr Dunn, gives the dimensions of the largest specimens taken from the above mentioned tables and also the number of returns respecting each species G N

THE EARTHQUAKES IN ZANTE

LAST week we noted the fact that another disastrous earthquake had occurred in Zante on Monday, April 17, and that it had been followed by various slighter shocks. According to a special correspondent of the *Times* at the town of Zante, the centre of the disturbance seems to have been under the sea about two miles from land. Before the great shock the inhabitants of the district of Vasilikos, near this centre, heard submarine rumblings, which increased in loudness till the earthquake occurred Two huge boulders were detached from the neighbouring mountain and rolled into the valley beneath The same correspondent records that on the afternoon of April 21 there were several violent shocks

The conditions under which this series of earthquakes has occurred will no doubt be carefully studied Meanwhile we may call attention to a good article contributed to the *Mediterranean Naturalist* for April by Mr W G. Forster, seismologist, manager, and electrician, Eastern Telegraph, Zante, on the earthquakes which did so much damage in January From this paper we reprint the following historic statement —

"From the traditions of the place it has always been considered pretty certain that Zante must invariably expect a more or less severe earthquake about every thirty years. I find, however, that this cycle of seismic disturbances is common to all earthquake districts in south-eastern Europe and Asia Minor, and that there exists also a fairly proven and established law which governs these periods of visitation, for instance, whenever any long time has elapsed without the slight shocks—which average one or more a week in earthquake districts of non volcanic regions—and when to these periods of comparative quiescence succeeds one of constant earth tremors, then a disastrous shock is nearly certain to take place. This is a very important point, and cannot be neglected when the question as to the origin of the shocks is under consideration.

"The last strong local earthquake previous to the present series of shocks occurred on October 26, 1873, and although it was far less severe, it originated within a mile or so of the present one's centrum, as proven by a knot of submarine cable having been then lost, buried under the immense mass which fell into it, at the bottom of the sea; and by the measurements taken at the time

"This earthquake had precisely the same characteristics as the present one, both previously and subsequently to its occurrence, and although very many severe and slight shocks have been felt since 1873, in no case were they of so pronounced a local nature as those just recently experienced When the great earthquake of August 27, 1886, occurred, which destroyed Filiatra on the mainland to the south east of Zante, this island was fortunately outside the direct vibrative waves of seismic forces radiating from the centrum of that shock; which covered up six knots of submarine cable in latitude 37°25′, longitude 21°11′ east of Greenwich, but still it did considerable damage, and its force was severe enough to cause the greatest alarm even in so distant a place as Malta

"From that year until the spring of 1890 there were numbers of small shocks, but after then and up to August, 1892, only a very few tremors were recorded On August 16 last year about twelve small shocks suddenly occurred during the day, purely local, and all from east to west After three days of absolute tranquillity they began again, and although merely pulsations they were of a very pronounced character

"At midnight on August 27 the shock was strong, and from then until the still smarter shocks of September 3 and 5 the earth seemed always shaking Another few days of quiescence were followed by a renewal of shocks This state of things continued until the middle of January last—and was again succeeded by a fortnight of perfect tranquillity At 9 p.m. on January 30 a very distinct rumbling occurred, which was followed by a short, sharp shock, as if from some falling mass, and then all was still again I noticed after the shock a series of small ripples on the sea, which was previously and subsequently quite calm The night passed very quietly until 5 34 a m, local time, when the whole island began to sway terrifically from east to west, with a purely undulating motion, finishing up by a movement which I can only describe as being similar to that of some mighty force wrenching out the bowels of the earth This shock lasted twelve seconds, and its centre was undoubtedly in the sea very close to the town, and due east of the same From its apex of origin its range of destruction, on the frontage of the town, was not wider than two miles, spreading out to about fifteen when it reached the villages at the base of the range of hills, six miles off.

"The destructive force had a tendency to incline from due east to the north west of the island, which is about 27 miles in length by an average breadth of eight, a subsequent shock taking a much lower range During the whole day shocks were alarmingly frequent and numbered some hundreds between the first and nightfall when everybody went to the open ground in a most panicstricken condition At 1 56 a m on February 1 another terrific shock took place—not so severe as the first, but with a range towards the south west and of increasing destructive force This shock lasted 20 seconds and was also succeeded by numberless others After 23 hours a third severe shock occurred and periodically during the whole week others of decreasing intensity took place. Since the first shock until the present date, at least one thousand (including pulsations and tremors) have been felt

"Of course the direct and indirect damage has been very great owing to the extensive zone of destruction, the scattered nature of the villages and to the bad construction of the houses in general and to their dilapidated condition owing to extreme poverty of the island. At least half a million sterling is required to rebuild the place, and as this amount can never be realised many of the ruins are likely to remain untouched and most of the population will have to emigrate"

SCIENTIFIC SERIALS

American Journal of Mathematics, vol xv 1 (Baltimore: Johns Hopkins Press, January, 1893) —The pièce de résistance of this number is a memoir by Prof. Cayley on symmetric functions and seminvariants (pp. 1–74), in which the author further develops the theory of seminvariants, and in connection therewith is led to some investigations on symmetric functions. The subject is treated with characteristic ability and affords ample evidence of the writer's recovery from his recent serious

illness. Prof. Cayley also contributes some tables of pure reciprocants to the weight S (pp. 75–77) Two short notes follow on the differential equation, $\Delta u+k^2u=0$ by Maxime Bôcher (pp 78–83), and geometrical illustrations of some theorems in number by Ellery W Davis (pp 84–90, with a diagram) M. Halphen is the mathematician whose portrait is given with this opening number

Bulletin de l'Académie Royale de Belgique, No 3 (1893) — Among the scientific papers communicated to the Academy are the following On the common cause of surface tension and evaporation of liquids, by G. Van der Mensbrugghe. The author deduces from his theory an explanation of the fact that evaporation is more rapid from a convex, and less rapid from a concave, than from a plane surface.—Survival after the successive section of the two vagi, by M C Vanlair Survival after successive section of both the branches of the vagus nerve can be obtained in full-grown animals as well as in young ones The time necessary for the regeneration of its inferior laryngean branch is generally much longer than that hitherto accepted In the full-grown dog the period exceeds at least ten months The regeneration of one branch is quite independent of the section of the other The question whether the pneumogastric, like the sciatic nerve, possesses the power of regenerating itself twice in succession remains as yet unanswered It is, however, certain that an interval of six months and a half does not suffice for its second regeneration —On the digestion of the cœlenterata, by Marcelin Chapeaux The action of the ferments secreted by the actiniæ upon starch, cellulose, chlorophyll, and fat, was investigated. Starch submitted to the action of an aqueous solution of the ferments, or injected into the gastro-vascular cavity, was transformed into glucose The action was slow in the case of non-hydrated starch The transformation took place equally well in acid and in alkaline solutions Cellulose and chlorophyll were not digested The fats were emulsioned by the ferments contained in the endodermic cellules These ferments were without effect upon the algæ Among the Siphonophora digestion is certainly exclusively intracellular No dissociation of fibrine is, on the other hand, ever observed in the gastro-vascular cavity, and no difference could be established between the alkalinity of the liquid contained in this cavity and the surrounding sea-water —Contribution to the nitrogen question, by A Petermann This is an experimental confirmation of the results of MM Schlœsing fils and Laurent, showing that the nitrogen is absorbed from the air by the micro-organisms of the soil

SOCIETIES AND ACADEMIES.

LONDON

Royal Society, March 2.—"Harmonic Analysis of Hourly Observations of Air Temperature and Pressure at British Observatories," by Lieut -General R. Strachey, R.E, F R S

This paper is a discussion of the results of the computations contained in a volume recently published by the Meteorological Office, of the harmonic components of the first four orders, for each month for twenty years, of the daily curves of temperature and pressure at Greenwich; and for the first three orders, for the temperature and pressure, for each month for twelve years, at the seven observatories maintained by the Meteorological Office.

This system of analysis supplies the means of establishing an exact comparison between various unsymmetrical curves, such as those representing hourly values of temperature, by resolving them into symmetrical components, having periods of twenty-four hours, twelve hours, eight hours, and six hours, and so forth, and its application to the records dealt with in the tables contained in the volume above referred to gives satisfactory proof of the important light it can bring to bear on the periodical changes of diurnal temperature.

In the usual expression the coefficients of the cosines of the arcs are designated by the letter p, and those of the sines by q. The total amplitude of the component is designated by P.

A modification of the usual notation is made by the introduction of the value of the epoch of the first maximum that occurs after midnight, which is designated by the letter μ, and establishes the connexion of the component with the hour of the day and the sun's place more conveniently than the method usually adopted.

I *Greenwich Temperature*

The examination of the tables shows that, with very considerable variations of absolute magnitude, there is on the whole very marked consistency in the main characteristics of the components.

Taking as a test the position of the epoch of maximum, which is more directly dependent on the sun's action and on his position than the amplitude, it will be seen that the values of μ indicate very clearly the closeness of this connexion.

In all the components a truly periodical variation of the value of μ is apparent, and the period of maximum always travels backwards, that is, it becomes earlier as the year passes from winter to summer, while it returns in the opposite direction in the change back to winter

For the first component the variation of the five years' mean of μ from the twenty years is in no month more than $2\frac{1}{2}$°, or ten minutes of time, and the average for all months is less than half that amount

In the second component the variation of the five-year mean from the twenty-year mean is in no month more than 6°, and the average is only 2° 3, or nine minutes of time.

In the third component the variation of the five-year from the twenty-year mean in no month exceeds 5°, and the average in all months is only 2° 1, or $8\frac{1}{2}$ minutes of time

The largest variation of the five-year mean of the fourth component for any month from the twenty year mean is 10°, and the average for all months is 4° 3, or seventeen minutes. Considering how small are the absolute values of the coefficients p_4 and q_4, on which the value of μ_4 depends, the average being a little less than $\frac{1}{10}$th of a degree Fahrenheit, it is rather a matter of surprise that the variations should be so small than that they should reach their actual amounts

The component of the first order, which in the winter is more than double the magnitude of any of the others, and in summer more than ten times as great, gives the dominant character to the daily curves of temperature In the series of twenty years variations in different years of as much as 100 per cent are to be found for almost every month, but for the most part even these irregularities disappear in the mean of a series of five years, and the monthly means for the twenty years are remarkably consistent

The progression of the value of P, in the course of the year, follows approximately the sine of the sun's meridional altitude and the empirical formula

$$P = 10 \cos s - 0\ 91$$

gives a close approximation to the values shown in the tables, if a "lagging" of eight or ten days is allowed in reckoning the sun's place.

The second component has two clearly marked *maxima* about the time of the equinoxes, and a principal *minimum* at midsummer

The component of the third order varies in a converse manner, having two well-marked *minima* at the equinoxes, with a principal *maximum* at midsummer

The component of the fourth order appears to combine the characters of the two previous ones, having two *maxima* about the time of the equinoxes, and a principal *minimum* in the winter

The mean value of μ for the first component is 214°, corresponding to 2h 26m p.m., the variation due to season being 12° or 48m of time, by which the maximum is earlier in summer than in winter.

In the second order the first maximum in June is 24°, or 1h 20m. earlier than in January.

In the third order the difference in the same direction is 63°, or 4h. 12m. of time

In the fourth order there is some doubt as to the manner in which the change of epoch of the summer and winter maxima is brought about But remembering that the fourth component includes four series of undulations, the most probable explanation of these changes is to be found in a change of the position of these undulations, during which, between January and February, when the first maximum is about 10° after midnight, or 0h. 40m a.m, the first recedes, and its place is taken by the second, which leads to sudden appearance of a maximum about 60°, or 4 a.m A similar change between October and November in an opposite direction would reproduce the maximum at 10° after midnight.

In the summer months (May, June, and July) the temperature curve during the day hours, from 8 a.m. to 8 p.m., hardly differs from a curve of sines, the first component being more than ten times as large as any of the others, which therefore influence the temperature, relatively, very little.

The relation of the epoch of the first maximum of the component of the third order to the time of sunrise is decidedly marked, the former occurring, on the average, about 12°, or 48m. after sunrise; the mean deviation of the interval from that amount being only 7°, or 28m.

The periodical variation in the position of the maximum leads, during the winter months, to a *positive* maximum of this component about 1 p.m., which is combined with *negative* maxima four hours earlier and later, which correspond to the *reduced* temperature in the mornings and afternoons of the *shorter* days. In like manner, in the summer months, when this component has a negative *maximum* about 1 p.m., instead of a negative *minimum*, as in winter, there will be two *positive* maxima, one four hours earlier, the other four hours later, corresponding to the *higher* temperature in the mornings and afternoons of the *longer* days.

It will be seen that these positions of the midsummer and midwinter maximum phases correspond respectively to days of 16 hours with nights of 8 hours, or days of 8 hours and nights of 16 hours, and that at these seasons, when the variations of temperature, due to these differences, are greatest, the amplitudes of this component are also the greatest. At the equinoxes, with 12 hour days and nights, the component becomes a minimum; and at this season the change in the position of the maximum takes place as already noticed.

It might be supposed that an analogous relation between the fourth component and the occurrence of days of 18 hours, combined with nights of 6 hours, and *vice versâ*, is likely to arise. But the data are not forthcoming to test this.

In the summer months the time of mean temperature is nearly where the first component becomes zero, the second and third components then balancing one another.

In the winter the time of morning mean temperature is later than in summer, and occurs when a positive value of the first component is equal to a negative value of the second.

The time of afternoon mean temperature throughout the year is somewhat either before or after 7 p.m., and almost exactly coincides with the time when the first and second components are equal, with opposite signs.

In the summer the time of absolute minimum is between the hours of 3 a.m. and 6 a.m., during which the whole of the components are negative.

Sunrise in December is about an hour and a half before the time of mean temperature; while in June it is more than four hours earlier.

Sunset in December is rather more than three hours *before* the time of mean temperature; in June it is about half an hour *after* that time.

The *rationale* of some of the empirical rules for obtaining the mean daily temperature from a limited number of observations is supplied by reference to the harmonic expressions for the hourly deviations of temperature from the mean value.

In the first place, it will be seen that by adding together the harmonic expressions for any two hours twelve hours apart, the whole of the *odd* components disappear, and that the sum is twice the mean value, added to twice the sum of the *even* components of the selected hours, which are equal.

By taking the mean of observations at any four hours, at intervals of six hours, both the odd components and those of the second order will disappear, and the result will only differ from the true mean by the amount of the fourth component for the selected hours.

So, if the mean of any three hours at equal intervals of eight hours be taken, the sums of the first, second, and fourth components will disappear, and the result will only differ from the true mean by the amount of the third component for the selected hours, which in no case can be so much as ½°.

2. *Temperature at the Seven Observatories.*

The examination of the tables will show that in their main characteristics the results closely resemble those for Greenwich, and it will not be necessary to discuss them in any detail.

The amplitude of the component of the first order is, however, in all cases less than that observed at Greenwich, the lowest values being those for Valencia and Falmouth, no doubt due to their position on the sea coast, for which stations the means for the years are 2°·28 and 2°·35 compared with 5°·10 at Greenwich.

The Kew values most resemble those at Greenwich, but the mean maximum at Kew is more than 1° less, and the mean for the year ½° less.

The mean values of μ_1 for the seven observatories lie between 205° and 220°, that for Greenwich being 214°. The means of the summer values are about 3° or 4° less than the mean of the year, and of the winter values as much above it, as in the case of Greenwich.

The amplitude of the first component conforms approximately, but not so closely as at Greenwich, with the sine of the sun's meridian altitude, but with a flattening of the curve in the summer months, and a tendency at some of the stations to a maximum value in May.

The components of the second and third orders, beyond which the analysis is not carried for these observatories, conform in all important respects to those for Greenwich, the numerical values of the latter being, however, in all cases somewhat higher. The epochs of maximum follow the same laws, with an increased divergence of the summer epoch from that of the winter at the more northern stations.

In order to test, and in some degree throw light, on the character and significance of the harmonic components of temperature that have been under discussion, and bearing in mind that they cannot be considered to represent separate effects of physical forces operating at the assumed periods of the components, I have, at the suggestion of Prof. G. Darwin, calculated the harmonic components from a curve representing an intermittent heating action such as that of the sun, continued only during a portion of the day, and commencing and ending abruptly at sunrise and sunset.

All cooling effects have been disregarded, and the sun's direct heating action is assumed to be proportional to the sine of his altitude, the power of a vertical sun being taken to be 10. Having calculated the sun's altitude for each hour of the day, for midwinter, the equinox, and midsummer, for certain selected latitudes, the corresponding heating effects have been computed to which the usual method of analysis has been applied.

The comparison of the results thus obtained with the corresponding components derived from actual observation at places having nearly the same latitudes as those selected, establishes their close similarity, and the conclusion is unavoidable, that, although both in the actual and hypothetical cases the harmonic components when combined are truly representative of the peculiar forms of the curves from which they were derived, this affords no evidence of the existence of recurring cycles of action corresponding to the different components, but that the results are, to a great extent, due to the form of the analysis.

The diurnal curve of temperature is *not* symmetrical in relation to the mean value, the maximum day temperature being much more in excess than the minimum night temperature is in defect. To adjust the first component, which is symmetrical about its mean value, to the actual unsymmetrical curve, it must be modified by the other components. That of the second order, which has one of its maxima not far removed from the minimum of the first order, supplies the chief portion of the compensation due to this cause.

Further, from the character of the analysis, when the diurnal curve is symmetrical on either side of the hour half way between noon and midnight—that is, when the day and night are equal in length—the third component becomes zero. Any departure from this symmetry introduces a component of the third order, with the result that with a day shorter than 12 hours one maximum will fall in the day between 6 a.m. and 6 p.m., and the other two in the night between 6 p.m. and 6 a.m.; while with a day longer than 12 hours, two maxima will occur in the day and only one in the night. In the former case the negative portions of the component correspond with the reduced morning and afternoon temperatures of the short day, and in the latter the two positive phases correspond with the higher temperature of the mornings and afternoons of the longer day.

These conclusions are in conformity with those previously indicated.

The available data are insufficient to enable us to say whether the corresponding results connected with the fourth component are as fully supported by observation as in the case of the third, but the facts so far as they go confirm this view.

Anthropological Institute, April 11 —Prof A Macalister, President, in the chair —Mr G M Atkinson exhibited a cranium and several metal ornaments found by Mr A Michell Whitley and Dr Talfourd Jones in a grave at Birling, near Eastbourne, Sussex The peculiar coffin like shape of the skull seemed to point to its belonging to the early Saxon period, while the metal ornaments were assigned to the late Roman or immediately post Roman age —Mr R Duckworth read a paper on two skulls from Nagyr, recently added to the Cambridge University collection One of them is a female skull, and is remarkably dolichocephalic, the cephalic index being 69 94 The other skull is that of an adult male —Prof Macalister read a paper on Egyptian mummies He described the manner in which they were prepared, the unguents used by the Egyptians and the various cloths in which the mummies were rolled He explained the difference between the Egyptian cloths and those manufactured in England at the present day, and said that the object of using so few threads in the weaving was for the purpose of saving time and trouble The material at the same time was brought to a high state of perfection as a manufacture, and indeed might even compare with some of the finest linen productions at the present day Specimens of cloth were exhibited and the author stated, on the authority of a linen manufacturer, that there was only one specimen of linen manufacture in the United Kingdom which could be recognised as of similar structure to the Egyptian productions —A paper on Damma Island and its natives by P W Bassett Smith, R N, was also read.

Geological Society, April 12 —W H Hudleston, F R S, President, in the chair —The following communications were read —On some Palæozoic Ostracoda from Westmoreland, by Prof T Rupert Jones, F R S In 1865 the author determined for Prof Harkness some fossil Ostracoda which he had obtained from the Lower Silurian rocks of South East Cumberland and North-East Westmoreland, and subsequently other specimens mentioned by Harkness and Nicholson in 1872 In 1891 Prof Nicholson and Mr Marr submitted a series of similar microzoa from the same district, and the author now endeavours to determine their specific alliances, and revises the list of those previously collected He has to notice about eleven forms of *Primitia, Beyrichia, Ulrichia, Æchmina*, and *Cythere lla*—several of them being closely allied as varieties, but all worthy of study as biological groups, such as have been illustrated from other regions by writers on the Ostracoda, with the view of the exact determination, if possible, of species and genera, of their local and more distant or regional distribution, and of their range in time —On some Palæozoic Ostracoda from the Girvan district in Ayrshire, by Prof T. Rupert Jones, F R S This paper aims at the completion of the palæontological account of the Girvan district, so far as the Ostracoda are concerned, and follows up the researches indicated in the "Monograph of the Silurian Fossils of the Girvan District in Ayrshire," by Nicholson and Etheridge, vol 1, 1880 In about a dozen pieces of the fossiliferous shales, submitted for examination some few years ago, the writer finds nearly thirty specimens of *Primitia, Beyrichia, Ulrichia, Sulcuna*, and *Cypridina* which show interesting gradations of form, not always easy to be defined as specific or even varietal, but valuable as illustrating modifications during the life-history of individuals, thus often leading to permanent characteristics of species and genera Like those formerly described in Nicholson and Etheridge's "Monograph," the specimens have all been collected by Mrs Elizabeth Gray, of Edinburgh.—The reading of these papers was followed by a discussion, in which the President, Mr Marr, and the author took part —On the dwindling and disappearance of limestones, by Frank Rutley The existence of chert between two sheets of eruptive rocks at Mullion Island seemed to the author to require some explanation Cherts are usually associated with limestones, and the absence of limestones in many cases where cherts are found points to their removal by underground waters The older the limestone the greater the probability of its thick beds having dwindled The thicknesses of the Ordovician, Silurian, Devonian, and Carboniferous Limestones seem to be in the ratio of 1 15 15 100 Many limestones once existing in Archæan rocks may have disappeared, as also limestones in later rocks. The author comments on the difficulty of distinguishing some cherty rocks from felstones Two appendices are added to the paper, the first on the transference of lime from older to newer deposits, and the second on the formation of nodular limestone bands —This paper gave rise to a discussion in which the President, Prof Hull, Mr Walford, Prof Judd, General McMahon, Prof T R Jones, Prof Hughes, Mr H W Monckton, Dr G H Hinde, and the author took part —On some Bryozoa from the Inferior Oolite of Shipton Gorge, Dorset, Part II, by Edwin A Walford

Royal Meteorological Society, April 19 —Dr C Theodore Williams, President, in the chair —The following papers were read —The direction of the wind over the British Isles, 1876-80, by Mr F C Bayard This is a reduction on an uniform plan of the observations made twice a day, mostly at 9 a m and 9 p m, at seventy stations during the lustrum 1876–80, and the results are given in tables of monthly and yearly percentages —Notes on two photographs of lightning taken at Sydney Observatory, December 7, 1892, by Mr H C Russell, F R S These photographs were taken with a half-plate view lens, mounted in a whole plate camera, and, as a matter of course, there is some distortion at the edges Both photographs show the gaslights in the streets as white specks, the specks being circular in the centre and crescent-shaped in other parts of the plate owing to distortion The lightning flashes are also distorted. Mr Russell believes that this distortion may account for the so called "ribbon" flashes, which are seen in many photographs of lightning He has also made some measurements of the length and distance of the flashes, and of the intensity of the light —Notes on lightning discharges in the neighbourhood of Bristol, 1892, by Dr E H Cook The author gives some particulars concerning two trees in Tyntesfield Park, which were struck by lightning, one on June 1 and the other on July 18, and also some notes concerning a flagstaff on the summit of Brandon Hill, which was struck on October 6 —Constructive errors in some hygrometers, by Mr W W. Midgley The author, in making an investigation into the hygrometrical condition of a number of cotton mills in the Bolton district, found that the mounting of the thermometers and the position of the water receptacle did not by any means conform to the regulations of the Royal Meteorological Society, and were so arranged that they gave the humidity results much too high The Cotton Factories Act of 1889 prescribes the maximum weight of vapour per cubic foot of air at certain temperatures; and the author points out that if the instruments for determining the amount present in the mills have an error of 20 per cent against the interests of the manufacturer, it is necessary that the makers of the mill hygrometers should adopt the Royal Meteorological Society's pattern for the purpose

PARIS

Academy of Sciences, April 17 —M Lœwy in the chair —Note on the observation of the partial eclipse of the sun of April 16, 1893, by M F Tisserand —On the observation of the total eclipse of the 16th inst, by M J Janssen —Effects of the drought upon this year's crops, reply to M Demontzey's note on the planting of the highlands, by M Chambrelent —Expansion of water at constant pressure and at constant volume, by M E. H Amagat At pressures higher than 200 atmospheres water has no maximum density above zero At the lower temperatures, contrary to what takes place in the case of other liquids, the coefficient of expansion increases with the pressure This increase is gradually effaced as the temperature rises, is sensibly zero at 50° or 60°, and changes sign for higher temperatures If water is kept at a constant volume the pressure increases rapidly with the temperature Thus, for unit volume the coefficient of pressure increases fourfold between 10° and 100°, and the variation is proportionately even more rapid between 0° and 10° —On the structure of simple finite and continued groups, by M Cartan —On a simple group with fourteen parameters, by M F Engel —Demonstration of the transcendental nature of the number *e*, by M. Adolf Hurwitz.—Comparison of the international meter with the wave-length of cadmium light, by M. Albert A Michelson.—Photography of gratings engraved upon metal, by M. Izarn It is possible to reproduce opaque gratings engraved upon metal in a manner analogous to the reproduction of transparent ones already described On covering such a grating with a layer of bichromated gelatine, and exposing to the sun through this layer, a grating effect is produced which, although rather feeble, is due to successive differences of structure corresponding to the rulings. These differences of structure are probably due to stationary reflected waves, and

need not necessarily be alternations of transparency and opacity in order to produce the desired effect. Very close contact between the film and the grating is essential —On atmospheric polarisation, by M. A Hurion —Researches on the higher alcohols and other impurities in vinic alcohol, by M Emile Gossart —On the general relations which exist between the coefficients in the fundamental laws of electricity and magnetism, by M E Mercadier —On the reflection of electric waves at the end of a linear conductor, by M Birkeland —Multiplication of the number of periods of sinusoidal currents, by M Désiré Korda —On the hygroscopic properties of several textile fabrics, by M Th Schlœsing fils —Contribution to the study of the Leclanché cell, by M A Ditte —Attempt at a general method of chemical synthesis, formation of nitrogen compounds, by M Raoul Pictet —On the stereochemistry of the malic compounds, and the variation of the rotatory power of liquids, by M Albert Colson —On a chlorobromide of iron, by M Lenormand —On the saccharates of lime, by M Petit —On a new soluble ferment doubling trehalose into glucose, by M Em Bourquelot —On the circulatory apparatus of *Mygale Cæmentaria*, Walck, by M Marcel Causard —Influence of the pressure of gases upon the development of vegetables, by M Paul Jaccard —On the ammonite layers of the inferior Malm in the county of Montejunta, Portugal, little known phases in the development of the mollusca, by M Paul Choffat —On the mode of reproduction of the parasites of cancer, by MM Armand Ruffer and H G Plimmer —M Lippmann presented to the Academy, in the names of MM Auguste and Louis Lumiere, coloured photographs obtained by the interference method

BERLIN

Physical Society, March 10 —Prof Kundt, President, in the chair —The President gave an account of some researches undertaken as an introduction to the study of Hall's phenomenon As is well known, this is directly proportional to the intensity of the primary current, but inversely proportional to the pressure of the plates, on the other hand, it is not strictly proportional to the magnetising current in the case of the several metals so far examined, and it appeared probable that it might more possibly be proportional rather to the magnetisation of the plate Prof Kundt wished to test this possibility in the case of iron, nickel, and cobalt, employing transparent metallic films of these metals magnetised to 28,000 units, whose magnetisation could be tested directly by means of their rotatory power It was found that the Hall effect increased hand in hand with the increase of rotatory power, and therefore proportionally to the magnetisation of the plates The effect was, as Hall had already shown, positive in the case of iron and cobalt, negative in that of nickel Bismuth deposited electrolytically in a transparent film gave very feeble or no results, whereas, when drawn out into a thin plate the effect was considerable.—Dr Wren spoke on Maxwell's proposition that waves of light exert pressure in the direction of their transmission, as proved in a certain case by Boltzmann. He deduced, under certain assumptions, a formula for the calculation of temperature based upon a determination of maximal energy

AMSTERDAM.

Royal Academy of Sciences, March 25 —Prof van de Sande Bakhuysen in the chair —Mr Pekelharing spoke of the peptone of Kuhne Some years ago he argued there was not a real difference between the substances called pept ne, and the substance called propeptone or hemialbumose The researches of Kuhne and his disciples afterwards proved that what was called peptone by Schmidt-Mülheim and by Salkowski, contained albumose. But it was not proved by Kühne that the substance called by himself peptone was really free from albumose Out of a solution of Kühne's peptone, saturated with ammoniumsulphate, there can be precipitated by metaphosphoric acid, and more fully by trichloracetic acid, a substance which has the properties of albumose It gives the biuretreaction, it is precipitated, the reaction may be acid, neutral, or alkaline, by ammoniumsulphate, it is precipitated by picrinic acid, and, in acid solution, by saturation with natriumchlorid So it is clear that there is no ground for believing with Kuhne that the substance called by him peptone is a substance *sui generis*, and not an impure albumose —Mr Bakhuis Roozeboom dealt with the cryohydrates in systems of two salts. Three cases are to be considered. The first is that the two salts may exist without combination. Then there is a cryohydratic point in which the two salts A and B exist with ice next the solution This point is a *minimum temperature*. Besides, there are two cryohydratic lines, representing the series of solutions which may exist with ice and A or ice and B as solids In the other cases when A and B form a double salt D, there are two cryohydratic points, one for the solution in equilibrium with ice + D + A, the other for ice + D + B, and three cryohydratic lines for the solutions in equilibrium with ice + D, ice + A, ice + B When the double salt is soluble without decomposition, the two cryohydratic points are both minimum temperatures, and therefore there must exist a maximum temperature on the line for ice + D, this maximum relates to the solution which presents the same relation A/B as in the double salt All these conclusions may be deduced from thermodynamical rules, they were confirmed in experimental research by Mr Schreinemakers

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—Carlsbad, a Medico-Practical Guide Dr E Kleen (Putnam) —Louis Agassiz, his Life and Work Dr Holder (Putnam).—Die Natürliche Auslese beim Menschen O Ammon (Jena, Fischer).—Public Health Laboratory Work H R Kenwood (Lewis) —Annual Statement of Works carried out by Public Works Department (Sydney, Potter).—The Principles of Agriculture G Fletcher (Derby, Central Educational Company).—Science et Religion T H Huxley (Paris, Baillière) —Au Bord de la Mer Dr E L Trouessart (Paris, Baillière) —Conférences Scientifiques et Allocutions—Constitution de la Matière Lord Kelvin. Traduites et Annotées sur la Deuxième Edition P Lugol and M Brillouin (Paris, Gauthier-Villars).—Premiers Principes d'Électricité Industrielle P Janet (Paris, Gauthier-Villars) —The Great Barrier Reef of Australia W Saville-Kent (W H Allen)

PAMPHLETS —Meteorological Results deduced from Observations taken at the Liverpool Observatory during the Years 1889, 1890 1891 (Liverpool) —On the Effects of Urban Fog upon Cultivated Plants Prof F W Oliver (Spottiswoode) —The Fundamental Hypotheses of Abstract Dynamics Prof J G MacGregor —Il Clima di Torino G B Rizzo (Torino, Clausen) —On the Application of Interference Methods to Spectroscopic Measurements A A Michelson (Washington, Smithsonian Institution).—Recreation W Odell (Torquay Iredale)

SERIALS —Journal of the Chemical Society, April (Gurney and Jackson).—Annalen des k k Naturhistorischen Hofmuseums, Band viii No. 1 (Wien, Holder) —Timehri No xxii (Stanford) —Notes from the Leyden Museum, vol xv No 2 (Leyden, Brill) —L'Anthropologie, tome iv No. 1 (Paris, Masson) —Journal of the Royal Microscopical Society, April (Williams and Norgate) —The Asclepiad, No 37, vol x (Longmans).—Records of the Geological Survey of India, vol xxvi Part 1 (Calcutta).

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